



Standard ECMA-402
7th Edition / June 2020

**ECMAScript[®] 2020
Internationalization
API Specification**

Standard

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ECMAScript® 2020 Internationalization API Specification



Contributing to this Specification

This specification is developed on GitHub with the help of the ECMAScript community. There are a number of ways to contribute to the development of this specification:

GitHub Repository: <https://github.com/tc39/ecma402>

Issues: [All Issues](#), [File a New Issue](#)

Pull Requests: [All Pull Requests](#), [Create a New Pull Request](#)

Test Suite: [Test262](#)

TC39-TG2:

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Community:

- Mailing list: [es-discuss](#)
- IRC: [#tc39](#) on [freenode](#)
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Refer to the [colophon](#) for more information on how this document is created.

Introduction

This specification's source can be found at <https://github.com/tc39/ecma402>.

The ECMAScript 2020 Internationalization API Specification (ECMA-402 7th Edition), provides key language sensitive functionality as a complement to the ECMAScript 2020 Language Specification (ECMA-262 11th Edition or successor). Its functionality has been selected from that of well-established internationalization APIs such as those of the Internationalization Components for Unicode (ICU) library, of the .NET framework, or of the Java platform.

The 1st Edition API was developed by an ad-hoc group established by Ecma TC39 in September 2010 based on a proposal by Nebojša Ćirić and Jungshik Shin.

The 2nd Edition API was adopted by the General Assembly of June 2015, as a complement to the ECMAScript 6th Edition.

The 3rd Edition API was the first edition released under Ecma TC39's new yearly release cadence and open development process. A plain-text source document was built from the ECMA-402 source document to serve as the base for further

development entirely on GitHub. Over the year of this standard's development, dozens of pull requests and issues were filed representing several of bug fixes, editorial fixes and other improvements. Additionally, numerous software tools were developed to aid in this effort including Ecmakup, Ecmardown, and Grammarkdown.

Dozens of individuals representing many organizations have made very significant contributions within Ecma TC39 to the development of this edition and to the prior editions. In addition, a vibrant community has emerged supporting TC39's ECMAScript efforts. This community has reviewed numerous drafts, filed dozens of bug reports, performed implementation experiments, contributed test suites, and educated the world-wide developer community about ECMAScript Internationalization. Unfortunately, it is impossible to identify and acknowledge every person and organization who has contributed to this effort.

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1 Scope

This Standard defines the application programming interface for ECMAScript objects that support programs that need to adapt to the linguistic and cultural conventions used by different human languages and countries.

2 Conformance

A conforming implementation of the ECMAScript 2020 Internationalization API Specification must conform to the ECMAScript 2020 Language Specification (ECMA-262 11th Edition, or successor), and must provide and support all the objects, properties, functions, and program semantics described in this specification.

A conforming implementation of the ECMAScript 2020 Internationalization API Specification is permitted to provide additional objects, properties, and functions beyond those described in this specification. In particular, a conforming implementation of the ECMAScript 2020 Internationalization API Specification is permitted to provide properties not described in this specification, and values for those properties, for objects that are described in this specification. A conforming implementation is not permitted to add optional arguments to the functions defined in this specification.

A conforming implementation is permitted to accept additional values, and then have implementation-defined behaviour instead of throwing a **RangeError**, for the following properties of *options* arguments:

- The *options* property "**localeMatcher**" in all constructors and **supportedLocalesOf** methods.
- The *options* properties "**usage**" and "**sensitivity**" in the Collator **constructor**.
- The *options* properties "**style**" and "**currencyDisplay**" in the NumberFormat **constructor**.
- The *options* properties "**minimumIntegerDigits**", "**minimumFractionDigits**", "**maximumFractionDigits**", "**minimumSignificantDigits**", and "**maximumSignificantDigits**" in the NumberFormat **constructor**, provided that the additional values are interpreted as **integer** values higher than the specified limits.
- The *options* properties listed in **Table 6** in the DateTimeFormat **constructor**.

- The *options* property "formatMatcher" in the `DateTimeFormat` constructor.
- The *options* property "type" in the `PluralRules` constructor.

3 Normative References

The following referenced documents are required for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ECMAScript 2020 Language Specification (ECMA-262 11th Edition, or successor).

<https://www.ecma-international.org/publications/standards/Ecma-262.htm>

NOTE Throughout this document, the phrase "ES2020, *x*" (where *x* is a sequence of numbers separated by periods) may be used as shorthand for "ECMAScript 2020 Language Specification (ECMA-262 11th Edition, sub clause *x*)".

- ISO/IEC 10646:2014: Information Technology – Universal Multiple-Octet Coded Character Set (UCS) plus Amendment 1:2015 and Amendment 2, plus additional amendments and corrigenda, or successor
 - https://www.iso.org/iso/catalogue_detail.htm?csnumber=63182
 - https://www.iso.org/iso/catalogue_detail.htm?csnumber=65047
 - https://www.iso.org/iso/catalogue_detail.htm?csnumber=66791
- ISO 4217:2015, Codes for the representation of currencies and funds, or successor
- IETF RFC 4647, Matching of Language Tags, or successor
- IANA Time Zone Database
- The Unicode Standard
- Unicode Technical Standard 35
 - Unicode Locale Data Markup Language
 - Unicode BCP 47 Locale Identifiers

4 Overview

This section contains a non-normative overview of the ECMAScript 2020 Internationalization API Specification.

4.1 Internationalization, Localization, and Globalization

Internationalization of software means designing it such that it supports or can be easily adapted to support the needs of users speaking different languages and having different cultural expectations, and enables worldwide communication between them. Localization then is the actual adaptation to a specific language and culture. Globalization of software is commonly understood to be the combination of internationalization and localization. Globalization starts at the lowest level by using a text representation that supports all languages in the world, and using standard identifiers to identify languages, countries, time zones, and other relevant parameters. It continues with using a user interface language and data presentation that the user understands, and finally often requires product-specific adaptations to the user's language, culture, and environment.

The ECMAScript 2020 Language Specification lays the foundation by using Unicode for text representation and by providing a few language-sensitive functions, but gives applications little control over the behaviour of these functions. The ECMAScript 2020 Internationalization API Specification builds on this by providing a set of customizable language-sensitive functionality. The API is useful even for applications that themselves are not internationalized, as even applications targeting only one language and one region need to properly support that one language and region. However, the API also enables applications that support multiple languages and regions, even concurrently, as may be needed in server environments.

4.2 API Overview

The ECMAScript 2020 Internationalization API Specification is designed to complement the ECMAScript 2020 Language Specification by providing key language-sensitive functionality. The API can be added to an implementation of the ECMAScript 2020 Language Specification (ECMA-262 11th Edition, or successor).

The ECMAScript 2020 Internationalization API Specification provides several key pieces of language-sensitive functionality that are required in most applications: String comparison (collation), number formatting, date and time formatting, pluralization rules, and case conversion. While the ECMAScript 2020 Language Specification provides functions for this basic functionality (on Array.prototype: toLocaleString; on String.prototype: localeCompare, toLocaleLowerCase, toLocaleUpperCase; on Number.prototype: toLocaleString; on Date.prototype: toLocaleString, toLocaleDateString, and toLocaleTimeString), it leaves the actual behaviour of these functions largely up to implementations to define. The ECMAScript 2020 Internationalization API Specification provides additional functionality, control over the language and over details of the behaviour to be used, and a more complete specification of required functionality.

Applications can use the API in two ways:

1. Directly, by using the constructors Intl.Collator, Intl.NumberFormat, Intl.DateTimeFormat, or Intl.PluralRules to construct an object, specifying a list of preferred languages and options to configure the behaviour of the resulting object. The object then provides a main function (compare, select, or format), which can be called repeatedly. It also provides a resolvedOptions function, which the application can use to find out the exact configuration of the object.
2. Indirectly, by using the functions of the ECMAScript 2020 Language Specification mentioned above. The collation and formatting functions are respecified in this specification to accept the same arguments as the Collator, NumberFormat, and DateTimeFormat constructors and produce the same results as their compare or format methods. The case conversion functions are respecified to accept a list of preferred languages.

The Intl object is used to package all functionality defined in the ECMAScript 2020 Internationalization API Specification to avoid name collisions.

4.3 Implementation Dependencies

Due to the nature of internationalization, the API specification has to leave several details implementation dependent:

- *The set of locales that an implementation supports with adequate localizations:* Linguists estimate the number of human languages to around 6000, and the more widely spoken ones have variations based on regions or other parameters. Even large locale data collections, such as the Common Locale Data Repository, cover only a subset of this large set. Implementations targeting resource-constrained devices may have to further reduce the subset.
- *The exact form of localizations such as format patterns:* In many cases locale-dependent conventions are not standardized, so different forms may exist side by side, or they vary over time. Different internationalization libraries may have implemented different forms, without any of them being actually wrong. In order to allow this API to be implemented on top of existing libraries, such variations have to be permitted.
- *Subsets of Unicode:* Some operations, such as collation, operate on strings that can include characters from the entire Unicode character set. However, both the Unicode standard and the ECMAScript standard allow implementations to limit their functionality to subsets of the Unicode character set. In addition, locale conventions typically don't specify the desired behaviour for the entire Unicode character set, but only for those characters that are relevant for the locale. While the Unicode Collation Algorithm combines a default collation order for the entire Unicode character set with the ability to tailor for local conventions, subsets and tailorings still result in differences in behaviour.

4.3.1 Compatibility across implementations

ECMA 402 describes the schema of the data used by its functions. The data contained inside is implementation-dependent, and expected to change over time and vary between implementations. The variation is visible by programmers, and it is possible to construct programs which will depend on a particular output. However, this specification attempts to describe reasonable constraints which will allow well-written programs to function across implementations. Implementations are encouraged to continue their efforts to harmonize linguistic data.

5 Notational Conventions

This standard uses a subset of the notational conventions of the ECMAScript 2020 Language Specification (ECMA-262 11th Edition), as ES2020:

- Object Internal Methods and Internal Slots, as described in ES2020, 6.1.7.2.
- Algorithm conventions, as described in ES2020, 5.2, and the use of **abstract operations**, as described in ES2020, 7.1, 7.2, 7.3.
- Internal Slots, as described in ES2020, 9.1.
- The **List** and **Record** Specification Type, as described in ES2020, 6.2.1.

NOTE As described in the ECMAScript Language Specification, algorithms are used to precisely specify the required semantics of ECMAScript constructs, but are not intended to imply the use of any specific implementation technique. Internal slots are used to define the semantics of object values, but are not part of the API. They are defined purely for expository purposes. An implementation of the API must behave as if it produced and operated upon internal slots in the manner described here.

As an extension to the **Record** Specification Type, the notation “[[<name>]]” denotes a field whose name is given by the variable *name*, which must have a String value. For example, if a variable *s* has the value “a”, then [[<*s*>]] denotes the field [[a]].

This specification uses blocks demarcated as Normative Optional to denote the sense of **Annex B** in ECMA 262. That is, normative optional sections are required when the ECMAScript host is a web browser. The content of the section is normative but optional if the ECMAScript host is not a web browser.

5.1 Well-Known Intrinsic Objects

The following table extends the Well-Known Intrinsic Objects table defined in ES2020, 6.1.7.4.

Table 1: Well-known Intrinsic Objects (Extensions)

Intrinsic Name	Global Name	ECMAScript Language Association
<code>%Collator%</code>	Intl.Collator	The Intl.Collator constructor (11.1)
<code>%CollatorPrototype%</code>	Intl.Collator.prototype	The initial value of the "prototype" data property of the intrinsic <code>%Collator%</code> (11.2.1).
<code>%Date_now%</code>	Date.now	The initial value of the "now" data property of the intrinsic <code>%Date%</code> (ES2020, 20.4.3.1)
<code>%DateTimeFormat%</code>	Intl.DateTimeFormat	The Intl.DateTimeFormat constructor (13.2).
<code>%DateTimeFormatPrototype%</code>	Intl.DateTimeFormat.prototype	The initial value of the "prototype" data property of the intrinsic <code>%DateTimeFormat%</code> (13.3.1).
<code>%Intl%</code>	Intl	The Intl object (8).
<code>%Locale%</code>	Intl.Locale	The Intl.Locale constructor (10.1).
<code>%LocalePrototype%</code>	Intl.Locale.prototype	The initial value of the prototype data property of the intrinsic <code>%Locale%</code> (10.2.1).
<code>%NumberFormat%</code>	Intl.NumberFormat	The Intl.NumberFormat constructor (12.2)
<code>%NumberFormatPrototype%</code>	Intl.NumberFormat.prototype	The initial value of the "prototype" data property of the intrinsic <code>%NumberFormat%</code> (12.3.1).
<code>%PluralRules%</code>	Intl.PluralRules	The Intl.PluralRules constructor (15.2).
<code>%PluralRulesPrototype%</code>	Intl.PluralRules.prototype	The initial value of the "prototype" data property of the intrinsic <code>%PluralRules%</code> (15.3.1).
<code>%RelativeTimeFormat%</code>	Intl.RelativeTimeFormat	The Intl.RelativeTimeFormat constructor (14.2).
<code>%RelativeTimeFormatPrototype%</code>	Intl.RelativeTimeFormat.prototype	The initial value of the prototype data property of the intrinsic <code>%RelativeTimeFormat%</code> (14.3.1).
<code>%StringProto_indexOf%</code>	String.prototype.indexOf	The initial value of the "indexOf" data property of the intrinsic <code>%StringPrototype%</code> (ES2020, 21.1.3.8)

6 Identification of Locales, Currencies, Time Zones, and Measurement Units

This clause describes the String values used in the ECMAScript 2020 Internationalization API Specification to identify locales, currencies, time zones, and measurement units.

6.1 Case Sensitivity and Case Mapping

The String values used to identify locales, currencies, and time zones are interpreted in a case-insensitive manner, treating the Unicode Basic Latin characters "A" to "Z" (U+0041 to U+005A) as equivalent to the corresponding Basic Latin characters "a" to "z" (U+0061 to U+007A). No other case folding equivalences are applied. When mapping to upper case, a mapping shall be used that maps characters in the range "a" to "z" (U+0061 to U+007A) to the corresponding characters in the range "A" to "Z" (U+0041 to U+005A) and maps no other characters to the latter range.

EXAMPLES "ß" (U+00DF) must not match or be mapped to "SS" (U+0053, U+0053). "ı" (U+0131) must not match or be mapped to "I" (U+0049).

6.2 Language Tags

The ECMAScript 2020 Internationalization API Specification identifies locales using Unicode BCP 47 locale identifiers as defined by [Unicode Technical Standard #35 LDML § 3 Unicode Language and Locale Identifiers](#), which may include extensions such as the [Unicode BCP 47 U Extension](#). Their canonical form is specified in [Unicode Technical Standard #35 LDML § 3.2.1 Canonical Unicode Locale Identifiers](#).

Unicode BCP 47 locale identifiers are structurally valid when they match those syntactical formatting criteria of Unicode Technical Standard 35, section 3.2, but it is not required to validate them according to the Unicode validation data. All structurally valid language tags are valid for use with the APIs defined by this standard. However, the set of locales and thus language tags that an implementation supports with adequate localizations is implementation dependent. The constructors Collator, NumberFormat, DateTimeFormat, and PluralRules map the language tags used in requests to locales supported by their respective implementations.

6.2.1 Unicode Locale Extension Sequences

This standard uses the term "*Unicode locale extension sequence*" - as described in [unicode_locale_extensions](#) in UTS 35 Unicode Locale Identifier, section 3.2 - for any substring of a language tag that is not part of a private use subtag sequence, starts with a separator "-" and the singleton "u", and includes the maximum sequence of following non-singleton subtags and their preceding "-" separators.

6.2.2 IsStructurallyValidLanguageTag (*locale*)

The IsStructurallyValidLanguageTag abstract operation verifies that the *locale* argument (which must be a String value)

- represents a well-formed "Unicode BCP 47 locale identifier" as specified in [Unicode Technical Standard 35 section 3.2](#),
- does not include duplicate variant subtags, and
- does not include duplicate singleton subtags.

The abstract operation returns true if *locale* can be generated from the EBNF grammar in section 3.2 of the Unicode Technical Standard 35, starting with [unicode_locale_id](#), and does not contain duplicate variant or singleton subtags (other than as a private use subtag). It returns false otherwise. Terminal value characters in the grammar are interpreted as the Unicode equivalents of the ASCII octet values given.

6.2.3 CanonicalizeUnicodeLocaleId (*locale*)

The CanonicalizeUnicodeLocaleId abstract operation returns the canonical and case-regularized form of the *locale* argument (which must be a String value that is a structurally valid Unicode BCP 47 locale identifier as verified by the [IsStructurallyValidLanguageTag](#) abstract operation). The following steps are taken:

1. Let *localeId* be the string *locale* after performing the algorithm to transform it to canonical syntax per [Unicode Technical Standard #35 LDML § 3.2.1 Canonical Unicode Locale Identifiers](#). (The result is a Unicode BCP 47 locale identifier, in canonical syntax but not necessarily in canonical form.)
2. Let *localeId* be the string *localeId* after performing the algorithm to [transform it to canonical form](#). (The result is a Unicode BCP 47 locale identifier, in both canonical syntax and canonical form.)
3. If *localeId* contains a substring *extension* that is a [Unicode locale extension sequence](#), then
 - a. Let *components* be ![UnicodeExtensionComponents](#)(*extension*).
 - b. Let *attributes* be *components*.[[Attributes]].
 - c. Let *keywords* be *components*.[[Keywords]].
 - d. Let *newExtension* be "u".
 - e. For each element *attr* of *attributes* in [List](#) order, do
 - i. Append "-" to *newExtension*.
 - ii. Append *attr* to *newExtension*.
 - f. For each element *keyword* of *keywords* in [List](#) order, do
 - i. Append "-" to *newExtension*.
 - ii. Append *keyword*.[[Key]] to *newExtension*.
 - iii. If *keyword*.[[Value]] is not the empty String, then
 1. Append "-" to *newExtension*.
 2. Append *keyword*.[[Value]] to *newExtension*.
 - g. **Assert:** *newExtension* is not equal to "u".
 - h. Let *localeId* be *localeId* with the substring corresponding to *extension* replaced by the string *newExtension*.
4. Return *localeId*.

NOTE The third step of this algorithm ensures that a [Unicode locale extension sequence](#) in the returned language tag contains:

- only the first instance of any attribute duplicated in the input, and
- only the first [keyword](#) for a given key in the input.

6.2.4 DefaultLocale ()

The DefaultLocale abstract operation returns a String value representing the structurally valid (6.2.2) and canonicalized (6.2.3) Unicode BCP 47 locale identifier for the host environment's current locale.

6.3 Currency Codes

The ECMAScript 2020 Internationalization API Specification identifies currencies using 3-letter currency codes as defined by ISO 4217. Their canonical form is upper case.

All well-formed 3-letter ISO 4217 currency codes are allowed. However, the set of combinations of currency code and language tag for which localized currency symbols are available is implementation dependent. Where a localized currency symbol is not available, the ISO 4217 currency code is used for formatting.

6.3.1 IsWellFormedCurrencyCode (*currency*)

The IsWellFormedCurrencyCode abstract operation verifies that the *currency* argument (which must be a String value) represents a well-formed 3-letter ISO currency code. The following steps are taken:

1. Let *normalized* be the result of mapping *currency* to upper case as described in 6.1.
2. If the number of elements in *normalized* is not 3, return **false**.
3. If *normalized* contains any character that is not in the range "A" to "Z" (U+0041 to U+005A), return **false**.
4. Return **true**.

6.4 Time Zone Names

The ECMAScript 2020 Internationalization API Specification identifies time zones using the Zone and Link names of the IANA Time Zone Database. Their canonical form is the corresponding Zone name in the casing used in the IANA Time Zone Database.

All registered Zone and Link names are allowed. Implementations must recognize all such names, and use best available current and historical information about their offsets from UTC and their daylight saving time rules in calculations. However, the set of combinations of time zone name and language tag for which localized time zone names are available is implementation dependent.

6.4.1 IsValidTimeZoneName (*timeZone*)

The IsValidTimeZoneName abstract operation verifies that the *timeZone* argument (which must be a String value) represents a valid Zone or Link name of the IANA Time Zone Database.

The abstract operation returns true if *timeZone*, converted to upper case as described in 6.1, is equal to one of the Zone or Link names of the IANA Time Zone Database, converted to upper case as described in 6.1. It returns false otherwise.

6.4.2 CanonicalizeTimeZoneName

The CanonicalizeTimeZoneName abstract operation returns the canonical and case-regularized form of the *timeZone* argument (which must be a String value that is a valid time zone name as verified by the IsValidTimeZoneName abstract operation). The following steps are taken:

1. Let *ianaTimeZone* be the Zone or Link name of the IANA Time Zone Database such that *timeZone*, converted to upper case as described in 6.1, is equal to *ianaTimeZone*, converted to upper case as described in 6.1.
2. If *ianaTimeZone* is a Link name, let *ianaTimeZone* be the corresponding Zone name as specified in the "backward" file of the IANA Time Zone Database.
3. If *ianaTimeZone* is "Etc/UTC" or "Etc/GMT", return "UTC".
4. Return *ianaTimeZone*.

The Intl.DateTimeFormat constructor allows this time zone name; if the time zone is not specified, the host environment's current time zone is used. Implementations shall support UTC and the host environment's current time zone (if different from UTC) in formatting.

6.4.3 DefaultTimeZone ()

The DefaultTimeZone abstract operation returns a String value representing the valid (6.4.1) and canonicalized (6.4.2) time zone name for the host environment's current time zone.

6.5 Measurement Unit Identifiers

The ECMAScript 2020 Internationalization API Specification identifies measurement units using a *core unit identifier* as defined by Unicode Technical Standard #35, Part 2, Section 6. Their canonical form is a string containing all lowercase letters with zero or more hyphens.

Only a limited set of core unit identifiers are allowed. An illegal core unit identifier results in a RangeError.

6.5.1 IsWellFormedUnitIdentifier (*unitIdentifier*)

The IsWellFormedUnitIdentifier abstract operation verifies that the *unitIdentifier* argument (which must be a String value) represents a well-formed core unit identifier as defined in UTS #35, Part 2, Section 6. In addition to obeying the UTS #35 core unit identifier syntax, *unitIdentifier* must be one of the identifiers sanctioned by UTS #35 or be a compound unit composed of two sanctioned simple units. The following steps are taken:

1. If the result of `IsSanctionedSimpleUnitIdentifier(unitIdentifier)` is **true**, then
 - a. Return **true**.
2. If the substring **"-per-"** does not occur exactly once in *unitIdentifier*, then
 - a. Return **false**.
3. Let *numerator* be the substring of *unitIdentifier* from the beginning to just before **"-per-"**.
4. If the result of `IsSanctionedSimpleUnitIdentifier(numerator)` is **false**, then
 - a. Return **false**.
5. Let *denominator* be the substring of *unitIdentifier* from just after **"-per-"** to the end.
6. If the result of `IsSanctionedSimpleUnitIdentifier(denominator)` is **false**, then
 - a. Return **false**.
7. Return **true**.

6.5.2 IsSanctionedSimpleUnitIdentifier (*unitIdentifier*)

The `IsSanctionedSimpleUnitIdentifier` abstract operation verifies that the given core unit identifier is among the simple units sanctioned in the current version of the ECMAScript Internationalization API Specification, a subset of the Validity Data as described in UTS #35, Part 1, Section 3.11; the list may grow over time. As discussed in UTS #35, a simple unit is one that does not have a numerator and denominator. The following steps are taken:

1. If *unitIdentifier* is listed in [Table 2](#) below, return **true**.
2. Else, Return **false**.

Table 2: Simple units sanctioned for use in ECMAScript

Simple Unit
acre
bit
byte
celsius
centimeter
day
degree
fahrenheit
fluid-ounce
foot
gallon
gigabit
gigabyte
gram
hectare
hour
inch
kilobit
kilobyte
kilogram
kilometer
liter
megabit
megabyte
meter
mile
mile-scandinavian
milliliter
millimeter
millisecond
minute
month
ounce

7 Requirements for Standard Built-in ECMAScript Objects

Unless specified otherwise in this document, the objects, functions, and constructors described in this standard are subject to the generic requirements and restrictions specified for standard built-in ECMAScript objects in the ECMAScript 2020 Language Specification, 11th edition, clause 17, or successor.

8 The Intl Object

The Intl object is the *%Intl%* intrinsic object and the initial value of the "Intl" property of the [global object](#). The Intl object is a single ordinary object.

The value of the `[[Prototype]]` internal slot of the Intl object is the intrinsic object *%ObjectPrototype%*.

The Intl object is not a [function object](#). It does not have a `[[Construct]]` internal method; it is not possible to use the Intl object as a [constructor](#) with the `new` operator. The Intl object does not have a `[[Call]]` internal method; it is not possible to invoke the Intl object as a function.

The Intl object has an internal slot, `[[FallbackSymbol]]`, which is a new *%Symbol%* in the current [realm](#) with the `[[Description]]` "IntlLegacyConstructedSymbol".

8.1 Constructor Properties of the Intl Object

8.1.1 Intl.Locale (...)

See 10.

8.1.2 Intl.Collator (...)

See 11.

8.1.3 Intl.NumberFormat (...)

See 12.

8.1.4 Intl.DateTimeFormat (...)

See 13.

8.1.5 Intl.RelativeTimeFormat (...)

See 14.

8.1.6 Intl.PluralRules (...)

See 15.

NOTE In ECMA 402 v1, Intl constructors supported a mode of operation where calling them with an existing object as a receiver would transform the receiver into the relevant Intl instance with all internal slots. In ECMA 402 v2, this capability was removed, to avoid adding internal slots on existing objects. In ECMA 402 v3, the capability was re-added as "normative optional" in a mode which chains the underlying Intl instance on any object, when the `constructor` is called. See [Issue 57](#) for details.

8.2 Function Properties of the Intl Object

8.2.1 Intl.getCanonicalLocales (*locales*)

When the `getCanonicalLocales` method is called with argument *locales*, the following steps are taken:

1. Let *ll* be `? CanonicalizeLocaleList(locales)`.
2. Return `CreateArrayFromList(ll)`.

9 Locale and Parameter Negotiation

The constructors for the objects providing locale sensitive services, Collator, NumberFormat, DateTimeFormat, PluralRules, and RelativeTimeFormat, use a common pattern to negotiate the requests represented by the locales and options arguments against the actual capabilities of their implementations. The common behaviour is described here in terms of internal slots describing the capabilities and of [abstract operations](#) using these internal slots.

9.1 Internal slots of Service Constructors

The constructors Intl.Collator, Intl.NumberFormat, Intl.DateTimeFormat, Intl.PluralRules, and Intl.RelativeTimeFormat have the following internal slots:

- `[[AvailableLocales]]` is a [List](#) that contains structurally valid ([6.2.2](#)) and canonicalized ([6.2.3](#)) Unicode BCP 47 locale identifiers identifying the locales for which the implementation provides the functionality of the constructed objects. Language tags on the list must not have a [Unicode locale extension sequence](#). The list must include the value returned by the `DefaultLocale` abstract operation ([6.2.4](#)), and must not include duplicates. Implementations must include in `[[AvailableLocales]]` locales that can serve as fallbacks in the algorithm used to resolve locales (see [9.2.7](#)). For example, implementations that provide a `"de-DE"` locale must include a `"de"` locale that can serve as a fallback for requests such as `"de-AT"` and `"de-CH"`. For locales that in current usage would include a script subtag (such as Chinese locales), old-style language tags without script subtags must be included such that, for example, requests for `"zh-TW"` and `"zh-HK"` lead to output in traditional Chinese rather than the default simplified Chinese. The ordering of the locales within `[[AvailableLocales]]` is irrelevant.
- `[[RelevantExtensionKeys]]` is a [List](#) of keys of the language tag extensions defined in Unicode Technical Standard 35 that are relevant for the functionality of the constructed objects.
- `[[SortLocaleData]]` and `[[SearchLocaleData]]` (for Intl.Collator) and `[[LocaleData]]` (for Intl.NumberFormat, Intl.DateTimeFormat, Intl.PluralRules, and Intl.RelativeTimeFormat) are records that have fields for each locale contained in `[[AvailableLocales]]`. The value of each of these fields must be a record that has fields for each key contained in `[[RelevantExtensionKeys]]`. The value of each of these fields must be a non-empty list of those values defined in Unicode Technical Standard 35 for the given key that are supported by the implementation for the given locale, with the first element providing the default value.

EXAMPLE An implementation of `DateTimeFormat` might include the language tag `"th"` in its `[[AvailableLocales]]` internal slot, and must (according to [13.3.3](#)) include the key `"ca"` in its `[[RelevantExtensionKeys]]` internal slot. For Thai, the `"buddhist"` calendar is usually the default, but an implementation might also support the calendars `"gregory"`, `"chinese"`, and `"islamic"` for the locale `"th"`. The `[[LocaleData]]` internal slot would therefore at least include `{{[th]: {[ca]: « "buddhist", "gregory", "chinese", "islamic" »}}}`.

9.2 Abstract Operations

Where the following **abstract operations** take an *availableLocales* argument, it must be an `[[AvailableLocales]]` **List** as specified in 9.1.

9.2.1 CanonicalizeLocaleList (*locales*)

The abstract operation CanonicalizeLocaleList takes the following steps:

1. If *locales* is **undefined**, then
 - a. Return a new empty **List**.
2. Let *seen* be a new empty **List**.
3. If `Type(locales)` is `String` or `Type(locales)` is `Object` and *locales* has an `[[InitializedLocale]]` internal slot, then
 - a. Let *O* be `CreateArrayFromList`(« *locales* »).
4. Else,
 - a. Let *O* be `? ToObject(locales)`.
5. Let *len* be `? ToLength(? Get(O, "length"))`.
6. Let *k* be 0.
7. Repeat, while *k* < *len*
 - a. Let *Pk* be `Tostring(k)`.
 - b. Let *kPresent* be `? HasProperty(O, Pk)`.
 - c. If *kPresent* is **true**, then
 - i. Let *kValue* be `? Get(O, Pk)`.
 - ii. If `Type(kValue)` is not `String` or `Object`, throw a **TypeError** exception.
 - iii. If `Type(kValue)` is `Object` and *kValue* has an `[[InitializedLocale]]` internal slot, then
 1. Let *tag* be *kValue*.`[[Locale]]`.
 - iv. Else,
 1. Let *tag* be `? ToString(kValue)`.
 - v. If `IsStructurallyValidLanguageTag(tag)` is **false**, throw a **RangeError** exception.
 - vi. Let *canonicalizedTag* be `CanonicalizeUnicodeLocaleId(tag)`.
 - vii. If *canonicalizedTag* is not an element of *seen*, append *canonicalizedTag* as the last element of *seen*.
 - d. Increase *k* by 1.
8. Return *seen*.

NOTE 1 Non-normative summary: The abstract operation interprets the *locales* argument as an array and copies its elements into a **List**, validating the elements as structurally valid language tags and canonicalizing them, and omitting duplicates.

NOTE 2 Requiring *kValue* to be a `String` or `Object` means that the **Number** value `NaN` will not be interpreted as the language tag `"nan"`, which stands for Min Nan Chinese.

9.2.2 BestAvailableLocale (*availableLocales*, *locale*)

The `BestAvailableLocale` abstract operation compares the provided argument *locale*, which must be a `String` value with a structurally valid and canonicalized Unicode BCP 47 locale identifier, against the locales in *availableLocales* and returns either the longest non-empty prefix of *locale* that is an element of *availableLocales*, or **undefined** if there is no such element. It uses the fallback mechanism of RFC 4647, section 3.4. The following steps are taken:

1. Let *candidate* be *locale*.
2. Repeat,
 - a. If *availableLocales* contains an element equal to *candidate*, return *candidate*.
 - b. Let *pos* be the character index of the last occurrence of `"-"` (U+002D) within *candidate*. If that character does not occur, return **undefined**.
 - c. If *pos* ≥ 2 and the character `"-"` occurs at index *pos*-2 of *candidate*, decrease *pos* by 2.
 - d. Let *candidate* be the substring of *candidate* from position 0, inclusive, to position *pos*, exclusive.

9.2.3 LookupMatcher (*availableLocales*, *requestedLocales*)

The LookupMatcher abstract operation compares *requestedLocales*, which must be a List as returned by CanonicalizeLocaleList, against the locales in *availableLocales* and determines the best available language to meet the request. The following steps are taken:

1. Let *result* be a new Record.
2. For each element *locale* of *requestedLocales* in List order, do
 - a. Let *noExtensionsLocale* be the String value that is *locale* with all Unicode locale extension sequences removed.
 - b. Let *availableLocale* be BestAvailableLocale(*availableLocales*, *noExtensionsLocale*).
 - c. If *availableLocale* is not **undefined**, then
 - i. Set *result*.[[*locale*]] to *availableLocale*.
 - ii. If *locale* and *noExtensionsLocale* are not the same String value, then
 1. Let *extension* be the String value consisting of the first substring of *locale* that is a Unicode locale extension sequence.
 2. Set *result*.[[*extension*]] to *extension*.
 - iii. Return *result*.
3. Let *defLocale* be DefaultLocale().
4. Set *result*.[[*locale*]] to *defLocale*.
5. Return *result*.

NOTE The algorithm is based on the Lookup algorithm described in RFC 4647 section 3.4, but options specified through Unicode locale extension sequences are ignored in the lookup. Information about such subsequences is returned separately. The abstract operation returns a record with a [[*locale*]] field, whose value is the language tag of the selected locale, which must be an element of *availableLocales*. If the language tag of the request locale that led to the selected locale contained a Unicode locale extension sequence, then the returned record also contains an [[*extension*]] field whose value is the first Unicode locale extension sequence within the request locale language tag.

9.2.4 BestFitMatcher (*availableLocales*, *requestedLocales*)

The BestFitMatcher abstract operation compares *requestedLocales*, which must be a List as returned by CanonicalizeLocaleList, against the locales in *availableLocales* and determines the best available language to meet the request. The algorithm is implementation dependent, but should produce results that a typical user of the requested locales would perceive as at least as good as those produced by the LookupMatcher abstract operation. Options specified through Unicode locale extension sequences must be ignored by the algorithm. Information about such subsequences is returned separately. The abstract operation returns a record with a [[*locale*]] field, whose value is the language tag of the selected locale, which must be an element of *availableLocales*. If the language tag of the request locale that led to the selected locale contained a Unicode locale extension sequence, then the returned record also contains an [[*extension*]] field whose value is the first Unicode locale extension sequence within the request locale language tag.

9.2.5 UnicodeExtensionComponents(*extension*)

The UnicodeExtensionComponents abstract operation returns the attributes and keywords from *extension*, which must be a Unicode locale extension sequence. If an attribute or a keyword occurs multiple times in *extension*, only the first occurrence is returned. The following steps are taken:

1. Let *attributes* be the empty List.
2. Let *keywords* be the empty List.
3. Let *isKeyword* be **false**.
4. Let *size* be the number of elements in *extension*.
5. Let *k* be 3.
6. Repeat, while *k* < *size*
 - a. Let *e* be ! Call(%StringProto_indexOf%, *extension*, «"-", *k* »).
 - b. If *e* = -1, let *len* be *size* - *k*; else let *len* be *e* - *k*.

- c. Let *subtag* be the String value equal to the substring of *extension* consisting of the code units at indices *k* (inclusive) through *k + len* (exclusive).
- d. If *isKeyword* is **false**, then
 - i. If *len* ≠ 2 and *subtag* is not an element of *attributes*, then
 1. Append *subtag* to *attributes*.
- e. Else,
 - i. If *len* = 2, then
 1. If *keywords* does not contain an element whose [[Key]] is the same as *key*, then
 - a. Append the Record{[[Key]]: *key*, [[Value]]: *value*} to *keywords*.
 - ii. Else,
 1. If *value* is not the empty String, then
 - a. Let *value* be the string-concatenation of *value* and "-".
 2. Let *value* be the string-concatenation of *value* and *subtag*.
 - f. If *len* = 2, then
 - i. Let *isKeyword* be **true**.
 - ii. Let *key* be *subtag*.
 - iii. Let *value* be the empty String.
 - g. Let *k* be *k + len + 1*.
7. If *isKeyword* is **true**, then
 - a. If *keywords* does not contain an element whose [[Key]] is the same as *key*, then
 - i. Append the Record{[[Key]]: *key*, [[Value]]: *value*} to *keywords*.
8. Return the Record{[[Attributes]]: *attributes*, [[Keywords]]: *keywords*}.

9.2.6 InsertUnicodeExtensionAndCanonicalize(*locale*, *extension*)

The InsertUnicodeExtensionAndCanonicalize abstract operation inserts *extension*, which must be a Unicode locale extension sequence, into *locale*, which must be a String value with a structurally valid and canonicalized Unicode BCP 47 locale identifier. The following steps are taken:

The following algorithm refers to UTS 35's Unicode Language and Locale Identifiers grammar.

1. **Assert:** *locale* does not contain a substring that is a Unicode locale extension sequence.
2. **Assert:** *extension* is a Unicode locale extension sequence.
3. **Assert:** *tag* matches the **unicode_locale_id** production.
4. Let *privateIndex* be ! Call(%StringProto_indexOf%, *locale*, « "-x-" »).
5. If *privateIndex* = -1, then
 - a. Let *locale* be the string-concatenation of *locale* and *extension*.
6. Else,
 - a. Let *preExtension* be the substring of *locale* from position 0, inclusive, to position *privateIndex*, exclusive.
 - b. Let *postExtension* be the substring of *locale* from position *privateIndex* to the end of the string.
 - c. Let *locale* be the string-concatenation of *preExtension*, *extension*, and *postExtension*.
7. **Assert:** IsStructurallyValidLanguageTag(*locale*) is **true**.
8. Return ! CanonicalizeUnicodeLocaleId(*locale*).

9.2.7 ResolveLocale (*availableLocales*, *requestedLocales*, *options*, *relevantExtensionKeys*, *localeData*)

The ResolveLocale abstract operation compares a BCP 47 language priority list *requestedLocales* against the locales in *availableLocales* and determines the best available language to meet the request. *availableLocales*, *requestedLocales*, and *relevantExtensionKeys* must be provided as List values, *options* and *localeData* as Records.

The following steps are taken:

1. Let *matcher* be *options*.[[localeMatcher]].
2. If *matcher* is "lookup", then

- a. Let *r* be `LookupMatcher(availableLocales, requestedLocales)`.
3. Else,
 - a. Let *r* be `BestFitMatcher(availableLocales, requestedLocales)`.
4. Let *foundLocale* be *r*.[[`locale`]].
5. Let *result* be a new `Record`.
6. Set *result*.[[`dataLocale`]] to *foundLocale*.
7. If *r* has an [[`extension`]] field, then
 - a. Let *components* be `! UnicodeExtensionComponents(r. [[extension]])`.
 - b. Let *keywords* be *components*.[[`Keywords`]].
8. Let *supportedExtension* be `"-u"`.
9. For each element *key* of *relevantExtensionKeys* in List order, do
 - a. Let *foundLocaleData* be *localeData*.[[`<foundLocale>`]].
 - b. Assert: `Type(foundLocaleData)` is `Record`.
 - c. Let *keyLocaleData* be *foundLocaleData*.[[`<key>`]].
 - d. Assert: `Type(keyLocaleData)` is `List`.
 - e. Let *value* be *keyLocaleData*[0].
 - f. Assert: `Type(value)` is either `String` or `Null`.
 - g. Let *supportedExtensionAddition* be `""`.
 - h. If *r* has an [[`extension`]] field, then
 - i. If *keywords* contains an element whose [[`Key`]] is the same as *key*, then
 1. Let *entry* be the element of *keywords* whose [[`Key`]] is the same as *key*.
 2. Let *requestedValue* be *entry*.[[`Value`]].
 3. If *requestedValue* is not the empty `String`, then
 - a. If *keyLocaleData* contains *requestedValue*, then
 - i. Let *value* be *requestedValue*.
 - ii. Let *supportedExtensionAddition* be the `string-concatenation` of `"-"`, *key*, `"."`, and *value*.
 4. Else if *keyLocaleData* contains `"true"`, then
 - a. Let *value* be `"true"`.
 - b. Let *supportedExtensionAddition* be the `string-concatenation` of `"-"` and *key*.
 - i. If *options* has a field [[`<key>`]], then
 - i. Let *optionsValue* be *options*.[[`<key>`]].
 - ii. Assert: `Type(optionsValue)` is either `String`, `Undefined`, or `Null`.
 - iii. If `Type(optionsValue)` is `String`, then
 1. Let *optionsValue* be the string *optionsValue* after performing the algorithm steps to transform Unicode extension values to canonical syntax per [Unicode Technical Standard #35 LDML § 3.2.1 Canonical Unicode Locale Identifiers](#), treating *key* as **ukey** and *optionsValue* as **uvalue** productions.
 2. Let *optionsValue* be the string *optionsValue* after performing the algorithm steps to replace Unicode extension values with their canonical form per [Unicode Technical Standard #35 LDML § 3.2.1 Canonical Unicode Locale Identifiers](#), treating *key* as **ukey** and *optionsValue* as **uvalue** productions.
 3. If *optionsValue* is the empty `String`, then
 - a. Let *optionsValue* be `"true"`.
 - iv. If *keyLocaleData* contains *optionsValue*, then
 1. If `SameValue(optionsValue, value)` is `false`, then
 - a. Let *value* be *optionsValue*.
 - b. Let *supportedExtensionAddition* be `""`.
 - j. Set *result*.[[`<key>`]] to *value*.
 - k. Append *supportedExtensionAddition* to *supportedExtension*.
10. If the number of elements in *supportedExtension* is greater than 2, then
 - a. Let *foundLocale* be `InsertUnicodeExtensionAndCanonicalize(foundLocale, supportedExtension)`.
11. Set *result*.[[`locale`]] to *foundLocale*.
12. Return *result*.

NOTE Non-normative summary: Two algorithms are available to match the locales: the Lookup algorithm described in RFC 4647 section 3.4, and an implementation dependent best-fit algorithm. Independent of the locale matching algorithm, options specified through Unicode locale extension sequences are negotiated separately, taking the caller's relevant extension keys and locale data as well as client-provided options into consideration. The abstract operation returns a record with a `[[locale]]` field whose value is the language tag of the selected locale, and fields for each key in *relevantExtensionKeys* providing the selected value for that key.

9.2.8 LookupSupportedLocales (*availableLocales*, *requestedLocales*)

The LookupSupportedLocales abstract operation returns the subset of the provided BCP 47 language priority list *requestedLocales* for which *availableLocales* has a matching locale when using the BCP 47 Lookup algorithm. Locales appear in the same order in the returned list as in *requestedLocales*. The following steps are taken:

1. Let *subset* be a new empty List.
2. For each element *locale* of *requestedLocales* in List order, do
 - a. Let *noExtensionsLocale* be the String value that is *locale* with all Unicode locale extension sequences removed.
 - b. Let *availableLocale* be `BestAvailableLocale(availableLocales, noExtensionsLocale)`.
 - c. If *availableLocale* is not **undefined**, append *locale* to the end of *subset*.
3. Return *subset*.

9.2.9 BestFitSupportedLocales (*availableLocales*, *requestedLocales*)

The BestFitSupportedLocales abstract operation returns the subset of the provided BCP 47 language priority list *requestedLocales* for which *availableLocales* has a matching locale when using the Best Fit Matcher algorithm. Locales appear in the same order in the returned list as in *requestedLocales*. The steps taken are implementation dependent.

9.2.10 SupportedLocales (*availableLocales*, *requestedLocales*, *options*)

The SupportedLocales abstract operation returns the subset of the provided BCP 47 language priority list *requestedLocales* for which *availableLocales* has a matching locale. Two algorithms are available to match the locales: the Lookup algorithm described in RFC 4647 section 3.4, and an implementation dependent best-fit algorithm. Locales appear in the same order in the returned list as in *requestedLocales*. The following steps are taken:

1. If *options* is not **undefined**, then
 - a. Let *options* be `? ToObject(options)`.
 - b. Let *matcher* be `? GetOption(options, "localeMatcher", "string", « "lookup", "best fit" », "best fit")`.
2. Else, let *matcher* be **"best fit"**.
3. If *matcher* is **"best fit"**, then
 - a. Let *supportedLocales* be `BestFitSupportedLocales(availableLocales, requestedLocales)`.
4. Else,
 - a. Let *supportedLocales* be `LookupSupportedLocales(availableLocales, requestedLocales)`.
5. Return `CreateArrayFromList(supportedLocales)`.

9.2.11 GetOption (*options*, *property*, *type*, *values*, *fallback*)

The abstract operation GetOption extracts the value of the property named *property* from the provided *options* object, converts it to the required *type*, checks whether it is one of a List of allowed *values*, and fills in a *fallback* value if necessary. If *values* is **undefined**, there is no fixed set of values and any is permitted.

1. Let *value* be `? Get(options, property)`.
2. If *value* is not **undefined**, then
 - a. **Assert:** *type* is **"boolean"** or **"string"**.
 - b. If *type* is **"boolean"**, then
 - i. Let *value* be `ToBoolean(value)`.

- c. If *type* is "string", then
 - i. Let *value* be ? ToString(*value*).
 - d. If *values* is not **undefined**, then
 - i. If *values* does not contain an element equal to *value*, throw a **RangeError** exception.
 - e. Return *value*.
3. Else, return *fallback*.

9.2.12 DefaultNumberOption (*value*, *minimum*, *maximum*, *fallback*)

The abstract operation DefaultNumberOption converts *value* to a **Number value**, checks whether it is in the allowed range, and fills in a *fallback* value if necessary.

1. If *value* is not **undefined**, then
 - a. Let *value* be ? ToNumber(*value*).
 - b. If *value* is NaN or less than *minimum* or greater than *maximum*, throw a **RangeError** exception.
 - c. Return floor(*value*).
2. Else, return *fallback*.

9.2.13 GetNumberOption (*options*, *property*, *minimum*, *maximum*, *fallback*)

The abstract operation GetNumberOption extracts the value of the property named *property* from the provided *options* object, converts it to a **Number value**, checks whether it is in the allowed range, and fills in a *fallback* value if necessary.

1. Let *value* be ? Get(*options*, *property*).
2. Return ? DefaultNumberOption(*value*, *minimum*, *maximum*, *fallback*).

9.2.14 PartitionPattern (*pattern*)

The PartitionPattern abstract operation is called with argument *pattern*. This abstract operation parses an abstract pattern string into a list of Records with two fields, [[Type]] and [[Value]]. The [[Value]] field will be a String value if [[Type]] is "literal", and **undefined** otherwise. The syntax of the abstract pattern strings is an implementation detail and is not exposed to users of ECMA-402. The following steps are taken:

1. Let *result* be a new empty List.
2. Let *beginIndex* be ! Call(%StringProto_indexOf%, *pattern*, « "", 0 »).
3. Let *endIndex* be 0.
4. Let *nextIndex* be 0.
5. Let *length* be the number of code units in *pattern*.
6. Repeat, while *beginIndex* is an integer index into *pattern*
 - a. Set *endIndex* to ! Call(%StringProto_indexOf%, *pattern*, « "", *beginIndex* »).
 - b. **Assert**: *endIndex* is greater than *beginIndex*.
 - c. If *beginIndex* is greater than *nextIndex*, then
 - i. Let *literal* be a substring of *pattern* from position *nextIndex*, inclusive, to position *beginIndex*, exclusive.
 - ii. Append a new Record { [[Type]]: "literal", [[Value]]: *literal* } as the last element of the list *result*.
 - d. Let *p* be the substring of *pattern* from position *beginIndex*, exclusive, to position *endIndex*, exclusive.
 - e. Append a new Record { [[Type]]: *p*, [[Value]]: **undefined** } as the last element of the list *result*.
 - f. Set *nextIndex* to *endIndex* + 1.
 - g. Set *beginIndex* to ! Call(%StringProto_indexOf%, *pattern*, « "", *nextIndex* »).
7. If *nextIndex* is less than *length*, then
 - a. Let *literal* be the substring of *pattern* from position *nextIndex*, inclusive, to position *length*, exclusive.
 - b. Append a new Record { [[Type]]: "literal", [[Value]]: *literal* } as the last element of the list *result*.
8. Return *result*.

10 Locale Objects

10.1 The Intl.Locale Constructor

The Locale [constructor](#) is the *%Locale%* intrinsic object and a standard built-in property of the Intl object.

10.1.1 ApplyOptionsToTag(*tag*, *options*)

The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#).

1. Assert: `Type(tag)` is String.
2. If `IsStructurallyValidLanguageTag(tag)` is **false**, throw a **RangeError** exception.
3. Let *language* be ? `GetOption(options, "language", "string", undefined, undefined)`.
4. If *language* is not **undefined**, then
 - a. If *language* does not match the **unicode_language_subtag** production, throw a **RangeError** exception.
5. Let *script* be ? `GetOption(options, "script", "string", undefined, undefined)`.
6. If *script* is not **undefined**, then
 - a. If *script* does not match the **unicode_script_subtag** production, throw a **RangeError** exception.
7. Let *region* be ? `GetOption(options, "region", "string", undefined, undefined)`.
8. If *region* is not **undefined**, then
 - a. If *region* does not match the **unicode_region_subtag** production, throw a **RangeError** exception.
9. Set *tag* to `CanonicalizeUnicodeLocaleId(tag)`.
10. Assert: *tag* matches the **unicode_locale_id** production.
11. Let *languageId* be the substring of *tag* corresponding to the **unicode_language_id** production.
12. If *language* is not **undefined**, then
 - a. Set *languageId* to *languageId* with the substring corresponding to the **unicode_language_subtag** production replaced by the string *language*.
13. If *script* is not **undefined**, then
 - a. If *languageId* does not contain a **unicode_script_subtag** production, then
 - i. Set *languageId* to the **string-concatenation** of the **unicode_language_subtag** production of *languageId*, "-", *script*, and the rest of *languageId*.
 - b. Else,
 - i. Set *languageId* to *languageId* with the substring corresponding to the **unicode_script_subtag** production replaced by the string *script*.
14. If *region* is not **undefined**, then
 - a. If *languageId* does not contain a **unicode_region_subtag** production, then
 - i. Set *languageId* to the **string-concatenation** of the **unicode_language_subtag** production of *languageId*, the substring corresponding to "-" and the **unicode_script_subtag** production if present, "-", *region*, and the rest of *languageId*.
 - b. Else,
 - i. Set *languageId* to *languageId* with the substring corresponding to the **unicode_region_subtag** production replaced by the string *region*.
15. Set *tag* to *tag* with the substring corresponding to the **unicode_language_id** production replaced by the string *languageId*.
16. Return `CanonicalizeUnicodeLocaleId(tag)`.

10.1.2 ApplyUnicodeExtensionToTag(*tag*, *options*, *relevantExtensionKeys*)

The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#).

1. **Assert:** `Type(tag)` is String.
2. **Assert:** `tag` matches the **unicode_locale_id** production.
3. If `tag` contains a substring that is a Unicode locale extension sequence, then
 - a. Let `extension` be the String value consisting of the first substring of `tag` that is a Unicode locale extension sequence.
 - b. Let `components` be `!UnicodeExtensionComponents(extension)`.
 - c. Let `attributes` be `components.[[Attributes]]`.
 - d. Let `keywords` be `components.[[Keywords]]`.
4. Else,
 - a. Let `attributes` be the empty List.
 - b. Let `keywords` be the empty List.
5. Let `result` be a new Record.
6. Repeat for each element `key` of `relevantExtensionKeys` in List order,
 - a. Let `value` be **undefined**.
 - b. If `keywords` contains an element whose `[[Key]]` is the same as `key`, then
 - i. Let `entry` be the element of `keywords` whose `[[Key]]` is the same as `key`.
 - ii. Let `value` be `entry.[[Value]]`.
 - c. Else
 - i. Let `entry` be empty.
 - d. **Assert:** `options` has a field `[[<key>]]`.
 - e. Let `optionsValue` be `options.[[<key>]]`.
 - f. If `optionsValue` is not **undefined**, then
 - i. **Assert:** `Type(optionsValue)` is String.
 - ii. Let `value` be `optionsValue`.
 - iii. If `entry` is not empty, then
 1. Set `entry.[[Value]]` to `value`.
 - iv. Else,
 1. Append the `Record{[[Key]]: key, [[Value]]: value}` to `keywords`.
 - g. Set `result.[[<key>]]` to `value`.
7. Let `locale` be the String value that is `tag` with all Unicode locale extension sequences removed.
8. Let `newExtension` be a Unicode BCP 47 U Extension based on `attributes` and `keywords`.
9. If `newExtension` is not the empty String, then
 - a. Let `locale` be `!InsertUnicodeExtensionAndCanonicalize(locale, newExtension)`.
10. Set `result.[[locale]]` to `locale`.
11. Return `result`.

10.1.3 Intl.Locale(*tag* [, *options*])

The following algorithm refers to UTS 35's Unicode Language and Locale Identifiers grammar. When the **Intl.Locale** function is called with an argument `tag` and an optional argument `options`, the following steps are taken:

1. If `NewTarget` is **undefined**, throw a **TypeError** exception.
2. Let `relevantExtensionKeys` be `%Locale%.[[RelevantExtensionKeys]]`.
3. Let `internalSlotsList` be « `[[InitializedLocale]]`, `[[Locale]]`, `[[Calendar]]`, `[[Collation]]`, `[[HourCycle]]`, `[[NumberingSystem]]` ».
4. If `relevantExtensionKeys` contains **"kf"**, then
 - a. Append `[[CaseFirst]]` as the last element of `internalSlotsList`.
5. If `relevantExtensionKeys` contains **"kn"**, then
 - a. Append `[[Numeric]]` as the last element of `internalSlotsList`.
6. Let `locale` be `? OrdinaryCreateFromConstructor(NewTarget, %LocalePrototype%, internalSlotsList)`.
7. If `Type(tag)` is not String or Object, throw a **TypeError** exception.
8. If `Type(tag)` is Object and `tag` has an `[[InitializedLocale]]` internal slot, then
 - a. Let `tag` be `tag.[[Locale]]`.
9. Else,
 - a. Let `tag` be `? ToString(tag)`.

10. If *options* is **undefined**, then
 - a. Let *options* be ! **ObjectCreate**(**null**).
11. Else
 - a. Let *options* be ? **ToObject**(*options*).
12. Set *tag* to ? **ApplyOptionsToTag**(*tag*, *options*).
13. Let *opt* be a new **Record**.
14. Let *calendar* be ? **GetOption**(*options*, "calendar", "string", **undefined**, **undefined**).
15. If *calendar* is not **undefined**, then
 - a. If *calendar* does not match the **type** sequence (from **UTS 35 Unicode Locale Identifier**, section 3.2), throw a **RangeError** exception.
16. Set *opt*.[[ca]] to *calendar*.
17. Let *collation* be ? **GetOption**(*options*, "collation", "string", **undefined**, **undefined**).
18. If *collation* is not **undefined**, then
 - a. If *collation* does not match the **type** sequence (from **UTS 35 Unicode Locale Identifier**, section 3.2), throw a **RangeError** exception.
19. Set *opt*.[[co]] to *collation*.
20. Let *hc* be ? **GetOption**(*options*, "hourCycle", "string", « "h11", "h12", "h23", "h24" », **undefined**).
21. Set *opt*.[[hc]] to *hc*.
22. Let *kf* be ? **GetOption**(*options*, "caseFirst", "string", « "upper", "lower", "false" », **undefined**).
23. Set *opt*.[[kf]] to *kf*.
24. Let *kn* be ? **GetOption**(*options*, "numeric", "boolean", **undefined**, **undefined**).
25. If *kn* is not **undefined**, set *kn* to ! **ToString**(*kn*).
26. Set *opt*.[[kn]] to *kn*.
27. Let *numberingSystem* be ? **GetOption**(*options*, "numberingSystem", "string", **undefined**, **undefined**).
28. If *numberingSystem* is not **undefined**, then
 - a. If *numberingSystem* does not match the **type** sequence (from **UTS 35 Unicode Locale Identifier**, section 3.2), throw a **RangeError** exception.
29. Set *opt*.[[nu]] to *numberingSystem*.
30. Let *r* be ! **ApplyUnicodeExtensionToTag**(*tag*, *opt*, *relevantExtensionKeys*).
31. Set *locale*.[[Locale]] to *r*.[[locale]].
32. Set *locale*.[[Calendar]] to *r*.[[ca]].
33. Set *locale*.[[Collation]] to *r*.[[co]].
34. Set *locale*.[[HourCycle]] to *r*.[[hc]].
35. If *relevantExtensionKeys* contains "kf", then
 - a. Set *locale*.[[CaseFirst]] to *r*.[[kf]].
36. If *relevantExtensionKeys* contains "kn", then
 - a. If ! **SameValue**(*r*.[[kn]], "true") is **true** or ! **SameValue**(*r*.[[kn]], "") is **true**, then
 - i. Let *numeric* be **true**.
 - b. Else,
 - i. Let *numeric* be **false**.
 - c. Set *locale*.[[Numeric]] to *numeric*.
37. Set *locale*.[[NumberingSystem]] to *r*.[[nu]].
38. Return *locale*.

10.2 Properties of the Intl.Locale Constructor

The Intl.Locale **constructor** has the following properties:

10.2.1 Intl.Locale.prototype

The value of **Intl.Locale.prototype** is %**LocalePrototype**%.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

10.2.2 Internal slots

The value of the `[[RelevantExtensionKeys]]` internal slot is « "ca", "co", "hc", "kf", "kn", "nu" ». If `%Collator%`.`[[RelevantExtensionKeys]]` does not contain "kf", then remove "kf" from `%Locale%`.`[[RelevantExtensionKeys]]`. If `%Collator%`.`[[RelevantExtensionKeys]]` does not contain "kn", then remove "kn" from `%Locale%`.`[[RelevantExtensionKeys]]`.

10.3 Properties of the Intl.Locale Prototype Object

The Intl.Locale prototype object is itself an ordinary object. `%LocalePrototype%` is not an Intl.Locale instance and does not have an `[[InitializedLocale]]` internal slot or any of the other internal slots of Intl.Locale instance objects.

10.3.1 Intl.Locale.prototype.constructor

The initial value of `Intl.Locale.prototype.constructor` is `%Locale%`.

10.3.2 Intl.Locale.prototype[@@toStringTag]

The initial value of the `@@toStringTag` property is the string value "Intl.Locale".

This property has the attributes { `[[Writable]]`: **false**, `[[Enumerable]]`: **false**, `[[Configurable]]`: **true** }.

10.3.3 Intl.Locale.prototype.maximize ()

1. Let *loc* be the **this** value.
2. Perform ? `RequireInternalSlot`(*loc*, `[[InitializedLocale]]`).
3. Let *maximal* be the result of the `Add Likely Subtags` algorithm applied to *loc*.`[[Locale]]`. If an error is signaled, set *maximal* to *loc*.`[[Locale]]`.
4. Return ! `Construct`(`%Locale%`, *maximal*).

10.3.4 Intl.Locale.prototype.minimize ()

1. Let *loc* be the **this** value.
2. Perform ? `RequireInternalSlot`(*loc*, `[[InitializedLocale]]`).
3. Let *minimal* be the result of the `Remove Likely Subtags` algorithm applied to *loc*.`[[Locale]]`. If an error is signaled, set *minimal* to *loc*.`[[Locale]]`.
4. Return ! `Construct`(`%Locale%`, *minimal*).

10.3.5 Intl.Locale.prototype.toString ()

1. Let *loc* be the **this** value.
2. Perform ? `RequireInternalSlot`(*loc*, `[[InitializedLocale]]`).
3. Return *loc*.`[[Locale]]`.

10.3.6 get Intl.Locale.prototype.baseName

`Intl.Locale.prototype.baseName` is an `accessor property` whose set accessor function is **undefined**. The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#). Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? `RequireInternalSlot`(*loc*, `[[InitializedLocale]]`).
3. Let *locale* be *loc*.`[[Locale]]`.

4. Return the substring of *locale* corresponding to the **unicode_language_id** production.

10.3.7 get Intl.Locale.prototype.calendar

Intl.Locale.prototype.calendar is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[Calendar]].

10.3.8 get Intl.Locale.prototype.caseFirst

This property only exists if [%Locale%](#).[[RelevantExtensionKeys]] contains "kf".

Intl.Locale.prototype.caseFirst is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[CaseFirst]].

10.3.9 get Intl.Locale.prototype.collation

Intl.Locale.prototype.collation is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[Collation]].

10.3.10 get Intl.Locale.prototype.hourCycle

Intl.Locale.prototype.hourCycle is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[HourCycle]].

10.3.11 get Intl.Locale.prototype.numeric

This property only exists if [%Locale%](#).[[RelevantExtensionKeys]] contains "kn".

Intl.Locale.prototype.numeric is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[Numeric]].

10.3.12 get Intl.Locale.prototype.numberingSystem

Intl.Locale.prototype.numberingSystem is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Return *loc*.[[NumberingSystem]].

10.3.13 get Intl.Locale.prototype.language

Intl.Locale.prototype.language is an [accessor property](#) whose set accessor function is **undefined**. The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#). Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Let *locale* be *loc*.[[Locale]].
4. **Assert**: *locale* matches the **unicode_locale_id** production.
5. Return the substring of *locale* corresponding to the **unicode_language_subtag** production of the **unicode_language_id**.

10.3.14 get Intl.Locale.prototype.script

Intl.Locale.prototype.script is an [accessor property](#) whose set accessor function is **undefined**. The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#). Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Let *locale* be *loc*.[[Locale]].
4. **Assert**: *locale* matches the **unicode_locale_id** production.
5. If the **unicode_language_id** production of *locale* does not contain the **["-" unicode_script_subtag]** sequence, return **undefined**.
6. Return the substring of *locale* corresponding to the **unicode_script_subtag** production of the **unicode_language_id**.

10.3.15 get Intl.Locale.prototype.region

Intl.Locale.prototype.region is an [accessor property](#) whose set accessor function is **undefined**. The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#). Its get accessor function performs the following steps:

1. Let *loc* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*loc*, [[InitializedLocale]]).
3. Let *locale* be *loc*.[[Locale]].
4. **Assert**: *locale* matches the **unicode_locale_id** production.
5. If the **unicode_language_id** production of *locale* does not contain the **["-" unicode_region_subtag]** sequence, return **undefined**.
6. Return the substring of *locale* corresponding to the **unicode_region_subtag** production of the **unicode_language_id**.

11 Collator Objects

11.1 The Intl.Collator Constructor

The Intl.Collator [constructor](#) is the *%Collator%* intrinsic object and a standard built-in property of the Intl object. Behaviour common to all service [constructor](#) properties of the Intl object is specified in [9.1](#).

11.1.1 InitializeCollator (*collator*, *locales*, *options*)

The abstract operation InitializeCollator accepts the arguments *collator* (which must be an object), *locales*, and *options*. It initializes *collator* as a **Collator** object. The following steps are taken:

1. Let *requestedLocales* be ? CanonicalizeLocaleList(*locales*).
2. If *options* is **undefined**, then
 - a. Let *options* be ObjectCreate(**null**).
3. Else,
 - a. Let *options* be ? ToObject(*options*).
4. Let *usage* be ? GetOption(*options*, "usage", "string", « "sort", "search" », "sort").
5. Set *collator*.[[Usage]] to *usage*.
6. If *usage* is "sort", then
 - a. Let *localeData* be %Collator%.[[SortLocaleData]].
7. Else,
 - a. Let *localeData* be %Collator%.[[SearchLocaleData]].
8. Let *opt* be a new Record.
9. Let *matcher* be ? GetOption(*options*, "localeMatcher", "string", « "lookup", "best fit" », "best fit").
10. Set *opt*.[[localeMatcher]] to *matcher*.
11. Let *numeric* be ? GetOption(*options*, "numeric", "boolean", **undefined**, **undefined**).
12. If *numeric* is not **undefined**, then
 - a. Let *numeric* be ! ToString(*numeric*).
13. Set *opt*.[[kn]] to *numeric*.
14. Let *caseFirst* be ? GetOption(*options*, "caseFirst", "string", « "upper", "lower", "false" », **undefined**).
15. Set *opt*.[[kf]] to *caseFirst*.
16. Let *relevantExtensionKeys* be %Collator%.[[RelevantExtensionKeys]].
17. Let *r* be ResolveLocale(%Collator%.[[AvailableLocales]], *requestedLocales*, *opt*, *relevantExtensionKeys*, *localeData*).
18. Set *collator*.[[Locale]] to *r*.[[locale]].
19. Let *collation* be *r*.[[co]].
20. If *collation* is **null**, let *collation* be "default".
21. Set *collator*.[[Collation]] to *collation*.
22. If *relevantExtensionKeys* contains "kn", then
 - a. Set *collator*.[[Numeric]] to ! SameValue(*r*.[[kn]], "true").
23. If *relevantExtensionKeys* contains "kf", then
 - a. Set *collator*.[[CaseFirst]] to *r*.[[kf]].
24. Let *sensitivity* be ? GetOption(*options*, "sensitivity", "string", « "base", "accent", "case", "variant" », **undefined**).
25. If *sensitivity* is **undefined**, then
 - a. If *usage* is "sort", then
 - i. Let *sensitivity* be "variant".
 - b. Else,
 - i. Let *dataLocale* be *r*.[[dataLocale]].
 - ii. Let *dataLocaleData* be *localeData*.[[<*dataLocale*>]].
 - iii. Let *sensitivity* be *dataLocaleData*.[[sensitivity]].
26. Set *collator*.[[Sensitivity]] to *sensitivity*.
27. Let *ignorePunctuation* be ? GetOption(*options*, "ignorePunctuation", "boolean", **undefined**, **false**).
28. Set *collator*.[[IgnorePunctuation]] to *ignorePunctuation*.
29. Return *collator*.

11.1.2 Intl.Collator ([*locales* [, *options*]])

When the **Intl.Collator** function is called with optional arguments *locales* and *options*, the following steps are taken:

1. If *NewTarget* is **undefined**, let *newTarget* be the **active function object**, else let *newTarget* be *NewTarget*.
2. Let *internalSlotsList* be « [[InitializedCollator]], [[Locale]], [[Usage]], [[Sensitivity]], [[IgnorePunctuation]], [[Collation]], [[BoundCompare]] ».
3. If *%Collator%*.[[RelevantExtensionKeys]] contains **"kn"**, then
 - a. Append [[Numeric]] as the last element of *internalSlotsList*.
4. If *%Collator%*.[[RelevantExtensionKeys]] contains **"kf"**, then
 - a. Append [[CaseFirst]] as the last element of *internalSlotsList*.
5. Let *collator* be ? **OrdinaryCreateFromConstructor**(*newTarget*, "%CollatorPrototype%", *internalSlotsList*).
6. Return ? **InitializeCollator**(*collator*, *locales*, *options*).

11.2 Properties of the Intl.Collator Constructor

The Intl.Collator **constructor** has the following properties:

11.2.1 Intl.Collator.prototype

The value of **Intl.Collator.prototype** is *%CollatorPrototype%*.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

11.2.2 Intl.Collator.supportedLocalesOf (*locales* [, *options*])

When the **supportedLocalesOf** method is called with arguments *locales* and *options*, the following steps are taken:

1. Let *availableLocales* be *%Collator%*.[[AvailableLocales]].
2. Let *requestedLocales* be ? **CanonicalizeLocaleList**(*locales*).
3. Return ? **SupportedLocales**(*availableLocales*, *requestedLocales*, *options*).

The value of the **"length"** property of the **supportedLocalesOf** method is 1.

11.2.3 Internal Slots

The value of the [[AvailableLocales]] internal slot is implementation defined within the constraints described in 9.1. The value of the [[RelevantExtensionKeys]] internal slot is a **List** that must include the element **"co"**, may include any or all of the elements **"kn"** and **"kf"**, and must not include any other elements.

NOTE Unicode Technical Standard 35 describes ten locale extension keys that are relevant to collation: **"co"** for collator usage and specializations, **"ka"** for alternate handling, **"kb"** for backward second level weight, **"kc"** for case level, **"kn"** for numeric, **"kh"** for hiragana quaternary, **"kk"** for normalization, **"kf"** for case first, **"kr"** for reordering, **"ks"** for collation strength, and **"vt"** for variable top. Collator, however, requires that the usage is specified through the **"usage"** property of the options object, alternate handling through the **"ignorePunctuation"** property of the options object, and case level and the strength through the **"sensitivity"** property of the options object. The **"co"** key in the language tag is supported only for collator specializations, and the keys **"kb"**, **"kh"**, **"kk"**, **"kr"**, and **"vt"** are not allowed in this version of the Internationalization API. Support for the remaining keys is implementation dependent.

The values of the [[SortLocaleData]] and [[SearchLocaleData]] internal slots are implementation defined within the constraints described in 9.1 and the following additional constraints, for all locale values *locale*:

- The first element of [[SortLocaleData]][[<locale>]].[[co]] and [[SearchLocaleData]][[<locale>]].[[co]] must be **null**.
- The values **"standard"** and **"search"** must not be used as elements in any [[SortLocaleData]][[<locale>]].[[co]] and [[SearchLocaleData]][[<locale>]].[[co]] list.
- [[SearchLocaleData]][[<locale>]] must have a sensitivity field with a String value equal to **"base"**, **"accent"**, **"case"**, or **"variant"**.

11.3 Properties of the Intl.Collator Prototype Object

The Intl.Collator prototype object is itself an ordinary object. *%CollatorPrototype%* is not an Intl.Collator instance and does not have an `[[InitializedCollator]]` internal slot or any of the other internal slots of Intl.Collator instance objects.

11.3.1 Intl.Collator.prototype.constructor

The initial value of `Intl.Collator.prototype.constructor` is the intrinsic object *%Collator%*.

11.3.2 Intl.Collator.prototype [@@toStringTag]

The initial value of the `@@toStringTag` property is the String value "Object".

This property has the attributes { `[[Writable]]`: **false**, `[[Enumerable]]`: **false**, `[[Configurable]]`: **true** }.

11.3.3 get Intl.Collator.prototype.compare

This named [accessor property](#) returns a function that compares two strings according to the sort order of this Collator object.

`Intl.Collator.prototype.compare` is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *collator* be **this** value.
2. Perform ? [RequireInternalSlot](#)(*collator*, `[[InitializedCollator]]`).
3. If *collator*.`[[BoundCompare]]` is **undefined**, then
 - a. Let *F* be a new built-in [function object](#) as defined in 11.3.3.1.
 - b. Set *F*.`[[Collator]]` to *collator*.
 - c. Set *collator*.`[[BoundCompare]]` to *F*.
4. Return *collator*.`[[BoundCompare]]`.

NOTE The returned function is bound to *collator* so that it can be passed directly to `Array.prototype.sort` or other functions.

11.3.3.1 Collator Compare Functions

A Collator compare function is an anonymous built-in function that has a `[[Collator]]` internal slot.

When a Collator compare function *F* is called with arguments *x* and *y*, the following steps are taken:

1. Let *collator* be *F*.`[[Collator]]`.
2. **Assert**: `Type(collator)` is Object and *collator* has an `[[InitializedCollator]]` internal slot.
3. If *x* is not provided, let *x* be **undefined**.
4. If *y* is not provided, let *y* be **undefined**.
5. Let *X* be ? [ToString](#)(*x*).
6. Let *Y* be ? [ToString](#)(*y*).
7. Return [CompareStrings](#)(*collator*, *X*, *Y*).

The "length" property of a Collator compare function is 2.

11.3.3.2 CompareStrings (collator, x, y)

When the CompareStrings abstract operation is called with arguments *collator* (which must be an object initialized as a Collator), *x* and *y* (which must be String values), it returns a Number other than NaN that represents the result of a locale-sensitive String comparison of *x* with *y*. The two Strings are compared in an implementation-defined fashion. The result is intended to order String values in the sort order specified by the effective locale and collation options computed during

construction of *collator*, and will be negative, zero, or positive, depending on whether *x* comes before *y* in the sort order, the Strings are equal under the sort order, or *x* comes after *y* in the sort order, respectively. String values must be interpreted as UTF-16 code unit sequences, and a *surrogate pair* (a code unit in the range 0xD800 to 0xDBFF followed by a code unit in the range 0xDC00 to 0xDFFF) within a string must be interpreted as the corresponding code point.

The sensitivity of *collator* is interpreted as follows:

- base: Only strings that differ in base letters compare as unequal. Examples: $a \neq b$, $a = \acute{a}$, $a = A$.
- accent: Only strings that differ in base letters or accents and other diacritic marks compare as unequal. Examples: $a \neq b$, $a \neq \acute{a}$, $a = A$.
- case: Only strings that differ in base letters or case compare as unequal. Examples: $a \neq b$, $a = \acute{a}$, $a \neq A$.
- variant: Strings that differ in base letters, accents and other diacritic marks, or case compare as unequal. Other differences may also be taken into consideration. Examples: $a \neq b$, $a \neq \acute{a}$, $a \neq A$.

NOTE 1 In some languages, certain letters with diacritic marks are considered base letters. For example, in Swedish, "ö" is a base letter that's different from "o".

If the collator is set to ignore punctuation, then strings that differ only in punctuation compare as equal.

For the interpretation of options settable through extension keys, see Unicode Technical Standard 35.

The CompareStrings abstract operation with any given *collator* argument, if considered as a function of the remaining two arguments *x* and *y*, must be a consistent comparison function (as defined in ES2020, 22.1.3.27) on the set of all Strings.

The actual return values are implementation-defined to permit implementers to encode additional information in the value. The method is required to return +0 when comparing Strings that are considered canonically equivalent by the Unicode standard.

NOTE 2 It is recommended that the CompareStrings abstract operation be implemented following Unicode Technical Standard 10, Unicode Collation Algorithm (available at <https://unicode.org/reports/tr10/>), using tailorings for the effective locale and collation options of *collator*. It is recommended that implementations use the tailorings provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>).

NOTE 3 Applications should not assume that the behaviour of the CompareStrings abstract operation for Collator instances with the same resolved options will remain the same for different versions of the same implementation.

11.3.4 Intl.Collator.prototype.resolvedOptions ()

This function provides access to the locale and collation options computed during initialization of the object.

1. Let *collator* be **this** value.
2. Perform ? [RequireInternalSlot](#)(*collator*, [[InitializedCollator]]).
3. Let *options* be ! [ObjectCreate](#)(%ObjectPrototype%).
4. For each row of [Table 3](#), except the header row, in table order, do
 - a. Let *p* be the Property value of the current row.
 - b. Let *v* be the value of *collator*'s internal slot whose name is the Internal Slot value of the current row.
 - c. If the current row has an Extension Key value, then
 - i. Let *extensionKey* be the Extension Key value of the current row.
 - ii. If %Collator%.[\[\[RelevantExtensionKeys\]\]](#) does not contain *extensionKey*, then
 1. Let *v* be **undefined**.
 - d. If *v* is not **undefined**, then
 - i. Perform ! [CreateDataPropertyOrThrow](#)(*options*, *p*, *v*).
5. Return *options*.

Table 3: Resolved Options of Collator Instances

Internal Slot	Property	Extension Key
[[Locale]]	"locale"	
[[Usage]]	"usage"	
[[Sensitivity]]	"sensitivity"	
[[IgnorePunctuation]]	"ignorePunctuation"	
[[Collation]]	"collation"	
[[Numeric]]	"numeric"	"kn"
[[CaseFirst]]	"caseFirst"	"kf"

11.4 Properties of Intl.Collator Instances

Intl.Collator instances are ordinary objects that inherit properties from `%CollatorPrototype%`.

Intl.Collator instances have an `[[InitializedCollator]]` internal slot.

Intl.Collator instances also have several internal slots that are computed by the `constructor`:

- `[[Locale]]` is a String value with the language tag of the locale whose localization is used for collation.
- `[[Usage]]` is one of the String values `"sort"` or `"search"`, identifying the collator usage.
- `[[Sensitivity]]` is one of the String values `"base"`, `"accent"`, `"case"`, or `"variant"`, identifying the collator's sensitivity.
- `[[IgnorePunctuation]]` is a Boolean value, specifying whether punctuation should be ignored in comparisons.
- `[[Collation]]` is a String value with the `"type"` given in Unicode Technical Standard 35 for the collation, except that the values `"standard"` and `"search"` are not allowed, while the value `"default"` is allowed.

Intl.Collator instances also have the following internal slots if the key corresponding to the name of the internal slot in Table 3 is included in the `[[RelevantExtensionKeys]]` internal slot of Intl.Collator:

- `[[Numeric]]` is a Boolean value, specifying whether numeric sorting is used.
- `[[CaseFirst]]` is one of the String values `"upper"`, `"lower"`, or `"false"`.

Finally, Intl.Collator instances have a `[[BoundCompare]]` internal slot that caches the function returned by the compare accessor (11.3.3).

12 NumberFormat Objects

12.1 Abstract Operations For NumberFormat Objects

12.1.1 SetNumberFormatDigitOptions (*intlObj*, *options*, *mnfdDefault*, *mxfdDefault*, *notation*)

The abstract operation SetNumberFormatDigitOptions applies digit options used for number formatting onto the intl object.

1. Assert: `Type(intlObj)` is Object.
2. Assert: `Type(options)` is Object.
3. Assert: `Type(mnfdDefault)` is Number.
4. Assert: `Type(mxfdDefault)` is Number.
5. Let *mnid* be ? `GetNumberOption(options, "minimumIntegerDigits", 1, 21, 1)`.

6. Let *mnfd* be ? *Get(options, "minimumFractionDigits")*.
7. Let *mxfd* be ? *Get(options, "maximumFractionDigits")*.
8. Let *mnsd* be ? *Get(options, "minimumSignificantDigits")*.
9. Let *mxsd* be ? *Get(options, "maximumSignificantDigits")*.
10. Set *intlObj*.[[MinimumIntegerDigits]] to *mnid*.
11. If *mnsd* is not **undefined** or *mxsd* is not **undefined**, then
 - a. Set *intlObj*.[[RoundingType]] to *significantDigits*.
 - b. Let *mnsd* be ? *DefaultNumberOption(mnsd, 1, 21, 1)*.
 - c. Let *mxsd* be ? *DefaultNumberOption(mxsd, mnsd, 21, 21)*.
 - d. Set *intlObj*.[[MinimumSignificantDigits]] to *mnsd*.
 - e. Set *intlObj*.[[MaximumSignificantDigits]] to *mxsd*.
12. Else if *mnfd* is not **undefined** or *mxfd* is not **undefined**, then
 - a. Set *intlObj*.[[RoundingType]] to *fractionDigits*.
 - b. Let *mnfd* be ? *DefaultNumberOption(mnfd, 0, 20, mnfdDefault)*.
 - c. Let *mxfdActualDefault* be *max(mnfd, mxfdDefault)*.
 - d. Let *mxfd* be ? *DefaultNumberOption(mxfd, mnfd, 20, mxfdActualDefault)*.
 - e. Set *intlObj*.[[MinimumFractionDigits]] to *mnfd*.
 - f. Set *intlObj*.[[MaximumFractionDigits]] to *mxfd*.
13. Else if *notation* is **"compact"**, then
 - a. Set *intlObj*.[[RoundingType]] to *compactRounding*.
14. Else,
 - a. Set *intlObj*.[[RoundingType]] to *fractionDigits*.
 - b. Set *intlObj*.[[MinimumFractionDigits]] to *mnfdDefault*.
 - c. Set *intlObj*.[[MaximumFractionDigits]] to *mxfdDefault*.

12.1.2 InitializeNumberFormat (*numberFormat, locales, options*)

The abstract operation InitializeNumberFormat accepts the arguments *numberFormat* (which must be an object), *locales*, and *options*. It initializes *numberFormat* as a NumberFormat object. The following steps are taken:

The following algorithm refers to the **type** nonterminal from UTS 35's Unicode Locale Identifier grammar.

1. Let *requestedLocales* be ? *CanonicalizeLocaleList(locales)*.
2. If *options* is **undefined**, then
 - a. Let *options* be *ObjectCreate(null)*.
3. Else,
 - a. Let *options* be ? *ToObject(options)*.
4. Let *opt* be a new *Record*.
5. Let *matcher* be ? *GetOption(options, "localeMatcher", "string", « "lookup", "best fit" », "best fit")*.
6. Set *opt*.[[localeMatcher]] to *matcher*.
7. Let *numberingSystem* be ? *GetOption(options, "numberingSystem", "string", undefined, undefined)*.
8. If *numberingSystem* is not **undefined**, then
 - a. If *numberingSystem* does not match the Unicode Locale Identifier **type** nonterminal, throw a **RangeError** exception.
9. Set *opt*.[[nu]] to *numberingSystem*.
10. Let *localeData* be *%NumberFormat%*.[[LocaleData]].
11. Let *r* be *ResolveLocale(%NumberFormat%.[[AvailableLocales]], requestedLocales, opt, %NumberFormat%.[[RelevantExtensionKeys]], localeData)*.
12. Set *numberFormat*.[[Locale]] to *r*.[[locale]].
13. Set *numberFormat*.[[DataLocale]] to *r*.[[dataLocale]].
14. Set *numberFormat*.[[NumberingSystem]] to *r*.[[nu]].
15. Perform ? *SetNumberFormatUnitOptions(numberFormat, options)*.
16. Let *style* be *numberFormat*.[[Style]].
17. If *style* is **"currency"**, then

- a. Let *currency* be *numberFormat*.[[Currency]].
 - b. Let *cDigits* be *CurrencyDigits*(*currency*).
 - c. Let *mnfdDefault* be *cDigits*.
 - d. Let *mxfdDefault* be *cDigits*.
18. Else,
- a. Let *mnfdDefault* be 0.
 - b. If *style* is "percent", then
 - i. Let *mxfdDefault* be 0.
 - c. Else,
 - i. Let *mxfdDefault* be 3.
19. Let *notation* be ? *GetOption*(*options*, "notation", "string", « "standard", "scientific", "engineering", "compact" », "standard").
20. Set *numberFormat*.[[Notation]] to *notation*.
21. Perform ? *SetNumberFormatDigitOptions*(*numberFormat*, *options*, *mnfdDefault*, *mxfdDefault*, *notation*).
22. Let *compactDisplay* be ? *GetOption*(*options*, "compactDisplay", "string", « "short", "long" », "short").
23. If *notation* is "compact", then
- a. Set *numberFormat*.[[CompactDisplay]] to *compactDisplay*.
24. Let *useGrouping* be ? *GetOption*(*options*, "useGrouping", "boolean", undefined, true).
25. Set *numberFormat*.[[UseGrouping]] to *useGrouping*.
26. Let *signDisplay* be ? *GetOption*(*options*, "signDisplay", "string", « "auto", "never", "always", "exceptZero" », "auto").
27. Set *numberFormat*.[[SignDisplay]] to *signDisplay*.
28. Return *numberFormat*.

12.1.3 CurrencyDigits (*currency*)

When the CurrencyDigits abstract operation is called with an argument *currency* (which must be an upper case String value), the following steps are taken:

1. If the ISO 4217 currency and funds code list contains *currency* as an alphabetic code, return the minor unit value corresponding to the *currency* from the list; otherwise, return 2.

12.1.4 Number Format Functions

A Number format function is an anonymous built-in function that has a [[NumberFormat]] internal slot.

When a Number format function *F* is called with optional argument *value*, the following steps are taken:

1. Let *nf* be *F*.[[NumberFormat]].
2. **Assert:** *Type*(*nf*) is Object and *nf* has an [[InitializedNumberFormat]] internal slot.
3. If *value* is not provided, let *value* be **undefined**.
4. Let *x* be ? *ToNumeric*(*value*).
5. Return ? *FormatNumeric*(*nf*, *x*).

The "length" property of a Number format function is 1.

12.1.5 FormatNumericToString (*intlObject*, *x*)

The FormatNumericToString abstract operation is called with arguments *intlObject* (which must be an object with [[RoundingType]], [[MinimumSignificantDigits]], [[MaximumSignificantDigits]], [[MinimumIntegerDigits]], [[MinimumFractionDigits]], and [[MaximumFractionDigits]] internal slots), and *x* (which must be a Number or BigInt value), and returns a **Record** containing two values: *x* as a String value with digits formatted according to the five formatting parameters in the field [[FormattedString]], and the final floating decimal value of *x* after rounding has been performed in the field [[RoundedNumber]].

1. If $x < 0$ or *x* is -0, let *isNegative* be **true**; else let *isNegative* be **false**.

2. If *isNegative*, then
 - a. Let *x* be *-x*.
3. If *intlObject*.[[RoundingType]] is *significantDigits*, then
 - a. Let *result* be *ToRawPrecision*(*x*, *intlObject*.[[MinimumSignificantDigits]], *intlObject*.[[MaximumSignificantDigits]]).
4. Else if *intlObject*.[[RoundingType]] is *fractionDigits*, then
 - a. Let *result* be *ToRawFixed*(*x*, *intlObject*.[[MinimumFractionDigits]], *intlObject*.[[MaximumFractionDigits]]).
5. Else,
 - a. **Assert**: *intlObject*.[[RoundingType]] is *compactRounding*.
 - b. Let *result* be *ToRawPrecision*(*x*, 1, 2).
 - c. If *result*.[[IntegerDigitsCount]] > 1, then
 - i. Let *result* be *ToRawFixed*(*x*, 0, 0).
6. Let *x* be *result*.[[RoundedNumber]].
7. Let *string* be *result*.[[FormattedString]].
8. Let *int* be *result*.[[IntegerDigitsCount]].
9. Let *minInteger* be *intlObject*.[[MinimumIntegerDigits]].
10. If *int* < *minInteger*, then
 - a. Let *forwardZeros* be the String consisting of *minInteger*−*int* occurrences of the character "0".
 - b. Set *string* to the string-concatenation of *forwardZeros* and *string*.
11. If *isNegative*, then
 - a. Let *x* be *-x*.
12. Return the **Record** { [[RoundedNumber]]: *x*, [[FormattedString]]: *string* }.

12.1.6 PartitionNumberPattern (*numberFormat*, *x*)

The PartitionNumberPattern abstract operation is called with arguments *numberFormat* (which must be an object initialized as a NumberFormat) and *x* (which must be a Number or BigInt value), interprets *x* as a numeric value, and creates the corresponding parts according to the effective locale and the formatting options of *numberFormat*. The following steps are taken:

1. Let *exponent* be 0.
2. If *x* is NaN, then
 - a. Let *n* be an implementation- and locale-dependent (ILD) String value indicating the NaN value.
3. Else if *x* is a non-finite Number, then
 - a. Let *n* be an ILD String value indicating infinity.
4. Else,
 - a. If *numberFormat*.[[Style]] is "percent", let *x* be $100 \times x$.
 - b. Let *exponent* be *ComputeExponent*(*numberFormat*, *x*).
 - c. Let *x* be $x \times 10^{-exponent}$.
 - d. Let *formatNumberResult* be *FormatNumericToString*(*numberFormat*, *x*).
 - e. Let *n* be *formatNumberResult*.[[FormattedString]].
 - f. Let *x* be *formatNumberResult*.[[RoundedNumber]].
5. Let *pattern* be *GetNumberFormatPattern*(*numberFormat*, *x*)
6. Let *result* be a new empty List.
7. Let *patternParts* be *PartitionPattern*(*pattern*).
8. For each element *patternPart* of *patternParts*, in List order, do
 - a. Let *p* be *patternPart*.[[Type]].
 - b. If *p* is "literal", then
 - i. Append a new **Record** { [[Type]]: "literal", [[Value]]: *patternPart*.[[Value]] } as the last element of *result*.
 - c. Else if *p* is equal to "number", then
 - i. Let *notationSubParts* be *PartitionNotationSubPattern*(*numberFormat*, *x*, *n*, *exponent*).
 - ii. Append all elements of *notationSubParts* to *result*.
 - d. Else if *p* is equal to "plusSign", then
 - i. Let *plusSignSymbol* be the ILND String representing the plus sign.
 - ii. Append a new **Record** { [[Type]]: "plusSign", [[Value]]: *plusSignSymbol* } as the last element of *result*.

- e. Else if *p* is equal to "minusSign", then
 - i. Let *minusSignSymbol* be the ILND String representing the minus sign.
 - ii. Append a new Record { [[Type]]: "minusSign", [[Value]]: *minusSignSymbol* } as the last element of *result*.
 - f. Else if *p* is equal to "percentSign" and *numberFormat*.[[Style]] is "percent", then
 - i. Let *percentSignSymbol* be the ILND String representing the percent sign.
 - ii. Append a new Record { [[Type]]: "percentSign", [[Value]]: *percentSignSymbol* } as the last element of *result*.
 - g. Else if *p* is equal to "unitPrefix" and *numberFormat*.[[Style]] is "unit", then
 - i. Let *unit* be *numberFormat*.[[Unit]].
 - ii. Let *unitDisplay* be *numberFormat*.[[UnitDisplay]].
 - iii. Let *mu* be an ILD String value representing *unit* before *x* in *unitDisplay* form, which may depend on *x* in languages having different plural forms.
 - iv. Append a new Record { [[Type]]: "unit", [[Value]]: *mu* } as the last element of *result*.
 - h. Else if *p* is equal to "unitSuffix" and *numberFormat*.[[Style]] is "unit", then
 - i. Let *unit* be *numberFormat*.[[Unit]].
 - ii. Let *unitDisplay* be *numberFormat*.[[UnitDisplay]].
 - iii. Let *mu* be an ILD String value representing *unit* after *x* in *unitDisplay* form, which may depend on *x* in languages having different plural forms.
 - iv. Append a new Record { [[Type]]: "unit", [[Value]]: *mu* } as the last element of *result*.
 - i. Else if *p* is equal to "currencyCode" and *numberFormat*.[[Style]] is "currency", then
 - i. Let *currency* be *numberFormat*.[[Currency]].
 - ii. Let *cd* be *currency*.
 - iii. Append a new Record { [[Type]]: "currency", [[Value]]: *cd* } as the last element of *result*.
 - j. Else if *p* is equal to "currencyPrefix" and *numberFormat*.[[Style]] is "currency", then
 - i. Let *currency* be *numberFormat*.[[Currency]].
 - ii. Let *currencyDisplay* be *numberFormat*.[[CurrencyDisplay]].
 - iii. Let *cd* be an ILD String value representing *currency* before *x* in *currencyDisplay* form, which may depend on *x* in languages having different plural forms.
 - iv. Append a new Record { [[Type]]: "currency", [[Value]]: *cd* } as the last element of *result*.
 - k. Else if *p* is equal to "currencySuffix" and *numberFormat*.[[Style]] is "currency", then
 - i. Let *currency* be *numberFormat*.[[Currency]].
 - ii. Let *currencyDisplay* be *numberFormat*.[[CurrencyDisplay]].
 - iii. Let *cd* be an ILD String value representing *currency* after *x* in *currencyDisplay* form, which may depend on *x* in languages having different plural forms. If the implementation does not have such a representation of *currency*, use *currency* itself.
 - iv. Append a new Record { [[Type]]: "currency", [[Value]]: *cd* } as the last element of *result*.
 - l. Else,
 - i. Let *unknown* be an ILND String based on *x* and *p*.
 - ii. Append a new Record { [[Type]]: "unknown", [[Value]]: *unknown* } as the last element of *result*.
9. Return *result*.

12.1.7 PartitionNotationSubPattern (*numberFormat*, *x*, *n*, *exponent*)

The PartitionNotationSubPattern abstract operation is called with arguments *numberFormat* (which must be an object initialized as a NumberFormat), *x* (which is a numeric value after rounding is applied), *n* (which is an intermediate formatted string), and *exponent* (an integer), and creates the corresponding parts for the number and notation according to the effective locale and the formatting options of *numberFormat*. The following steps are taken:

1. Let *result* be a new empty List.
2. If *x* is NaN, then
 - a. Append a new Record { [[Type]]: "nan", [[Value]]: *n* } as the last element of *result*.
3. Else if *x* is a non-finite Number, then
 - a. Append a new Record { [[Type]]: "infinity", [[Value]]: *n* } as the last element of *result*.
4. Else,
 - a. Let *notationSubPattern* be GetNotationSubPattern(*numberFormat*, *exponent*)

- b. Let *patternParts* be `PartitionPattern(notationSubPattern)`.
- c. For each element *patternPart* of *patternParts*, in `List` order, do
 - i. Let *p* be `patternPart.[Type]`.
 - ii. If *p* is `"literal"`, then
 - 1. Append a new `Record` { `[Type]: "literal"`, `[Value]: patternPart.[Value]` } as the last element of *result*.
 - iii. Else if *p* is equal to `"number"`, then
 - 1. If the `numberFormat.[NumberingSystem]` matches one of the values in the `"Numbering System"` column of `Table 4` below, then
 - a. Let *digits* be a `List` whose 10 `String` valued elements are the UTF-16 string representations of the 10 *digits* specified in the `"Digits"` column of the matching row in `Table 4`.
 - b. Replace each *digit* in *n* with the value of `digits[digit]`.
 - 2. Else use an implementation dependent algorithm to map *n* to the appropriate representation of *n* in the given numbering system.
 - 3. Let *decimalSepIndex* be `Call(%StringProto_indexOf%, n, « "." , 0 »)`.
 - 4. If *decimalSepIndex* > 0, then
 - a. Let *integer* be the substring of *n* from position 0, inclusive, to position *decimalSepIndex*, exclusive.
 - b. Let *fraction* be the substring of *n* from position *decimalSepIndex*, exclusive, to the end of *n*.
 - 5. Else,
 - a. Let *integer* be *n*.
 - b. Let *fraction* be `undefined`.
 - 6. If the `numberFormat.[UseGrouping]` is `true`, then
 - a. Let *groupSepSymbol* be the implementation-, locale-, and numbering system-dependent (ILND) `String` representing the grouping separator.
 - b. Let *groups* be a `List` whose elements are, in left to right order, the substrings defined by ILND set of locations within the *integer*.
 - c. **Assert:** The number of elements in *groups* `List` is greater than 0.
 - d. Repeat, while *groups* `List` is not empty
 - i. Remove the first element from *groups* and let *integerGroup* be the value of that element.
 - ii. Append a new `Record` { `[Type]: "integer"`, `[Value]: integerGroup` } as the last element of *result*.
 - iii. If *groups* `List` is not empty, then
 - i. Append a new `Record` { `[Type]: "group"`, `[Value]: groupSepSymbol` } as the last element of *result*.
 - 7. Else,
 - a. Append a new `Record` { `[Type]: "integer"`, `[Value]: integer` } as the last element of *result*.
 - 8. If *fraction* is not `undefined`, then
 - a. Let *decimalSepSymbol* be the ILND `String` representing the decimal separator.
 - b. Append a new `Record` { `[Type]: "decimal"`, `[Value]: decimalSepSymbol` } as the last element of *result*.
 - c. Append a new `Record` { `[Type]: "fraction"`, `[Value]: fraction` } as the last element of *result*.
 - iv. Else if *p* is equal to `"compactSymbol"`, then
 - 1. Let *compactSymbol* be an ILD string representing *exponent* in short form, which may depend on *x* in languages having different plural forms. The implementation must be able to provide this string, or else the pattern would not have a `"{compactSymbol}"` placeholder.
 - 2. Append a new `Record` { `[Type]: "compact"`, `[Value]: compactSymbol` } as the last element of *result*.
 - v. Else if *p* is equal to `"compactName"`, then
 - 1. Let *compactName* be an ILD string representing *exponent* in long form, which may depend on *x* in languages having different plural forms. The implementation must be able to provide this string, or else the pattern would not have a `"{compactName}"` placeholder.
 - 2. Append a new `Record` { `[Type]: "compact"`, `[Value]: compactName` } as the last element of *result*.
 - vi. Else if *p* is equal to `"scientificSeparator"`, then
 - 1. Let *scientificSeparator* be the ILND `String` representing the exponent separator.
 - 2. Append a new `Record` { `[Type]: "exponentSeparator"`, `[Value]: scientificSeparator` } as the last element of *result*.

- vii. Else if p is equal to "scientificExponent", then
 - 1. If $exponent < 0$, then
 - a. Let *minusSignSymbol* be the ILND String representing the minus sign.
 - b. Append a new Record { [[Type]]: "exponentMinusSign", [[Value]]: *minusSignSymbol* } as the last element of *result*.
 - c. Let $exponent$ be $-exponent$.
 - 2. Let *exponentResult* be `ToRawFixed(exponent, 1, 0, 0)`.
 - 3. Append a new Record { [[Type]]: "exponentInteger", [[Value]]: *exponentResult*.[[FormattedString]] } as the last element of *result*.
 - viii. Else,
 - 1. Let *unknown* be an ILND String based on x and p .
 - 2. Append a new Record { [[Type]]: "unknown", [[Value]]: *unknown* } as the last element of *result*.
5. Return *result*.

Table 4: Numbering systems with simple digit mappings

Numbering System	Digits
arab	U+0660 to U+0669
arabext	U+06F0 to U+06F9
bali	U+1B50 to U+1B59
beng	U+09E6 to U+09EF
deva	U+0966 to U+096F
fullwide	U+FF10 to U+FF19
gujr	U+0AE6 to U+0AEF
guru	U+0A66 to U+0A6F
hanidec	U+3007, U+4E00, U+4E8C, U+4E09, U+56DB, U+4E94, U+516D, U+4E03, U+516B, U+4E5D
khmr	U+17E0 to U+17E9
knda	U+0CE6 to U+0CEF
laoo	U+0ED0 to U+0ED9
latn	U+0030 to U+0039
limb	U+1946 to U+194F
mlym	U+0D66 to U+0D6F
mong	U+1810 to U+1819
mymr	U+1040 to U+1049
orya	U+0B66 to U+0B6F
tamldec	U+0BE6 to U+0BEF
telu	U+0C66 to U+0C6F
thai	U+0E50 to U+0E59
tibt	U+0F20 to U+0F29

NOTE 1 The computations rely on String values and locations within numeric strings that are dependent upon the implementation and the effective locale of *numberFormat* ("ILD") or upon the implementation, the effective locale, and the numbering system of *numberFormat* ("ILND"). The ILD and ILND Strings mentioned, other than those for currency names, must not contain any characters in the General Category "Number, decimal digit" as specified by the Unicode Standard.

NOTE 2 It is recommended that implementations use the locale provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>).

12.1.8 FormatNumeric(*numberFormat*, *x*)

The FormatNumeric abstract operation is called with arguments *numberFormat* (which must be an object initialized as a NumberFormat) and *x* (which must be a Number or BigInt value), and performs the following steps:

1. Let *parts* be ? PartitionNumberPattern(*numberFormat*, *x*).
2. Let *result* be the empty String.
3. For each *part* in *parts*, do
 - a. Set *result* to the string-concatenation of *result* and *part*.[[Value]].
4. Return *result*.

12.1.9 FormatNumericToParts(*numberFormat*, *x*)

The FormatNumericToParts abstract operation is called with arguments *numberFormat* (which must be an object initialized as a NumberFormat) and *x* (which must be a Number or BigInt value), and performs the following steps:

1. Let *parts* be ? PartitionNumberPattern(*numberFormat*, *x*).
2. Let *result* be ArrayCreate(0).
3. Let *n* be 0.
4. For each *part* in *parts*, do
 - a. Let *O* be ObjectCreate(%ObjectPrototype%).
 - b. Perform ! CreateDataPropertyOrThrow(*O*, "type", *part*.[[Type]]).
 - c. Perform ! CreateDataPropertyOrThrow(*O*, "value", *part*.[[Value]]).
 - d. Perform ! CreateDataPropertyOrThrow(*result*, ! ToString(*n*), *O*).
 - e. Increment *n* by 1.
5. Return *result*.

12.1.10 ToRawPrecision(*x*, *minPrecision*, *maxPrecision*)

When the ToRawPrecision abstract operation is called with arguments *x* (which must be a finite non-negative Number or BigInt), *minPrecision*, and *maxPrecision* (both must be integers between 1 and 21), the following steps are taken:

1. Let *p* be *maxPrecision*.
2. If *x* = 0, then
 - a. Let *m* be the String consisting of *p* occurrences of the character "0".
 - b. Let *e* be 0.
 - c. Let *xFinal* be 0.
3. Else,
 - a. Let *e* be the base 10 logarithm of *x* rounded down to the nearest integer.
 - b. Let *n* be an integer such that $10^{p-1} \leq n < 10^p$ and for which the exact mathematical value of $n \times 10^{e-p+1} - x$ is as close to zero as possible. If there is more than one such *n*, pick the one for which $n \times 10^{e-p+1}$ is larger.
 - c. Let *m* be the String consisting of the digits of the decimal representation of *n* (in order, with no leading zeroes).
 - d. Let *xFinal* be $n \times 10^{e-p+1}$.
4. If $e \geq p-1$, then
 - a. Let *m* be the string-concatenation of *m* and $e-p+1$ occurrences of the character "0".
 - b. Let *int* be $e+1$.

5. Else if $e \geq 0$, then
 - a. Let m be the **string-concatenation** of the first $e+1$ characters of m , the character ".", and the remaining $p-(e+1)$ characters of m .
 - b. Let int be $e+1$.
6. Else,
 - a. **Assert**: $e < 0$.
 - b. Let m be the **string-concatenation** of the String value "0.", $-(e+1)$ occurrences of the character "0", and m .
 - c. Let int be 1.
7. If m contains the character ".", and $maxPrecision > minPrecision$, then
 - a. Let cut be $maxPrecision - minPrecision$.
 - b. Repeat, while $cut > 0$ and the last character of m is "0"
 - i. Remove the last character from m .
 - ii. Decrease cut by 1.
 - c. If the last character of m is ".", then
 - i. Remove the last character from m .
8. Return the **Record** { [[FormattedString]]: m , [[RoundedNumber]]: $xFinal$, [[IntegerDigitsCount]]: int }.

12.1.11 ToRawFixed(x , $minInteger$, $minFraction$, $maxFraction$)

When the ToRawFixed abstract operation is called with arguments x (which must be a finite non-negative Number or BigInt), $minInteger$ (which must be an integer between 1 and 21), $minFraction$, and $maxFraction$ (which must be integers between 0 and 20), the following steps are taken:

1. Let f be $maxFraction$.
2. Let n be an integer for which the exact mathematical value of $n \div 10^f - x$ is as close to zero as possible. If there are two such n , pick the larger n .
3. Let $xFinal$ be $n \div 10^f$.
4. If $n = 0$, let m be the String "0". Otherwise, let m be the String consisting of the digits of the decimal representation of n (in order, with no leading zeroes).
5. If $f \neq 0$, then
 - a. Let k be the number of characters in m .
 - b. If $k \leq f$, then
 - i. Let z be the String value consisting of $f+1-k$ occurrences of the character "0".
 - ii. Let m be the **string-concatenation** of z and m .
 - iii. Let k be $f+1$.
 - c. Let a be the first $k-f$ characters of m , and let b be the remaining f characters of m .
 - d. Let m be the **string-concatenation** of a , ".", and b .
 - e. Let int be the number of characters in a .
6. Else, let int be the number of characters in m .
7. Let cut be $maxFraction - minFraction$.
8. Repeat, while $cut > 0$ and the last character of m is "0"
 - a. Remove the last character from m .
 - b. Decrease cut by 1.
9. If the last character of m is ".", then
 - a. Remove the last character from m .
10. Return the **Record** { [[FormattedString]]: m , [[RoundedNumber]]: $xFinal$, [[IntegerDigitsCount]]: int }.

12.1.12 UnwrapNumberFormat(nf)

The UnwrapNumberFormat abstract operation gets the underlying NumberFormat operation for various methods which implement ECMA-402 v1 semantics for supporting initializing existing Intl objects.

1. **Assert**: $Type(nf)$ is Object.

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2. If *nf* does not have an `[[InitializedNumberFormat]]` internal slot and `? InstanceofOperator(nf, %NumberFormat%)` is **true**, then
 - a. Let *nf* be `? Get(nf, %Intl%.[[FallbackSymbol]])`.
3. Perform `? RequireInternalSlot(nf, [[InitializedNumberFormat]])`.
4. Return *nf*.

NOTE See 8.1 Note 1 for the motivation of the normative optional text.

12.1.13 SetNumberFormatUnitOptions (*intlObj*, *options*)

The abstract operation SetNumberFormatUnitOptions resolves the user-specified options relating to units onto the intl object.

1. Assert: Type(*intlObj*) is Object.
2. Assert: Type(*options*) is Object.
3. Let *style* be `? GetOption(options, "style", "string", « "decimal", "percent", "currency", "unit" », "decimal")`.
4. Set *intlObj*.[[Style]] to *style*.
5. Let *currency* be `? GetOption(options, "currency", "string", undefined, undefined)`.
6. If *currency* is not **undefined**, then
 - a. If the result of `IsWellFormedCurrencyCode(currency)` is **false**, throw a **RangeError** exception.
7. If *style* is "currency" and *currency* is **undefined**, throw a **TypeError** exception.
8. Let *currencyDisplay* be `? GetOption(options, "currencyDisplay", "string", « "code", "symbol", "narrowSymbol", "name" », "symbol")`.
9. Let *currencySign* be `? GetOption(options, "currencySign", "string", « "standard", "accounting" », "standard")`.
10. Let *unit* be `? GetOption(options, "unit", "string", undefined, undefined)`.
11. If *unit* is not **undefined**, then
 - a. If the result of `IsWellFormedUnitIdentifier(unit)` is **false**, throw a **RangeError** exception.
12. If *style* is "unit" and *unit* is **undefined**, throw a **TypeError** exception.
13. Let *unitDisplay* be `? GetOption(options, "unitDisplay", "string", « "short", "narrow", "long" », "short")`.
14. If *style* is "currency", then
 - a. Let *currency* be the result of converting *currency* to upper case as specified in 6.1.
 - b. Set *intlObj*.[[Currency]] to *currency*.
 - c. Set *intlObj*.[[CurrencyDisplay]] to *currencyDisplay*.
 - d. Set *intlObj*.[[CurrencySign]] to *currencySign*.
15. If *style* is "unit", then
 - a. Set *intlObj*.[[Unit]] to *unit*.
 - b. Set *intlObj*.[[UnitDisplay]] to *unitDisplay*.

12.1.14 GetNumberFormatPattern (*numberFormat*, *x*)

The abstract operation GetNumberFormatPattern considers the resolved unit-related options in the number format object along with the final scaled and rounded number being formatted and returns a pattern, a String value as described in 12.3.3.

1. Let *localeData* be `%NumberFormat%.[[LocaleData]]`.
2. Let *dataLocale* be `numberFormat.[[DataLocale]]`.
3. Let *dataLocaleData* be `localeData.[[<dataLocale>]]`.
4. Let *patterns* be `dataLocaleData.[[patterns]]`.
5. Assert: *patterns* is a **Record** (see 12.3.3).
6. Let *style* be `numberFormat.[[Style]]`.
7. If *style* is "percent", then
 - a. Let *patterns* be `patterns.[[percent]]`.

8. Else if *style* is "unit", then
 - a. Let *unit* be *numberFormat*.[[Unit]].
 - b. Let *unitDisplay* be *numberFormat*.[[UnitDisplay]].
 - c. Let *patterns* be *patterns*.[[unit]].
 - d. If *patterns* doesn't have a field [[<*unit*>]], then
 - i. Let *unit* be "fallback".
 - e. Let *patterns* be *patterns*.[[<*unit*>]].
 - f. Let *patterns* be *patterns*.[[<*unitDisplay*>]].
9. Else if *style* is "currency", then
 - a. Let *currency* be *numberFormat*.[[Currency]].
 - b. Let *currencyDisplay* be *numberFormat*.[[CurrencyDisplay]].
 - c. Let *currencySign* be *numberFormat*.[[CurrencySign]].
 - d. Let *patterns* be *patterns*.[[currency]].
 - e. If *patterns* doesn't have a field [[<*currency*>]], then
 - i. Let *currency* be "fallback".
 - f. Let *patterns* be *patterns*.[[<*currency*>]].
 - g. Let *patterns* be *patterns*.[[<*currencyDisplay*>]].
 - h. Let *patterns* be *patterns*.[[<*currencySign*>]].
10. Else,
 - a. Assert: *style* is "decimal".
 - b. Let *patterns* be *patterns*.[[decimal]].
11. Let *signDisplay* be *numberFormat*.[[SignDisplay]].
12. If *signDisplay* is "never", then
 - a. Let *pattern* be *patterns*.[[zeroPattern]].
13. Else if *signDisplay* is "auto", then
 - a. If *x* is 0 or *x* > 0 or *x* is NaN, then
 - i. Let *pattern* be *patterns*.[[zeroPattern]].
 - b. Else,
 - i. Let *pattern* be *patterns*.[[negativePattern]].
14. Else if *signDisplay* is "always", then
 - a. If *x* is 0 or *x* > 0 or *x* is NaN, then
 - i. Let *pattern* be *patterns*.[[positivePattern]].
 - b. Else,
 - i. Let *pattern* be *patterns*.[[negativePattern]].
15. Else,
 - a. Assert: *signDisplay* is "exceptZero".
 - b. If *x* is 0 or *x* is -0 or *x* is NaN, then
 - i. Let *pattern* be *patterns*.[[zeroPattern]].
 - c. Else if *x* > 0, then
 - i. Let *pattern* be *patterns*.[[positivePattern]].
 - d. Else,
 - i. Let *pattern* be *patterns*.[[negativePattern]].
16. Return *pattern*.

12.1.15 GetNotationSubPattern (*numberFormat*, *exponent*)

The abstract operation GetNotationSubPattern considers the resolved notation and *exponent*, and returns a String value for the notation sub pattern as described in 12.3.3.

1. Let *localeData* be %NumberFormat%.[[LocaleData]].
2. Let *dataLocale* be *numberFormat*.[[DataLocale]].
3. Let *dataLocaleData* be *localeData*.[[<*dataLocale*>]].
4. Let *notationSubPatterns* be *dataLocaleData*.[[notationSubPatterns]].
5. Assert: *notationSubPatterns* is a Record (see 12.3.3).

6. Let *notation* be *numberFormat*.[[Notation]].
7. If *notation* is "scientific" or *notation* is "engineering", then
 - a. Return *notationSubPatterns*.[[scientific]].
8. Else if *exponent* is not 0, then
 - a. Assert: *notation* is "compact".
 - b. Let *compactDisplay* be *numberFormat*.[[CompactDisplay]].
 - c. Let *compactPatterns* be *notationSubPatterns*.[[compact]].[<*compactDisplay*>]].
 - d. Return *compactPatterns*.[<*exponent*>]].
9. Else,
 - a. Return "{number}".

12.1.16 ComputeExponent (*numberFormat*, *x*)

The abstract operation ComputeExponent computes an exponent (power of ten) by which to scale *x* according to the number formatting settings. It handles cases such as 999 rounding up to 1000, requiring a different exponent.

1. If $x = 0$, then
 - a. Return 0.
2. If $x < 0$, then
 - a. Let $x = -x$.
3. Let *magnitude* be the base 10 logarithm of *x* rounded down to the nearest integer.
4. Let *exponent* be ComputeExponentForMagnitude(*numberFormat*, *magnitude*).
5. Let *x* be $x \times 10^{-\textit{exponent}}$.
6. Let *formatNumberResult* be FormatNumericToString(*numberFormat*, *x*).
7. If *formatNumberResult*.[[RoundedNumber]] = 0, then
 - a. Return *exponent*.
8. Let *newMagnitude* be the base 10 logarithm of *x* rounded down to the nearest integer.
9. If *newMagnitude* is *magnitude* – *exponent*, then
 - a. Return *exponent*.
10. Return ComputeExponentForMagnitude(*numberFormat*, *magnitude* + 1).

12.1.17 ComputeExponentForMagnitude (*numberFormat*, *magnitude*)

The abstract operation ComputeExponentHelper computes an exponent by which to scale a number of the given magnitude (power of ten of the most significant digit) according to the locale and the desired notation (scientific, engineering, or compact).

1. Let *notation* be *numberFormat*.[[Notation]].
2. If *notation* is "standard", then
 - a. Return 0.
3. Else if *notation* is "scientific", then
 - a. Return *magnitude*.
4. Else if *notation* is "engineering", then
 - a. Let *thousands* be the greatest integer that is not greater than $\textit{magnitude} \div 3$.
 - b. Return *thousands* × 3.
5. Else,
 - a. Assert: *notation* is "compact".
 - b. Let *exponent* be an implementation- and locale-dependent (ILD) integer by which to scale a number of the given magnitude in compact notation for the current locale.
 - c. Return *exponent*.

12.2 The Intl.NumberFormat Constructor

The NumberFormat constructor is the %NumberFormat% intrinsic object and a standard built-in property of the Intl object.

Behaviour common to all service [constructor](#) properties of the Intl object is specified in 9.1.

12.2.1 Intl.NumberFormat ([*locales* [, *options*]])

When the **Intl.NumberFormat** function is called with optional arguments *locales* and *options*, the following steps are taken:

1. If *NewTarget* is **undefined**, let *newTarget* be the [active function object](#), else let *newTarget* be *NewTarget*.
2. Let *numberFormat* be ? [OrdinaryCreateFromConstructor](#)(*newTarget*, "%NumberFormatPrototype%", «
[[InitializedNumberFormat]], [[Locale]], [[DataLocale]], [[NumberingSystem]], [[Style]], [[Unit]], [[UnitDisplay]],
[[Currency]], [[CurrencyDisplay]], [[CurrencySign]], [[MinimumIntegerDigits]], [[MinimumFractionDigits]],
[[MaximumFractionDigits]], [[MinimumSignificantDigits]], [[MaximumSignificantDigits]], [[RoundingType]],
[[Notation]], [[CompactDisplay]], [[UseGrouping]], [[SignDisplay]], [[BoundFormat]] »).
3. Perform ? [InitializeNumberFormat](#)(*numberFormat*, *locales*, *options*).

NORMATIVE OPTIONAL

4. Let *this* be the **this** value.
5. If *NewTarget* is **undefined** and [Type](#)(*this*) is Object and ? [InstanceofOperator](#)(*this*, %NumberFormat%) is **true**, then
 - a. Perform ? [DefinePropertyOrThrow](#)(*this*, %Intl%.[\[\[FallbackSymbol\]\]](#), PropertyDescriptor{ [[Value]]:
numberFormat, [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }).
 - b. Return *this*.

6. Return *numberFormat*.

NOTE See 8.1 Note 1 for the motivation of the normative optional text.

12.3 Properties of the Intl.NumberFormat Constructor

The Intl.NumberFormat [constructor](#) has the following properties:

12.3.1 Intl.NumberFormat.prototype

The value of **Intl.NumberFormat.prototype** is %NumberFormatPrototype%.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

12.3.2 Intl.NumberFormat.supportedLocalesOf (*locales* [, *options*])

When the **supportedLocalesOf** method is called with arguments *locales* and *options*, the following steps are taken:

1. Let *availableLocales* be %NumberFormat%.[\[\[AvailableLocales\]\]](#).
2. Let *requestedLocales* be ? [CanonicalizeLocaleList](#)(*locales*).
3. Return ? [SupportedLocales](#)(*availableLocales*, *requestedLocales*, *options*).

The value of the "length" property of the **supportedLocalesOf** method is 1.

12.3.3 Internal slots

The value of the [\[\[AvailableLocales\]\]](#) internal slot is implementation defined within the constraints described in 9.1.

The value of the [\[\[RelevantExtensionKeys\]\]](#) internal slot is « "nu" ».

NOTE 1 Unicode Technical Standard 35 describes two locale extension keys that are relevant to number formatting, "nu" for numbering system and "cu" for currency. Intl.NumberFormat, however, requires that the currency of a currency format is specified through the currency property in the options objects.

The value of the [[LocaleData]] internal slot is implementation defined within the constraints described in 9.1 and the following additional constraints:

- The list that is the value of the "nu" field of any locale field of [[LocaleData]] must not include the values "native", "traditio", or "finance".
- [[LocaleData]].[[<locale>]] must have a [[patterns]] field for all locale values *locale*. The value of this field must be a Record, which must have fields with the names of the four number format styles: "decimal", "percent", "currency", and "unit".
- The two fields "currency" and "unit" noted above must be Records with at least one field, "fallback". The "currency" may have additional fields with keys corresponding to currency codes according to 6.3. Each field of "currency" must be a Record with fields corresponding to the possible currencyDisplay values: "code", "symbol", "narrowSymbol", and "name". Each of those fields must contain a Record with fields corresponding to the possible currencySign values: "standard" or "accounting". The "unit" field (of [[LocaleData]].[[<locale>]]) may have additional fields beyond the required field "fallback" with keys corresponding to core measurement unit identifiers corresponding to 6.5. Each field of "unit" must be a Record with fields corresponding to the possible unitDisplay values: "narrow", "short", and "long".
- All of the leaf fields so far described for the patterns tree ("decimal", "percent", great-grandchildren of "currency", and grandchildren of "unit") must be Records with the keys "positivePattern", "zeroPattern", and "negativePattern".
- The value of the aforementioned fields (the sign-dependent pattern fields) must be string values that must contain the substring "{number}". "positivePattern" must contain the substring "{plusSign}" but not "{minusSign}"; "negativePattern" must contain the substring "{minusSign}" but not "{plusSign}"; and "zeroPattern" must not contain either "{plusSign}" or "{minusSign}". Additionally, the values within the "percent" field must also contain the substring "{percentSign}"; the values within the "currency" field must also contain one or more of the following substrings: "{currencyCode}", "{currencyPrefix}", or "{currencySuffix}"; and the values within the "unit" field must also contain one or more of the following substrings: "{unitPrefix}" or "{unitSuffix}". The pattern strings must not contain any characters in the General Category "Number, decimal digit" as specified by the Unicode Standard.
- [[LocaleData]].[[<locale>]] must also have a [[notationSubPatterns]] field for all locale values *locale*. The value of this field must be a Record, which must have two fields: [[scientific]] and [[compact]]. The [[scientific]] field must be a string value containing the substrings "{number}", "{scientificSeparator}", and "{scientificExponent}". The [[compact]] field must be a Record with two fields: "short" and "long". Each of these fields must be a Record with integer keys corresponding to all discrete magnitudes the implementation supports for compact notation. Each of these fields must be a string value which may contain the substring "{number}". Strings descended from "short" must contain the substring "{compactSymbol}", and strings descended from "long" must contain the substring "{compactName}".

NOTE 2 It is recommended that implementations use the locale data provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>).

12.4 Properties of the Intl.NumberFormat Prototype Object

The Intl.NumberFormat prototype object is itself an ordinary object. %NumberFormatPrototype% is not an Intl.NumberFormat instance and does not have an [[InitializedNumberFormat]] internal slot or any of the other internal slots of Intl.NumberFormat instance objects.

12.4.1 Intl.NumberFormat.prototype.constructor

The initial value of Intl.NumberFormat.prototype.constructor is the intrinsic object %NumberFormat%.

12.4.2 Intl.NumberFormat.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the String value "Object".

This property has the attributes { `[[Writable]]: false`, `[[Enumerable]]: false`, `[[Configurable]]: true` }.

12.4.3 `Intl.NumberFormat.prototype.format`

`Intl.NumberFormat.prototype.format` is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *nf* be the **this** value.
2. If `Type(nf)` is not `Object`, throw a **TypeError** exception.
3. Let *nf* be ? `UnwrapNumberFormat(nf)`.
4. If `nf.[[BoundFormat]]` is **undefined**, then
 - a. Let *F* be a new built-in [function object](#) as defined in [Number Format Functions \(12.1.4\)](#).
 - b. Set `F.[[NumberFormat]]` to *nf*.
 - c. Set `nf.[[BoundFormat]]` to *F*.
5. Return `nf.[[BoundFormat]]`.

NOTE The returned function is bound to *nf* so that it can be passed directly to `Array.prototype.map` or other functions. This is considered a historical artefact, as part of a convention which is no longer followed for new features, but is preserved to maintain compatibility with existing programs.

12.4.4 `Intl.NumberFormat.prototype.formatToParts (value)`

When the `formatToParts` method is called with an optional argument *value*, the following steps are taken:

1. Let *nf* be the **this** value.
2. Perform ? `RequireInternalSlot(nf, [[InitializedNumberFormat]])`.
3. Let *x* be ? `ToNumeric(value)`.
4. Return ? `FormatNumericToParts(nf, x)`.

12.4.5 `Intl.NumberFormat.prototype.resolvedOptions ()`

This function provides access to the locale and formatting options computed during initialization of the object.

1. Let *nf* be **this** value.
2. If `Type(nf)` is not `Object`, throw a **TypeError** exception.
3. Let *nf* be ? `UnwrapNumberFormat(nf)`.
4. Let *options* be ! `ObjectCreate(%ObjectPrototype%)`.
5. For each row of [Table 5](#), except the header row, in table order, do
 - a. Let *p* be the Property value of the current row.
 - b. Let *v* be the value of *nf*'s internal slot whose name is the Internal Slot value of the current row.
 - c. If *v* is not **undefined**, then
 - i. Perform ! `CreateDataPropertyOrThrow(options, p, v)`.
6. Return *options*.

Table 5: Resolved Options of NumberFormat Instances

Internal Slot	Property
[[Locale]]	"locale"
[[NumberingSystem]]	"numberingSystem"
[[Style]]	"style"
[[Currency]]	"currency"
[[CurrencyDisplay]]	"currencyDisplay"
[[CurrencySign]]	"currencySign"
[[Unit]]	"unit"
[[UnitDisplay]]	"unitDisplay"
[[MinimumIntegerDigits]]	"minimumIntegerDigits"
[[MinimumFractionDigits]]	"minimumFractionDigits"
[[MaximumFractionDigits]]	"maximumFractionDigits"
[[MinimumSignificantDigits]]	"minimumSignificantDigits"
[[MaximumSignificantDigits]]	"maximumSignificantDigits"
[[UseGrouping]]	"useGrouping"
[[Notation]]	"notation"
[[CompactDisplay]]	"compactDisplay"
[[SignDisplay]]	"signDisplay"

12.5 Properties of Intl.NumberFormat Instances

Intl.NumberFormat instances are ordinary objects that inherit properties from [%NumberFormatPrototype%](#).

Intl.NumberFormat instances have an `[[InitializedNumberFormat]]` internal slot.

Intl.NumberFormat instances also have several internal slots that are computed by the [constructor](#):

- `[[Locale]]` is a String value with the language tag of the locale whose localization is used for formatting.
- `[[DataLocale]]` is a String value with the language tag of the nearest locale for which the implementation has data to perform the formatting operation. It will be a parent locale of `[[Locale]]`.
- `[[NumberingSystem]]` is a String value with the "type" given in Unicode Technical Standard 35 for the numbering system used for formatting.
- `[[Style]]` is one of the String values **"decimal"**, **"currency"**, **"percent"**, or **"unit"**, identifying the type of quantity being measured.
- `[[Currency]]` is a String value with the currency code identifying the currency to be used if formatting with the **"currency"** unit type. It is only used when `[[Style]]` has the value **"currency"**.
- `[[CurrencyDisplay]]` is one of the String values **"code"**, **"symbol"**, **"narrowSymbol"**, or **"name"**, specifying whether to display the currency as an ISO 4217 alphabetic currency code, a localized currency symbol, or a localized currency name if formatting with the **"currency"** style. It is only used when `[[Style]]` has the value **"currency"**.
- `[[CurrencySign]]` is one of the String values **"standard"** or **"accounting"**, specifying whether to render negative numbers in accounting format, often signified by parenthesis. It is only used when `[[Style]]` has the value **"currency"** and when `[[SignDisplay]]` is not **"never"**.
- `[[Unit]]` is a core unit identifier, as defined by Unicode Technical Standard #35, Part 2, Section 6. It is only used when

[[Style]] has the value **"unit"**.

- [[UnitDisplay]] is one of the String values **"short"**, **"narrow"**, or **"long"**, specifying whether to display the unit as a symbol, narrow symbol, or localized long name if formatting with the **"unit"** style. It is only used when [[Style]] has the value **"unit"**.
- [[MinimumIntegerDigits]] is a non-negative **integer Number value** indicating the minimum **integer** digits to be used. Numbers will be padded with leading zeroes if necessary.
- [[MinimumFractionDigits]] and [[MaximumFractionDigits]] are non-negative **integer** Number values indicating the minimum and maximum fraction digits to be used. Numbers will be rounded or padded with trailing zeroes if necessary. These properties are only used when [[RoundingType]] is **fractionDigits**.
- [[MinimumSignificantDigits]] and [[MaximumSignificantDigits]] are positive **integer** Number values indicating the minimum and maximum fraction digits to be shown. If present, the formatter uses however many fraction digits are required to display the specified number of significant digits. These properties are only used when [[RoundingType]] is **significantDigits**.
- [[UseGrouping]] is a Boolean value indicating whether a grouping separator should be used.
- [[RoundingType]] is one of the values **fractionDigits**, **significantDigits**, or **compactRounding**, indicating which rounding strategy to use. If **fractionDigits**, the number is rounded according to [[MinimumFractionDigits]] and [[MaximumFractionDigits]], as described above. If **significantDigits**, the number is rounded according to [[MinimumSignificantDigits]] and [[MaximumSignificantDigits]] as described above. If **compactRounding**, the number is rounded to 1 maximum fraction digit if there is 1 digit before the decimal separator, and otherwise round to 0 fraction digits.
- [[Notation]] is one of the String values **"standard"**, **"scientific"**, **"engineering"**, or **"compact"**, specifying whether the number should be displayed without scaling, scaled to the units place with the power of ten in scientific notation, scaled to the nearest thousand with the power of ten in scientific notation, or scaled to the nearest locale-dependent compact decimal notation power of ten with the corresponding compact decimal notation affix.
- [[CompactDisplay]] is one of the String values **"short"** or **"long"**, specifying whether to display compact notation affixes in short form ("5K") or long form ("5 thousand") if formatting with the **"compact"** notation. It is only used when [[Notation]] has the value **"compact"**.
- [[SignDisplay]] is one of the String values **"auto"**, **"always"**, **"never"**, or **"exceptZero"**, specifying whether to show the sign on negative numbers only, positive and negative numbers including zero, neither positive nor negative numbers, or positive and negative numbers but not zero. In scientific notation, this slot affects the sign display of the mantissa but not the exponent.

Finally, Intl.NumberFormat instances have a [[BoundFormat]] internal slot that caches the function returned by the format accessor (12.4.3).

13 DateTimeFormat Objects

13.1 Abstract Operations For DateTimeFormat Objects

Several DateTimeFormat algorithms use values from the following table, which provides internal slots, property names and allowable values for the components of date and time formats:

Table 6: Components of date and time formats

Internal Slot	Property	Values
[[Weekday]]	"weekday"	"narrow", "short", "long"
[[Era]]	"era"	"narrow", "short", "long"
[[Year]]	"year"	"2-digit", "numeric"
[[Month]]	"month"	"2-digit", "numeric", "narrow", "short", "long"
[[Day]]	"day"	"2-digit", "numeric"
[[Hour]]	"hour"	"2-digit", "numeric"
[[Minute]]	"minute"	"2-digit", "numeric"
[[Second]]	"second"	"2-digit", "numeric"
[[TimeZoneName]]	"timeZoneName"	"short", "long"

13.1.1 InitializeDateTimeFormat (*dateTimeFormat*, *locales*, *options*)

The abstract operation InitializeDateTimeFormat accepts the arguments *dateTimeFormat* (which must be an object), *locales*, and *options*. It initializes *dateTimeFormat* as a DateTimeFormat object. This abstract operation functions as follows:

The following algorithm refers to the **type** nonterminal from UTS 35's Unicode Locale Identifier grammar.

1. Let *requestedLocales* be ? CanonicalizeLocaleList(*locales*).
2. Let *options* be ? ToDateTimeOptions(*options*, "any", "date").
3. Let *opt* be a new Record.
4. Let *matcher* be ? GetOption(*options*, "localeMatcher", "string", « "lookup", "best fit" », "best fit").
5. Set *opt*.[[localeMatcher]] to *matcher*.
6. Let *calendar* be ? GetOption(*options*, "calendar", "string", undefined, undefined).
7. If *calendar* is not **undefined**, then
 - a. If *calendar* does not match the Unicode Locale Identifier **type** nonterminal, throw a RangeError exception.
8. Set *opt*.[[ca]] to *calendar*.
9. Let *numberingSystem* be ? GetOption(*options*, "numberingSystem", "string", undefined, undefined).
10. If *numberingSystem* is not **undefined**, then
 - a. If *numberingSystem* does not match the Unicode Locale Identifier **type** nonterminal, throw a RangeError exception.
11. Set *opt*.[[nu]] to *numberingSystem*.
12. Let *hour12* be ? GetOption(*options*, "hour12", "boolean", undefined, undefined).
13. Let *hourCycle* be ? GetOption(*options*, "hourCycle", "string", « "h11", "h12", "h23", "h24" », undefined).
14. If *hour12* is not **undefined**, then
 - a. Let *hourCycle* be **null**.
15. Set *opt*.[[hc]] to *hourCycle*.
16. Let *localeData* be %DateTimeFormat%.[[LocaleData]].
17. Let *r* be ResolveLocale(%DateTimeFormat%.[[AvailableLocales]], *requestedLocales*, *opt*, %DateTimeFormat%.[[RelevantExtensionKeys]], *localeData*).
18. Set *dateTimeFormat*.[[Locale]] to *r*.[[locale]].
19. Let *calendar* be *r*.[[ca]].
20. Set *dateTimeFormat*.[[Calendar]] to *calendar*.
21. Set *dateTimeFormat*.[[HourCycle]] to *r*.[[hc]].
22. Set *dateTimeFormat*.[[NumberingSystem]] to *r*.[[nu]].
23. Let *dataLocale* be *r*.[[dataLocale]].
24. Let *timeZone* be ? Get(*options*, "timeZone").

25. If *timeZone* is not **undefined**, then
 - a. Let *timeZone* be ? ToString(*timeZone*).
 - b. If the result of IsValidTimeZoneName(*timeZone*) is **false**, then
 - i. Throw a **RangeError** exception.
 - c. Let *timeZone* be CanonicalizeTimeZoneName(*timeZone*).
26. Else,
 - a. Let *timeZone* be DefaultTimeZone().
27. Set *dateTimeFormat*.[[TimeZone]] to *timeZone*.
28. Let *opt* be a new Record.
29. For each row of Table 6, except the header row, in table order, do
 - a. Let *prop* be the name given in the Property column of the row.
 - b. Let *value* be ? GetOption(*options*, *prop*, "string", « the strings given in the Values column of the row », **undefined**).
 - c. Set *opt*.[[<prop>]] to *value*.
30. Let *dataLocaleData* be localeData.[[<dataLocale>]].
31. Let *formats* be dataLocaleData.[[formats]].[[<calendar>]].
32. Let *matcher* be ? GetOption(*options*, "formatMatcher", "string", « "basic", "best fit" », "best fit").
33. If *matcher* is "basic", then
 - a. Let *bestFormat* be BasicFormatMatcher(*opt*, *formats*).
34. Else,
 - a. Let *bestFormat* be BestFitFormatMatcher(*opt*, *formats*).
35. For each row in Table 6, except the header row, in table order, do
 - a. Let *prop* be the name given in the Property column of the row.
 - b. Let *p* be *bestFormat*.[[<prop>]].
 - c. If *p* not **undefined**, then
 - i. Set *dateTimeFormat*'s internal slot whose name is the Internal Slot column of the row to *p*.
36. If *dateTimeFormat*.[[Hour]] is not **undefined**, then
 - a. Let *hcDefault* be dataLocaleData.[[hourCycle]].
 - b. Let *hc* be *dateTimeFormat*.[[HourCycle]].
 - c. If *hc* is **null**, then
 - i. Set *hc* to *hcDefault*.
 - d. If *hour12* is not **undefined**, then
 - i. If *hour12* is **true**, then
 1. If *hcDefault* is "h11" or "h23", then
 - a. Set *hc* to "h11".
 2. Else,
 - a. Set *hc* to "h12".
 - ii. Else,
 1. Assert: *hour12* is **false**.
 2. If *hcDefault* is "h11" or "h23", then
 - a. Set *hc* to "h23".
 3. Else,
 - a. Set *hc* to "h24".
 - e. Set *dateTimeFormat*.[[HourCycle]] to *hc*.
 - f. If *dateTimeFormat*.[[HourCycle]] is "h11" or "h12", then
 - i. Let *pattern* be *bestFormat*.[[pattern12]].
 - g. Else,
 - i. Let *pattern* be *bestFormat*.[[pattern]].
37. Else,
 - a. Set *dateTimeFormat*.[[HourCycle]] to **undefined**.
 - b. Let *pattern* be *bestFormat*.[[pattern]].
38. Set *dateTimeFormat*.[[Pattern]] to *pattern*.
39. Return *dateTimeFormat*.

13.1.2 ToDateWithOptions (*options*, *required*, *defaults*)

When the `ToDateTimeOptions` abstract operation is called with arguments *options*, *required*, and *defaults*, the following steps are taken:

1. If *options* is **undefined**, let *options* be **null**; otherwise let *options* be `? ToObject(options)`.
2. Let *options* be `ObjectCreate(options)`.
3. Let *needDefaults* be **true**.
4. If *required* is **"date"** or **"any"**, then
 - a. For each of the property names **"weekday"**, **"year"**, **"month"**, **"day"**, do
 - i. Let *prop* be the **property name**.
 - ii. Let *value* be `? Get(options, prop)`.
 - iii. If *value* is not **undefined**, let *needDefaults* be **false**.
5. If *required* is **"time"** or **"any"**, then
 - a. For each of the property names **"hour"**, **"minute"**, **"second"**, do
 - i. Let *prop* be the **property name**.
 - ii. Let *value* be `? Get(options, prop)`.
 - iii. If *value* is not **undefined**, let *needDefaults* be **false**.
6. If *needDefaults* is **true** and *defaults* is either **"date"** or **"all"**, then
 - a. For each of the property names **"year"**, **"month"**, **"day"**, do
 - i. Perform `? CreateDataPropertyOrThrow(options, prop, "numeric")`.
7. If *needDefaults* is **true** and *defaults* is either **"time"** or **"all"**, then
 - a. For each of the property names **"hour"**, **"minute"**, **"second"**, do
 - i. Perform `? CreateDataPropertyOrThrow(options, prop, "numeric")`.
8. Return *options*.

13.1.3 BasicFormatMatcher (*options*, *formats*)

When the `BasicFormatMatcher` abstract operation is called with two arguments *options* and *formats*, the following steps are taken:

1. Let *removalPenalty* be 120.
2. Let *additionPenalty* be 20.
3. Let *longLessPenalty* be 8.
4. Let *longMorePenalty* be 6.
5. Let *shortLessPenalty* be 6.
6. Let *shortMorePenalty* be 3.
7. Let *bestScore* be **-Infinity**.
8. Let *bestFormat* be **undefined**.
9. **Assert:** `Type(formats)` is **List**.
10. For each element *format* of *formats* in **List** order, do
 - a. Let *score* be 0.
 - b. For each *property* shown in **Table 6**, do
 - i. Let *optionsProp* be `options.[[<property>]]`.
 - ii. Let *formatProp* be `format.[[<property>]]`.
 - iii. If *optionsProp* is **undefined** and *formatProp* is not **undefined**, then decrease *score* by *additionPenalty*.
 - iv. Else if *optionsProp* is not **undefined** and *formatProp* is **undefined**, then decrease *score* by *removalPenalty*.
 - v. Else if *optionsProp* \neq *formatProp*,
 1. Let *values* be **<<"2-digit", "numeric", "narrow", "short", "long">>**.
 2. Let *optionsPropIndex* be the index of *optionsProp* within *values*.
 3. Let *formatPropIndex* be the index of *formatProp* within *values*.
 4. Let *delta* be `max(min(formatPropIndex - optionsPropIndex, 2), -2)`.
 5. If *delta* = 2, decrease *score* by *longMorePenalty*.
 6. Else if *delta* = 1, decrease *score* by *shortMorePenalty*.
 7. Else if *delta* = -1, decrease *score* by *shortLessPenalty*.
 8. Else if *delta* = -2, decrease *score* by *longLessPenalty*.
 - c. If *score* > *bestScore*, then

- i. Let *bestScore* be *score*.
 - ii. Let *bestFormat* be *format*.
11. Return *bestFormat*.

13.1.4 BestFitFormatMatcher (*options*, *formats*)

When the BestFitFormatMatcher abstract operation is called with two arguments *options* and *formats*, it performs implementation dependent steps, which should return a set of component representations that a typical user of the selected locale would perceive as at least as good as the one returned by BasicFormatMatcher.

13.1.5 DateTime Format Functions

A DateTime format function is an anonymous built-in function that has a [[DateTimeFormat]] internal slot.

When a DateTime format function *F* is called with optional argument *date*, the following steps are taken:

1. Let *dtf* be *F*.[[DateTimeFormat]].
2. **Assert:** Type(*dtf*) is Object and *dtf* has an [[InitializedDateTimeFormat]] internal slot.
3. If *date* is not provided or is **undefined**, then
 - a. Let *x* be Call(%Date_now%, **undefined**).
4. Else,
 - a. Let *x* be ? ToNumber(*date*).
5. Return ? FormatDateTime(*dtf*, *x*).

The "length" property of a DateTime format function is 1.

13.1.6 PartitionDateTimePattern (*dateTimeFormat*, *x*)

The PartitionDateTimePattern abstract operation is called with arguments *dateTimeFormat* (which must be an object initialized as a DateTimeFormat) and *x* (which must be a Number value), interprets *x* as a time value as specified in ES2015, 20.4.1.1, and creates the corresponding parts according to the effective locale and the formatting options of *dateTimeFormat*.

The following steps are taken:

1. Let *x* be TimeClip(*x*).
2. If *x* is NaN, throw a RangeError exception.
3. Let *locale* be *dateTimeFormat*.[[Locale]].
4. Let *nfOptions* be ObjectCreate(**null**).
5. Perform ! CreateDataPropertyOrThrow(*nfOptions*, "useGrouping", false).
6. Let *nf* be ? Construct(%NumberFormat%, « *locale*, *nfOptions* »).
7. Let *nf2Options* be ObjectCreate(**null**).
8. Perform ! CreateDataPropertyOrThrow(*nf2Options*, "minimumIntegerDigits", 2).
9. Perform ! CreateDataPropertyOrThrow(*nf2Options*, "useGrouping", false).
10. Let *nf2* be ? Construct(%NumberFormat%, « *locale*, *nf2Options* »).
11. Let *tm* be ToLocalTime(*x*, *dateTimeFormat*.[[Calendar]], *dateTimeFormat*.[[TimeZone]]).
12. Let *result* be a new empty List.
13. Let *patternParts* be PartitionPattern(*dateTimeFormat*.[[Pattern]]).
14. For each element *patternPart* of *patternParts*, in List order, do
 - a. Let *p* be *patternPart*.[[Type]].
 - b. If *p* is "literal", then
 - i. Append a new Record { [[Type]]: "literal", [[Value]]: *patternPart*.[[Value]] } as the last element of the list *result*.
 - c. Else if *p* matches a Property column of the row in Table 6, then
 - i. Let *f* be the value of *dateTimeFormat*'s internal slot whose name is the Internal Slot column of the matching row.
 - ii. Let *v* be the value of *tm*'s field whose name is the Internal Slot column of the matching row.
 - iii. If *p* is "year" and *v* ≤ 0, let *v* be 1 - *v*.

- iv. If p is "month", increase v by 1.
 - v. If p is "hour" and $dateTimeFormat.[[HourCycle]]$ is "h11" or "h12", then
 - 1. Let v be v modulo 12.
 - 2. If v is 0 and $dateTimeFormat.[[HourCycle]]$ is "h12", let v be 12.
 - vi. If p is "hour" and $dateTimeFormat.[[HourCycle]]$ is "h24", then
 - 1. If v is 0, let v be 24.
 - vii. If f is "numeric", then
 - 1. Let fv be $FormatNumeric(nf, v)$.
 - viii. Else if f is "2-digit", then
 - 1. Let fv be $FormatNumeric(nf2, v)$.
 - 2. If the "length" property of fv is greater than 2, let fv be the substring of fv containing the last two characters.
 - ix. Else if f is "narrow", "short", or "long", then let fv be a String value representing f in the desired form; the String value depends upon the implementation and the effective locale and calendar of $dateTimeFormat$. If p is "month", then the String value may also depend on whether $dateTimeFormat$ has a $[[Day]]$ internal slot. If p is "timeZoneName", then the String value may also depend on the value of the $[[InDST]]$ field of tm . If p is "era", then the String value may also depend on whether $dateTimeFormat$ has a $[[Era]]$ internal slot and if the implementation does not have a localized representation of f , then use f itself.
 - x. Append a new $Record$ { $[[Type]]: p$, $[[Value]]: fv$ } as the last element of the list $result$.
- d. Else if p is equal to "ampm", then
- i. Let v be $tm.[[Hour]]$.
 - ii. If v is greater than 11, then
 - 1. Let fv be an implementation and locale dependent String value representing "post meridiem".
 - iii. Else,
 - 1. Let fv be an implementation and locale dependent String value representing "ante meridiem".
 - iv. Append a new $Record$ { $[[Type]]: "dayPeriod"$, $[[Value]]: fv$ } as the last element of the list $result$.
- e. Else if p is equal to "relatedYear", then
- i. Let v be $tm.[[RelatedYear]]$.
 - ii. Let fv be $FormatNumber(nf, v)$.
 - iii. Append a new $Record$ { $[[Type]]: "relatedYear"$, $[[Value]]: fv$ } as the last element of the list $result$.
- f. Else if p is equal to "yearName", then
- i. Let v be $tm.[[YearName]]$.
 - ii. Append a new $Record$ { $[[Type]]: "yearName"$, $[[Value]]: v$ } as the last element of the list $result$.
- g. Else,
- i. Let $unknown$ be an implementation-, locale-, and numbering system-dependent String based on x and p .
 - ii. Append a new $Record$ { $[[Type]]: "unknown"$, $[[Value]]: unknown$ } as the last element of $result$.
15. Return $result$.

NOTE 1 It is recommended that implementations use the locale and calendar dependent strings provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>), and use CLDR "abbreviated" strings for $DateTimeFormat$ "short" strings, and CLDR "wide" strings for $DateTimeFormat$ "long" strings.

NOTE 2 It is recommended that implementations use the time zone information of the IANA Time Zone Database.

13.1.7 FormatDateTime($dateTimeFormat, x$)

The $FormatDateTime$ abstract operation is called with arguments $dateTimeFormat$ (which must be an object initialized as a $DateTimeFormat$) and x (which must be a $Number$ value), and performs the following steps:

1. Let $parts$ be ? $PartitionDateTimePattern(dateTimeFormat, x)$.
2. Let $result$ be the empty String.
3. For each $part$ in $parts$, do
 - a. Set $result$ to the string-concatenation of $result$ and $part.[[Value]]$.
4. Return $result$.

13.1.8 FormatDateTimeToParts (*dateTimeFormat*, *x*)

The FormatDateTimeToParts abstract operation is called with arguments *dateTimeFormat* (which must be an object initialized as a DateTimeFormat) and *x* (which must be a Number value), and performs the following steps:

1. Let *parts* be ? PartitionDateTimePattern(*dateTimeFormat*, *x*).
2. Let *result* be ArrayCreate(0).
3. Let *n* be 0.
4. For each *part* in *parts*, do
 - a. Let *O* be ObjectCreate(%ObjectPrototype%).
 - b. Perform ! CreateDataPropertyOrThrow(*O*, "type", *part*.[[Type]]).
 - c. Perform ! CreateDataPropertyOrThrow(*O*, "value", *part*.[[Value]]).
 - d. Perform ! CreateDataProperty(*result*, ! ToString(*n*), *O*).
 - e. Increment *n* by 1.
5. Return *result*.

13.1.9 ToLocalTime (*t*, *calendar*, *timeZone*)

When the ToLocalTime abstract operation is called with arguments *t*, *calendar*, and *timeZone*, the following steps are taken:

1. Assert: Type(*t*) is Number.
2. If *calendar* is "gregory",
 - a. Let *timeZoneOffset* be the value calculated according to LocalTZA(*t*, true) where the local time zone is replaced with timezone *timeZone*.
 - b. Let *tz* be the time value *t* + *timeZoneOffset*.
 - c. Return a record with fields calculated from *tz* according to Table 7.
3. Else,
 - a. Return a record with the fields of Column 1 of Table 7 calculated from *t* for the given *calendar* and *timeZone*. The calculations should use best available information about the specified *calendar* and *timeZone*, including current and historical information about time zone offsets from UTC and daylight saving time rules.

Table 7: Record returned by ToLocalTime

Field	Value Calculation for Gregorian Calendar
[[Weekday]]	WeekDay(tz) specified in ES2020's Week Day
[[Era]]	Let year be YearFromTime(tz) specified in ES2020's Year Number. If year is less than 0, return 'BC', else, return 'AD'.
[[Year]]	YearFromTime(tz) specified in ES2020's Year Number
[[RelatedYear]]	undefined
[[YearName]]	undefined
[[Month]]	MonthFromTime(tz) specified in ES2020's Month Number
[[Day]]	DateFromTime(tz) specified in ES2020's Date Number
[[Hour]]	HourFromTime(tz) specified in ES2020's Hours, Minutes, Second, and Milliseconds
[[Minute]]	MinuteFromTime(tz) specified in ES2020's Hours, Minutes, Second, and Milliseconds
[[Second]]	SecondFromTime(tz) specified in ES2020's Hours, Minutes, Second, and Milliseconds
[[InDST]]	Calculate true or false using the best available information about the specified <i>calendar</i> and <i>timeZone</i> , including current and historical information about time zone offsets from UTC and daylight saving time rules.

NOTE It is recommended that implementations use the time zone information of the IANA Time Zone Database.

13.1.10 UnwrapDateTimeFormat(*dtf*)

The UnwrapDateTimeFormat abstract operation gets the underlying DateTimeFormat operation for various methods which implement ECMA-402 v1 semantics for supporting initializing existing Intl objects.

1. Assert: Type(*dtf*) is Object.

NORMATIVE OPTIONAL

2. If *dtf* does not have an `[[InitializedDateTimeFormat]]` internal slot and ? InstanceOfOperator(*dtf*, %DateTimeFormat%) is **true**, then
 - a. Let *dtf* be ? Get(*dtf*, %Intl%.`[[FallbackSymbol]]`).
3. Perform ? RequireInternalSlot(*dtf*, `[[InitializedDateTimeFormat]]`).
4. Return *dtf*.

NOTE See 8.1 Note 1 for the motivation of the normative optional text.

13.2 The Intl.DateTimeFormat Constructor

The Intl.DateTimeFormat constructor is the %DateTimeFormat% intrinsic object and a standard built-in property of the Intl object. Behaviour common to all service constructor properties of the Intl object is specified in 9.1.

13.2.1 Intl.DateTimeFormat ([*locales* [, *options*]])

When the **Intl.DateTimeFormat** function is called with optional arguments *locales* and *options*, the following steps are taken:

1. If NewTarget is **undefined**, let *newTarget* be the active function object, else let *newTarget* be NewTarget.
2. Let *dateTimeFormat* be ? OrdinaryCreateFromConstructor(*newTarget*, "%DateTimeFormatPrototype%", « `[[InitializedDateTimeFormat]]`, `[[Locale]]`, `[[Calendar]]`, `[[NumberingSystem]]`, `[[TimeZone]]`, `[[Weekday]]`, `[[Era]]`, `[[Year]]`, `[[Month]]`, `[[Day]]`, `[[Hour]]`, `[[Minute]]`, `[[Second]]`, `[[TimeZoneName]]`, `[[HourCycle]]`, `[[Pattern]]`, `[[BoundFormat]]` »).
3. Perform ? InitializeDateTimeFormat(*dateTimeFormat*, *locales*, *options*).

NORMATIVE OPTIONAL

4. Let *this* be the **this** value.
5. If NewTarget is **undefined** and Type(*this*) is Object and ? InstanceOfOperator(*this*, %DateTimeFormat%) is **true**, then
 - a. Perform ? DefinePropertyOrThrow(*this*, %Intl%.`[[FallbackSymbol]]`, PropertyDescriptor{ `[[Value]]`: *dateTimeFormat*, `[[Writable]]`: **false**, `[[Enumerable]]`: **false**, `[[Configurable]]`: **false** }).
 - b. Return *this*.
6. Return *dateTimeFormat*.

NOTE See 8.1 Note 1 for the motivation of the normative optional text.

13.3 Properties of the Intl.DateTimeFormat Constructor

The Intl.DateTimeFormat constructor has the following properties:

13.3.1 Intl.DateTimeFormat.prototype

The value of **Intl.DateTimeFormat.prototype** is %DateTimeFormatPrototype%.

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

13.3.2 Intl.DateTimeFormat.supportedLocalesOf (*locales* [, *options*])

When the **supportedLocalesOf** method is called with arguments *locales* and *options*, the following steps are taken:

1. Let *availableLocales* be %DateTimeFormat%.[[AvailableLocales]].
2. Let *requestedLocales* be ? CanonicalizeLocaleList(*locales*).
3. Return ? SupportedLocales(*availableLocales*, *requestedLocales*, *options*).

The value of the "length" property of the **supportedLocalesOf** method is 1.

13.3.3 Internal slots

The value of the [[AvailableLocales]] internal slot is implementation defined within the constraints described in 9.1.

The value of the [[RelevantExtensionKeys]] internal slot is « "ca", "nu", "hc" ».

NOTE 1 Unicode Technical Standard 35 describes three locale extension keys that are relevant to date and time formatting, "ca" for calendar, "tz" for time zone, "hc" for hour cycle, and implicitly "nu" for the numbering system of the number format used for numbers within the date format. DateTimeFormat, however, requires that the time zone is specified through the "timeZone" property in the options objects.

The value of the [[LocaleData]] internal slot is implementation defined within the constraints described in 9.1 and the following additional constraints, for all locale values *locale*:

- [[LocaleData]].[<locale>].[[nu]] must be a List that does not include the values "native", "traditio", or "finance".
- [[LocaleData]].[<locale>].[[hc]] must be « null, "h11", "h12", "h23", "h24" ».
- [[LocaleData]].[<locale>].[[hourCycle]] must be a String value equal to "h11", "h12", "h23", or "h24".
- [[LocaleData]].[<locale>] must have a [[formats]] field. This formats field must have a [[<calendar>]] field for all calendar values *calendar*. The value of this field must be a list of records, each of which has a subset of the fields shown in Table 6, where each field must have one of the values specified for the field in Table 6. Multiple records in a list may use the same subset of the fields as long as they have different values for the fields. The following subsets must be available for each locale:
 - weekday, year, month, day, hour, minute, second
 - weekday, year, month, day
 - year, month, day
 - year, month
 - month, day
 - hour, minute, second
 - hour, minute

Each of the records must also have a [[pattern]] field, whose value is a String value that contains for each of the date and time format component fields of the record a substring starting with "{", followed by the name of the field, followed by "}". If the record has an hour field, it must also have a [[pattern12]] field, whose value is a String value that, in addition to the substrings of the [[pattern]] field, contains a substring "{ampm}". If the record has a [[year]] field, the [[pattern]] and [[pattern12]] values may contain the substrings "{yearName}" and "{relatedYear}".

EXAMPLE An implementation might include the following record as part of its English locale data: {[[hour]]: "numeric", [[minute]]: "2-digit", [[second]]: "2-digit", [[pattern]]: "{hour}:{minute}:{second}", [[pattern12]]: "{hour}:{minute}:{second}{ampm}"}

NOTE 2 It is recommended that implementations use the locale data provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>).

13.4 Properties of the Intl.DateTimeFormat Prototype Object

The Intl.DateTimeFormat prototype object is itself an ordinary object. *%DateTimeFormatPrototype%* is not an Intl.DateTimeFormat instance and does not have an `[[InitializedDateTimeFormat]]` internal slot or any of the other internal slots of Intl.DateTimeFormat instance objects.

13.4.1 Intl.DateTimeFormat.prototype.constructor

The initial value of `Intl.DateTimeFormat.prototype.constructor` is the intrinsic object *%DateTimeFormat%*.

13.4.2 Intl.DateTimeFormat.prototype [@@toStringTag]

The initial value of the `@@toStringTag` property is the String value "Object".

This property has the attributes { `[[Writable]]`: **false**, `[[Enumerable]]`: **false**, `[[Configurable]]`: **true** }.

13.4.3 get Intl.DateTimeFormat.prototype.format

`Intl.DateTimeFormat.prototype.format` is an [accessor property](#) whose set accessor function is **undefined**. Its get accessor function performs the following steps:

1. Let *dtf* be **this** value.
2. If `Type(dtf)` is not Object, throw a **TypeError** exception.
3. Let *dtf* be ? `UnwrapDateTimeFormat(dtf)`.
4. If `dtf.[[BoundFormat]]` is **undefined**, then
 - a. Let *F* be a new built-in [function object](#) as defined in [Date Time Format Functions \(13.1.5\)](#).
 - b. Set `F.[[DateTimeFormat]]` to *dtf*.
 - c. Set `dtf.[[BoundFormat]]` to *F*.
5. Return `dtf.[[BoundFormat]]`.

NOTE The returned function is bound to *dtf* so that it can be passed directly to `Array.prototype.map` or other functions. This is considered a historical artefact, as part of a convention which is no longer followed for new features, but is preserved to maintain compatibility with existing programs.

13.4.4 Intl.DateTimeFormat.prototype.formatToParts (*date*)

When the `formatToParts` method is called with an argument *date*, the following steps are taken:

1. Let *dtf* be **this** value.
2. Perform ? `RequireInternalSlot(dtf, [[InitializedDateTimeFormat]])`.
3. If *date* is **undefined**, then
 - a. Let *x* be `Call(%Date_now%, undefined)`.
4. Else,
 - a. Let *x* be ? `ToNumber(date)`.
5. Return ? `FormatDateTimeToParts(dtf, x)`.

13.4.5 Intl.DateTimeFormat.prototype.resolvedOptions ()

This function provides access to the locale and formatting options computed during initialization of the object.

1. Let *dtf* be **this** value.
2. If `Type(dtf)` is not Object, throw a **TypeError** exception.
3. Let *dtf* be ? `UnwrapDateTimeFormat(dtf)`.
4. Let *options* be ! `ObjectCreate(%ObjectPrototype%)`.
5. For each row of [Table 8](#), except the header row, in table order, do

- a. Let *p* be the Property value of the current row.
 - b. If *p* is "hour12", then
 - i. Let *hc* be *dtf*.[[HourCycle]].
 - ii. If *hc* is "h11" or "h12", let *v* be **true**.
 - iii. Else if, *hc* is "h23" or "h24", let *v* be **false**.
 - iv. Else, let *v* be **undefined**.
 - c. Else,
 - i. Let *v* be the value of *dtf*'s internal slot whose name is the Internal Slot value of the current row.
 - d. If *v* is not **undefined**, then
 - i. Perform ! [CreateDataPropertyOrThrow](#)(*options*, *p*, *v*).
6. Return *options*.

Table 8: Resolved Options of DateTimeFormat Instances

Internal Slot	Property
[[Locale]]	"locale"
[[Calendar]]	"calendar"
[[NumberingSystem]]	"numberingSystem"
[[TimeZone]]	"timeZone"
[[HourCycle]]	"hourCycle"
	"hour12"
[[Weekday]]	"weekday"
[[Era]]	"era"
[[Year]]	"year"
[[Month]]	"month"
[[Day]]	"day"
[[Hour]]	"hour"
[[Minute]]	"minute"
[[Second]]	"second"
[[TimeZoneName]]	"timeZoneName"

For web compatibility reasons, if the property "hourCycle" is set, the "hour12" property should be set to **true** when "hourCycle" is "h11" or "h12", or to **false** when "hourCycle" is "h23" or "h24".

NOTE 1 In this version of the ECMAScript 2020 Internationalization API, the "timeZone" property will be the name of the default time zone if no "timeZone" property was provided in the options object provided to the Intl.DateTimeFormat constructor. The first edition left the "timeZone" property **undefined** in this case.

NOTE 2 For compatibility with versions prior to the fifth edition, the "hour12" property is set in addition to the "hourCycle" property.

13.5 Properties of Intl.DateTimeFormat Instances

Intl.DateTimeFormat instances are ordinary objects that inherit properties from %DateTimeFormatPrototype%.

Intl.DateTimeFormat instances have an `[[InitializedDateTimeFormat]]` internal slot.

Intl.DateTimeFormat instances also have several internal slots that are computed by the [constructor](#):

- `[[Locale]]` is a String value with the language tag of the locale whose localization is used for formatting.
- `[[Calendar]]` is a String value with the **"type"** given in Unicode Technical Standard 35 for the calendar used for formatting.
- `[[NumberingSystem]]` is a String value with the **"type"** given in Unicode Technical Standard 35 for the numbering system used for formatting.
- `[[TimeZone]]` is a String value with the IANA time zone name of the time zone used for formatting.
- `[[Weekday]]`, `[[Era]]`, `[[Year]]`, `[[Month]]`, `[[Day]]`, `[[Hour]]`, `[[Minute]]`, `[[Second]]`, `[[TimeZoneName]]` are each either **undefined**, indicating that the component is not used for formatting, or one of the String values given in [Table 6](#), indicating how the component should be presented in the formatted output.
- `[[HourCycle]]` is a String value indicating whether the 12-hour format ("**h11**", "**h12**") or the 24-hour format ("**h23**", "**h24**") should be used. "**h11**" and "**h23**" start with hour 0 and go up to 11 and 23 respectively. "**h12**" and "**h24**" start with hour 1 and go up to 12 and 24. `[[HourCycle]]` is only used when `[[Hour]]` is not **undefined**.
- `[[Pattern]]` is a String value as described in [13.3.3](#).

Finally, Intl.DateTimeFormat instances have a `[[BoundFormat]]` internal slot that caches the function returned by the format accessor ([13.4.3](#)).

14 RelativeTimeFormat Objects

14.1 Abstract Operations for RelativeTimeFormat Objects

14.1.1 InitializeRelativeTimeFormat (*relativeTimeFormat*, *locales*, *options*)

The abstract operation InitializeRelativeTimeFormat accepts the arguments *relativeTimeFormat* (which must be an object), *locales*, and *options*. It initializes *relativeTimeFormat* as a RelativeTimeFormat object.

The following algorithm refers to [UTS 35's Unicode Language and Locale Identifiers grammar](#). The following steps are taken:

1. Let *requestedLocales* be ? [CanonicalizeLocaleList](#)(*locales*).
2. If *options* is **undefined**, then
 - a. Let *options* be [ObjectCreate](#)(**null**).
3. Else,
 - a. Let *options* be ? [ToObject](#)(*options*).
4. Let *opt* be a new [Record](#).
5. Let *matcher* be ? [GetOption](#)(*options*, "localeMatcher", "string", «"lookup", "best fit"», "best fit").
6. Set *opt*.`[[LocaleMatcher]]` to *matcher*.
7. Let *numberingSystem* be ? [GetOption](#)(*options*, "numberingSystem", "string", **undefined**, **undefined**).
8. If *numberingSystem* is not **undefined**, then
 - a. If *numberingSystem* does not match the **type** sequence (from [UTS 35 Unicode Locale Identifier](#), section 3.2), throw a [RangeError](#) exception.
9. Set *opt*.`[[nu]]` to *numberingSystem*.
10. Let *localeData* be [%RelativeTimeFormat%](#).`[[LocaleData]]`.
11. Let *r* be [ResolveLocale](#)([%RelativeTimeFormat%](#).`[[AvailableLocales]]`, *requestedLocales*, *opt*, [%RelativeTimeFormat%](#).`[[RelevantExtensionKeys]]`, *localeData*).
12. Let *locale* be *r*.`[[Locale]]`.
13. Set *relativeTimeFormat*.`[[Locale]]` to *locale*.
14. Set *relativeTimeFormat*.`[[DataLocale]]` to *r*.`[[DataLocale]]`.

15. Set *relativeTimeFormat*.[[NumberingSystem]] to *r*.[[nu]].
16. Let *s* be ? *GetOption*(*options*, "style", "string", «"long", "short", "narrow"», "long").
17. Set *relativeTimeFormat*.[[Style]] to *s*.
18. Let *numeric* be ? *GetOption*(*options*, "numeric", "string", «"always", "auto"», "always").
19. Set *relativeTimeFormat*.[[Numeric]] to *numeric*.
20. Let *relativeTimeFormat*.[[NumberFormat]] be ! *Construct*(%NumberFormat%, «*locale* »).
21. Let *relativeTimeFormat*.[[PluralRules]] be ! *Construct*(%PluralRules%, «*locale* »).
22. Return *relativeTimeFormat*.

14.1.2 SingularRelativeTimeUnit (*unit*)

1. **Assert:** *Type*(*unit*) is String.
2. If *unit* is "seconds", return "second".
3. If *unit* is "minutes", return "minute".
4. If *unit* is "hours", return "hour".
5. If *unit* is "days", return "day".
6. If *unit* is "weeks", return "week".
7. If *unit* is "months", return "month".
8. If *unit* is "quarters", return "quarter".
9. If *unit* is "years", return "year".
10. If *unit* is not one of "second", "minute", "hour", "day", "week", "month", "quarter", or "year", throw a **RangeError** exception.
11. Return *unit*.

14.1.3 PartitionRelativeTimePattern (*relativeTimeFormat*, *value*, *unit*)

When the *PartitionRelativeTimePattern* abstract operation is called with arguments *relativeTimeFormat*, *value*, and *unit* it returns a String value representing *value* (which must be a **Number value**) according to the effective locale and the formatting options of *relativeTimeFormat*.

1. **Assert:** *relativeTimeFormat* has an [[InitializedRelativeTimeFormat]] internal slot.
2. **Assert:** *Type*(*value*) is Number.
3. **Assert:** *Type*(*unit*) is String.
4. If *value* is NaN, +∞, or -∞, throw a **RangeError** exception.
5. Let *unit* be ? *SingularRelativeTimeUnit*(*unit*).
6. Let *localeData* be %RelativeTimeFormat%.[[LocaleData]].
7. Let *dataLocale* be *relativeTimeFormat*.[[DataLocale]].
8. Let *fields* be *localeData*.[[<*dataLocale*>]].
9. Let *style* be *relativeTimeFormat*.[[Style]].
10. If *style* is equal to "short", then
 - a. Let *entry* be the string-concatenation of *unit* and "-short".
11. Else if *style* is equal to "narrow", then
 - a. Let *entry* be the string-concatenation of *unit* and "-narrow".
12. Else,
 - a. Let *entry* be *unit*.
13. If *fields* doesn't have a field [[<*entry*>]], then
 - a. Let *entry* be *unit*.
14. Let *patterns* be *fields*.[[<*entry*>]].
15. Let *numeric* be *relativeTimeFormat*.[[Numeric]].
16. If *numeric* is equal to "auto", then
 - a. Let *valueString* be *ToString*(*value*).
 - b. If *patterns* has a field [[<*valueString*>]], then
 - i. Let *result* be *patterns*.[[<*valueString*>]].
 - ii. Return a **List** containing the **Record** { [[Type]]: "literal", [[Value]]: *result* }.

17. If *value* is -0 or if *value* is less than 0, then
 - a. Let *tl* be "past".
18. Else,
 - a. Let *tl* be "future".
19. Let *po* be *patterns*.[[<*tl*>]].
20. Let *fv* be ! PartitionNumberPattern(*relativeTimeFormat*.[[NumberFormat]], *value*).
21. Let *pr* be ! ResolvePlural(*relativeTimeFormat*.[[PluralRules]], *value*).
22. Let *pattern* be *po*.[[<*pr*>]].
23. Return ! MakePartsList(*pattern*, *unit*, *fv*).

14.1.4 MakePartsList (*pattern*, *unit*, *parts*)

The MakePartsList abstract operation is called with arguments *pattern*, a pattern String, *unit*, a String, and *parts*, a List of Records representing a formatted Number.

NOTE Example:

```
MakePartsList("AA{0}BB", "hour", « { [[Type]]: "integer", [[Value]]: "15
```

Output (List of Records):

```
«
  { [[Type]]: "literal", [[Value]]: "AA"},
  { [[Type]]: "integer", [[Value]]: "15", [[Unit]]: "hour"},
  { [[Type]]: "literal", [[Value]]: "BB" }
»
```

1. Let *patternParts* be PartitionPattern(*pattern*).
2. Let *result* be a new empty List.
3. For each element *patternPart* of *patternParts*, in List order, do
 - a. If *patternPart*.[[Type]] is "literal", then
 - i. Append Record { [[Type]]: "literal", [[Value]]: *patternPart*.[[Value]] } to *result*.
 - b. Else,
 - i. Assert: *patternPart*.[[Type]] is "0".
 - ii. For each *part* in *parts*, do
 1. Append Record { [[Type]]: *part*.[[Type]], [[Value]]: *part*.[[Value]], [[Unit]]: *unit* } to *result*.
4. Return *result*.

14.1.5 FormatRelativeTime (*relativeTimeFormat*, *value*, *unit*)

The FormatRelativeTime abstract operation is called with arguments *relativeTimeFormat* (which must be an object initialized as a RelativeTimeFormat), *value* (which must be a Number value), and *unit* (which must be a String denoting the value unit) and performs the following steps:

1. Let *parts* be ? PartitionRelativeTimePattern(*relativeTimeFormat*, *value*, *unit*).
2. Let *result* be an empty String.
3. For each *part* in *parts*, do
 - a. Set *result* to the string-concatenation of *result* and *part*.[[Value]].
4. Return *result*.

14.1.6 FormatRelativeTimeToParts (*relativeTimeFormat*, *value*, *unit*)

The FormatRelativeTimeToParts abstract operation is called with arguments *relativeTimeFormat* (which must be an object initialized as a RelativeTimeFormat), *value* (which must be a Number value), and *unit* (which must be a String denoting the

value unit) and performs the following steps:

1. Let *parts* be ? [PartitionRelativeTimePattern](#)(*relativeTimeFormat*, *value*, *unit*).
2. Let *result* be [ArrayCreate](#)(0).
3. Let *n* be 0.
4. For each *part* in *parts*, do
 - a. Let *O* be [ObjectCreate](#)(%ObjectPrototype%).
 - b. Perform ! [CreateDataPropertyOrThrow](#)(*O*, "type", *part*.[[Type]]).
 - c. Perform ! [CreateDataPropertyOrThrow](#)(*O*, "value", *part*.[[Value]]).
 - d. If *part* has a [[Unit]] field,
 - i. Perform ! [CreateDataPropertyOrThrow](#)(*O*, "unit", *part*.[[Unit]]).
 - e. Perform ! [CreateDataPropertyOrThrow](#)(*result*, ! [ToString](#)(*n*), *O*).
 - f. Increment *n* by 1.
5. Return *result*.

14.2 The Intl.RelativeTimeFormat Constructor

The [RelativeTimeFormat constructor](#) is the %[RelativeTimeFormat](#)% intrinsic object and a standard built-in property of the Intl object. Behaviour common to all service [constructor](#) properties of the Intl object is specified in [9.1](#).

14.2.1 Intl.RelativeTimeFormat ([*locales* [, *options*]])

When the [Intl.RelativeTimeFormat](#) function is called with optional arguments the following steps are taken:

1. If `NewTarget` is **undefined**, throw a **TypeError** exception.
2. Let *relativeTimeFormat* be ? [OrdinaryCreateFromConstructor](#)(`NewTarget`, "%[RelativeTimeFormatPrototype](#)", « [[[InitializedRelativeTimeFormat](#)]], [[[Locale](#)]], [[[DataLocale](#)]], [[[Style](#)]], [[[Numeric](#)]], [[[NumberFormat](#)]], [[[NumberingSystem](#)]], [[[PluralRules](#)]] »).
3. Return ? [InitializeRelativeTimeFormat](#)(*relativeTimeFormat*, *locales*, *options*).

14.3 Properties of the Intl.RelativeTimeFormat Constructor

The [Intl.RelativeTimeFormat constructor](#) has the following properties:

14.3.1 Intl.RelativeTimeFormat.prototype

The value of [Intl.RelativeTimeFormat.prototype](#) is %[RelativeTimeFormatPrototype](#)%.

This property has the attributes { [[[Writable](#)]]: **false**, [[[Enumerable](#)]]: **false**, [[[Configurable](#)]]: **false** }.

14.3.2 Intl.RelativeTimeFormat.supportedLocalesOf (*locales* [, *options*])

When the [supportedLocalesOf](#) method of %[RelativeTimeFormat](#)% is called, the following steps are taken:

1. Let *availableLocales* be %[RelativeTimeFormat](#)%.[[[AvailableLocales](#)]].
2. Let *requestedLocales* be ? [CanonicalizeLocaleList](#)(*locales*).
3. Return ? [SupportedLocales](#)(*availableLocales*, *requestedLocales*, *options*).

14.3.3 Internal slots

The value of the [[[AvailableLocales](#)]] internal slot is implementation defined within the constraints described in [9.1](#).

The value of the [[[RelevantExtensionKeys](#)]] internal slot is « "nu" ».

NOTE 1 Unicode Technical Standard 35 implicitly describes one locale extension key that is relevant to relative time formatting, "nu" for numbering system.

The value of the `[[LocaleData]]` internal slot is implementation defined within the constraints described in 9.1 and the following additional constraints, for all locale values *locale*:

- `[[LocaleData]][<locale>]` has fields "second", "minute", "hour", "day", "week", "month", "quarter", and "year". Additional fields may exist with the previous names concatenated with the strings "-narrow" or "-short". The values corresponding to these fields are Records which contain these two categories of fields:
 - "future" and "past" fields, which are Records with a field for each of the plural categories relevant for *locale*. The value corresponding to those fields is a pattern which may contain "{0}" to be replaced by a formatted number.
 - Optionally, additional fields whose key is the result of `ToString` of a Number, and whose values are literal Strings which are not treated as templates.
- The list that is the value of the "nu" field of any locale field of `[[LocaleData]]` must not include the values "native", "traditio", or "finance".

NOTE 2 It is recommended that implementations use the locale data provided by the Common Locale Data Repository (available at <http://cldr.unicode.org/>).

14.4 Properties of the Intl.RelativeTimeFormat Prototype Object

The Intl.RelativeTimeFormat prototype object is itself an ordinary object. `%RelativeTimeFormatPrototype%` is not an Intl.RelativeTimeFormat instance and does not have an `[[InitializedRelativeTimeFormat]]` internal slot or any of the other internal slots of Intl.RelativeTimeFormat instance objects.

14.4.1 Intl.RelativeTimeFormat.prototype.constructor

The initial value of `Intl.RelativeTimeFormat.prototype.constructor` is `%RelativeTimeFormat%`.

14.4.2 Intl.RelativeTimeFormat.prototype[@@toStringTag]

The initial value of the `@@toStringTag` property is the string value "Intl.RelativeTimeFormat".

This property has the attributes { `[[Writable]]`: false, `[[Enumerable]]`: false, `[[Configurable]]`: true }.

14.4.3 Intl.RelativeTimeFormat.prototype.format(value, unit)

When the `format` method is called with arguments *value* and *unit*, the following steps are taken:

1. Let *relativeTimeFormat* be the **this** value.
2. Perform ? `RequireInternalSlot(relativeTimeFormat, [[InitializedRelativeTimeFormat]])`.
3. Let *value* be ? `ToNumber(value)`.
4. Let *unit* be ? `Tostring(unit)`.
5. Return ? `FormatRelativeTime(relativeTimeFormat, value, unit)`.

14.4.4 Intl.RelativeTimeFormat.prototype.formatToParts(value, unit)

When the `formatToParts` method is called with arguments *value* and *unit*, the following steps are taken:

1. Let *relativeTimeFormat* be the **this** value.
2. Perform ? `RequireInternalSlot(relativeTimeFormat, [[InitializedRelativeTimeFormat]])`.
3. Let *value* be ? `ToNumber(value)`.
4. Let *unit* be ? `Tostring(unit)`.
5. Return ? `FormatRelativeTimeToParts(relativeTimeFormat, value, unit)`.

14.4.5 Intl.RelativeTimeFormat.prototype.resolvedOptions ()

This function provides access to the locale and options computed during initialization of the object.

1. Let *relativeTimeFormat* be the **this** value.
2. Perform ? `RequireInternalSlot(relativeTimeFormat, [[InitializedRelativeTimeFormat]])`.
3. Let *options* be ! `ObjectCreate(%ObjectPrototype%)`.
4. For each row of Table 9, except the header row, in table order, do
 - a. Let *p* be the Property value of the current row.
 - b. Let *v* be the value of *relativeTimeFormat*'s internal slot whose name is the Internal Slot value of the current row.
 - c. **Assert:** *v* is not **undefined**.
 - d. Perform ! `CreateDataPropertyOrThrow(options, p, v)`.
5. Return *options*.

Table 9: Resolved Options of RelativeTimeFormat Instances

Internal Slot	Property
[[Locale]]	"locale"
[[Style]]	"style"
[[Numeric]]	"numeric"
[[NumberingSystem]]	"numberingSystem"

14.5 Properties of Intl.RelativeTimeFormat Instances

Intl.RelativeTimeFormat instances are ordinary objects that inherit properties from `%RelativeTimeFormatPrototype%`.

Intl.RelativeTimeFormat instances have an `[[InitializedRelativeTimeFormat]]` internal slot.

Intl.RelativeTimeFormat instances also have several internal slots that are computed by the [constructor](#):

- `[[Locale]]` is a String value with the language tag of the locale whose localization is used for formatting.
- `[[DataLocale]]` is a String value with the language tag of the nearest locale for which the implementation has data to perform the formatting operation. It will be a parent locale of `[[Locale]]`.
- `[[Style]]` is one of the String values **"long"**, **"short"**, or **"narrow"**, identifying the relative time format style used.
- `[[Numeric]]` is one of the String values **"always"** or **"auto"**, identifying whether numerical descriptions are always used, or used only when no more specific version is available (e.g., "1 day ago" vs "yesterday").
- `[[NumberFormat]]` is an Intl.NumberFormat object used for formatting.
- `[[NumberingSystem]]` is a String value with the **"type"** given in Unicode Technical Standard 35 for the numbering system used for formatting.
- `[[PluralRules]]` is an Intl.PluralRules object used for formatting.

15 PluralRules Objects

15.1 Abstract Operations for PluralRules Objects

15.1.1 InitializePluralRules (*pluralRules*, *locales*, *options*)

The abstract operation InitializePluralRules accepts the arguments *pluralRules* (which must be an object), *locales*, and *options*. It initializes *pluralRules* as a PluralRules object. The following steps are taken:

1. Let *requestedLocales* be ? `CanonicalizeLocaleList(locales)`.

2. If *options* is **undefined**, then
 - a. Let *options* be **ObjectCreate**(**null**).
3. Else
 - a. Let *options* be ? **ToObject**(*options*).
4. Let *opt* be a new **Record**.
5. Let *matcher* be ? **GetOption**(*options*, "localeMatcher", "string", « "lookup", "best fit" », "best fit").
6. Set *opt*.[[localeMatcher]] to *matcher*.
7. Let *t* be ? **GetOption**(*options*, "type", "string", « "cardinal", "ordinal" », "cardinal").
8. Set *pluralRules*.[[Type]] to *t*.
9. Perform ? **SetNumberFormatDigitOptions**(*pluralRules*, *options*, 0, 3, "standard").
10. Let *localeData* be %PluralRules%.[[LocaleData]].
11. Let *r* be **ResolveLocale**(%PluralRules%.[[AvailableLocales]], *requestedLocales*, *opt*, %PluralRules%.[[RelevantExtensionKeys]], *localeData*).
12. Set *pluralRules*.[[Locale]] to the value of *r*.[[locale]].
13. Return *pluralRules*.

15.1.2 GetOperands (*s*)

When the GetOperands abstract operation is called with argument *s*, it performs the following steps:

1. **Assert**: **Type**(*s*) is String.
2. Let *n* be ! **ToNumber**(*s*).
3. **Assert**: *n* is finite.
4. Let *dp* be ! **Call**(%StringProto_indexOf%, *s*, « "." »).
5. If *dp* = -1, then
 - a. Set *iv* to *n*.
 - b. Let *f* be 0.
 - c. Let *v* be 0.
6. Else,
 - a. Let *iv* be the substring of *s* from position 0, inclusive, to position *dp*, exclusive.
 - b. Let *fv* be the substring of *s* from position *dp*, exclusive, to the end of *s*.
 - c. Let *f* be ! **ToNumber**(*fv*).
 - d. Let *v* be the length of *fv*.
7. Let *i* be **abs**(! **ToNumber**(*iv*)).
8. If *f* ≠ 0, then
 - a. Let *ft* be the value of *fv* stripped of trailing "0".
 - b. Let *w* be the length of *ft*.
 - c. Let *t* be ! **ToNumber**(*ft*).
9. Else,
 - a. Let *w* be 0.
 - b. Let *t* be 0.
10. Return a new **Record** { [[Number]]: *n*, [[IntegerDigits]]: *i*, [[NumberOfFractionDigits]]: *v*, [[NumberOfFractionDigitsWithoutTrailing]]: *w*, [[FractionDigits]]: *f*, [[FractionDigitsWithoutTrailing]]: *t* }.

Table 10: Plural Rules Operands **Record** Fields

Internal Slot	Type	Description
[[Number]]	Number	Absolute value of the source number (<i>integer</i> and decimals)
[[IntegerDigits]]	Number	Number of digits of [[Number]].
[[NumberOfFractionDigits]]	Number	Number of visible fraction digits in [[Number]], <i>with</i> trailing zeroes.
[[NumberOfFractionDigitsWithoutTrailing]]	Number	Number of visible fraction digits in [[Number]], <i>without</i> trailing zeroes.
[[FractionDigits]]	Number	Number of visible fractional digits in [[Number]], <i>with</i> trailing zeroes.
[[FractionDigitsWithoutTrailing]]	Number	Number of visible fractional digits in [[Number]], <i>without</i> trailing zeroes.

15.1.3 PluralRuleSelect (*locale*, *type*, *n*, *operands*)

When the PluralRuleSelect abstract operation is called with four arguments, it performs an implementation-dependent algorithm to map *n* to the appropriate plural representation of the Plural Rules Operands **Record** *operands* by selecting the rules denoted by *type* for the corresponding *locale*, or the String value "other".

15.1.4 ResolvePlural (*pluralRules*, *n*)

When the ResolvePlural abstract operation is called with arguments *pluralRules* (which must be an object initialized as a PluralRules) and *n* (which must be a **Number** value), it returns a String value representing the plural form of *n* according to the effective locale and the options of *pluralRules*. The following steps are taken:

1. **Assert:** Type(*pluralRules*) is Object.
2. **Assert:** *pluralRules* has an [[InitializedPluralRules]] internal slot.
3. **Assert:** Type(*n*) is Number.
4. If *n* is not a finite Number, then
 - a. Return "other".
5. Let *locale* be *pluralRules*.[[Locale]].
6. Let *type* be *pluralRules*.[[Type]].
7. Let *res* be ! FormatNumericToString(*pluralRules*, *n*).
8. Let *s* be *res*.[[FormattedString]].
9. Let *operands* be ? GetOperands(*s*).
10. Return ? PluralRuleSelect(*locale*, *type*, *n*, *operands*).

15.2 The Intl.PluralRules Constructor

The PluralRules **constructor** is the %PluralRules% intrinsic object and a standard built-in property of the Intl object. Behaviour common to all service **constructor** properties of the Intl object is specified in 9.1.

15.2.1 Intl.PluralRules ([*locales* [, *options*]])

When the **Intl.PluralRules** function is called with optional arguments *locales* and *options*, the following steps are taken:

1. If NewTarget is **undefined**, throw a **TypeError** exception.
2. Let *pluralRules* be ? OrdinaryCreateFromConstructor(NewTarget, "%PluralRulesPrototype%", « [[InitializedPluralRules]], [[Locale]], [[Type]], [[MinimumIntegerDigits]], [[MinimumFractionDigits]],

[[MaximumFractionDigits]], [[MinimumSignificantDigits]], [[MaximumSignificantDigits]], [[RoundingType]] »).

3. Return ? [InitializePluralRules](#)(*pluralRules*, *locales*, *options*).

15.3 Properties of the Intl.PluralRules Constructor

The Intl.PluralRules [constructor](#) has the following properties:

15.3.1 Intl.PluralRules.prototype

The value of **Intl.PluralRules.prototype** is [%PluralRulesPrototype%](#).

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **false** }.

15.3.2 Intl.PluralRules.supportedLocalesOf (*locales* [, *options*])

When the **supportedLocalesOf** method is called with arguments *locales* and *options*, the following steps are taken:

1. Let *availableLocales* be [%PluralRules%](#).[[AvailableLocales]].
2. Let *requestedLocales* be ? [CanonicalizeLocaleList](#)(*locales*).
3. Return ? [SupportedLocales](#)(*availableLocales*, *requestedLocales*, *options*).

The value of the "length" property of the **supportedLocalesOf** method is 1.

15.3.3 Internal slots

The value of the [[AvailableLocales]] internal slot is implementation defined within the constraints described in [9.1](#).

The value of the [[RelevantExtensionKeys]] internal slot is « ».

NOTE 1 Unicode Technical Standard 35 describes no locale extension keys that are relevant to the pluralization process.

The value of the [[LocaleData]] internal slot is implementation defined within the constraints described in [9.1](#).

NOTE 2 It is recommended that implementations use the locale data provided by the Common Locale Data Repository (available at <http://cldr.unicode.org>).

15.4 Properties of the Intl.PluralRules Prototype Object

The Intl.PluralRules prototype object is itself an ordinary object. [%PluralRulesPrototype%](#) is not an Intl.PluralRules instance and does not have an [[InitializedPluralRules]] internal slot or any of the other internal slots of Intl.PluralRules instance objects.

15.4.1 Intl.PluralRules.prototype.constructor

The initial value of **Intl.PluralRules.prototype.constructor** is the intrinsic object [%PluralRules%](#).

15.4.2 Intl.PluralRules.prototype [@@toStringTag]

The initial value of the @@toStringTag property is the String value "Object".

This property has the attributes { [[Writable]]: **false**, [[Enumerable]]: **false**, [[Configurable]]: **true** }.

15.4.3 Intl.PluralRules.prototype.select(*value*)

When the **select** method is called with an argument *value*, the following steps are taken:

1. Let *pr* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*pr*, [[InitializedPluralRules]]).
3. Let *n* be ? [ToNumber](#)(*value*).
4. Return ? [ResolvePlural](#)(*pr*, *n*).

15.4.4 Intl.PluralRules.prototype.resolvedOptions ()

This function provides access to the locale and options computed during initialization of the object.

1. Let *pr* be the **this** value.
2. Perform ? [RequireInternalSlot](#)(*pr*, [[InitializedPluralRules]]).
3. Let *options* be ! [ObjectCreate](#)(%ObjectPrototype%).
4. For each row of [Table 11](#), except the header row, in table order, do
 - a. Let *p* be the Property value of the current row.
 - b. Let *v* be the value of *pr*'s internal slot whose name is the Internal Slot value of the current row.
 - c. If *v* is not **undefined**, then
 - i. Perform ! [CreateDataPropertyOrThrow](#)(*options*, *p*, *v*).
5. Let *pluralCategories* be a [List](#) of Strings representing the possible results of [PluralRuleSelect](#) for the selected locale *pr*.[[Locale]]. This [List](#) consists of unique String values, from the the list "zero", "one", "two", "few", "many" and "other", that are relevant for the locale whose localization is specified in LDML Language Plural Rules.
6. Perform ! [CreateDataProperty](#)(*options*, "pluralCategories", [CreateArrayFromList](#)(*pluralCategories*)).
7. Return *options*.

Table 11: Resolved Options of PluralRules Instances

Internal Slot	Property
[[Locale]]	"locale"
[[Type]]	"type"
[[MinimumIntegerDigits]]	"minimumIntegerDigits"
[[MinimumFractionDigits]]	"minimumFractionDigits"
[[MaximumFractionDigits]]	"maximumFractionDigits"
[[MinimumSignificantDigits]]	"minimumSignificantDigits"
[[MaximumSignificantDigits]]	"maximumSignificantDigits"

15.5 Properties of Intl.PluralRules Instances

Intl.PluralRules instances are ordinary objects that inherit properties from %PluralRulesPrototype%.

Intl.PluralRules instances have an [[InitializedPluralRules]] internal slot.

Intl.PluralRules instances also have several internal slots that are computed by the [constructor](#):

- [[Locale]] is a String value with the language tag of the locale whose localization is used by the plural rules.
- [[Type]] is one of the String values "cardinal" or "ordinal", identifying the plural rules used.
- [[MinimumIntegerDigits]] is a non-negative [integer Number value](#) indicating the minimum [integer](#) digits to be used.
- [[MinimumFractionDigits]] and [[MaximumFractionDigits]] are non-negative [integer Number values](#) indicating the minimum and maximum fraction digits to be used. Numbers will be rounded or padded with trailing zeroes if necessary.
- [[MinimumSignificantDigits]] and [[MaximumSignificantDigits]] are positive [integer Number values](#) indicating the

minimum and maximum fraction digits to be used. Either none or both of these properties are present; if they are, they override minimum and maximum [integer](#) and fraction digits.

- `[[RoundingType]]` is one of the values `fractionDigits` or `significantDigits`, indicating which rounding strategy to use, as discussed in [12.5](#).

16 Locale Sensitive Functions of the ECMAScript Language Specification

The ECMAScript Language Specification, edition 10 or successor, describes several locale sensitive functions. An ECMAScript implementation that implements this Internationalization API Specification shall implement these functions as described here.

NOTE The `Collator`, `NumberFormat`, or `DateTimeFormat` objects created in the algorithms in this clause are only used within these algorithms. They are never directly accessed by ECMAScript code and need not actually exist within an implementation.

16.1 Properties of the String Prototype Object

16.1.1 `String.prototype.localeCompare` (*that* [, *locales* [, *options*]])

This definition supersedes the definition provided in ES2020, [21.1.3.10](#).

When the **localeCompare** method is called with argument *that* and optional arguments *locales*, and *options*, the following steps are taken:

1. Let *O* be `RequireObjectCoercible(this value)`.
2. Let *S* be `? ToString(O)`.
3. Let *thatValue* be `? ToString(that)`.
4. Let *collator* be `? Construct(%Collator%, « locales, options »)`.
5. Return `CompareStrings(collator, S, thatValue)`.

The value of the `"length"` property of the **localeCompare** method is 1.

NOTE 1 The **localeCompare** method itself is not directly suitable as an argument to `Array.prototype.sort` because the latter requires a function of two arguments.

NOTE 2 The **localeCompare** function is intentionally generic; it does not require that its `this` value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

16.1.2 `String.prototype.toLocaleLowerCase` ([*locales*])

This definition supersedes the definition provided in ES2020, [21.1.3.23](#).

This function interprets a String value as a sequence of code points, as described in ES2020, [6.1.4](#). The following steps are taken:

1. Let *O* be `RequireObjectCoercible(this value)`.
2. Let *S* be `? ToString(O)`.
3. Let *requestedLocales* be `? CanonicalizeLocaleList(locales)`.
4. If *requestedLocales* is not an empty List, then
 - a. Let *requestedLocale* be *requestedLocales*[0].
5. Else,
 - a. Let *requestedLocale* be `DefaultLocale()`.

6. Let *noExtensionsLocale* be the String value that is *requestedLocale* with all Unicode locale extension sequences (6.2.1) removed.
7. Let *availableLocales* be a List with language tags that includes the languages for which the Unicode Character Database contains language sensitive case mappings. Implementations may add additional language tags if they support case mapping for additional locales.
8. Let *locale* be `BestAvailableLocale(availableLocales, noExtensionsLocale)`.
9. If *locale* is **undefined**, let *locale* be **"und"**.
10. Let *cpList* be a List containing in order the code points of *S* as defined in ES2020, 6.1.4, starting at the first element of *S*.
11. Let *cuList* be a List where the elements are the result of a lower case transformation of the ordered code points in *cpList* according to the Unicode Default Case Conversion algorithm or an implementation defined conversion algorithm. A conforming implementation's lower case transformation algorithm must always yield the same *cpList* given the same *cuList* and locale.
12. Let *L* be a String whose elements are the UTF-16 Encoding (defined in ES2020, 6.1.4) of the code points of *cuList*.
13. Return *L*.

Lower case code point mappings may be derived according to a tailored version of the Default Case Conversion Algorithms of the Unicode Standard. Implementations may use locale specific tailoring defined in `SpecialCasings.txt` and/or CLDR and/or any other custom tailoring.

NOTE 1 The case mapping of some code points may produce multiple code points. In this case the result String may not be the same length as the source String. Because both **toLocaleUpperCase** and **toLocaleLowerCase** have context-sensitive behaviour, the functions are not symmetrical. In other words, **s.toLocaleUpperCase().toLocaleLowerCase()** is not necessarily equal to **s.toLocaleLowerCase()**.

NOTE 2 The **toLocaleLowerCase** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

16.1.3 String.prototype.toLocaleUpperCase ([locales])

This definition supersedes the definition provided in ES2020, 21.1.3.24.

This function interprets a String value as a sequence of code points, as described in ES2020, 6.1.4. This function behaves in exactly the same way as **String.prototype.toLocaleLowerCase**, except that characters are mapped to their *uppercase* equivalents. A conforming implementation's upper case transformation algorithm must always yield the same result given the same sequence of code points and locale.

NOTE The **toLocaleUpperCase** function is intentionally generic; it does not require that its **this** value be a String object. Therefore, it can be transferred to other kinds of objects for use as a method.

16.2 Properties of the Number Prototype Object

The following definition(s) refer to the abstract operation `thisNumberValue` as defined in ES2020, 20.1.3.

16.2.1 Number.prototype.toLocaleString ([locales [, options]])

This definition supersedes the definition provided in ES2020, 20.1.3.4.

When the **toLocaleString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *x* be ? `thisNumberValue(this value)`.
2. Let *numberFormat* be ? `Construct(%NumberFormat%, « locales, options »)`.
3. Return ? `FormatNumeric(numberFormat, x)`.

16.3 Properties of the BigInt Prototype Object

The following definition(s) refer to the abstract operation `thisBigIntValue` as defined in ES2020, 20.2.3.

16.3.1 BigInt.prototype.toLocaleString ([*locales* [, *options*]])

This definition supersedes the definition provided in ES2020, 20.2.3.2.

When the **toLocaleString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *x* be ? `thisBigIntValue`(**this** value).
2. Let *numberFormat* be ? `Construct(%NumberFormat%, « locales, options »)`.
3. Return ? `FormatNumeric(numberFormat, x)`.

16.4 Properties of the Date Prototype Object

The following definition(s) refer to the abstract operation `thisTimeValue` as defined in ES2020, 20.4.4.

16.4.1 Date.prototype.toLocaleString ([*locales* [, *options*]])

This definition supersedes the definition provided in ES2020, 20.4.4.39.

When the **toLocaleString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *x* be ? `thisTimeValue`(**this** value).
2. If *x* is NaN, return "Invalid Date".
3. Let *options* be ? `ToDateTimeOptions(options, "any", "all")`.
4. Let *dateFormat* be ? `Construct(%DateTimeFormat%, « locales, options »)`.
5. Return ? `FormatDateTime(dateFormat, x)`.

16.4.2 Date.prototype.toLocaleDateString ([*locales* [, *options*]])

This definition supersedes the definition provided in ES2020, 20.4.4.38.

When the **toLocaleDateString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *x* be ? `thisTimeValue`(**this** value).
2. If *x* is NaN, return "Invalid Date".
3. Let *options* be ? `ToDateTimeOptions(options, "date", "date")`.
4. Let *dateFormat* be ? `Construct(%DateTimeFormat%, « locales, options »)`.
5. Return ? `FormatDateTime(dateFormat, x)`.

16.4.3 Date.prototype.toLocaleTimeString ([*locales* [, *options*]])

This definition supersedes the definition provided in ES2020, 20.4.4.40.

When the **toLocaleTimeString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *x* be ? `thisTimeValue`(**this** value).
2. If *x* is NaN, return "Invalid Date".
3. Let *options* be ? `ToDateTimeOptions(options, "time", "time")`.
4. Let *timeFormat* be ? `Construct(%DateTimeFormat%, « locales, options »)`.
5. Return ? `FormatDateTime(timeFormat, x)`.

16.5 Properties of the Array Prototype Object

16.5.1 Array.prototype.toLocaleString ([*locales* [, *options*]])

This definition supersedes the definition provided in ES2020, 22.1.3.29.

When the **toLocaleString** method is called with optional arguments *locales* and *options*, the following steps are taken:

1. Let *array* be ? **ToObject**(**this** value).
2. Let *len* be ? **ToLength**(? **Get**(*array*, "length")).
3. Let *separator* be the String value for the list-separator String appropriate for the host environment's current locale (this is derived in an implementation-defined way).
4. Let *R* be the empty String.
5. Let *k* be 0.
6. Repeat, while *k* < *len*
 - a. If *k* > 0, then
 - i. Set *R* to the **string-concatenation** of *R* and *separator*.
 - b. Let *nextElement* be ? **Get**(*array*, ! **ToInteger**(*k*)).
 - c. If *nextElement* is not **undefined** or **null**, then
 - i. Let *S* be ? **ToString**(? **Invoke**(*nextElement*, "toLocaleString", « *locales*, *options* »)).
 - ii. Set *R* to the **string-concatenation** of *R* and *S*.
 - d. Increase *k* by 1.
7. Return *R*.

NOTE 1 This algorithm's steps mirror the steps taken in 22.1.3.29, with the exception that **Invoke**(*nextElement*, "toLocaleString") now takes *locales* and *options* as arguments.

NOTE 2 The elements of the array are converted to Strings using their **toLocaleString** methods, and these Strings are then concatenated, separated by occurrences of a separator String that has been derived in an implementationdefined locale-specific way. The result of calling this function is intended to be analogous to the result of **toString**, except that the result of this function is intended to be locale-specific.

NOTE 3 The **toLocaleString** function is intentionally generic; it does not require that its **this** value be an Array object. Therefore it can be transferred to other kinds of objects for use as a method.

A Implementation Dependent Behaviour

The following aspects of the ECMAScript 2020 Internationalization API Specification are implementation dependent:

- In all functionality:
 - Additional values for some properties of *options* arguments (2)
 - The default locale (6.2.4)
 - The default time zone (6.4.3)
 - The set of available locales for each **constructor** (9.1)
 - The **BestFitMatcher** algorithm (9.2.4)
 - The **BestFitSupportedLocales** algorithm (9.2.9)
- In Locale:
 - Support for the Unicode extensions keys "kn", "kf" and the parallel options properties "numeric", "caseFirst" (10.1.3)
- In Collator:
 - Support for the Unicode extensions keys "kn", "kf" and the parallel options properties "numeric", "caseFirst" (11.1.1)
 - The set of supported "co" key values (collations) per locale beyond a default collation (11.2.3)
 - The set of supported "kn" key values (numeric collation) per locale (11.2.3)

- The set of supported "kf" key values (case order) per locale (11.2.3)
- The default search sensitivity per locale (11.2.3)
- The sort order for each supported locale and options combination (11.3.3.1)
- In NumberFormat:
 - The set of supported "nu" key values (numbering systems) per locale (12.3.3)
 - The patterns used for formatting values as decimal, percent, currency, or unit values per locale, with or without the sign, with or without accounting format for currencies, and in standard, compact, or scientific notation (12.1.8)
 - Localized representations of NaN and Infinity (12.1.8)
 - The implementation of numbering systems not listed in Table 4 (12.1.8)
 - Localized decimal and grouping separators (12.1.8)
 - Localized plus and minus signs (12.1.8)
 - Localized digit grouping schemata (12.1.8)
 - Localized magnitude thresholds for compact notation (12.1.8)
 - Localized symbols for compact and scientific notation (12.1.8)
 - Localized narrow, short, and long currency symbols and names (12.1.8)
 - Localized narrow, short, and long unit symbols (12.1.8)
- In DateTimeFormat:
 - The BestFitFormatMatcher algorithm (13.1.1)
 - The set of supported "ca" key values (calendars) per locale (13.3.3)
 - The set of supported "nu" key values (numbering systems) per locale (13.3.3)
 - The default hourCycle setting per locale (13.3.3)
 - The set of supported date-time formats per locale beyond a core set, including the representations used for each component and the associated patterns (13.3.3)
 - Localized weekday names, era names, month names, am/pm indicators, and time zone names (13.1.7)
 - The calendric calculations used for calendars other than "gregory", and adjustments for local time zones and daylight saving time (13.1.7)
- In RelativeTimeFormat:
 - The set of supported "nu" key values (numbering systems) per locale (14.3.3)
 - The patterns used for formatting values (14.3.3)
- In PluralRules:
 - List of Strings representing the possible results of plural selection and their corresponding order per locale. (15.1.1)

B Additions and Changes That Introduce Incompatibilities with Prior Editions

- 11.1, 12.2, 13.2 In ECMA-402, 1st Edition, constructors could be used to create Intl objects from arbitrary objects. This is no longer possible in 2nd Edition.
- 13.4.3 In ECMA-402, 1st Edition, the "length" property of the function object *F* was set to 0. In 2nd Edition, "length" is set to 1.

C Colophon

This specification is authored on [GitHub](#) in a plaintext source format called [Ecm Markup](#). Ecm Markup is an HTML and Markdown dialect that provides a framework and toolset for authoring ECMAScript specifications in plaintext and processing the specification into a full-featured HTML rendering that follows the editorial conventions for this document. Ecm Markup builds on and integrates a number of other formats and technologies including [Grammarkdown](#) for defining syntax and [Ecm Markup](#) for authoring algorithm steps. PDF renderings of this specification are produced by printing the HTML rendering to a PDF.

Prior editions of this specification were authored using Word—the Ecm Markup source text that formed the basis of this

edition was produced by converting the ECMAScript 2015 Word document to Ecm Markup using an automated conversion tool.