traitlets Documentation

Release 5.14.2

The IPython Development Team

Mar 12, 2024

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docs
https://traitlets.readthedocs.io/

license
Modified BSD License

Traitlets is a framework that lets Python classes have attributes with type checking, dynamically calculated default values, and 'on change' callbacks.

The package also includes a mechanism to use traitlets for configuration, loading values from files or from command line arguments. This is a distinct layer on top of traitlets, so you can use traitlets in your code without using the configuration machinery.

CHAPTER

ONE

USING TRAITLETS

In short, traitlets let the user define classes that have

1. Attributes (traits) with type checking and dynamically computed default values
2. Traits emit change events when attributes are modified
3. Traitlets perform some validation and allow coercion of new trait values on assignment. They also allow the user to define custom validation logic for attributes based on the value of other attributes.

1.1 Default values, and checking type and value

At its most basic, traitlets provides type checking, and dynamic default value generation of attributes on *traitlets.HasTraits* subclasses:

```
from traitlets import HasTraits, Int, Unicode, default
import getpass


class Identity(HasTraits):
    username = Unicode()

    @default("username")
    def _default_username(self):
        return getpass.getuser()
```

```
class Foo(HasTraits):
    bar = Int()


foo = Foo(bar="3")  # raises a TraitError
```

```
TraitError: The 'bar' trait of a Foo instance must be an int,
but a value of '3' <class 'str'> was specified
```

1.2 observe

Traitlets implement the observer pattern

```
class Foo(HasTraits):
    bar = Int()
    baz = Unicode()


foo = Foo()


def func(change):
    print(change["old"])
    print(change["new"])  # as of traitlets 4.3, one should be able to
    # write print(change.new) instead


foo.observe(func, names=["bar"])
foo.bar = 1  # prints '0\n 1'
foo.baz = "abc"  # prints nothing
```

When observers are methods of the class, a decorator syntax can be used.

```
class Foo(HasTraits):
    bar = Int()
    baz = Unicode()

    @observe("bar")
    def _observe_bar(self, change):
        print(change["old"])
        print(change["new"])
```

1.3 Validation and Coercion

1.3.1 Custom Cross-Validation

Each trait type (`Int`, `Unicode`, `Dict` etc.) may have its own validation or coercion logic. In addition, we can register custom cross-validators that may depend on the state of other attributes.

Basic Example: Validating the Parity of a Trait

```
from traitlets import HasTraits, TraitError, Int, Bool, validate


class Parity(HasTraits):
    data = Int()
    parity = Int()
```

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```
    @validate("data")
    def _valid_data(self, proposal):
        if proposal["value"] % 2 != self.parity:
            raise TraitError("data and parity should be consistent")
        return proposal["value"]

    @validate("parity")
    def _valid_parity(self, proposal):
        parity = proposal["value"]
        if parity not in [0, 1]:
            raise TraitError("parity should be 0 or 1")
        if self.data % 2 != parity:
            raise TraitError("data and parity should be consistent")
        return proposal["value"]


parity_check = Parity(data=2)

# Changing required parity and value together while holding cross validation
with parity_check.hold_trait_notifications():
    parity_check.data = 1
    parity_check.parity = 1
```

Notice how all of the examples above return `proposal['value']`. Returning a value is necessary for validation to work properly, since the new value of the trait will be the return value of the function decorated by `@validate`. If this function does not have any `return` statement, then the returned value will be `None`, instead of what we wanted (which is `proposal['value']`).

However, we recommend that custom cross-validators don't modify the state of the HasTraits instance.

Advanced Example: Validating the Schema

The `List` and `Dict` trait types allow the validation of nested properties.

```
from traitlets import HasTraits, Dict, Bool, Unicode


class Nested(HasTraits):
    value = Dict(
        per_key_traits={"configuration": Dict(value_trait=Unicode()), "flag": Bool()}
    )


n = Nested()
n.value = dict(flag=True, configuration={})  # OK
n.value = dict(flag=True, configuration="")  # raises a TraitError.
```

However, for deeply nested properties it might be more appropriate to use an external validator:

```
import jsonschema

value_schema = {
```

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```
    "type": "object",
    "properties": {
        "price": {"type": "number"},
        "name": {"type": "string"},
    },
}

from traitlets import HasTraits, Dict, TraitError, validate, default


class Schema(HasTraits):
    value = Dict()

    @default("value")
    def _default_value(self):
        return dict(name="", price=1)

    @validate("value")
    def _validate_value(self, proposal):
        try:
            jsonschema.validate(proposal["value"], value_schema)
        except jsonschema.ValidationError as e:
            raise TraitError(e)
        return proposal["value"]


s = Schema()
s.value = dict(name="", price="1")  # raises a TraitError
```

1.3.2 Holding Trait Cross-Validation and Notifications

Sometimes it may be impossible to transition between valid states for a `HasTraits` instance by changing attributes one by one. The `hold_trait_notifications` context manager can be used to hold the custom cross validation until the context manager is released. If a validation error occurs, changes are rolled back to the initial state.

1.4 Custom Events

Finally, trait types can emit other events types than trait changes. This capability was added so as to enable notifications on change of values in container classes. The items available in the dictionary passed to the observer registered with `observe` depends on the event type.

CHAPTER

TWO

TRAIT TYPES

class traitlets.**TraitType**

The base class for all trait types.

__init__(*default_value: Any = traitlets.Undefined*, *allow_none: bool = False*, *read_only: bool | None = None*, *help: str | None = None*, *config: Any = None*, ***kwargs: Any*) → None

Declare a traitlet.

If *allow_none* is True, None is a valid value in addition to any values that are normally valid. The default is up to the subclass. For most trait types, the default value for `allow_none` is False.

If *read_only* is True, attempts to directly modify a trait attribute raises a TraitError.

If *help* is a string, it documents the attribute's purpose.

Extra metadata can be associated with the traitlet using the .tag() convenience method or by using the traitlet instance's .metadata dictionary.

from_string(*s: str*) → G | None

Get a value from a config string

such as an environment variable or CLI arguments.

Traits can override this method to define their own parsing of config strings.

See also:

item_from_string

New in version 5.0.

2.1 Numbers

traitlets.**Integer**

alias of `Int`

class traitlets.**Int**

class traitlets.**Long**

On Python 2, these are traitlets for values where the `int` and `long` types are not interchangeable. On Python 3, they are both aliases for *`Integer`*.

In almost all situations, you should use *`Integer`* instead of these.

class traitlets.**Float**(*default_value: float | Sentinel = ...*, *allow_none: Literal[False] = ...*, *read_only: bool | None = ...*, *help: str | None = ...*, *config: Any | None = ...*, ***kwargs: Any*)

class traitlets.**Float**(*default_value: float | Sentinel | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

A float trait.

class traitlets.**Complex**(*default_value: Any = traitlets.Undefined, allow_none: bool = False, read_only: bool | None = None, help: str | None = None, config: Any = None, **kwargs: Any*)

A trait for complex numbers.

class traitlets.**CInt**

class traitlets.**CLong**

class traitlets.**CFloat**

class traitlets.**CComplex**

Casting variants of the above. When a value is assigned to the attribute, these will attempt to convert it by calling e.g. `value = int(value)`.

2.2 Strings

class traitlets.**Unicode**(*default_value: str | Sentinel = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

class traitlets.**Unicode**(*default_value: str | Sentinel | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

A trait for unicode strings.

class traitlets.**Bytes**(*default_value: Any = traitlets.Undefined, allow_none: bool = False, read_only: bool | None = None, help: str | None = None, config: Any = None, **kwargs: Any*)

A trait for byte strings.

class traitlets.**CUnicode**

class traitlets.**CBytes**

Casting variants. When a value is assigned to the attribute, these will attempt to convert it to their type. They will not automatically encode/decode between unicode and bytes, however.

class traitlets.**ObjectName**(*default_value: Any = traitlets.Undefined, allow_none: bool = False, read_only: bool | None = None, help: str | None = None, config: Any = None, **kwargs: Any*)

A string holding a valid object name in this version of Python.

This does not check that the name exists in any scope.

class traitlets.**DottedObjectName**(*default_value: Any = traitlets.Undefined, allow_none: bool = False, read_only: bool | None = None, help: str | None = None, config: Any = None, **kwargs: Any*)

A string holding a valid dotted object name in Python, such as A.b3._c

2.3 Containers

class traitlets.**List**(*trait: List[T] | Tuple[T] | Set[T] | Sentinel | TraitType[T, Any] | None = None*, *default_value: List[T] | Tuple[T] | Set[T] | Sentinel | None = traitlets.Undefined*, *minlen: int = 0*, *maxlen: int = 9223372036854775807*, ***kwargs: Any*)

An instance of a Python list.

__init__(*trait: List[T] | Tuple[T] | Set[T] | Sentinel | TraitType[T, Any] | None = None*, *default_value: List[T] | Tuple[T] | Set[T] | Sentinel | None = traitlets.Undefined*, *minlen: int = 0*, *maxlen: int = 9223372036854775807*, ***kwargs: Any*) → None

Create a List trait type from a list, set, or tuple.

The default value is created by doing `list(default_value)`, which creates a copy of the `default_value`.

`trait` can be specified, which restricts the type of elements in the container to that TraitType.

If only one arg is given and it is not a Trait, it is taken as `default_value`:

```
c = List([1, 2, 3])
```

Parameters

- **trait** (*TraitType [optional]*) – the type for restricting the contents of the Container. If unspecified, types are not checked.
- **default_value** (*SequenceType [optional]*) – The default value for the Trait. Must be list/tuple/set, and will be cast to the container type.
- **minlen** (*Int [default 0]*) – The minimum length of the input list
- **maxlen** (*Int [default sys.maxsize]*) – The maximum length of the input list

from_string_list(*s_list: list[str]*) → T | None

Return the value from a list of config strings

This is where we parse CLI configuration

item_from_string(*s: str*, *index: int | None = None*) → T | str

Cast a single item from a string

Evaluated when parsing CLI configuration from a string

class traitlets.**Set**(*trait: Any = None*, *default_value: Any = traitlets.Undefined*, *minlen: int = 0*, *maxlen: int = 9223372036854775807*, ***kwargs: Any*)

An instance of a Python set.

__init__(*trait: Any = None*, *default_value: Any = traitlets.Undefined*, *minlen: int = 0*, *maxlen: int = 9223372036854775807*, ***kwargs: Any*) → None

Create a Set trait type from a list, set, or tuple.

The default value is created by doing `set(default_value)`, which creates a copy of the `default_value`.

`trait` can be specified, which restricts the type of elements in the container to that TraitType.

If only one arg is given and it is not a Trait, it is taken as `default_value`:

```
c = Set({1, 2, 3})
```

Parameters

- **trait** (*TraitType [optional]*) – the type for restricting the contents of the Container. If unspecified, types are not checked.

- **default_value** (*SequenceType [optional]*) – The default value for the Trait. Must be list/tuple/set, and will be cast to the container type.
- **minlen** (Int *[default 0]*) – The minimum length of the input list
- **maxlen** (Int *[default sys.maxsize]*) – The maximum length of the input list

class traitlets.**Tuple**(**traits: Any*, ***kwargs: Any*)

An instance of a Python tuple.

__init__(**traits: Any*, ***kwargs: Any*) → None

Create a tuple from a list, set, or tuple.

Create a fixed-type tuple with Traits:

```
t = Tuple(Int(), Str(), CStr())
```

would be length 3, with Int,Str,CStr for each element.

If only one arg is given and it is not a Trait, it is taken as default_value:

```
t = Tuple((1, 2, 3))
```

Otherwise, `default_value` *must* be specified by keyword.

Parameters

- ***traits** (*TraitTypes [optional]*) – the types for restricting the contents of the Tuple. If unspecified, types are not checked. If specified, then each positional argument corresponds to an element of the tuple. Tuples defined with traits are of fixed length.
- **default_value** (*SequenceType [optional]*) – The default value for the Tuple. Must be list/tuple/set, and will be cast to a tuple. If `traits` are specified, `default_value` must conform to the shape and type they specify.
- ****kwargs** – Other kwargs passed to *Container*

class traitlets.**Dict**(*value_trait:* TraitType*[t.Any, t.Any]* | *dict[K, V]* | *Sentinel* | *None* = *None*, *per_key_traits: t.Any* = *None*, *key_trait:* TraitType*[t.Any, t.Any]* | *None* = *None*, *default_value: dict[K, V]* | *Sentinel* | *None* = *traitlets.Undefined*, ***kwargs: t.Any*)

An instance of a Python dict.

One or more traits can be passed to the constructor to validate the keys and/or values of the dict. If you need more detailed validation, you may use a custom validator method.

Changed in version 5.0: Added key_trait for validating dict keys.

Changed in version 5.0: Deprecated ambiguous `trait`, `traits` args in favor of `value_trait`, `per_key_traits`.

__init__(*value_trait:* TraitType*[t.Any, t.Any]* | *dict[K, V]* | *Sentinel* | *None* = *None*, *per_key_traits: t.Any* = *None*, *key_trait:* TraitType*[t.Any, t.Any]* | *None* = *None*, *default_value: dict[K, V]* | *Sentinel* | *None* = *traitlets.Undefined*, ***kwargs: t.Any*) → None

Create a dict trait type from a Python dict.

The default value is created by doing `dict(default_value)`, which creates a copy of the `default_value`.

Parameters

- **value_trait** (TraitType *[optional]*) – The specified trait type to check and use to restrict the values of the dict. If unspecified, values are not checked.

- **per_key_traits** (*Dictionary of {keys:trait types} [optional, keyword-only]*) – A Python dictionary containing the types that are valid for restricting the values of the dict on a per-key basis. Each value in this dict should be a Trait for validating
- **key_trait** (TraitType *[optional, keyword-only]*) – The type for restricting the keys of the dict. If unspecified, the types of the keys are not checked.
- **default_value** (*SequenceType [optional, keyword-only]*) – The default value for the Dict. Must be dict, tuple, or None, and will be cast to a dict if not None. If any key or value traits are specified, the *default_value* must conform to the constraints.

Examples

a dict whose values must be text >>> d = Dict(Unicode())

d2['n'] must be an integer d2['s'] must be text >>> d2 = Dict(per_key_traits={"n": Integer(), "s": Unicode()})

d3's keys must be text d3's values must be integers >>> d3 = Dict(value_trait=Integer(), key_trait=Unicode())

from_string_list(*s_list: list[str]*) → Any

Return a dict from a list of config strings.

This is where we parse CLI configuration.

Each item should have the form `"key=value"`.

item parsing is done in *item_from_string()*.

item_from_string(*s: str*) → dict[K, V]

Cast a single-key dict from a string.

Evaluated when parsing CLI configuration from a string.

Dicts expect strings of the form key=value.

Returns a one-key dictionary, which will be merged in *from_string_list()*.

2.4 Classes and instances

class traitlets.**Instance**(*klass: type[T] = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**Instance**(*klass: type[T] = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**Instance**(*klass: str | None = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**Instance**(*klass: str | None = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

A trait whose value must be an instance of a specified class.

The value can also be an instance of a subclass of the specified class.

Subclasses can declare default classes by overriding the klass attribute

__init__(*klass: type[T] = None, args: tuple[Any, ...] | None = None, kw: dict[str, Any] | None = None, allow_none: Literal[False] = False, read_only: bool | None = None, help: str | None = None, **kwargs: Any*) → None

__init__(*klass: type[T] = None, args: tuple[Any, ...] | None = None, kw: dict[str, Any] | None = None, allow_none: Literal[True] = False, read_only: bool | None = None, help: str | None = None, **kwargs: Any*) → None

__init__(*klass: str | None = None, args: tuple[Any, ...] | None = None, kw: dict[str, Any] | None = None, allow_none: Literal[False] = False, read_only: bool | None = None, help: str | None = None, **kwargs: Any*) → None

__init__(*klass: str | None = None, args: tuple[Any, ...] | None = None, kw: dict[str, Any] | None = None, allow_none: Literal[True] = False, read_only: bool | None = None, help: str | None = None, **kwargs: Any*) → None

Construct an Instance trait.

This trait allows values that are instances of a particular class or its subclasses. Our implementation is quite different from that of enthough.traits as we don't allow instances to be used for klass and we handle the `args` and `kw` arguments differently.

Parameters

- **klass** (*class, str*) – The class that forms the basis for the trait. Class names can also be specified as strings, like 'foo.bar.Bar'.
- **args** (*tuple*) – Positional arguments for generating the default value.
- **kw** (*dict*) – Keyword arguments for generating the default value.
- **allow_none** (*bool [default False]*) – Indicates whether None is allowed as a value.
- ****kwargs** – Extra kwargs passed to *ClassBasedTraitType*

Notes

If both `args` and `kw` are None, then the default value is None. If `args` is a tuple and `kw` is a dict, then the default is created as `klass(*args, **kw)`. If exactly one of `args` or `kw` is None, the None is replaced by `()` or `{}`, respectively.

class traitlets.**Type**(*default_value: Sentinel | None | str = ..., klass: None | str = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**Type**(*default_value: Sentinel | None | str = ..., klass: None | str = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**Type**(*default_value: S = ..., klass: S = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**Type**(*default_value: S | None = ..., klass: S = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

A trait whose value must be a subclass of a specified class.

__init__(*default_value: Sentinel | None | str = traitlets.Undefined, klass: None | str = None, allow_none: Literal[False] = False, read_only: bool | None = None, help: str | None = None, config: Any | None = None, **kwargs: Any*) → None

__init__(*default_value: Sentinel | None | str = traitlets.Undefined, klass: None | str = None, allow_none: Literal[True] = False, read_only: bool | None = None, help: str | None = None, config: Any | None = None, **kwargs: Any*) → None

__init__(*default_value: S = traitlets.Undefined, klass: S = None, allow_none: Literal[False] = False, read_only: bool | None = None, help: str | None = None, config: Any | None = None, **kwargs: Any*) → None

__init__(*default_value: S | None = traitlets.Undefined, klass: S = None, allow_none: Literal[True] = False, read_only: bool | None = None, help: str | None = None, config: Any | None = None, **kwargs: Any*) → None

Construct a Type trait

A Type trait specifies that its values must be subclasses of a particular class.

If only `default_value` is given, it is used for the `klass` as well. If neither are given, both default to `object`.

Parameters

- **default_value** (*class, str or None*) – The default value must be a subclass of klass. If an str, the str must be a fully specified class name, like 'foo.bar.Bah'. The string is resolved into real class, when the parent *HasTraits* class is instantiated.
- **klass** (*class, str [default object]*) – Values of this trait must be a subclass of klass. The klass may be specified in a string like: 'foo.bar.MyClass'. The string is resolved into real class, when the parent *HasTraits* class is instantiated.
- **allow_none** (*bool [default False]*) – Indicates whether None is allowed as an assignable value.
- ****kwargs** – extra kwargs passed to *ClassBasedTraitType*

class traitlets.**This**(***kwargs: Any*)

A trait for instances of the class containing this trait.

Because how how and when class bodies are executed, the `This` trait can only have a default value of None. This, and because we always validate default values, `allow_none` is *always* true.

class traitlets.**ForwardDeclaredInstance**(*klass: type[T] = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredInstance**(*klass: type[T] = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredInstance**(*klass: str | None = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredInstance**(*klass: str | None = ..., args: tuple[Any, ...] | None = ..., kw: dict[str, Any] | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., **kwargs: Any*)

Forward-declared version of Instance.

class traitlets.**ForwardDeclaredType**(*default_value: Sentinel | None | str = ..., klass: None | str = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredType**(*default_value: Sentinel | None | str = ..., klass: None | str = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredType**(*default_value: S = ..., klass: S = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

class traitlets.**ForwardDeclaredType**(*default_value: S | None = ..., klass: S = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any | None = ..., **kwargs: Any*)

Forward-declared version of Type.

2.5 Miscellaneous

class traitlets.**Bool**(*default_value: bool | Sentinel = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

class traitlets.**Bool**(*default_value: bool | Sentinel | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

A boolean (True, False) trait.

class traitlets.**CBool**

Casting variant. When a value is assigned to the attribute, this will attempt to convert it by calling `value = bool(value)`.

class traitlets.**Enum**(*values: Sequence[G], default_value: G | Sentinel = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

class traitlets.**Enum**(*values: Sequence[G] | None, default_value: G | Sentinel | None = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

An enum whose value must be in a given sequence.

class traitlets.**CaselessStrEnum**(*values: Any, default_value: Any = traitlets.Undefined, **kwargs: Any*)

An enum of strings where the case should be ignored.

class traitlets.**UseEnum**(*enum_class: type[Any], default_value: Any = None, **kwargs: Any*)

Use a Enum class as model for the data type description. Note that if no default-value is provided, the first enum-value is used as default-value.

```
# -- SINCE: Python 3.4 (or install backport: pip install enum34)
import enum
from traitlets import HasTraits, UseEnum


class Color(enum.Enum):
    red = 1  # -- IMPLICIT: default_value
    blue = 2
```

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```
    green = 3


class MyEntity(HasTraits):
    color = UseEnum(Color, default_value=Color.blue)


entity = MyEntity(color=Color.red)
entity.color = Color.green  # USE: Enum-value (preferred)
entity.color = "green"  # USE: name (as string)
entity.color = "Color.green"  # USE: scoped-name (as string)
entity.color = 3  # USE: number (as int)
assert entity.color is Color.green
```

class traitlets.**TCPAddress**(*default_value: bool | Sentinel = ..., allow_none: Literal[False] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

class traitlets.**TCPAddress**(*default_value: bool | None | Sentinel = ..., allow_none: Literal[True] = ..., read_only: bool | None = ..., help: str | None = ..., config: Any = ..., **kwargs: Any*)

A trait for an (ip, port) tuple.

This allows for both IPv4 IP addresses as well as hostnames.

class traitlets.**CRegExp**(*default_value: Any = traitlets.Undefined, allow_none: bool = False, read_only: bool | None = None, help: str | None = None, config: Any = None, **kwargs: Any*)

A casting compiled regular expression trait.

Accepts both strings and compiled regular expressions. The resulting attribute will be a compiled regular expression.

class traitlets.**Union**(*trait_types: Any, **kwargs: Any*)

A trait type representing a Union type.

__init__(*trait_types: Any, **kwargs: Any*) → None

Construct a Union trait.

This trait allows values that are allowed by at least one of the specified trait types. A Union traitlet cannot have metadata on its own, besides the metadata of the listed types.

Parameters

- **trait_types** (*sequence*) – The list of trait types of length at least 1.
- ****kwargs** – Extra kwargs passed to *TraitType*

Notes

Union([Float(), Bool(), Int()]) attempts to validate the provided values with the validation function of Float, then Bool, and finally Int.

Parsing from string is ambiguous for container types which accept other collection-like literals (e.g. List accepting both *[]* and *()* precludes Union from ever parsing `Union([List(), Tuple()])` as a tuple; you can modify behaviour of too permissive container traits by overriding `_literal_from_string_pairs` in subclasses. Similarly, parsing unions of numeric types is only unambiguous if types are provided in order of increasing permissiveness, e.g. `Union([Int(), Float()])` (since floats accept integer-looking values).

class traitlets.**Callable**(*default_value: Any = traitlets.Undefined*, *allow_none: bool = False*, *read_only: bool | None = None*, *help: str | None = None*, *config: Any = None*, ***kwargs: Any*)

A trait which is callable.

Notes

Classes are callable, as are instances with a __call__() method.

class traitlets.**Any**(*default_value: Any = ...*, ***, *allow_none: Literal[False]*, *read_only: bool | None = ...*, *help: str | None = ...*, *config: Any | None = ...*, ***kwargs: Any*)

class traitlets.**Any**(*default_value: Any = ...*, ***, *allow_none: Literal[True]*, *read_only: bool | None = ...*, *help: str | None = ...*, *config: Any | None = ...*, ***kwargs: Any*)

class traitlets.**Any**(*default_value: Any = ...*, ***, *allow_none: Literal[True, False] = ...*, *help: str | None = ...*, *read_only: bool | None = False*, *config: Any = None*, ***kwargs: Any*)

A trait which allows any value.

CHAPTER

THREE

DEFINING NEW TRAIT TYPES

To define a new trait type, subclass from *TraitType*. You can define the following things:

class traitlets.**MyTrait**

info_text
A short string describing what this trait should hold.

default_value
A default value, if one makes sense for this trait type. If there is no obvious default, don't provide this.

validate(*obj*, *value*)
Check whether a given value is valid. If it is, it should return the value (coerced to the desired type, if necessary). If not, it should raise `TraitError`. `TraitType.error()` is a convenient way to raise an descriptive error saying that the given value is not of the required type.

`obj` is the object to which the trait belongs.

For instance, here's the definition of the *TCPAddress* trait:

```
class TCPAddress(TraitType[G, S]):
    """A trait for an (ip, port) tuple.

    This allows for both IPv4 IP addresses as well as hostnames.
    """

    default_value = ("127.0.0.1", 0)
    info_text = "an (ip, port) tuple"

    if t.TYPE_CHECKING:

        @t.overload
        def __init__(
            self: TCPAddress[tuple[str, int], tuple[str, int]],
            default_value: bool | Sentinel = ...,
            allow_none: Literal[False] = ...,
            read_only: bool | None = ...,
            help: str | None = ...,
            config: t.Any = ...,
            **kwargs: t.Any,
        ) -> None:
            ...

        @t.overload
```

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```
        def __init__(
            self: TCPAddress[tuple[str, int] | None, tuple[str, int] | None],
            default_value: bool | None | Sentinel = ...,
            allow_none: Literal[True] = ...,
            read_only: bool | None = ...,
            help: str | None = ...,
            config: t.Any = ...,
            **kwargs: t.Any,
        ) -> None:
            ...

        def __init__(
            self: TCPAddress[tuple[str, int] | None, tuple[str, int] | None]
            | TCPAddress[tuple[str, int], tuple[str, int]],
            default_value: bool | None | Sentinel = Undefined,
            allow_none: Literal[True, False] = False,
            read_only: bool | None = None,
            help: str | None = None,
            config: t.Any = None,
            **kwargs: t.Any,
        ) -> None:
            ...

    def validate(self, obj: t.Any, value: t.Any) -> G:
        if isinstance(value, tuple):
            if len(value) == 2:
                if isinstance(value[0], str) and isinstance(value[1], int):
                    port = value[1]
                    if port >= 0 and port <= 65535:
                        return t.cast(G, value)
        self.error(obj, value)

    def from_string(self, s: str) -> G:
        if self.allow_none and s == "None":
            return t.cast(G, None)
        if ":" not in s:
            raise ValueError("Require `ip:port`, got %r" % s)
        ip, port_str = s.split(":", 1)
        port = int(port_str)
        return t.cast(G, (ip, port))
```

CHAPTER

FOUR

TRAITLETS API REFERENCE

Any class with trait attributes must inherit from *HasTraits*.

class traitlets.**HasTraits**(**kwargs: *Any*)

has_trait(*name: str*) → bool

Returns True if the object has a trait with the specified name.

trait_has_value(*name: str*) → bool

Returns True if the specified trait has a value.

This will return false even if `getattr` would return a dynamically generated default value. These default values will be recognized as existing only after they have been generated.

Example

```
class MyClass(HasTraits):
    i = Int()


mc = MyClass()
assert not mc.trait_has_value("i")
mc.i  # generates a default value
assert mc.trait_has_value("i")
```

trait_names(**metadata: *Any*) → list[str]

Get a list of all the names of this class' traits.

classmethod class_trait_names(**metadata: *Any*) → list[str]

Get a list of all the names of this class' traits.

This method is just like the *trait_names()* method, but is unbound.

traits(**metadata: *Any*) → dict[str, TraitType[Any, Any]]

Get a `dict` of all the traits of this class. The dictionary is keyed on the name and the values are the TraitType objects.

The TraitTypes returned don't know anything about the values that the various HasTrait's instances are holding.

The metadata kwargs allow functions to be passed in which filter traits based on metadata values. The functions should take a single value as an argument and return a boolean. If any function returns False, then the trait is not included in the output. If a metadata key doesn't exist, None will be passed to the function.

classmethod class_traits(**metadata: *Any*) → dict[str, TraitType[Any, Any]]

Get a `dict` of all the traits of this class. The dictionary is keyed on the name and the values are the TraitType objects.

This method is just like the *traits()* method, but is unbound.

The TraitTypes returned don't know anything about the values that the various HasTrait's instances are holding.

The metadata kwargs allow functions to be passed in which filter traits based on metadata values. The functions should take a single value as an argument and return a boolean. If any function returns False, then the trait is not included in the output. If a metadata key doesn't exist, None will be passed to the function.

trait_metadata(*traitname: str*, *key: str*, *default: Any = None*) → Any

Get metadata values for trait by key.

add_traits(**traits: *Any*) → None

Dynamically add trait attributes to the HasTraits instance.

You then declare the trait attributes on the class like this:

```
from traitlets import HasTraits, Int, Unicode

class Requester(HasTraits):
    url = Unicode()
    timeout = Int(30)  # 30 will be the default value
```

For the available trait types and the arguments you can give them, see *Trait Types*.

4.1 Dynamic default values

traitlets.**default**(*name: str*) → DefaultHandler

A decorator which assigns a dynamic default for a Trait on a HasTraits object.

Parameters

name – The str name of the Trait on the object whose default should be generated.

Notes

Unlike observers and validators which are properties of the HasTraits instance, default value generators are class-level properties.

Besides, default generators are only invoked if they are registered in subclasses of *this_type*.

```
class A(HasTraits):
    bar = Int()

    @default('bar')
    def get_bar_default(self):
        return 11

class B(A):
    bar = Float()  # This trait ignores the default generator defined in
```

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```
                    # the base class A

class C(B):

    @default('bar')
    def some_other_default(self):  # This default generator should not be
        return 3.0                 # ignored since it is defined in a
                                   # class derived from B.a.this_class.
```

To calculate a default value dynamically, decorate a method of your class with `@default({traitname})`. This method will be called on the instance, and should return the default value. For example:

```
import getpass

class Identity(HasTraits):
    username = Unicode()

    @default('username')
    def _username_default(self):
        return getpass.getuser()
```

4.2 Callbacks when trait attributes change

`traitlets.`**`observe`**(**names: Sentinel | str*, *type: str = 'change'*) → ObserveHandler

A decorator which can be used to observe Traits on a class.

The handler passed to the decorator will be called with one `change` dict argument. The change dictionary at least holds a 'type' key and a 'name' key, corresponding respectively to the type of notification and the name of the attribute that triggered the notification.

Other keys may be passed depending on the value of 'type'. In the case where type is 'change', we also have the following keys: * `owner` : the HasTraits instance * `old` : the old value of the modified trait attribute * `new` : the new value of the modified trait attribute * `name` : the name of the modified trait attribute.

Parameters

- ***names** – The str names of the Traits to observe on the object.
- **type** (*str, kwarg-only*) – The type of event to observe (e.g. 'change')

To do something when a trait attribute is changed, decorate a method with *traitlets.observe()*. The method will be called with a single argument, a dictionary of the form:

```
{
  'owner': object, # The HasTraits instance
  'new': 6, # The new value
  'old': 5, # The old value
  'name': "foo", # The name of the changed trait
  'type': 'change', # The event type of the notification, usually 'change'
}
```

For example:

```
from traitlets import HasTraits, Integer, observe

class TraitletsExample(HasTraits):
    num = Integer(5, help="a number").tag(config=True)

    @observe('num')
    def _num_changed(self, change):
        print("{name} changed from {old} to {new}".format(**change))
```

Changed in version 4.1: The `_{trait}_changed` magic method-name approach is deprecated.

You can also add callbacks to a trait dynamically:

HasTraits.**observe**(*handler: Callable[[...], Any]*, *names: Sentinel | str | Iterable[Sentinel | str] = traitlets.All*, *type: Sentinel | str = 'change'*) → None

Setup a handler to be called when a trait changes.

This is used to setup dynamic notifications of trait changes.

Parameters

- **handler** (*callable*) – A callable that is called when a trait changes. Its signature should be `handler(change)`, where `change` is a dictionary. The change dictionary at least holds a 'type' key. * `type`: the type of notification. Other keys may be passed depending on the value of 'type'. In the case where type is 'change', we also have the following keys: * `owner` : the HasTraits instance * `old` : the old value of the modified trait attribute * `new` : the new value of the modified trait attribute * `name` : the name of the modified trait attribute.
- **names** (*list, str, All*) – If names is All, the handler will apply to all traits. If a list of str, handler will apply to all names in the list. If a str, the handler will apply just to that name.
- **type** (*str, All (default: 'change')*) – The type of notification to filter by. If equal to All, then all notifications are passed to the observe handler.

Note: If a trait attribute with a dynamic default value has another value set before it is used, the default will not be calculated. Any callbacks on that trait will will fire, and *old_value* will be `None`.

4.3 Validating proposed changes

traitlets.**validate**(**names: Sentinel | str*) → ValidateHandler

A decorator to register cross validator of HasTraits object's state when a Trait is set.

The handler passed to the decorator must have one `proposal` dict argument. The proposal dictionary must hold the following keys:

- `owner` : the HasTraits instance
- `value` : the proposed value for the modified trait attribute
- `trait` : the TraitType instance associated with the attribute

Parameters

***names** – The str names of the Traits to validate.

Notes

Since the owner has access to the `HasTraits` instance via the 'owner' key, the registered cross validator could potentially make changes to attributes of the `HasTraits` instance. However, we recommend not to do so. The reason is that the cross-validation of attributes may run in arbitrary order when exiting the `hold_trait_notifications` context, and such changes may not commute.

Validator methods can be used to enforce certain aspects of a property. These are called on proposed changes, and can raise a TraitError if the change should be rejected, or coerce the value if it should be accepted with some modification. This can be useful for things such as ensuring a path string is always absolute, or check if it points to an existing directory.

For example:

```
from traitlets import HasTraits, Unicode, validate, TraitError

class TraitletsExample(HasTraits):
    path = Unicode('', help="a path")

    @validate('path')
    def _check_prime(self, proposal):
        path = proposal['value']
        if not path.endswith('/'):
            # ensure path always has trailing /
            path = path + '/'
        if not os.path.exists(path):
            raise TraitError("path %r does not exist" % path)
        return path
```

CHAPTER

FIVE

CONFIGURABLE OBJECTS WITH TRAITLETS.CONFIG

This document describes *traitlets.config*, the traitlets-based configuration system used by IPython and Jupyter.

5.1 The main concepts

There are a number of abstractions that the IPython configuration system uses. Each of these abstractions is represented by a Python class.

Configuration object: *Config*

A configuration object is a simple dictionary-like class that holds configuration attributes and sub-configuration objects. These classes support dotted attribute style access (`cfg.Foo.bar`) in addition to the regular dictionary style access (`cfg['Foo']['bar']`). The Config object is a wrapper around a simple dictionary with some convenience methods, such as merging and automatic section creation.

Application: *Application*

An application is a process that does a specific job. The most obvious application is the **ipython** command line program. Each application may read configuration files and a single set of command line options and then produces a master configuration object for the application. This configuration object is then passed to the configurable objects that the application creates, usually either via the *config* or *parent* constructor arguments. These configurable objects implement the actual logic of the application and know how to configure themselves given the configuration object.

Applications always have a *log* attribute that is a configured Logger. This allows centralized logging configuration per-application.

Configurable: *Configurable*

A configurable is a regular Python class that serves as a base class for all main classes in an application. The *Configurable* base class is lightweight and only does one thing.

This *Configurable* is a subclass of *HasTraits* that knows how to configure itself. Class level traits with the metadata `config=True` become values that can be configured from the command line and configuration files.

Developers create *Configurable* subclasses that implement all of the logic in the application. Each of these subclasses has its own configuration information that controls how instances are created. When constructing a *Configurable*, the *config* or *parent* arguments can be passed to the constructor (respectively a *Config* and a Configurable object with a `.config`).

Singletons: *SingletonConfigurable*

Any object for which there is a single canonical instance. These are just like Configurables, except they have a class method *instance()*, that returns the current active instance (or creates one if it does not exist). *Application* is a singleton. This lets objects easily connect to the current running Application without passing objects around everywhere. For instance, to get the current running Application instance, simply do: `app = Application.instance()`.

Note: Singletons are not strictly enforced - you can have many instances of a given singleton class, but the `instance()` method will always return the same one.

Having described these main concepts, we can now state the main idea in our configuration system: *"configuration" allows the default values of class attributes to be controlled on a class by class basis*. Thus all instances of a given class are configured in the same way. Furthermore, if two instances need to be configured differently, they need to be instances of two different classes. While this model may seem a bit restrictive, we have found that it expresses most things that need to be configured extremely well. However, it is possible to create two instances of the same class that have different trait values. This is done by overriding the configuration.

Now, we show what our configuration objects and files look like.

5.2 Configuration objects and files

A configuration object is little more than a wrapper around a dictionary. A configuration *file* is simply a mechanism for producing that object. Configuration files currently can be a plain Python script or a JSON file. The former has the benefit that it can perform extensive logic to populate the config object, while the latter is just a direct JSON serialization of the config dictionary and can be easily processed by external software. When both Python and JSON configuration file are present, both will be loaded, with JSON configuration having higher priority.

The configuration files can be loaded by calling *Application.load_config_file()*, which takes the relative path to the config file (with or without file extension) and the directories in which to search for the config file. All found configuration files will be loaded in reverse order, so that configs in earlier directories will have higher priority.

5.2.1 Python configuration Files

A Python configuration file is a pure Python file that populates a configuration object. This configuration object is a *Config* instance. It is available inside the config file as `c`, and you simply set attributes on this. All you have to know is:

- The name of the class to configure.
- The name of the attribute.
- The type of each attribute.

The answers to these questions are provided by the various *Configurable* subclasses that an application uses. Let's look at how this would work for a simple configurable subclass

```
# Sample configurable:
from traitlets.config.configurable import Configurable
from traitlets import Int, Float, Unicode, Bool


class School(Configurable):
    name = Unicode("defaultname", help="the name of the object").tag(config=True)
    ranking = Integer(0, help="the class's ranking").tag(config=True)
    value = Float(99.0)
    # The rest of the class implementation would go here..


# Construct from config via School(config=..)
```

In this example, we see that `School` has three attributes, two of which (`name`, `ranking`) can be configured. All of the attributes are given types and default values. If a `School` is instantiated, but not configured, these default values will be used. But let's see how to configure this class in a configuration file

```
# Sample config file
c.School.name = "coolname"
c.School.ranking = 10
```

After this configuration file is loaded, the values set in it will override the class defaults anytime a `School` is created. Furthermore, these attributes will be type checked and validated anytime they are set. This type checking is handled by the *traitlets* module, which provides the *Unicode*, *Integer* and *Float* types; see *Trait Types* for the full list.

It should be very clear at this point what the naming convention is for configuration attributes:

```
c.ClassName.attribute_name = attribute_value
```

Here, `ClassName` is the name of the class whose configuration attribute you want to set, `attribute_name` is the name of the attribute you want to set and `attribute_value` the value you want it to have. The `ClassName` attribute of `c` is not the actual class, but instead is another *Config* instance.

Note: The careful reader may wonder how the `ClassName` (`School` in the above example) attribute of the configuration object `c` gets created. These attributes are created on the fly by the *Config* instance, using a simple naming convention. Any attribute of a *Config* instance whose name begins with an uppercase character is assumed to be a sub-configuration and a new empty *Config* instance is dynamically created for that attribute. This allows deeply hierarchical information created easily (`c.Foo.Bar.value`) on the fly.

5.2.2 JSON configuration Files

A JSON configuration file is simply a file that contains a *Config* dictionary serialized to JSON. A JSON configuration file has the same base name as a Python configuration file, but with a .json extension.

Configuration described in previous section could be written as follows in a JSON configuration file:

```
{
  "School": {
    "name": "coolname",
    "ranking": 10
  }
}
```

JSON configuration files can be more easily generated or processed by programs or other languages.

5.3 Configuration files inheritance

Note: This section only applies to Python configuration files.

Let's say you want to have different configuration files for various purposes. Our configuration system makes it easy for one configuration file to inherit the information in another configuration file. The `load_subconfig()` command can be used in a configuration file for this purpose. Here is a simple example that loads all of the values from the file `base_config.py`:

Listing 1: examples/docs/configs/base_config.py

```
c = get_config()  # noqa
c.School.name = "Harvard"
c.School.ranking = 100
```

into the configuration file `main_config.py`:

Listing 2: examples/docs/configs/main_config.py

```
c = get_config()  # noqa

# Load everything from base_config.py
load_subconfig("base_config.py")  # noqa

# Now override one of the values
c.School.name = "bettername"
```

In a situation like this the `load_subconfig()` makes sure that the search path for sub-configuration files is inherited from that of the parent. Thus, you can typically put the two in the same directory and everything will just work. An example app using these configuration files can be found at examples/docs/load_config_app.py.

5.4 Class based configuration inheritance

There is another aspect of configuration where inheritance comes into play. Sometimes, your classes will have an inheritance hierarchy that you want to be reflected in the configuration system. Here is a simple example:

```
from traitlets.config import Application, Configurable
from traitlets import Integer, Float, Unicode, Bool


class Foo(Configurable):
    name = Unicode("fooname", config=True)
    value = Float(100.0, config=True)


class Bar(Foo):
    name = Unicode("barname", config=True)
    othervalue = Int(0, config=True)


# construct Bar(config=..)
```

Now, we can create a configuration file to configure instances of `Foo` and `Bar`:

```
# config file
c = get_config()  # noqa

c.Foo.name = "bestname"
c.Bar.othervalue = 10
```

This class hierarchy and configuration file accomplishes the following:

- The default value for `Foo.name` and `Bar.name` will be `'bestname'`. Because `Bar` is a `Foo` subclass it also picks up the configuration information for `Foo`.
- The default value for `Foo.value` and `Bar.value` will be `100.0`, which is the value specified as the class default.
- The default value for `Bar.othervalue` will be 10 as set in the configuration file. Because `Foo` is the parent of `Bar` it doesn't know anything about the `othervalue` attribute.

5.5 Command-line arguments

All configurable options can also be supplied at the command line when launching the application. Internally, when *Application.initialize()* is called, a *KVArgParseConfigLoader* instance is constructed to load values into a *Config* object. (For advanced users, this can be overridden in the helper method `Application._create_loader()`.)

Most command-line scripts simply need to call *Application.launch_instance()*, which will create the Application singleton, parse the command-line arguments, and start the application:

```
from traitlets.config import Application


class MyApp(Application):
    def start(self):
        pass  # app logic goes here


if __name__ == "__main__":
    MyApp.launch_instance()
```

By default, config values are assigned from command-line arguments in much the same way as in a config file:

```
$ ipython --InteractiveShell.autoindent=False --BaseIPythonApplication.profile='myprofile
↪'
```

is the same as adding:

```
c.InteractiveShell.autoindent = False
c.BaseIPythonApplication.profile = "myprofile"
```

to your configuration file. Command-line arguments take precedence over values read from configuration files. (This is done in *Application.load_config_file()* by merging `Application.cli_config` over values read from configuration files.)

Note that even though *Application* is a *SingletonConfigurable*, multiple applications could still be started and called from each other by constructing them as one would with any other *Configurable*:

Listing 3: examples/docs/multiple_apps.py

```
from traitlets.config import Application


class OtherApp(Application):
    def start(self):
        print("other")
```

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```
class MyApp(Application):
    classes = [OtherApp]

    def start(self):
        # similar to OtherApp.launch_instance(), but without singleton
        self.other_app = OtherApp(config=self.config)
        self.other_app.initialize(["--OtherApp.log_level", "INFO"])
        self.other_app.start()


if __name__ == "__main__":
    MyApp.launch_instance()
```

Changed in version 5.0: Prior to 5.0, fully specified `--Class.trait=value` arguments required an equals sign and no space separating the key and value. But after 5.0, these arguments can be separated by space as with aliases.

Changed in version 5.0: extra quotes around strings and literal prefixes are no longer required.

See also:

Interpreting command-line strings

Changed in version 5.0: If a scalar (*Unicode*, `Integer`, etc.) is specified multiple times on the command-line, this will now raise. Prior to 5.0, all instances of the option before the last would be ignored.

Changed in version 5.0: In 5.0, positional extra arguments (typically a list of files) must be contiguous, for example:

```
mycommand file1 file2 --flag
```

or:

```
mycommand --flag file1 file2
```

whereas prior to 5.0, these "extra arguments" be distributed among other arguments:

```
mycommand file1 --flag file2
```

Note: By default, an error in a configuration file will cause the configuration file to be ignored and a warning logged. Application subclasses may specify *raise_config_file_errors = True* to exit on failure to load config files instead.

New in version 4.3: The environment variable `TRAITLETS_APPLICATION_RAISE_CONFIG_FILE_ERROR` to `'1'` or `'true'` to change the default value of `raise_config_file_errors`.

5.5.1 Common Arguments

Since the strictness and verbosity of the full `--Class.trait=value` form are not ideal for everyday use, common arguments can be specified as *flags* or *aliases*.

In general, flags and aliases are prefixed by `--`, except for those that are single characters, in which case they can be specified with a single `-`, e.g.:

```
$ ipython -i -c "import numpy; x=numpy.linspace(0,1)" --profile testing --colors=lightbg
```

Flags and aliases are declared by specifying `flags` and `aliases` attributes as dictionaries on subclasses of *Application*.

A key in both those dictionaries might be a string or tuple of strings. One-character strings are converted into "short" options (like `-v`); longer strings are "long" options (like `--verbose`).

Aliases

For convenience, applications have a mapping of commonly used traits, so you don't have to specify the whole class name:

```
$ ipython --profile myprofile
# and
$ ipython --profile='myprofile'
# are equivalent to
$ ipython --BaseIPythonApplication.profile='myprofile'
```

When specifying `alias` dictionary in code, the values might be the strings like `'Class.trait'` or two-tuples like `('Class.trait', "Some help message")`. For example:

Listing 4: examples/docs/aliases.py

```
from traitlets import Bool
from traitlets.config import Application, Configurable


class Foo(Configurable):
    enabled = Bool(False, help="whether enabled").tag(config=True)


class App(Application):
    classes = [Foo]
    dry_run = Bool(False, help="dry run test").tag(config=True)
    aliases = {
        "dry-run": "App.dry_run",
        ("f", "foo-enabled"): ("Foo.enabled", "whether foo is enabled"),
    }


if __name__ == "__main__":
    App.launch_instance()
```

By default, the `--log-level` alias will be set up for `Application.log_level`.

Flags

Applications can also be passed **flags**. Flags are options that take no arguments. They are simply wrappers for setting one or more configurables with predefined values, often True/False.

For instance:

```
$ ipcontroller --debug
# is equivalent to
$ ipcontroller --Application.log_level=DEBUG
# and
$ ipython --matplotlib
# is equivalent to
$ ipython --matplotlib auto
# or
$ ipython --no-banner
# is equivalent to
$ ipython --TerminalIPythonApp.display_banner=False
```

And a runnable code example:

Listing 5: examples/docs/flags.py

```
from traitlets import Bool
from traitlets.config import Application, Configurable


class Foo(Configurable):
    enabled = Bool(False, help="whether enabled").tag(config=True)


class App(Application):
    classes = [Foo]
    dry_run = Bool(False, help="dry run test").tag(config=True)
    flags = {
        "dry-run": ({"App": {"dry_run": True}}, dry_run.help),
        ("f", "enable-foo"): (
            {
                "Foo": {"enabled": True},
            },
            "Enable foo",
        ),
        ("disable-foo"): (
            {
                "Foo": {"enabled": False},
            },
            "Disable foo",
        ),
    }


if __name__ == "__main__":
    App.launch_instance()
```

Since flags are a bit more complicated to set up, there are a couple of common patterns implemented in helper methods.

For example, `traitlets.config.boolean_flag()` sets up the flags `--x` and `--no-x`. By default, the following few flags are set up: `--debug` (setting `log_level=DEBUG`), `--show-config`, and `--show-config-json` (print config to stdout and exit).

5.5.2 Subcommands

Configurable applications can also have **subcommands**. Subcommands are modeled after **`git`**, and are called with the form **`command subcommand [...args]`**. For instance, the QtConsole is a subcommand of terminal IPython:

```
$ jupyter qtconsole --profile myprofile
```

Subcommands are specified as a dictionary assigned to a `subcommands` class member of *`Application`* instances. This dictionary maps *subcommand names* to two-tuples containing these:

1. A subclass of *`Application`* to handle the subcommand. This can be specified as:
   - simply as a class, where its *`SingletonConfigurable.instance()`* will be invoked (straight-forward, but loads subclasses on import time);
   - as a string which can be imported to produce the above class;
   - as a factory function accepting a single argument like that:

     ```
     app_factory(parent_app: Application) -> Application
     ```

     Note: The return value of the factory above is an *instance*, not a class, so the *`SingletonConfigurable.instance()`* is not invoked in this case.

   In all cases, the instantiated app is stored in `Application.subapp` and its *`Application.initialize()`* is invoked.
2. A short description of the subcommand for use in help output.

For example (refer to `examples/subcommands_app.py` for a more complete example):

Listing 6: examples/docs/subcommands.py

```
from traitlets.config import Application


class SubApp1(Application):
    pass


class SubApp2(Application):
    @classmethod
    def get_subapp_instance(cls, app: Application) -> Application:
        app.clear_instance()  # since Application is singleton, need to clear main app
        return cls.instance(parent=app)


class MainApp(Application):
    subcommands = {
        "subapp1": (SubApp1, "First subapp"),
        "subapp2": (SubApp2.get_subapp_instance, "Second subapp"),
```

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```
    }


if __name__ == "__main__":
    MainApp.launch_instance()
```

To see a list of the available aliases, flags, and subcommands for a configurable application, simply pass `-h` or `--help`. To see the full list of configurable options (*very* long), pass `--help-all`.

For more complete examples of setting up *Application*, refer to the application examples.

5.5.3 Other `Application` members

The following are typically set as class variables of *Application* subclasses, but can also be set as instance variables.

- `.classes`: A list of *Configurable* classes. Similar to configs, any class name can be used in `--Class.trait=value` arguments, including classes that the *Application* might not know about. However, the `--help-all` menu will only enumerate `config` traits of classes in `Application.classes`. Similarly, `.classes` is used in other places where an application wants to list all configurable traits; examples include *Application.generate_config_file()* and the *Command-line tab completion with argcomplete* handling.
- `.name`, `.description`, `.option_description`, `.keyvalue_description`, `.subcommand_description`, `.examples`, `.version`: Various strings used in the `--help` menu and other messages
- `.log_level`, `.log_datefmt`, `.log_format`, `.logging_config`: Configurable options to control application logging, which is emitted via the logger `Application.log`. For more information about these, refer to their respective traits' `.help`.
- `.show_config`, `.show_config_json`: Configurable boolean options, which if set to `True`, will cause the application to print the config to stdout instead of calling *Application.start()*

Additionally, the following are set by *Application*:

- `.cli_config`: The *Config* created from the command-line arguments. This is saved to override any config values loaded from configuration files called by *Application.load_config_file()*.
- `.extra_args`: This is a list holding any positional arguments remaining from the command-line arguments parsed during *Application.initialize()*. As noted earlier, these must be contiguous in the command-line.

5.5.4 Interpreting command-line strings

New in version 5.0: *from_string()*, *from_string_list()*, and *item_from_string()*.

Prior to 5.0, we only had good support for Unicode or similar string types on the command-line. Other types were supported via `ast.literal_eval()`, which meant that simple types such as integers were well supported, too.

The downside of this implementation was that the `literal_eval()` happened before the type of the target trait was known, meaning that strings that could be interpreted as literals could end up with the wrong type, famously:

```
$ ipython -c 1
...
[TerminalIPythonApp] CRITICAL | Bad config encountered during initialization:
[TerminalIPythonApp] CRITICAL | The 'code_to_run' trait of a TerminalIPythonApp instance␣
↪must be a unicode string, but a value of 1 <class 'int'> was specified.
```

This resulted in requiring redundant "double-quoting" of strings in many cases. That gets confusing when the shell *also* interprets quotes, so one had to:

```
$ ipython -c "'1'"
```

in order to set a string that looks like an integer.

traitlets 5.0 defers parsing of interpreting command-line strings to *from_string()*, which is an arbitrary function that will be called with the string given on the command-line. This eliminates the need to 'guess' how to interpret strings before we know what they are configuring.

Backward compatibility

It is not feasible to be perfectly backward-compatible when fixing behavior as problematic as this. However, we are doing our best to ensure that folks who had workarounds for this funky behavior are disrupted as little as we can manage. That means that we have kept what look like literals working wherever we could, so if you were double-quoting strings to ensure the were interpreted as strings, that will continue to work with warnings for the foreseeable future.

If you have an example command-line call that used to work with traitlets 4 but does not any more with traitlets 5, please let us know.

Custom traits

New in version 5.0.

Custom trait types can override *from_string()* to specify how strings should be interpreted. This could for example allow specifying hex-encoded bytes on the command-line:

Listing 7: examples/docs/from_string.py

```
from binascii import a2b_hex
from traitlets.config import Application
from traitlets import Bytes


class HexBytes(Bytes):
    def from_string(self, s):
        return a2b_hex(s)


class App(Application):
    aliases = {"key": "App.key"}
    key = HexBytes(
        help="""
        Key to be used.

        Specify as hex on the command-line.
        """,
        config=True,
    )

    def start(self):
        print(f"key={self.key}")
```

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```
if __name__ == "__main__":
    App.launch_instance()
```

```
$ examples/docs/from_string.py --key=a1b2
key=b'\xa2\xb2'
```

5.5.5 Container traits

In traitlets 5.0, items for container traits can be specified by passing the key multiple times, e.g.:

```
myprogram -l a -l b
```

to produce the list `["a", "b"]`

or for dictionaries use `key=value`:

```
myprogram -d a=5 -d b=10
```

to produce the dict `{"a": 5, "b": 10}`.

In traitlets prior to 5.0, container traits (List, Dict) could *technically* be configured on the command-line by specifying a repr of a Python list or dict, e.g:

```
ipython --ScriptMagics.script_paths='{"perl": "/usr/bin/perl"}'
```

but that gets pretty tedious, especially with more than a couple of fields. This still works with a FutureWarning, but the new way allows container items to be specified by passing the argument multiple times:

```
ipython \
    --ScriptMagics.script_paths perl=/usr/bin/perl \
    --ScriptMagics.script_paths ruby=/usr/local/opt/bin/ruby
```

This handling is good enough that we can recommend defining aliases for container traits for the first time! For example:

Listing 8: examples/docs/container.py

```
from traitlets.config import Application
from traitlets import Dict, Integer, List, Unicode


class App(Application):
    aliases = {"x": "App.x", "y": "App.y"}
    x = List(Unicode(), config=True)
    y = Dict(Integer(), config=True)

    def start(self):
        print(f"x={self.x}")
        print(f"y={self.y}")


if __name__ == "__main__":
    App.launch_instance()
```

produces:

```
$ examples/docs/container.py -x a -x b -y a=10 -y b=5
x=['a', 'b']
y={'a': 10, 'b': 5}
```

Note: Specifying the value trait of Dict was necessary to cast the values in *y* to integers. Otherwise, they values of *y* would have been the strings `'10'` and `'5'`.

For container types, *List.from_string_list()* is called with the list of all values specified on the command-line and is responsible for turning the list of strings into the appropriate type. Each item is then passed to *List.item_from_string()* which is responsible for handling the item, such as casting to integer or parsing `key=value` in the case of a Dict.

The deprecated `ast.literal_eval()` handling is preserved for backward-compatibility in the event of a single item that 'looks like' a list or dict literal.

If you would prefer, you can also use custom container traits which define :meth`~.TraitType.from_string` to expand a single string into a list, for example:

```
class PathList(List):
    def from_string(self, s):
        return s.split(os.pathsep)
```

which would allow:

```
myprogram --path /bin:/usr/local/bin:/opt/bin
```

to set a `PathList` trait with `["/bin", "/usr/local/bin", "/opt/bin"]`.

5.5.6 Command-line tab completion with `argcomplete`

New in version 5.8.

`traitlets` has limited support for command-line tab completion for scripts based on *Application* using argcomplete. To use this, follow the instructions for setting up argcomplete; you will likely want to activate global completion by doing something alone the lines of:

```
# pip install argcomplete
mkdir -p ~/.bash_completion.d/
activate-global-python-argcomplete --dest=~/.bash_completion.d/argcomplete
# source ~/.bash_completion.d/argcomplete from your ~/.bashrc
```

(Follow relevant instructions for your shell.) For any script you want tab-completion to work on, include the line:

```
# PYTHON_ARGCOMPLETE_OK
```

in the first 1024 bytes of the script.

The following options can be tab-completed:

- Flags and aliases
- The classes in `Application.classes`, which can be initially completed as `--Class.`

  - Once a completion is narrows to a single class, the individual `config` traits of the class will be tab-completable, as `--Class.trait`.

- The available values for *traitlets.Bool* and *traitlets.Enum* will be completable, as well as any other custom *traitlets.TraitType* which defines a `argcompleter()` method returning a list of available string completions.
- Custom completer methods can be assigned to a trait by tagging an `argcompleter` metadata tag. Refer to argcomplete's documentation for examples of creating custom completer methods.

Detailed examples of these can be found in the docstring of examples/argcomplete_app.py.

Caveats with `argcomplete` handling

The support for `argcomplete` is still relatively new and may not work with all ways in which an *Application* is used. Some known caveats:

- `argcomplete` is called when any `Application` first constructs and uses a `KVArgParseConfigLoader` instance, which constructs a `argparse.ArgumentParser` instance. We assume that this is usually first done in scripts when parsing the command-line arguments, but technically a script can first call `Application.initialize(["other", "args"])` for some other reason.
- `traitlets` does not actually add `"--Class.trait"` options to the `ArgumentParser`, but instead directly parses them from `argv`. In order to complete these, a custom `CompletionFinder` is subclassed from `argcomplete.CompletionFinder`, which dynamically inserts the `"--Class."` and `"--Class.trait"` completions when it thinks suitable. However, this handling may be a bit fragile.
- Because `traitlets` initializes configs from `argv` and not from `ArgumentParser`, it may be more difficult to write custom completers which dynamically provide completions based on the state of other parsed arguments.
- Subcommand handling is especially tricky. `argcomplete` libraries' strategy is to call the python script with no arguments e.g. `len(sys.argv) == 1`, run until `argcomplete` is called on an `ArgumentParser` and determine what completions are available. On the other hand, the `traitlet` subcommand-handling strategy is to check `sys.argv[1]` and see if it matches a subcommand, and if so then dynamically load the subcommand app and initialize it with `sys.argv[1:]`. To reconcile these two different approaches, some hacking was done to get `traitlets` to recognize the current command-line as seen by `argcomplete`, and to get `argcomplete` to start parsing command-line arguments after subcommands have been evaluated.
  - Currently, completing subcommands themselves is not yet supported.
  - Some applications like `Jupyter` have custom ways of constructing subcommands or parsing `argv` which complicates matters even further.

More details about these caveats can be found in the original pull request.

5.6 Design requirements

Here are the main requirements we wanted our configuration system to have:

- Support for hierarchical configuration information.
- Full integration with command line option parsers. Often, you want to read a configuration file, but then override some of the values with command line options. Our configuration system automates this process and allows each command line option to be linked to a particular attribute in the configuration hierarchy that it will override.
- Configuration files that are themselves valid Python code. This accomplishes many things. First, it becomes possible to put logic in your configuration files that sets attributes based on your operating system, network setup, Python version, etc. Second, Python has a super simple syntax for accessing hierarchical data structures,

namely regular attribute access (`Foo.Bar.Bam.name`). Third, using Python makes it easy for users to import configuration attributes from one configuration file to another. Fourth, even though Python is dynamically typed, it does have types that can be checked at runtime. Thus, a `1` in a config file is the integer '1', while a `'1'` is a string.

- A fully automated method for getting the configuration information to the classes that need it at runtime. Writing code that walks a configuration hierarchy to extract a particular attribute is painful. When you have complex configuration information with hundreds of attributes, this makes you want to cry.
- Type checking and validation that doesn't require the entire configuration hierarchy to be specified statically before runtime. Python is a very dynamic language and you don't always know everything that needs to be configured when a program starts.

CHAPTER

SIX

TRAITLETS CONFIG API REFERENCE

class traitlets.config.**Configurable**(***kwargs: Any*)

classmethod class_config_rst_doc() → str

Generate rST documentation for this class' config options.

Excludes traits defined on parent classes.

classmethod class_config_section(*classes: Sequence[type[*HasTraits*]] | None = None*) → str

Get the config section for this class.

Parameters

classes (*list, optional*) – The list of other classes in the config file. Used to reduce redundant information.

classmethod class_get_help(*inst:* HasTraits | *None = None*) → str

Get the help string for this class in ReST format.

If *inst* is given, its current trait values will be used in place of class defaults.

classmethod class_get_trait_help(*trait: TraitType[Any, Any]*, *inst:* HasTraits | *None = None*, *helptext: str | None = None*) → str

Get the helptext string for a single trait.

Parameters

- **inst** – If given, its current trait values will be used in place of the class default.
- **helptext** – If not given, uses the *help* attribute of the current trait.

classmethod class_print_help(*inst:* HasTraits | *None = None*) → None

Get the help string for a single trait and print it.

classmethod section_names() → list[str]

return section names as a list

update_config(*config:* Config) → None

Update config and load the new values

class traitlets.config.**SingletonConfigurable**(***kwargs: Any*)

A configurable that only allows one instance.

This class is for classes that should only have one instance of itself or *any* subclass. To create and retrieve such a class use the *SingletonConfigurable.instance()* method.

classmethod clear_instance() → None

unset _instance for this class and singleton parents.

classmethod initialized() → bool

Has an instance been created?

classmethod instance(**args: Any*, ***kwargs: Any*) → CT

Returns a global instance of this class.

This method create a new instance if none have previously been created and returns a previously created instance is one already exists.

The arguments and keyword arguments passed to this method are passed on to the `__init__()` method of the class upon instantiation.

Examples

Create a singleton class using instance, and retrieve it:

```
>>> from traitlets.config.configurable import SingletonConfigurable
>>> class Foo(SingletonConfigurable): pass
>>> foo = Foo.instance()
>>> foo == Foo.instance()
True
```

Create a subclass that is retrieved using the base class instance:

```
>>> class Bar(SingletonConfigurable): pass
>>> class Bam(Bar): pass
>>> bam = Bam.instance()
>>> bam == Bar.instance()
True
```

class traitlets.config.**LoggingConfigurable**(***kwargs: Any*)

A parent class for Configurables that log.

Subclasses have a log trait, and the default behavior is to get the logger from the currently running Application.

log

Logger or LoggerAdapter instance

class traitlets.config.**JSONFileConfigLoader**(*filename: str*, *path: str | None = None*, ***kw: Any*)

A JSON file loader for config

Can also act as a context manager that rewrite the configuration file to disk on exit.

Example:

```
with JSONFileConfigLoader('myapp.json','/home/jupyter/configurations/') as c:
    c.MyNewConfigurable.new_value = 'Updated'
```

load_config() → *Config*

Load the config from a file and return it as a Config object.

class traitlets.config.**Application**(***kwargs: Any*)

A singleton application with full configuration support.

cli_config

The subset of our configuration that came from the command-line

We re-load this configuration after loading config files, to ensure that it maintains highest priority.

document_config_options() → str

Generate rST format documentation for the config options this application

Returns a multiline string.

emit_alias_help() → Generator[str, None, None]

Yield the lines for alias part of the help.

emit_description() → Generator[str, None, None]

Yield lines with the application description.

emit_examples() → Generator[str, None, None]

Yield lines with the usage and examples.

This usage string goes at the end of the command line help string and should contain examples of the application's usage.

emit_flag_help() → Generator[str, None, None]

Yield the lines for the flag part of the help.

emit_help(*classes: bool = False*) → Generator[str, None, None]

Yield the help-lines for each Configurable class in self.classes.

If classes=False (the default), only flags and aliases are printed.

emit_help_epilogue(*classes: bool*) → Generator[str, None, None]

Yield the very bottom lines of the help message.

If classes=False (the default), print *–help-all* msg.

emit_options_help() → Generator[str, None, None]

Yield the lines for the options part of the help.

emit_subcommands_help() → Generator[str, None, None]

Yield the lines for the subcommand part of the help.

flatten_flags() → tuple[dict[str, Any], dict[str, Any]]

Flatten flags and aliases for loaders, so cl-args override as expected.

This prevents issues such as an alias pointing to InteractiveShell, but a config file setting the same trait in TerminalInteraciveShell getting inappropriate priority over the command-line arg. Also, loaders expect `(key: longname)` and not `key: (longname, help)` items.

Only aliases with exactly one descendent in the class list will be promoted.

generate_config_file(*classes: List[Type[*Configurable*]] | None = None*) → str

generate default config file from Configurables

get_default_logging_config() → Dict[str, Any]

Return the base logging configuration.

The default is to log to stderr using a StreamHandler, if no default handler already exists.

The log handler level starts at logging.WARN, but this can be adjusted by setting the `log_level` attribute.

The `logging_config` trait is merged into this allowing for finer control of logging.

initialize(*argv: List[str] | None = None*) → None

Do the basic steps to configure me.

Override in subclasses.

initialize_subcommand(*subc: str*, *argv: List[str] | None = None*) → None

Initialize a subcommand with argv.

json_config_loader_class

alias of *JSONFileConfigLoader*

classmethod launch_instance(*argv: List[str] | None = None*, ***kwargs: Any*) → None

Launch a global instance of this Application

If a global instance already exists, this reinitializes and starts it

load_config_environ() → None

Load config files by environment.

load_config_file(*filename: str*, *path: str | Sequence[str | None] | None = None*) → None

Load config files by filename and path.

property loaded_config_files: list[str]

Currently loaded configuration files

log_datefmt

The date format used by logging formatters for %(asctime)s

log_format

The Logging format template

log_level

Set the log level by value or name.

logging_config

Configure additional log handlers.

The default stderr logs handler is configured by the log_level, log_datefmt and log_format settings.

This configuration can be used to configure additional handlers (e.g. to output the log to a file) or for finer control over the default handlers.

If provided this should be a logging configuration dictionary, for more information see: https://docs.python.org/3/library/logging.config.html#logging-config-dictschema

This dictionary is merged with the base logging configuration which defines the following:

- A logging formatter intended for interactive use called `console`.
- A logging handler that writes to stderr called `console` which uses the formatter `console`.
- A logger with the name of this application set to `DEBUG` level.

This example adds a new handler that writes to a file:

```
c.Application.logging_config = {
    "handlers": {
        "file": {
            "class": "logging.FileHandler",
            "level": "DEBUG",
            "filename": "<path/to/file>",
        }
    },
    "loggers": {
        "<application-name>": {
```

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```
            "level": "DEBUG",
            # NOTE: if you don't list the default "console"
            # handler here then it will be disabled
            "handlers": ["console", "file"],
        },
    },
}
```

parse_command_line(*argv: List[str] | None = None*) → None

Parse the command line arguments.

print_alias_help() → None

Print the alias parts of the help.

print_description() → None

Print the application description.

print_examples() → None

Print usage and examples (see *emit_examples()*).

print_flag_help() → None

Print the flag part of the help.

print_help(*classes: bool = False*) → None

Print the help for each Configurable class in self.classes.

If classes=False (the default), only flags and aliases are printed.

print_options() → None

Print the options part of the help.

print_subcommands() → None

Print the subcommand part of the help.

print_version() → None

Print the version string.

python_config_loader_class

alias of `PyFileConfigLoader`

show_config

Instead of starting the Application, dump configuration to stdout

show_config_json

Instead of starting the Application, dump configuration to stdout (as JSON)

start() → None

Start the app mainloop.

Override in subclasses.

start_show_config() → None

start function used when show_config is True

class traitlets.config.**Config**(**args: Any*, ***kwds: Any*)

An attribute-based dict that can do smart merges.

Accessing a field on a config object for the first time populates the key with either a nested Config object for keys starting with capitals or *LazyConfigValue* for lowercase keys, allowing quick assignments such as:

```
c = Config()
c.Class.int_trait = 5
c.Class.list_trait.append("x")
```

collisions(*other:* Config) → dict[str, Any]

Check for collisions between two config objects.

Returns a dict of the form {"Class": {"trait": "collision message"}}`, indicating which values have been ignored.

An empty dict indicates no collisions.

copy() → a shallow copy of D

has_key(*key: Any*) → bool

True if the dictionary has the specified key, else False.

merge(*other: Any*) → None

merge another config object into this one

class traitlets.config.loader.**LazyConfigValue**(***kwargs: Any*)

Proxy object for exposing methods on configurable containers

These methods allow appending/extending/updating to add to non-empty defaults instead of clobbering them.

Exposes:

- append, extend, insert on lists
- update on dicts
- update, add on sets

add(*obj: Any*) → None

Add an item to a set

append(*obj: Any*) → None

Append an item to a List

extend(*other: Any*) → None

Extend a list

get_value(*initial: Any*) → Any

construct the value from the initial one

after applying any insert / extend / update changes

merge_into(*other: Any*) → Any

Merge with another earlier LazyConfigValue or an earlier container. This is useful when having global system-wide configuration files.

Self is expected to have higher precedence.

Parameters

other (*LazyConfigValue or container*) –

Returns
if `other` is also lazy, a reified container otherwise.

Return type
LazyConfigValue

prepend(*other: Any*) → None

like list.extend, but for the front

to_dict() → dict[str, Any]

return JSONable dict form of my data

Currently update as dict or set, extend, prepend as lists, and inserts as list of tuples.

update(*other: Any*) → None

Update either a set or dict

class traitlets.config.loader.**KVArgParseConfigLoader**(*argv: list[str] | None = None*, *aliases: dict[str, str] | None = None*, *flags: dict[str, str] | None = None*, *log: Any = None*, *classes: list[type[Any]] | None = None*, *subcommands: Dict[str, Any] | None = None*, **parser_args: Any*, ***parser_kw: Any*)

A config loader that loads aliases and flags with argparse,

as well as arbitrary –Class.trait value

__init__(*argv: list[str] | None = None*, *aliases: dict[str, str] | None = None*, *flags: dict[str, str] | None = None*, *log: Any = None*, *classes: list[type[Any]] | None = None*, *subcommands: Dict[str, Any] | None = None*, **parser_args: Any*, ***parser_kw: Any*) → None

Create a config loader for use with argparse.

Parameters

- **classes** (*optional, list*) – The classes to scan for *container* config-traits and decide for their "multiplicity" when adding them as *argparse* arguments.
- **argv** (*optional, list*) – If given, used to read command-line arguments from, otherwise sys.argv[1:] is used.
- ***parser_args** (*tuple*) – A tuple of positional arguments that will be passed to the constructor of `argparse.ArgumentParser`.
- ****parser_kw** (*dict*) – A tuple of keyword arguments that will be passed to the constructor of `argparse.ArgumentParser`.
- **aliases** (*dict of str to str*) – Dict of aliases to full traitlets names for CLI parsing
- **flags** (*dict of str to str*) – Dict of flags to full traitlets names for CLI parsing
- **log** – Passed to *ConfigLoader*

Returns
config – The resulting Config object.

Return type
Config

load_config(*argv: list[str] | None = None*, *aliases: ~typing.Any = None*, *flags: ~typing.Any = <Sentinel deprecated>*, *classes: ~typing.Any = None*) → *Config*

Parse command line arguments and return as a Config object.

Parameters

- **argv** (*optional, list*) – If given, a list with the structure of sys.argv[1:] to parse arguments from. If not given, the instance's self.argv attribute (given at construction time) is used.
- **flags** – Deprecated in traitlets 5.0, instantiate the config loader with the flags.

CHAPTER

SEVEN

UTILS

A simple utility to import something by its string name.

traitlets.**import_item**(*name: str*) → Any

Import and return `bar` given the string `foo.bar`.

Calling `bar = import_item("foo.bar")` is the functional equivalent of executing the code `from foo import bar`.

Parameters
name (*string*) – The fully qualified name of the module/package being imported.

Returns
mod – The module that was imported.

Return type
module object

traitlets.**signature_has_traits**(*cls: Type[T]*) → Type[T]

Return a decorated class with a constructor signature that contain Trait names as kwargs.

This is a way to expand the signature of the `HasTraits` class constructor. This enables auto-completion of trait-names in IPython and xeus-python when having Jedi>=0.15 by adding trait names with their default values in the constructor signature.

Example:

```
from inspect import signature

from traitlets import HasTraits, Int, Unicode, signature_has_traits

@signature_has_traits
class Foo(HasTraits):
    number1 = Int()
    number2 = Int()
    value = Unicode('Hello')

    def __init__(self, arg1, **kwargs):
        self.arg1 = arg1

        super(Foo, self).__init__(**kwargs)

print(signature(Foo))  # <Signature (arg1, *, number1=0, number2=0, value='Hello',␣
↪**kwargs)>
```

7.1 Links

class traitlets.**link**(*source: Any*, *target: Any*, *transform: Any = None*)

Link traits from different objects together so they remain in sync.

Parameters

- **source** (*(object / attribute name) pair*) –
- **target** (*(object / attribute name) pair*) –
- **transform** (*iterable with two callables (optional)*) – Data transformation between source and target and target and source.

Examples

```
>>> class X(HasTraits):
...     value = Int()
```

```
>>> src = X(value=1)
>>> tgt = X(value=42)
>>> c = link((src, "value"), (tgt, "value"))
```

Setting source updates target objects: >>> src.value = 5 >>> tgt.value 5

class traitlets.**directional_link**(*source: Any*, *target: Any*, *transform: Any = None*)

Link the trait of a source object with traits of target objects.

Parameters

- **source** (*(object, attribute name) pair*) –
- **target** (*(object, attribute name) pair*) –
- **transform** (*callable (optional)*) – Data transformation between source and target.

Examples

```
>>> class X(HasTraits):
...     value = Int()
```

```
>>> src = X(value=1)
>>> tgt = X(value=42)
>>> c = directional_link((src, "value"), (tgt, "value"))
```

Setting source updates target objects: >>> src.value = 5 >>> tgt.value 5

Setting target does not update source object: >>> tgt.value = 6 >>> src.value 5

CHAPTER

EIGHT

MIGRATION FROM TRAITLETS 4.0 TO TRAITLETS 4.1

Traitlets 4.1 introduces a totally new decorator-based API for configuring traitlets and a couple of other changes.

However, it is a backward-compatible release and the deprecated APIs will be supported for some time.

8.1 Separation of metadata and keyword arguments in `TraitType` constructors

In traitlets 4.0, trait types constructors used all unrecognized keyword arguments passed to the constructor (like `sync` or `config`) to populate the `metadata` dictionary.

In trailets 4.1, we deprecated this behavior. The preferred method to populate the metadata for a trait type instance is to use the new `tag` method.

```
x = Int(allow_none=True, sync=True)  # deprecated
x = Int(allow_none=True).tag(sync=True)  # ok
```

We also deprecated the `get_metadata` method. The metadata of a trait type instance can directly be accessed via the `metadata` attribute.

8.2 Deprecation of `on_trait_change`

The most important change in this release is the deprecation of the `on_trait_change` method.

Instead, we introduced two methods, `observe` and `unobserve` to register and unregister handlers (instead of passing `remove=True` to `on_trait_change` for the removal).

- The `observe` method takes one positional argument (the handler), and two keyword arguments, `names` and `type`, which are used to filter by notification type or by the names of the observed trait attribute. The special value `All` corresponds to listening to all the notification types or all notifications from the trait attributes. The `names` argument can be a list of string, a string, or `All` and `type` can be a string or `All`.
- The observe handler's signature is different from the signature of on_trait_change. It takes a single change dictionary argument, containing

```
{"type": "<The type of notification.>"}
```

In the case where `type` is the string `'change'`, the following additional attributes are provided:

```
{
    "owner": "<the HasTraits instance>",
    "old": "<the old trait attribute value>",
    "new": "<the new trait attribute value>",
    "name": "<the name of the changing attribute>",
}
```

The `type` key in the change dictionary is meant to enable protocols for other notification types. By default, its value is equal to the `'change'` string which corresponds to the change of a trait value.

Example:

```
from traitlets import HasTraits, Int, Unicode


class Foo(HasTraits):
    bar = Int()
    baz = Unicode()


def handle_change(change):
    print("{name} changed from {old} to {new}".format(**change))


foo = Foo()
foo.observe(handle_change, names="bar")
```

8.3 The new `@observe` decorator

The use of the magic methods `_{trait}_changed` as change handlers is deprecated, in favor of a new `@observe` method decorator.

The `@observe` method decorator takes the names of traits to be observed as positional arguments and has a `type` keyword-only argument (defaulting to `'change'`) to filter by notification type.

Example:

```
class Foo(HasTraits):
    bar = Int()
    baz = EventfulContainer()  # hypothetical trait type emitting
    # other notifications types

    @observe("bar")  # 'change' notifications for `bar`
    def handler_bar(self, change):
        pass

    @observe("baz ", type="element_change")  # 'element_change' notifications for `baz`
    def handler_baz(self, change):
        pass

    @observe("bar", "baz", type=All)  # all notifications for `bar` and `baz`
    def handler_all(self, change):
        pass
```

8.4 dynamic defaults generation with decorators

The use of the magic methods `_{trait}_default` for dynamic default generation is not deprecated, but a new `@default` method decorator is added.

Example:

Default generators should only be called if they are registered in subclasses of `trait.this_type`.

```
from traitlets import HasTraits, Int, Float, default


class A(HasTraits):
    bar = Int()

    @default("bar")
    def get_bar_default(self):
        return 11


class B(A):
    bar = Float()  # This ignores the default generator
    # defined in the base class A


class C(B):
    @default("bar")
    def some_other_default(self):  # This should not be ignored since
        return 3.0  # it is defined in a class derived
        # from B.a.this_class.
```

8.5 Deprecation of magic method for cross-validation

`traitlets` enables custom cross validation between the different attributes of a `HasTraits` instance. For example, a slider value should remain bounded by the `min` and `max` attribute. This validation occurs before the trait notification fires.

The use of the magic methods `_{name}_validate` for custom cross-validation is deprecated, in favor of a new `@validate` method decorator.

The method decorated with the `@validate` decorator take a single `proposal` dictionary

```
{
    "trait": "<the trait type instance being validated>",
    "value": "<the proposed value>",
    "owner": "<the underlying HasTraits instance>",
}
```

Custom validators may raise `TraitError` exceptions in case of invalid proposal, and should return the value that will be eventually assigned.

Example:

```
from traitlets import HasTraits, TraitError, Int, Bool, validate


class Parity(HasTraits):
    value = Int()
    parity = Int()

    @validate("value")
    def _valid_value(self, proposal):
        if proposal["value"] % 2 != self.parity:
            raise TraitError("value and parity should be consistent")
        return proposal["value"]

    @validate("parity")
    def _valid_parity(self, proposal):
        parity = proposal["value"]
        if parity not in [0, 1]:
            raise TraitError("parity should be 0 or 1")
        if self.value % 2 != parity:
            raise TraitError("value and parity should be consistent")
        return proposal["value"]


parity_check = Parity(value=2)

# Changing required parity and value together while holding cross validation
with parity_check.hold_trait_notifications():
    parity_check.value = 1
    parity_check.parity = 1
```

The presence of the `owner` key in the proposal dictionary enable the use of other attributes of the object in the cross validation logic. However, we recommend that the custom cross validator don't modify the other attributes of the object but only coerce the proposed value.

8.6 Backward-compatible upgrades

One challenge in adoption of a changing API is how to adopt the new API while maintaining backward compatibility for subclasses, as event listeners methods are *de facto* public APIs.

Take for instance the following class:

```
from traitlets import HasTraits, Unicode


class Parent(HasTraits):
    prefix = Unicode()
    path = Unicode()

    def _path_changed(self, name, old, new):
        self.prefix = os.path.dirname(new)
```

And you know another package has the subclass:

```
from parent import Parent


class Child(Parent):
    def _path_changed(self, name, old, new):
        super()._path_changed(name, old, new)
        if not os.path.exists(new):
            os.makedirs(new)
```

If the parent package wants to upgrade without breaking Child, it needs to preserve the signature of `_path_changed`. For this, we have provided an `@observe_compat` decorator, which automatically shims the deprecated signature into the new signature:

```
from traitlets import HasTraits, Unicode, observe, observe_compat


class Parent(HasTraits):
    prefix = Unicode()
    path = Unicode()

    @observe("path")
    @observe_compat  # <- this allows super()._path_changed in subclasses to work with␣
↪the old signature.
    def _path_changed(self, change):
        self.prefix = os.path.dirname(change["value"])
```

CHAPTER

NINE

CHANGES IN TRAITLETS

9.1 5.14.2

(Full Changelog)

9.1.1 Maintenance and upkeep improvements

- Update Release Scripts #900 (@blink1073)
- chore: update pre-commit hooks #897 (@pre-commit-ci)
- Bump the actions group with 1 update #896 (@dependabot)

9.1.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @dependabot | @pre-commit-ci

9.2 5.14.1

(Full Changelog)

9.2.1 Bugs fixed

- FIX: map - to _ for environment variable prefix. #895 (@Carreau)

9.2.2 Maintenance and upkeep improvements

- chore: update pre-commit hooks #894 (@pre-commit-ci)
- Update ruff config #893 (@blink1073)

9.2.3 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @Carreau | @pre-commit-ci

9.3 5.14.0

(Full Changelog)

9.3.1 Enhancements made

- Add option to load traitlets values from environment. #856 (@Carreau)

9.3.2 Maintenance and upkeep improvements

- Update types for mypy 1.7 #892 (@blink1073)
- chore: update pre-commit hooks #890 (@pre-commit-ci)
- Clean up lint handling #888 (@blink1073)

9.3.3 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @Carreau | @pre-commit-ci

9.4 5.13.0

(Full Changelog)

9.4.1 Bugs fixed

- Use passed-in `info` argument for `TraitType.error()` #884 (@kylebarron)

9.4.2 Maintenance and upkeep improvements

- Improve generics handling #886 (@blink1073)
- Finish Strict Typing #885 (@blink1073)

9.4.3 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @kylebarron

9.5 5.12.0

(Full Changelog)

9.5.1 Enhancements made

- Pass **kwds in MetaHasDescriptors **new** and **init** #881 (@fleming79)

9.5.2 Maintenance and upkeep improvements

- Adopt sp-repo-review #883 (@blink1073)
- Cleanup after remove Python 2 support #882 (@shadchin)
- Add more project URLs, trove classifiers #879 (@bollwyvl)

9.5.3 Documentation improvements

- Fix docs version #880 (@bollwyvl)

9.5.4 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @bollwyvl | @fleming79 | @pre-commit-ci | @shadchin

9.6 5.11.2

(Full Changelog)

9.6.1 Maintenance and upkeep improvements

- More typing cleanup #877 (@blink1073)

9.6.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073

9.7 5.11.1

(Full Changelog)

9.7.1 Maintenance and upkeep improvements

- Typing fixups #875 (@blink1073)

9.7.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073

9.8 5.11.0

(Full Changelog)

9.8.1 Maintenance and upkeep improvements

- More Typing Adoption #873 (@blink1073)

9.8.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073

9.9 5.10.1

(Full Changelog)

9.9.1 Maintenance and upkeep improvements

- Typing upgrades #868 (@blink1073)

9.9.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073

9.10 5.10.0

(Full Changelog)

9.10.1 Enhancements made

- Added type hints to HasTraits.observe() and friends. (#834 #834 (@scholer)
- feat: trait typing #818 (@maartenbreddels)

9.10.2 Maintenance and upkeep improvements

- Fix mypy deps and support Python 3.8-3.12 #862 (@blink1073)
- Update pytest requirement from <7.2,>=7.0 to >=7.0,<7.5 #861 (@dependabot)
- Bump actions/checkout from 3 to 4 #860 (@dependabot)
- Fix typing #848 (@blink1073)
- Update docs config #843 (@blink1073)
- Use local coverage #842 (@blink1073)
- Adjust argcomplete typings #839 (@blink1073)
- Better warnings #838 (@NickCrews)
- Update typings (#836 #836 (@blink1073)

9.10.3 Documentation improvements

- rename `MyClass` to `School` #858 (@metaperl)
- Even though returning a value from a validation method is ideal, by no means is `proposal['value']` the only thing that can be returned #855 (@metaperl)
- Document help parameter of TraitType.**init**(). #847 (@metaperl)

9.10.4 Other merged PRs

- Clean up license (#832)Co-authored-by: pre-commit-ci[bot] <66853113+pre-commit-ci[bot]@users.noreply.github.com> #832 (@dcsaba89)

9.10.5 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @dcsaba89 | @dependabot | @maartenbreddels | @metaperl | @NickCrews | @pre-commit-ci | @rmorshea | @saulshanabrook | @scholer

9.11 5.9.0

(Full Changelog)

9.11.1 Enhancements made

- Polishing argcomplete support #829 (@azjps)

9.11.2 Maintenance and upkeep improvements

- Test that name and description can be set via constructor. #826 (@Carreau)

9.11.3 Contributors to this release

(GitHub contributors page for this release)

@azjps | @blink1073 | @Carreau

9.12 5.8.1

(Full Changelog)

9.12.1 Bugs fixed

- fix: mro_trait can be unbound when the class is not in mro #824 (@maartenbreddels)

9.12.2 Maintenance and upkeep improvements

9.12.3 Documentation improvements

- Add more api docs #821 (@blink1073)

9.12.4 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @maartenbreddels | @pre-commit-ci | @rmorshea

9.13 5.8.0

(Full Changelog)

9.13.1 Enhancements made

-Shell command-line tab-completion via `argcomplete` #811 (@azjps)

- Define `trait.__doc__ = trait.help` for better API Docs #816 (@minrk)

9.13.2 Maintenance and upkeep improvements

- Expose more attributes for typing #817 (@blink1073)
- Fix lint #814 (@blink1073)

9.13.3 Documentation improvements

- Additional `Application` examples and docs #811 (@azjps)

9.13.4 Contributors to this release

(GitHub contributors page for this release)

@azjps | @blink1073 | @minrk

9.14 5.7.1

(Full Changelog)

9.14.1 Bugs fixed

- fix: some descriptors raise AttributeError #812 (@maartenbreddels)

9.14.2 Contributors to this release

(GitHub contributors page for this release)

@maartenbreddels

9.15 5.7.0

(Full Changelog)

9.15.1 Enhancements made

- Performance: decrease runtime overhead for constructing HasTraits (up to 20x faster) #777 (@maartenbreddels)

9.15.2 Maintenance and upkeep improvements

- Minor fixes for Application.aliases #810 (@azjps)
- Adopt ruff and address lint #809 (@blink1073)

9.15.3 Contributors to this release

(GitHub contributors page for this release)

@azjps | @blink1073 | @maartenbreddels | @naterush | @pre-commit-ci

9.16 5.6.0

(Full Changelog)

9.16.1 Maintenance and upkeep improvements

- Adopt jupyter releaser #806 (@blink1073)
- Use base setup dependency type #805 (@blink1073)
- More CI Cleanup #803 (@blink1073)
- More maintenance cleanup #802 (@blink1073)
- Add project description #801 (@blink1073)
- Bump actions/setup-python from 2 to 4 #798 (@dependabot)
- Bump actions/checkout from 2 to 3 #797 (@dependabot)
- Bump pre-commit/action from 2.0.0 to 3.0.0 #796 (@dependabot)

- Bump actions/upload-artifact from 2 to 3 #795 (@dependabot)
- Add dependabot #794 (@blink1073)
- Add more typings #791 (@blink1073)
- Format changelog #789 (@blink1073)

9.16.2 Contributors to this release

(GitHub contributors page for this release)

@blink1073 | @dependabot | @maartenbreddels | @pre-commit-ci | @rmorshea

9.17 5.5.0

- Clean up application typing
- Update tests and docs to use non-deprecated functions
- Clean up version handling
- Prep for jupyter releaser
- Format the changelog

9.18 5.4.0

- Fix version_info
- Make generated config files more lintable
- Fix union trait from string
- Add security.md, and tidelift badge

9.19 5.3.0

- Fix traitlet name in docstring
- Re-support multiple-alias key for ArgParseConfigLoader

9.20 5.2.2

- Make `traitlets.__all__` explicit and validate in test.
- Fix `KeyError` in `Application.get_default_logging_config`.

9.21 5.2.1

- logging: Don't attempt to close handlers unless they have been opened. Fixes `ValueError: Unable to configure formatter 'console'` traceback.

9.22 5.2.0

Traitlets 5.2 brings a couple of updates and changes to traitlets, and is recommended for all users. What follows is a non-exhaustive list of changes:

- Application: add logging_config trait.
- Disambiguate the use of the term value in the example.
- Add mypy typing support.
- DOC: Add log example.
- Internal cleanup: linters, autoformatters, CI.

9.23 5.1.1

5.1.1 fixes compatibility issues with Python 3.10 (rc2).

9.24 5.1.0

Traitlets 5.1 brings a couple of updates and changes to traitlets, and is recommended for all users. What follow is a non-exhaustive list of changes:

- Removal of the `ipython_genutils` dependency, this should remove any direct and indirect reliance on `nose` and prepare traitlets 5.1 for Python 3.10 and above compatibility, some test suite changes also accommodate Python 3.10 changes. If you package traitlets downstream, make sure to remove this dependency.
- Removal of `ipython_genutils` may have change the default encoding detected for the command line argument parsing when not utf-8. We expect this to affect a small portion of older windows version. If you encounter issue let us know.
- Stop recommendation of `CUnicode` in some circumstances as it's deprecated.
- Our test suite is now using GitHub action instead of travis CI. If you are packaging downstream using the git repository, you may have to exclude the `.github` folder now, and can remove exclusion of
- It fixes a parsing issue for list of one single element on the CLI.
- We reserve the right to remove official support for Python 3.7 in subsequent minor revisions.

9.25 5.0.5

- Support deprecated literals for sets, tuples on the command-line: `nbconvert --TagRemovePreprocessor.remove_cell_tags='{"tag"}'`
- Fix `from_string_list` for Tuples in general
- Fix support for `List(default_value=None, allow_none=True)` and other Container traits
- Fix help output for nested aliases and tuple traits

9.26 5.0.4

- Support deprecated use of byte-literals for bytes on the command-line: `ipython kernel --Session.key="b'abc'"`. The `b` prefix is no longer needed in traitlets 5.0, but is supported for backward-compatibility
- Improve output of configuration errors, especially when help output would make it hard to find the helpful error message

9.27 5.0.3

- Fix regression in handling `--opt=None` on the CLI for configurable traits with `allow_none=True`

9.28 5.0.2

- Fix casting bytes to unicode

9.29 5.0.0

(This is an in-progress changelog, please let us know if something is missing/or could be phrased better)

Traitlets 5.0 is a new version of traitlets that accumulate changes over a period of more close to four years; A number of internal refactoring made the internal code structure cleaner and simpler, and greatly improved the diagnostic error messages as well has help and documentation generation.

We expect no code change needed for any consumer of the Python API (ipywidgets, and alike), though CLI argument parsing have seen a complete rewrite, so if you have an application that does use the parsing logic of traitlets you may see changes in behavior, and now have access to more features. There was also a cleanup of what was considered a part of the public API, certain previously exposed utility functions and types are no longer available. Please see an exhaustive list below.

::: seealso `commandline` docs for details about command-line parsing and the changes in 5.0.

Please let us know if you find issues with the new command-line parsing changes. :::

We also want to thanks in particular a number of regular contributor through the years that have patiently waited for their often large contribution to be available, if **rough** order of number of contribution:

- Ryan Morshead - @rmorshea - For serving as a maintainer of the 4.x branch and providing a number of bug fix through the years.

- Kostis Anagnostopoulos - @ankostis - Who push a major refactor of the CLI paring, as well as many help-generating function.
- Benjamin Ragan-Kelley – @minrk – for reviewing and help fixing edge case in most of the above
- Matthias Bussonnier – @carreau
- Sylvain Corlay
- Francisco de la Peña
- Martin Renou
- Yves Delley
- Thomas Kluyver
- hristian Clauss
- maartenbreddels
- Aliaksei Urbanski
- Kevin Bates
- David Brochart

As well as many of the passer-by, and less frequent contributors:

- Tim Paine
- Jake VanderPlas
- Frédéric Chapoton
- Dan Allan
- Adam Chainz
- William Krinsman
- Travis DePrato
- Todd
- Thomas Aarholt
- Lumir Balhar
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Major changes are:

- Removal of Python 2 support,
- Removal of Python 3.0-3.6 support
- we now follow NEP 29, and are thus Python 3.7+ only.
- remove `six` as a dependency
- remove `funcsig` as a dependency.
- no longer exposes the following functions / types:
  - ClassTypes
  - DefaultHandler
  - EventHandler
  - ForwardDeclaredMixin
  - ObserveHandler
  - SequenceTypes
  - ValidateHandler
  - add_article
  - class_of
  - getargspec
  - getmembers
  - is_trait
  - isidentifier
  - repr_type

Here is a list of most Pull requests that went into 5.0 and a short description.

- #362 , #361 introduces:
  - help for aliases , aliases dict values can now be a tuple with ('target', 'help string')
  - subcommands can now be arbitrary callable and do not need to be subclass of `Application`
- #306 Add compatibility with the `trait` package for Dictionaries and add the `key_trait` parameters allowing to restrict the type of the key of a mapping. The constructor parameters `trait` and `traits` are renamed to `value_trait` and `per_key_traits`.
- #319 adds ability to introduce both shot and long version of aliases, allowing for short and long options `-` and `--`.
- #322 rewrite command line argument parsing to use argparse, and allow more flexibility in assigning literals without quoting.
- #332 Make it easier to redefined default values of parents classes.
- #333 introduces a `Callable` trait.
- #340 Old way of passing containers in the command line is now deprecated, and will emit warning on the command line.
- #341 introduces `--Application.show_config=True` which will make by default any application show it configuration, all the files it loaded configuration from, and exit.

- #349 unify ability to declare default values across traitlets with a singular method `default` method, and #525 adds a warning that `Undefined`is deprecated.
- #355 fix a random ordering issues in command lines flags.
- #356 allow both `self` and `cls` in `__new__` method for genericity.
- #360 Simplify overwriting and extending the command line argument parser.
- #371 introduces a `FuzzyEnum` trait that allow case insensitive and unique prefix matching.
- #384 Ass a `trait_values` method to extra a mapping of trait and their values.
- #393 `Link` now have a transform attribute (taking two functions inverse of each other), that affect how a value is mapped between a source and a target.
- #394 `Link` now have a `link` method to re-link object after `unlink` has been called.
- #402 rewrite handling of error messages for nested traits.
- #405 all function that use to print help now have an equivalent that yields the help lines.
- #413 traits now have a method `trait_has_value`, returning a boolean to know if a value has been assigned to a trait (excluding the default), in order to help avoiding circular validation at initialisation.
- #416 Explicitly export traitlets in `__all__` to avoid exposing implementation details.
- #438 introduces `.info_rst()` to let traitlets overwrite the automatically generated rst documentation.
- #458 Add a sphinx extension to automatically document options of `Application` instance in projects using traitlets.
- #509 remove all base `except:` meaning traitlets will not catch a number of `BaseException` s anymore.
- #515 Add a class decorator to enable tab completion of keyword arguments in signature.
- #516 a `Sentinel` Traitlets was made public by mistake and is now deprecated.
- #517 use parent Logger within logggin configurable when possible.
- #522 Make loading config files idempotent and expose the list of loaded config files for long running services.

9.29.1 API changes

This list is auto-generated by `frappuccino`, comparing with traitlets 4.3.3 API and edited for shortness:

```
The following items are new:
    + traitlets.Sentinel
    + traitlets.config.application.Application.emit_alias_help(self)
    + traitlets.config.application.Application.emit_description(self)
    + traitlets.config.application.Application.emit_examples(self)
    + traitlets.config.application.Application.emit_flag_help(self)
    + traitlets.config.application.Application.emit_help(self, classes=False)
    + traitlets.config.application.Application.emit_help_epilogue(self, classes)
    + traitlets.config.application.Application.emit_options_help(self)
    + traitlets.config.application.Application.emit_subcommands_help(self)
    + traitlets.config.application.Application.start_show_config(self)
    + traitlets.config.application.default_aliases
    + traitlets.config.application.default_flags
    + traitlets.config.default_aliases
    + traitlets.config.default_flags
```

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```
+ traitlets.config.loader.DeferredConfig
+ traitlets.config.loader.DeferredConfig.get_value(self, trait)
+ traitlets.config.loader.DeferredConfigList
+ traitlets.config.loader.DeferredConfigList.get_value(self, trait)
+ traitlets.config.loader.DeferredConfigString
+ traitlets.config.loader.DeferredConfigString.get_value(self, trait)
+ traitlets.config.loader.LazyConfigValue.merge_into(self, other)
+ traitlets.config.loader.Undefined
+ traitlets.config.loader.class_trait_opt_pattern
+ traitlets.traitlets.BaseDescriptor.subclass_init(self, cls)
+ traitlets.traitlets.Bool.from_string(self, s)
+ traitlets.traitlets.Bytes.from_string(self, s)
+ traitlets.traitlets.Callable
+ traitlets.traitlets.Callable.validate(self, obj, value)
+ traitlets.traitlets.CaselessStrEnum.info(self)
+ traitlets.traitlets.CaselessStrEnum.info_rst(self)
+ traitlets.traitlets.Complex.from_string(self, s)
+ traitlets.traitlets.Container.from_string(self, s)
+ traitlets.traitlets.Container.from_string_list(self, s_list)
+ traitlets.traitlets.Container.item_from_string(self, s)
+ traitlets.traitlets.Dict.from_string(self, s)
+ traitlets.traitlets.Dict.from_string_list(self, s_list)
+ traitlets.traitlets.Dict.item_from_string(self, s)
+ traitlets.traitlets.Enum.from_string(self, s)
+ traitlets.traitlets.Enum.info_rst(self)
+ traitlets.traitlets.Float.from_string(self, s)
+ traitlets.traitlets.FuzzyEnum
+ traitlets.traitlets.FuzzyEnum.info(self)
+ traitlets.traitlets.FuzzyEnum.info_rst(self)
+ traitlets.traitlets.FuzzyEnum.validate(self, obj, value)
+ traitlets.traitlets.HasTraits.trait_defaults(self, *names, **metadata)
+ traitlets.traitlets.HasTraits.trait_has_value(self, name)
+ traitlets.traitlets.HasTraits.trait_values(self, **metadata)
+ traitlets.traitlets.Instance.from_string(self, s)
+ traitlets.traitlets.Int.from_string(self, s)
+ traitlets.traitlets.ObjectName.from_string(self, s)
+ traitlets.traitlets.TCPAddress.from_string(self, s)
+ traitlets.traitlets.TraitType.default(self, obj='None')
+ traitlets.traitlets.TraitType.from_string(self, s)
+ traitlets.traitlets.Unicode.from_string(self, s)
+ traitlets.traitlets.Union.default(self, obj='None')
+ traitlets.traitlets.UseEnum.info_rst(self)
+ traitlets.traitlets.directional_link.link(self)
+ traitlets.traitlets.link.link(self)
+ traitlets.utils.cast_unicode(s, encoding='None')
+ traitlets.utils.decorators
+ traitlets.utils.decorators.Undefined
+ traitlets.utils.decorators.signature_has_traits(cls)
+ traitlets.utils.descriptions
+ traitlets.utils.descriptions.add_article(name, definite=False, capital=False)
+ traitlets.utils.descriptions.class_of(value)
+ traitlets.utils.descriptions.describe(article, value, name='None', verbose=False,␣
```

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```
↪capital=False)
    + traitlets.utils.descriptions.repr_type(obj)

The following items have been removed (or moved to superclass):
    - traitlets.ClassTypes
    - traitlets.SequenceTypes
    - traitlets.config.absolute_import
    - traitlets.config.application.print_function
    - traitlets.config.configurable.absolute_import
    - traitlets.config.configurable.print_function
    - traitlets.config.loader.KeyValueConfigLoader.clear
    - traitlets.config.loader.KeyValueConfigLoader.load_config
    - traitlets.config.loader.flag_pattern
    - traitlets.config.loader.kv_pattern
    - traitlets.config.print_function
    - traitlets.traitlets.ClassBasedTraitType.error
    - traitlets.traitlets.Container.element_error
    - traitlets.traitlets.List.validate
    - traitlets.traitlets.TraitType.instance_init
    - traitlets.traitlets.Union.make_dynamic_default
    - traitlets.traitlets.add_article
    - traitlets.traitlets.class_of
    - traitlets.traitlets.repr_type
    - traitlets.utils.getargspec.PY3
    - traitlets.utils.importstring.string_types
    - traitlets.warn_explicit

The following signatures differ between versions:

    - traitlets.config.application.Application.generate_config_file(self)
    + traitlets.config.application.Application.generate_config_file(self, classes='None')

    - traitlets.config.application.catch_config_error(method, app, *args, **kwargs)
    + traitlets.config.application.catch_config_error(method)

    - traitlets.config.configurable.Configurable.class_config_section()
    + traitlets.config.configurable.Configurable.class_config_section(classes='None')

    - traitlets.config.configurable.Configurable.class_get_trait_help(trait, inst='None')
    + traitlets.config.configurable.Configurable.class_get_trait_help(trait, inst='None',
↪ helptext='None')

    - traitlets.config.loader.ArgParseConfigLoader.load_config(self, argv='None',␣
↪aliases='None', flags='None')
    + traitlets.config.loader.ArgParseConfigLoader.load_config(self, argv='None',␣
↪aliases='None', flags='<deprecated>', classes='None')

    - traitlets.traitlets.Dict.element_error(self, obj, element, validator)
    + traitlets.traitlets.Dict.element_error(self, obj, element, validator, side='Values
↪')

    - traitlets.traitlets.HasDescriptors.setup_instance(self, *args, **kwargs)
```

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```
    + traitlets.traitlets.HasDescriptors.setup_instance(*args, **kwargs)

    - traitlets.traitlets.HasTraits.setup_instance(self, *args, **kwargs)
    + traitlets.traitlets.HasTraits.setup_instance(*args, **kwargs)

    - traitlets.traitlets.TraitType.error(self, obj, value)
    + traitlets.traitlets.TraitType.error(self, obj, value, error='None', info='None')
```

9.30 4.3

9.31 4.3.2

4.3.2 on GitHub

4.3.2 is a tiny release, relaxing some of the deprecations introduced in 4.3.1:

- using `_traitname_default()` without the `@default` decorator is no longer deprecated.
- Passing `config=True` in traitlets constructors is no longer deprecated.

9.32 4.3.1

4.3.1 on GitHub

- Compatibility fix for Python 3.6a1
- Fix bug in Application.classes getting extra entries when multiple Applications are instantiated in the same process.

9.33 4.3.0

4.3.0 on GitHub

- Improve the generated config file output.
- Allow TRAITLETS_APPLICATION_RAISE_CONFIG_FILE_ERROR env to override `Application.raise_config_file_errors`, so that config file errors can result in exiting immediately.
- Avoid using root logger. If no application logger is registered, the `'traitlets'` logger will be used instead of the root logger.
- Change/Validation arguments are now Bunch objects, allowing attribute-access, in addition to dictionary access.
- Reduce number of common deprecation messages in certain cases.
- Ensure command-line options always have higher priority than config files.
- Add bounds on numeric traits.
- Improves various error messages.

9.34 4.2

9.35 4.2.2 - 2016-07-01

4.2.2 on GitHub

Partially revert a change in 4.1 that prevented IPython's command-line options from taking priority over config files.

9.36 4.2.1 - 2016-03-14

4.2.1 on GitHub

Demotes warning about unused arguments in `HasTraits.__init__` introduced in 4.2.0 to DeprecationWarning.

9.37 4.2.0 - 2016-03-14

4.2 on GitHub

- `JSONFileConfigLoader` can be used as a context manager for updating configuration.
- If a value in config does not map onto a configurable trait, a message is displayed that the value will have no effect.
- Unused arguments are passed to `super()` in `HasTraits.__init__`, improving support for multiple inheritance.
- Various bugfixes and improvements in the new API introduced in 4.1.
- Application subclasses may specify `raise_config_file_errors = True` to exit on failure to load config files, instead of the default of logging the failures.

9.38 4.1 - 2016-01-15

4.1 on GitHub

Traitlets 4.1 introduces a totally new decorator-based API for configuring traitlets. Highlights:

- Decorators are used, rather than magic method names, for registering trait-related methods. See `using_traitlets` and `migration` for more info.
- Deprecate `Trait(config=True)` in favor of `Trait().tag(config=True)`. In general, metadata is added via `tag` instead of the constructor.

Other changes:

- Trait attributes initialized with `read_only=True` can only be set with the `set_trait` method. Attempts to directly modify a read-only trait attribute raises a `TraitError`.
- The directional link now takes an optional `transform` attribute allowing the modification of the value.
- Various fixes and improvements to config-file generation (fixed ordering, Undefined showing up, etc.)
- Warn on unrecognized traits that aren't configurable, to avoid silently ignoring mistyped config.

9.39 4.0 - 2015-06-19

4.0 on GitHub

First release of traitlets as a standalone package.

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