# pytermor

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(yet another) Python library initially designed for formatting terminal output using ANSI escape codes.

Provides *high-level* methods for working with text sections, colors, formats, alignment and wrapping, as well as *low-level* modules which allow to operate with *ANSI* sequences directly and also implement automatic format termination. Depending on the context and technical requirements either approach can be used. Also includes a set of additional number/string/time formatters for pretty output, filters, templating engine, escape sequence parser and provides support for several color spaces, which is also used for fluent color approximation if terminal capabilities do not allow to work in True Color mode. See *Features* page for the details.

The library is extendable and supports a variety of formatters (called *renderers*), which determine the output syntax:

- `SgrRenderer`, global default; formats the text with ANSI escape sequences for ttys;
- `TmuxRenderer`, suitable for integration with tmux (terminal multiplexer);
- `HtmlRenderer`, which makes a HTML page with all the formatting composed by CSS styles;
- `SgrDebugger`, same as `SgrRenderer`, but ESC (0x1B) bytes are replaced with a regular letter, therefore all the sequences are no longer sequences and can be seen as a text, for SGR debugging;
- etc.

No dependencies required, only Python Standard Library (although there are some for testing and docs building).

## Contents

# 1

# INSTALLATION

Python 3.8 or later should be installed and available in `$PATH`; that's basically it if intended usage of the package is as a library.

Listing 1: Installing into a project

```
$ python -m pip install pytermor
```

Listing 2: Standalone installation (for developing or experimenting)

```
$ git clone git@github.com:delameter/pytermor.git .
$ python -m venv venv
$ PYTHONPATH=. venv/bin/python -m pytermor
v2.41.1-dev1:Feb-23
```

# 2

# FEATURES

## 2.1 Flexible input formats

*fargs syntax* allows to compose formatted text parts much faster and keeps the code compact:

```
import pytermor as pt

ex_st = pt.Style(bg='#ffff00', fg='black')
text = pt.FrozenText(
    'This is red ', pt.cv.RED,
    "This is white ",
    "This is black on yellow", ex_st,
)
pt.echo(text)
```

## 2.2 Content-aware format nesting

r Template tags and non-closing *Fragments* allow to build complex formats.

```
import pytermor as pt

s = """:[fg=red]nested for:[bold]mat:[bg=blue]ting a:[fg=yellow]nd :[-]over:[-]laps"""
pt.echo(pt.TemplateEngine().substitute(s))
```

## 2.3 256 colors / True Color support

The library supports extended color modes:

- XTerm 256 colors indexed mode
- True Color RGB mode (16M colors)

```
import pytermor as pt

for outm in ['xterm_16', 'xterm_256', 'true_color']:
    print(' '+outm.ljust(12), end="")
    for c in range((W := 80) + 1):
        b = pt.RGB.from_ratios(1 - (p := c / W), 2 * min(p, 1 - p), p).int
        f = pt.Fragment(" ·"[c & 1], pt.Style(fg=(1 << 24) - b, bg=b, bold=True))
        print(f.render(pt.SgrRenderer(outm)), end=["", 2*"\n"][c >= W], flush=True)
```

## 2.4 Different color spaces

Currently supported spaces: *RGB*, *HSV*, *XYZ*, *LAB*. Any of these can be transparently translated to any other.

```
import pytermor as pt

col = pt.RGB(0xDA9AC4)
for v in [col.rgb, col.hsv, col.xyz, col.lab]:
    print(repr(v))
```

## 2.5 Named colors collection

Registry containing more than 2400 named colors, in addition to default 256 from `xterm` palette.

## 2.6 Extendable renderers

*Renderers* is a family of classes responsible for creating formatted strings from *IRenderable* instances, which, in general, consist of a text piece and a *Style* – a set of formatting rules. Concrete implementation of the renderer determines the target format and/or platform.

This is how *SgrRenderer*, *HtmlRenderer*, *TmuxRenderer*, *SgrDebugger* (from top to bottom) output can be seen in a terminal emulator:

## 2.7 Number formatters

Set of highly customizable helpers, see *numfmt*.

*format_si()* output sample:

*format_time_ns()* output samples:

*format_time_delta()* output sample:

## 2.8 Data dumps

Special formatters for raw binary/string data.

These examples were composed for a terminal 80-chars wide; tracers dynamically change the amount of elements per line at each *dump()* call.

Input data for all examples below was the same.

Listing 1: Decomposition into separate bytes by *BytesTracer*. Note the hexadecimal offset format.

```
 0x00 | 3D 90 39 05  B9 54 BA 89  90 A8 86 4C  A3 99 75 DD  BC 02 0D 0A
 0x14 | 7A E8 E6 40  76 4B 36 1C  00 AD 02 E2  61 45 FD 92  CD B6 71 02
 0x28 | 4F 52 EC 39  64 22 68 6A  2E 4E 80 1E  67 07 31 0D  83 55 4D F2
 0x3C | D0 D5 D9 41  72 54 6D 2B  03 80 FE 95  B3 28 C4 3E  FC BC 4E 30
 0x50 | 5C 6B 5C C3  99 B3 A4 93  24 E9 43 E9  30 B8 6A BC  74 F9 EA 4A
 0x64 | 30 4F 9A 38  71 DF B2 39  19 30 56 7C  73 91 56 6E  B8 38 48 F5
 0x78 | B7 5B 08 BD  96 B5 4F 6E
----------------------------------------------------------------------(0x80)
```

Listing 2: Decomposition into UTF-8 sequences by *StringTracer*

```
  0 |     3d efbfbd     39     05 efbfbd     54 efbfbd efbfbd |=9·T
  8 | efbfbd efbfbd efbfbd     4c efbfbd efbfbd     75   ddbc |Lu
 16 |     02     0d     0a     7a efbfbd efbfbd     40     76 |·z@v
 24 |     4b     36     1c     00 efbfbd     02 efbfbd     61 |K6···a
 32 |     45 efbfbd efbfbd   cdb6     71     02     4f     52 |Eq·OR
 40 | efbfbd     39     64     22     68     6a     2e     4e |9d"hj.N
 48 | efbfbd     1e     67     07     31     0d efbfbd     55 |·g·1U
 56 |     4d efbfbd efbfbd efbfbd efbfbd     41     72     54 |MArT
 64 |     6d     2b     03 efbfbd efbfbd efbfbd efbfbd     28 |m+·(
 72 | efbfbd     3e efbfbd efbfbd     4e     30     5c     6b |>N0\k
 80 |     5c   c399 efbfbd efbfbd efbfbd     24 efbfbd     43 |\Ù$C
 88 | efbfbd     30 efbfbd     6a efbfbd     74 efbfbd efbfbd |0jt
 96 |     4a     30     4f efbfbd     38     71   dfb2     39 |J0O8q9
104 |     19     30     56     7c     73 efbfbd     56     6e |·0V|sVn
112 | efbfbd     38     48 efbfbd efbfbd     5b     08 efbfbd |8H[·
120 | efbfbd efbfbd     4f     6e                             |On
----------------------------------------------------------------------(124)
```

Listing 3: Decomposition into Unicode codepoints by *StringUcpTracer*

```
  0 |U+   3D FFFD   39   05 FFFD   54 FFFD FFFD FFFD FFFD FFFD |=9·T
 11 |U+   4C FFFD FFFD   75  77C   02   0D   0A   7A FFFD FFFD |Lu·z
 22 |U+   40   76   4B   36   1C   00 FFFD   02 FFFD   61   45 |@vK6···aE
 33 |U+ FFFD FFFD  376   71   02   4F   52 FFFD   39   64   22 |q·OR9d"
 44 |U+   68   6A   2E   4E FFFD   1E   67   07   31   0D FFFD |hj.N·g·1
 55 |U+   55   4D FFFD FFFD FFFD FFFD   41   72   54   6D   2B |UMArTm+
 66 |U+   03 FFFD FFFD FFFD FFFD   28 FFFD   3E FFFD FFFD   4E |·(>N
 77 |U+   30   5C   6B   5C   D9 FFFD FFFD FFFD   24 FFFD   43 |0\k\Ù$C
 88 |U+ FFFD   30 FFFD   6A FFFD   74 FFFD FFFD   4A   30   4F |0jtJ0O
 99 |U+ FFFD   38   71  7F2   39   19   30   56   7C   73 FFFD |8q9·0V|s
110 |U+   56   6E FFFD   38   48 FFFD FFFD   5B   08 FFFD FFFD |Vn8H[·
121 |U+ FFFD   4F   6E                                         |On
-------------------------------------------------------------------------(124)
```

# 3

# LIBRARY STRUCTURE

| | |
|---|---|
| *ansi* | Classes for working with ANSI escape sequences on a lower level. |
| *color* | Abstractions for color definitions in three primary modes: 4-bit, 8-bit and 24-bit (`xterm-16`, `xterm-256` and `True Color/RGB`, respectively). |
| *common* | |
| *config* | Library fine tuning module. |
| *cval* | Color preset list: |
| *exception* | |
| *filter* | Formatters for prettier output and utility classes to avoid writing boilerplate code when dealing with escape sequences. |
| *numfmt* | utilnum |
| *renderer* | Renderers transform *Style* instances into lower-level abstractions like *SGR sequences*, tmux-compatible directives, HTML markup etc., depending on renderer type. |
| *style* | Reusable data classes that control the appearance of the output -- colors (text/background/underline) and attributes (*bold*, *underlined*, *italic*, etc.). |
| *template* | |
| *term* | A |
| *text* | "Front-end" module of the library. |

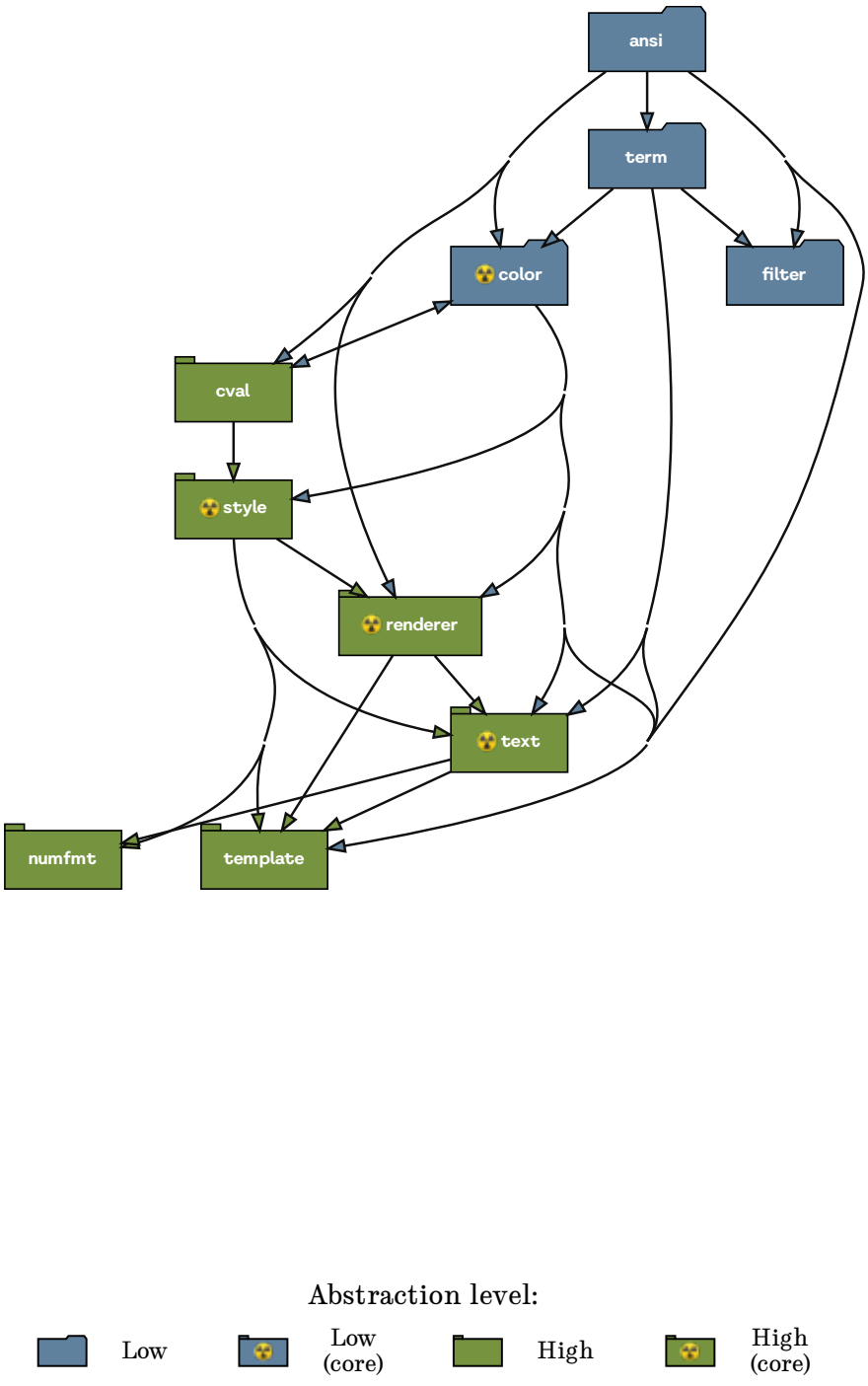


Fig. 1: Module dependency graph[Page 9, 2]

[2] Overly common modules (`exception`, `log`, `config` and `common` itself) are not shown, as they turn the graph into a mess. Same applies to internal modules which name starts with _.

# 4

# EXAMPLES

## 4.1 Rendering

The library can be split into two domains, the first one being "**high**-level" domain, which includes templating, style abstractions, text implementations which support aligning, wrapping, padding, etc., as well as number formatting helpers and a registry of preset colors.

The second one is "**low**-level", containing colors and color spaces definitions, helpers for composing various terminal escape sequences, the escape sequence abstractions themselves, as well as a large set of filters for chain-like application.

### 4.1.1 High-level

Imagine we want to colorize `git --help` output *manually*, i.e., we will not pipe an output of `git` and apply filters to do the job (yet), instead we copy-paste the output to python source code files as string literals and will try to add a formatting using all primary approaches.

Listing 1: Part of the input

```
These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
   clone             Clone a repository into a new directory
   init              Create an empty Git repository or reinitialize an existing one
   [..]
```

Part of the output

These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
  clone  Clone a repository into a new directory

```
init        Create an empty Git repository or reinitialize an existing one
[..]
```

The examples in this part are sorted from simple ones at the beginning to complicated ones at the end.

### Isolated pre-rendering

Use *render()* method to apply a *style* to a string part individually for each of them.

```
import pytermor as pt

subtitle = pt.render("start a working area", pt.Style(fg=pt.cv.YELLOW, bold=True))
subtitle += " (see also: "
subtitle += pt.render("git help tutorial", pt.cv.GREEN)
subtitle += ")"

pt.echo(subtitle)
```

start a working area (see also: git help tutorial)

*render()* method uses *SgrRenderer* by default, which is set up automatically depending on output device characteristics and environment setup.

Note that `render()` accepts *FT* as format argument, which can be *Style* or *Color* or *str* or *int* (there are a few methods to define a color).

### Fragments

*Fragment* is a basic class implementing *IRenderable* interface and contains a text string along with a *Style* instance and that's it.

`Fragment` instances can be safely concatenated with a regular *str* (but not with another *Fragment*) from the left side as well as from the right side (line #15). If you attempt to add one `Fragment` to another `Fragment`, you'll end up with a *Text* instance (see the example after next).

```
from collections.abc import Iterable
import pytermor as pt

data = [
    ("clone", "Clone a repository into a new directory"),
    ("init", "Create an empty Git repository or reinitialize an existing one"),
]

st = pt.Style(fg=pt.cv.GREEN)
for name, desc in data:
    frag = pt.Fragment(name.ljust(16), st)
    pt.echo('  ' + frag + desc)
```

```
clone       Clone a repository into a new directory
init        Create an empty Git repository or reinitialize an existing one
```

### Fragments in f-strings

Another approach to align a formatted text is to combine Python's *f-strings* with *Fragment* instances.

```
import pytermor as pt

data = [
    ("bisect", "Use binary search to find the commit that introduced a bug"),
    ("diff", "Show changes between commits, commit and working tree, etc"),
    ("grep", "Print lines matching a pattern"),
]

st = pt.Style(fg=pt.cv.GREEN)
for name, desc in data:
    frag = pt.Fragment(name, st)
    pt.echo(f"  {frag:<16s}    {desc}")
```

### Texts & FrozenTexts

*Text* is a general-purpose composite *IRenderable* implementation, which can contain any amount of strings linked with styles (i.e. *Fragment* instances).

`Text` also supports aligning, padding with specified chars to specified width, but most importantly it supports fargs syntax (for the details see *fargs syntax*), which allows to compose formatted text parts much faster and keeps the code compact. Generally speaking, the basic input parameter is either a tuple of string and *Style* or *Color*, which then will be applied to preceeding string, or a standalone string. Usually explicit definition of a tuple is not neccessary, but there are cases, when it is.

```
import pytermor as pt

subtitle_st = pt.Style(fg=pt.cv.YELLOW, bold=True)
command_st = pt.Style(fg=pt.cv.GREEN)
text = pt.FrozenText(
    ("work on the current change ", subtitle_st),
    "(see also: ",
    "git help everyday", command_st,
    ")"
)
pt.echo(text)
```

*FrozenText* is an immutable version of *Text* (to be precise, its quite the opposite: `Text` is a child of `FrozenText`).

We will utilize aligning capabilities of `FrozenText` class in a following code fragment:

```
import pytermor as pt

data = [
    ("add", "Add file contents to the index"),
    ("mv", "Move or rename a file, a directory, or a symlink"),
    ("restore", "Restore working tree files"),
]
st = pt.Style(fg=pt.cv.GREEN)

```

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```
for name, desc in data:
    pt.echo([pt.FrozenText("  ", name, st, width=18, pad=4), desc])
```

At highlighted line we compose a *FrozenText* instance with command name and set up desired width (18=16+2 for right margin), and explicitly set up left padding with `pad` argument. Padding chars and regular spaces originating from the alignment process are always applied to the opposite sides of text.

Note that although *text.echo()* accepts a single *RT* as a first argument, it also accepts a sequence of them, which allows us to call `echo` just once. *common.RT* is a type var including *str* type and all *IRenderable* implementations.

### Template tags

There is a support of library's internal tag format, which allows to inline formatting into the original string, and get the final result by calling just one method:

```
import pytermor as pt

s = """@st:[fg=yellow bold] @cmd:[fg=green]
:[st]grow, mark and tweak your common history:[-]
   :[cmd]branch:[-]            List, create, or delete branches
   :[cmd]commit:[-]            Record changes to the repository
   :[cmd]merge:[-]             Join two or more development histories together
"""
pt.echo(pt.TemplateEngine().substitute(s))
```

Here `@st:[fg=yellow bold]` is a definition of a custom user style named `st`, `:[st]` is a opening tag for that style, and `:[-]` is a closing tag matching the most recently opened one. See *Templates* for the details.

### Regexp group substitution

A little bit artificial example, but this method can be applied to solve real tasks nevertheless. The trick is to apply the desired style to a string containing special characters like `r"\1"`, which will represent regexp group 1 after passing it into `re.sub()`. The actual string being passed as 2nd argument will be `ESC [ 32m \1 ESC [ m`. Regexp substitution function will replace all `\1` with a matching group in every line of the input, therefore the match will end up being surrounded with (already rendered) SGRs responsible for green text color, ???, PROFIT:

```
import re
import pytermor as pt

s = """
   fetch            Download objects and refs from another repository
   pull             Fetch from and integrate with another repository or a local␣
↪branch
   push             Update remote refs along with associated objects
"""

regex = re.compile(r"^(\s+)(\S+)(.+)$")
for line in s.splitlines():
```

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```
    pt.echo(
        regex.sub(
            pt.render(r"\1" + pt.Fragment(r"\2", pt.cv.GREEN) + r"\3"),
            line,
        )
    )

```

For more complex logic it's usually better to extract it into separate function:

```
def replace_expand(m: re.Match) -> str:
    tpl = pt.render(r"\1" + pt.Fragment(r"\2", pt.cv.GREEN) + r"\3")
    return m.expand(tpl)
regex.sub(replace_expand, "...")
```

Another approach:

```
def replace_manual(m: re.Match) -> str:
    return pt.render(m.group(1) + pt.Fragment(m.group(2), pt.cv.GREEN) + m.group(3))
regex.sub(replace_manual, "...")
```

### Refilters

Refilters (**Re**ndering **filter**s) are usually applied in sequences, where each of those matches one or two named regexp groups and applies the specified styles accordingly.

In the example below we first (#10-12) implement `_render()` method in a new class inherited from *AbstractNamedGroupsRefilter*, then (#14-16) the refilter is created (note regexp group name `'cmd'` and matching dictionary key, which value is a *FT*), then (#19) the refilter is applied and result is printed.

---

**Note:** Although filters in general are classified as **low**-level, this example is placed into **high**-level group, because no manipulation at byte level or at color channel level is performed.

---

```
import re
import pytermor as pt

s = """
   reset             Reset current HEAD to the specified state
   switch            Switch branches
   tag               Create, list, delete or verify a tag object signed with GPG
"""

class SgrNamedGroupsRefilter(pt.AbstractNamedGroupsRefilter):
    def _render(self, v: pt.IT, st: pt.FT) -> str:
        return pt.render(v, st, pt.SgrRenderer)

f = SgrNamedGroupsRefilter(
    re.compile(r"(\s+)(?P<cmd>\S+)(.+)"),
    {"cmd": pt.cv.GREEN},
)

pt.echo(pt.apply_filters(s, f))
```

### 4.1.2 Low-level

The examples in this part are sorted from simple (for the developer) ones at the beginning to complicated (for the developer) ones at the end. But after you change the point of view, the results are reversed: first ones are most complicated for the interpreter to run, while the ones at the end are simplest (roughly one robust method per instance is invoked). Therefore, the answer to the question "which method is most suitable" should always be evaluated on the individual basis.

#### Preset compositions

Preset composition methods produce sequence instances or already rendered sequence bytes as if they were rendered by *SgrRenderer*. Methods with names starting with `make_` return seq. instances, and methods named `compose_*` return *str*, which means that more than one sequence were involved.

In the next example we create an SGR which colors text to black, and bg to 0xffaf00 (line #3), then compose a sequence chain which includes:

- CUP (Cursor Position) instruction: `ESC [1;1H`;
- SGR instruction with our prev. defined colors: `ESC [30;48;5;214m`;
- EL (Erase in Line) instruction: `ESC [0K`.

Effectively this results in a whole terminal line colored with colors specified, and note that we did not fill the line with spaces or something like that – this method is (in theory) faster, because the tty needs to process only ~10-20 characters of input instead of 120+ (average terminal width).

```
1  import pytermor as pt
2
3  col_sgr = pt.make_color_256(30, pt.ColorTarget.BG) + pt.ansi.SeqIndex.BLACK
4  seq = pt.compose_clear_line_fill_bg(col_sgr)
5  pt.echo(seq + 'AAAA    BBBB')
```

AAA BBBB

---

**Note:** `compose_*` methods do not belong to any *renderer*, so the decision of using or not using these depending on a terminal settings should be made by the developer on a higher level. The suggested implementation of conditional composite sequences would be to request current renderer setup and ensure *is_format_allowed* returns *True*, in which case it's ok to write composite sequences (as the default renderer already uses them):

```
seq = ""
if pt.RendererManager.get_default().is_format_allowed:
  seq = pt.compose_clear_line_fill_bg(pt.cv.NAVY_BLUE)
pt.echo(seq + 'AAAA    BBBB')
```

---

**Todo:** More consistent way of working with composite sequences would be to merge classes from *ansi* module with classes from *text* module, i.e. make *ISequence* children also inherit *IRenderable* interface and therefore be rendered using the same mechanism as for *Text* or *Fragment*, but that would require quite a bit of refactoring and, considering relatively rare usage of pre-rendered composites, was deferred for a time.

---

### Assisted wrapping

Similar to the next one, but here we call helper method *ansi.enclose()*, which automatically builds the closing sequence complement to specified opening one, while there we pick and insert a closing sequence manually.

```
import pytermor as pt

pt.echo(pt.enclose(pt.SeqIndex.CYAN, "imported") + " rich.inspect")
```

### Manual wrapping

Pretty straightforward wrapping of target string into a format which, for example, colors the text with a specified color, can be performed with f-stings. All inheritors of *ISequence* class implement `__str__()` method, which ensures that they can be safely evaluated in f-strings even without format specifying.

Resetter, of closing sequence, in this case can vary; for example, it can be "hard-reset" sequence, which resets the terminal format stack completely (`ESC [m`), or it can be text color reset sequence (`ESC [39m`), or even more exotic ones.

*SeqIndex* class contains prepared sequences which can be inserted into f-string directly without any modifications.

```
import pytermor as pt

print(f"{pt.SeqIndex.CYAN}imported{pt.SeqIndex.RESET} rich.inspect", end="")
```

### Manual instantiating

In case of necessity of some non-standard sequence types or "illegal" parameter values there is also a possibility to build the sequence from the scratch, instantiating one of the base sequence classes and providing required parameters values.

If your case is covered with an existing helper method in *term* package, use it instead of making new instance directly. This approach will make it easier to maintain the code, if something in internal logic of sequence base classes changes in the future.

```
print(pt.SequenceCSI("J", 2).assemble(), end="")
# equivalent to
print(pt.make_erase_in_display(2).assemble(), end="")
```

### Manual assembling (don't do this)

The last resort method which works in 100% is to assemble the sequence char by char manually, contain it as a string in source code and just print it when there is a necessity to do that. The only problem with this approach is an empirical rule, which says:

> Each raw ANSI escape sequence in the source code reduces the readability of the whole file by 50%.

This means that even 2 SGRs would give 25% readability of the original, while 4 SGRs give 6% (this rule is a joke I made up just now, but the key idea should be true).

**In short:**

- they are hard to modify,
- they are hard to maintain,

- they are hard to debug.

Even if it seems OK for a while:

```
print('\x1b[41m', end="(¬¬)")
print('\x1b[41m\x1b[2J\x1b[1;1H', end="(OO)")
```

...things get worse pretty fast:

```
print('\x1b[38;2;232;232;22m\x1b[1;41m\x1b[2J\x1b[1;1H', end="(°°)")
```

Compare with the next fragment, which does literally the same as the *highlighted line* from the example above, but is much easier to read thanks to low-level abstractions:

```
print(pt.make_color_rgb(232, 232, 22), end="")
print(pt.ansi.SeqIndex.BOLD + pt.ansi.SeqIndex.BG_RED, end="")
print(pt.make_erase_in_display(2).assemble(), end="")
print(pt.make_reset_cursor().assemble(), end="(°~°)")
```

Or after adding some high-level abstractions as well:

```
st = pt.Style(fg=0xe8e816, bg='red', bold=True)
fill = pt.compose_clear_line_fill_bg(st.fg.to_sgr())
pt.echo(fill + "(°v°)", st)
```

# 5

# GUIDE · HIGH-LEVEL

## 5.1 Core API

### 5.1.1 Glossary

**rendering**
: A process of transforming text-describing instances into specified output format, e.g. instance of *Fragment* class with content and *Style* class containing colors and other text formatting can be rendered into terminal-compatible string with *SgrRenderer*, or into HTML markup with *HtmlRenderer*, etc.

**style**
: Class describing text format options: text color, background color, boldness, underlining, etc. Styles can be inherited and merged with each other. See *Style* constructor description for the details.

**color**
: Three different classes describing the color options: *Color16*, *Color256* and *ColorRGB*. The first one corresponds to 16-color terminal mode, the second – to 256-color mode, and the last one represents full RGB color space rather than color index palette. The first two also contain terminal *SGR* bindings.

### 5.1.2 Core methods

| | |
|---|---|
| *text.render*([string, fmt, renderer]) | . |
| *text.echo*([string, fmt, renderer, nl, file, ...]) | . |
| *color.resolve_color*(subject[, color_type, ...]) | Suggested usage is to transform the user input in a free form in an attempt to find any matching color. |
| *style.make_style*([fmt]) | General *Style* constructor. |
| *style.merge_styles*([origin, fallbacks, ...]) | Bulk style merging method. |

## 5.2 Text fragments

### 5.2.1 Renderable class hierarchy

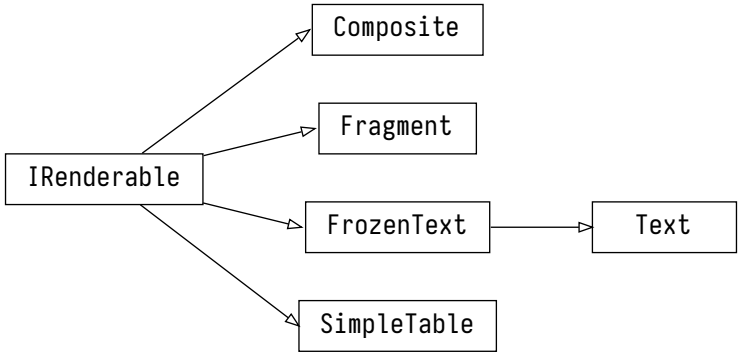



Fig. 1: *IRenderable* inheritance diagram

## 5.3 Styles

## 5.4 Colors

### 5.4.1 Color mode fallbacks

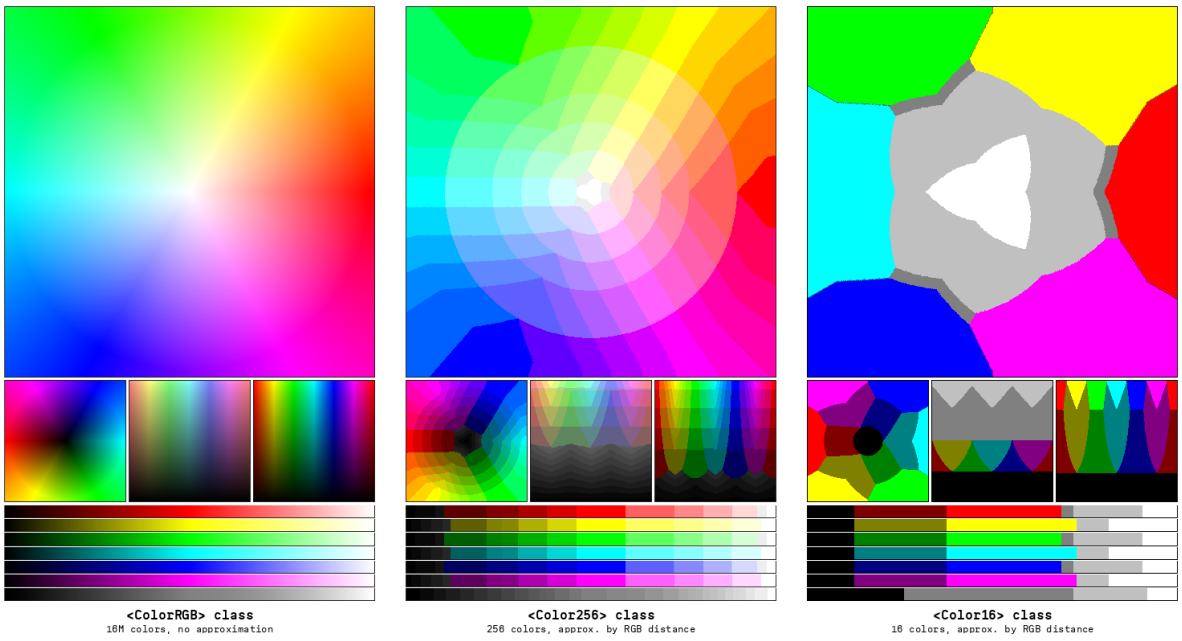



Fig. 2: Color approximations for indexed modes

### 5.4.2 Color class hierarchy

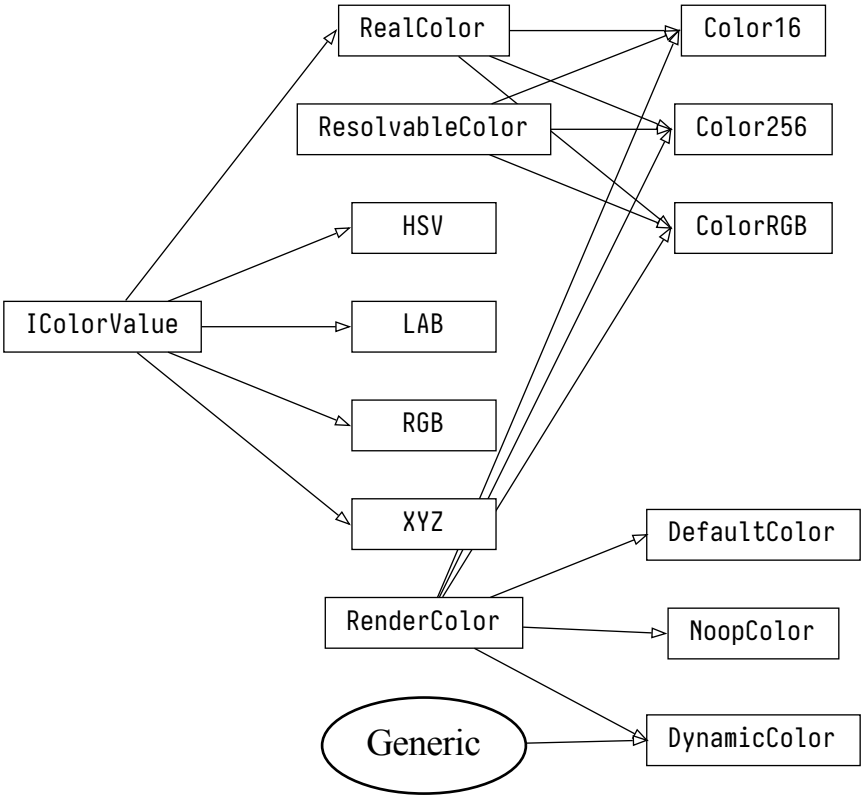



Fig. 3: `Color` inheritance diagram

## 5.5 fargs syntax

**Todo:** @TODO

## 5.6 Renderers

### 5.6.1 Renderer setup

The library provides options to select the output format, and that option comes in the form of *renderers* .

Selecting the renderer can be accomplished in several ways:

a. By using general-purpose functions *`render()`* and *`echo()`* – both have an argument `renderer` (preferrable; *introduced in v2.x*).

b. Method *`RendererManager.set_default()`* sets the default renderer globally. After that calling *`render()`* will automatically invoke a said renderer and apply the required formatting (but only if `renderer`

argument of `render()` method is left empty).

c. Set up the config variable *Config.renderer_class* directly or via environment variable.

d. Use renderer's instance method *IRenderer.render()* directly, but that's not recommended and possibly will be deprecated in the future.

Generally speaking, if you need to invoke a custom renderer just once, it's convenient to use the first method for this matter, and use the second one in all the other cases.

On the contrary, if there is a necessity to use more than one renderer alternatingly, it's better to avoid using the global one at all, and just instantiate and invoke both renderers independently.

#### TL;DR

To unconditionally print formatted message to standard output, call *force_ansi_rendering()* and then *render()*.

### 5.6.2 Default renderers priority

When it comes to the rendering, *RendererManager* will use the first non-empty renderer from the list below, skipping the undefined elements:

1. Explicitly specified as argument `renderer` in methods *render()*, *echo()*, *echoi()*.
2. Default renderer in global *RendererManager* class (see *RendererManager.set_default()*)
3. Renderer class in the current loaded library config: *Config.renderer_class*.
4. Value from environment variable PYTERMOR_RENDERER_CLASS.
5. Default library renderer *SgrRenderer*.

Argument > RendererManager > Config > Environment > Library's default

### 5.6.3 Output mode auto-selection

*SgrRenderer* can be set up with automatic output mode *OutputMode.AUTO*. In that case the renderer will return *OutputMode.NO_ANSI* for any output device other than terminal emulator, or try to find a matching rule from this list:

Table 1: Auto output mode parameters and results

| Is a tty? | `TERM` env. var | `COLORTERM` env. var[1] | Result output mode |
|---|---|---|---|
| <any> | | | *Config.force_output_mode*[2] |
| No | <any> | | *NO_ANSI* |
| Yes | `xterm-256color` | `24bit`, `truecolor` | *TRUE_COLOR* |
| | `*-256color`[3] | <any> | *XTERM_256* |
| | `xterm-color` | <any> | *XTERM_16* |
| | `xterm` | <any> | *NO_ANSI* |
| | <any other> | <any> | *Config.default_output_mode*[4] |

[1] should both env. var requirements be present, they both must be true as well (i.e. logical AND is applied).
[2] empty by default and thus ignored
[3] * represents any string; that's how e.g. *bash 5* determines the color support.
[4] *XTERM_256* by default, but can be customized.

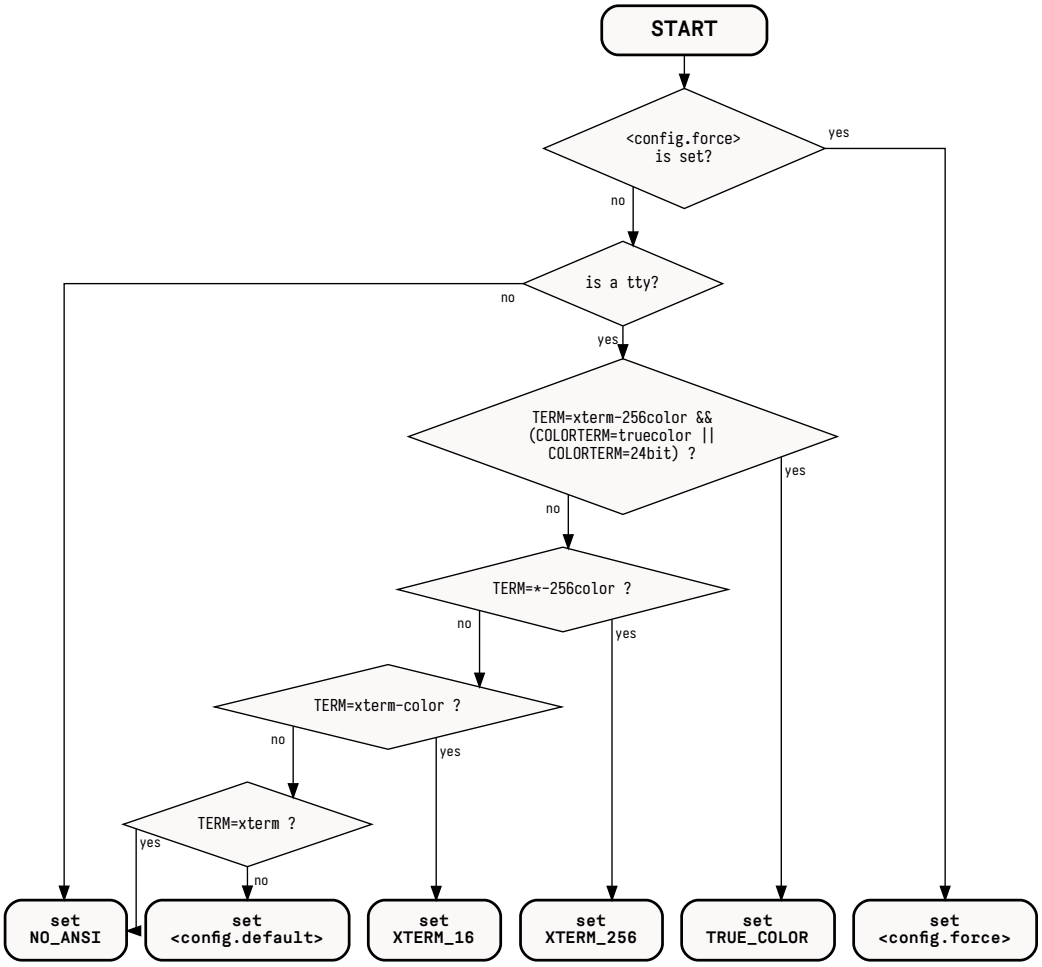



Fig. 4: Auto output mode algorithm

### 5.6.4 Renderer class hierarchy

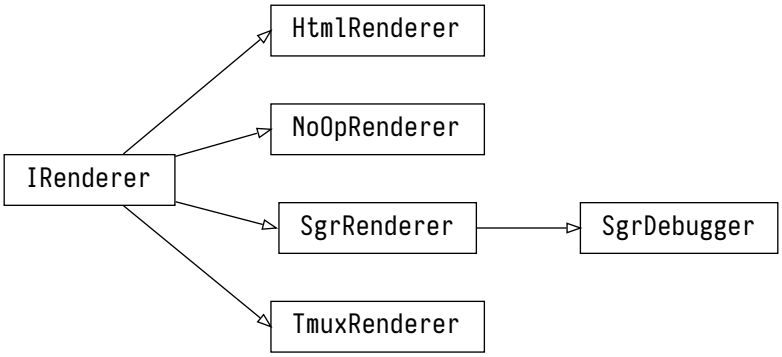



Fig. 5: *IRenderer* inheritance tree

## 5.7 Templates

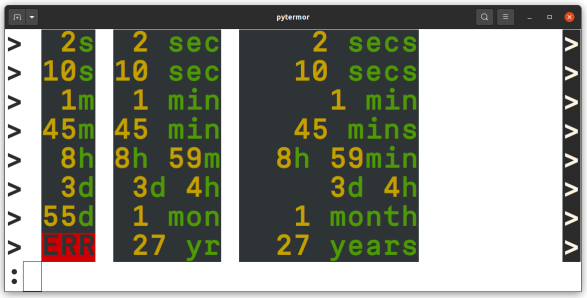
## 5.8 Number formatters

**Todo:** The library contains @TODO

### 5.8.1 Auto-float formatter

### 5.8.2 Prefixed-unit formatter

### 5.8.3 Time delta formatter



### 5.8.4 NumFormatter class hierarchy

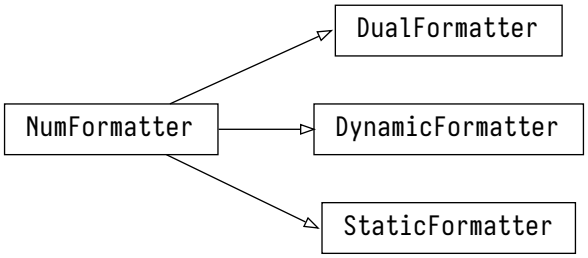



Fig. 6: `NumFormatter` inheritance tree

## 5.9 Named colors collection

**Todo:** @TODO

## 5.10 Dynamic/deferred colors

**Todo:** @TODO

# 6

# GUIDE · LOW-LEVEL

## 6.1 Core API II

So, what's happening under the hood?

### 6.1.1 Glossary

**ASCII**
: Basic charset developed back in 1960s, consisting of 128 code points. Nevertheless it is still used nowadays as a part of Unicode character set.

**ANSI**
: ..escape sequence is a standard for in-band signaling to control cursor location, color, font styling, and other options on video text terminals and terminal emulators. Certain sequences of bytes, most starting with an *ASCII* escape character (ESC 0x1B) and a bracket character ([ 0x5B), are embedded into text. The terminal interprets these sequences as commands, rather than text to display verbatim.[1]

**SGR**
: ..sequence is a subtype of *ANSI* escape sequences with a varying amount of parameters. SGR sequences used for changing the color of text or/and terminal background (in 3 different color modes), as well as for decorating text with italic font, underline, overline, cross-line, making it bold or blinking etc. Represented by `SequenceSGR` class.

[1] https://en.wikipedia.org/wiki/ANSI_escape_code

### 6.1.2 Core methods

| | |
|---|---|
| *ansi.SequenceSGR*(*params) | Class representing SGR (Select Graphic Rendition)-type escape sequence with varying amount of parameters. |
| *term.make_color_256*(code[, target]) | Wrapper for creation of *SequenceSGR* that sets foreground (or background) to one of 256-color palette value.: |
| *term.make_color_rgb*(r, g, b[, target]) | Wrapper for creation of *SequenceSGR* operating in True Color mode (16M). Valid values for `r`, `g` and `b` are in range of [0; 255]. This range linearly translates into [0x00; 0xFF] for each channel. The result value is composed as "#RRGGBB". For example, a sequence with color of #ff3300 can be created with::. |
| *color.Color256.to_sgr*([target, upper_bound]) | Make an *SGR sequence* out of `Color`. |

#### Sources

1. XTerm Control Sequences
2. ECMA-48 specification

## 6.2 SGR sequences

### 6.2.1 Format soft reset

**Todo:** This is how you **should** format examples:


Fig. 1: https://chrisyeh96.github.io/2020/03/28/terminal-colors.html#color-schemes

There are two ways to manage color and attribute termination:

- hard reset (SGR-0 or `ESC [0m`)
- soft reset (SGR-22, 23, 24 etc.)

The main difference between them is that *hard* reset disables all formatting after itself, while *soft* reset disables only actually necessary attributes (i.e. used as opening sequence in `Span` instance's context) and keeps the other.

That's what `Span` class is designed for: to simplify creation of soft-resetting text spans, so that developer doesn't have to restore all previously applied formats after every closing sequence.

#### Example

We are given a text span which is initially *bold* and *underlined*. We want to recolor a few words inside of this span. By default this will result in losing all the formatting to the right of updated text span (because *RESET*, or `ESC [0m`, clears all text attributes).

However, there is an option to specify what attributes should be disabled or let the library do that for you:


As you can see, the update went well – we kept all the previously applied formatting. Of course, this method cannot be 100% applicable; for example, imagine that original text was colored blue. After the update "string" word won't be blue anymore, as we used `SeqIndex.COLOR_OFF` escape sequence to neutralize our own yellow color. But it still can be helpful for a majority of cases (especially when text is generated and formatted by the same program and in one go).

### 6.2.2 Working with Spans

Use `Span` constructor to create new instance with specified control sequence(s) as a opening/starter sequence and **automatically composed** closing sequence that will terminate attributes defined in opening sequence while keeping the others (soft reset).

Resulting sequence params' order is the same as argument's order.

Each sequence param can be specified as:

- string key (see `ansi-presets`);
- integer param value;
- existing *SequenceSGR* instance (params will be extracted).

It's also possible to avoid auto-composing mechanism and create `Span` with explicitly set parameters using `Span.init_explicit()`.

### 6.2.3 Creating and applying SGRs

You can use any of predefined sequences from *SeqIndex* registry or create your own via standard constructor. Valid argument values as well as preset constants are described in `ansi-presets` page.

---

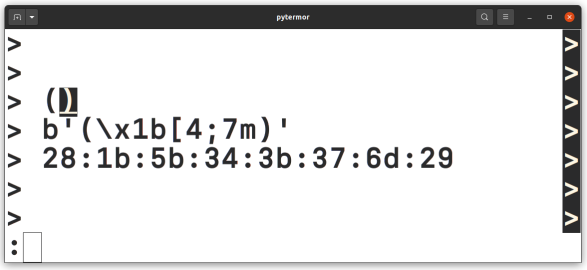
**Important:** *SequenceSGR* with zero params `ESC [m` is interpreted by terminal emulators as `ESC [0m`, which is *hard* reset sequence.

---

There is also a set of methods for dynamic *SequenceSGR* creation:

- *make_color_256()* will produce sequence operating in 256-colors mode (for a complete list see `ansi-presets`);
- *make_color_rgb()* will create a sequence capable of setting the colors in True Color 16M mode (however, some terminal emulators doesn't support it).

To get the resulting sequence chars use `assemble()` method or cast instance to *str*.




- First line is the string with encoded escape sequence;
- Second line shows up the string in raw mode, as if sequences were ignored by the terminal;
- Third line is hexadecimal string representation.

### 6.2.4 SGR sequence structure

1. `ESC` is escape *control character*, which opens a control sequence (can also be written as `\x1b`, `\033` or `\e`).
2. `[` is sequence *classifier*; it determines the type of control sequence (in this case it's CSI (Control Sequence Introducer)).
3. `4` and `7` are *parameters* of the escape sequence; they mean "underlined" and "inversed" attributes respectively. Those parameters must be separated by `;`.
4. `m` is sequence *terminator*; it also determines the sub-type of sequence, in our case SGR. Sequences of this kind are most commonly encountered.

### 6.2.5 Combining SGRs

One instance of *SequenceSGR* can be added to another. This will result in a new `SequenceSGR` with combined params.

### 6.2.6 Sequence class hierarchy

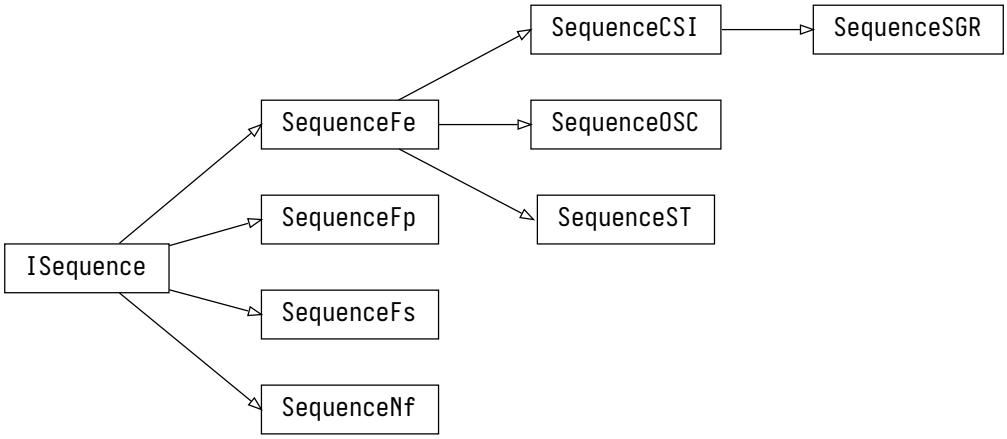



Fig. 2: *ISequence* inheritance tree

## 6.3 Sequence presets

Preset lists are omitted from API docs to avoid unnesessary duplication; summary list of all presets defined in the library (excluding `util*`) is displayed here.

**Todo:** USAGE - list all memthods that accept string keys of those prsets.

There are two types of color palettes used in modern terminals – first one containing 16 colors (*Color16*), and second one consisting of 256 colors (*Color256*). There is also True Color mode (referenced as *RGB* mode), but it is not palette-based.

#### Legend

- INT (intcode module -- 1st or 3rd SGR param value)
- STY (style module)

### 6.3.1 Meta, attributes, resetters

| | Name | INT | STY | Description |
|---|---|---|---|---|
| **Meta** | | | | |
| | NOOP | | V | No-operation; always assembled as empty string |
| | RESET | 0 | | Reset all attributes and colors |
| **Attributes** | | | | |
| | BOLD | 1 | V[1] | Bold or increased intensity |
| | DIM | 2 | V | Faint, decreased intensity |
| | ITALIC | 3 | V | Italic; *not widely supported* |
| | UNDERLINED | 4 | V | Underline |
| | BLINK_SLOW | 5 | V[2] | Set blinking to < 150 cpm |
| | BLINK_FAST | 6 | | Set blinking to 150+ cpm; *not widely supported* |
| | INVERSED | 7 | V | Swap foreground and background colors |
| | HIDDEN | 8 | | Conceal characters; *not widely supported* |
| | CROSSLINED | 9 | V | Strikethrough |
| | DOUBLE_UNDERLINED | 21 | | Double-underline; *on several terminals disables* BOLD *instead* |
| | COLOR_EXTENDED | 38 | | Set foreground color [*indexed/RGB* mode]; *use* `make_color_256` *and* `make_color_rgb` *instead* |
| | BG_COLOR_EXTENDED | 48 | | Set background color [*indexed/RGB* mode]; *use* `make_color_256` *and* `make_color_rgb` *instead* |
| | OVERLINED | 53 | V | Overline; *not widely supported* |
| **Resetters** | | | | |
| | BOLD_DIM_OFF | 22 | | Disable BOLD and DIM attributes. *Special aspects... It's impossible to reliably disable them on a separate basis.* |
| | ITALIC_OFF | 23 | | Disable italic |
| | UNDERLINED_OFF | 24 | | Disable underlining |
| | BLINK_OFF | 25 | | Disable blinking |
| | INVERSED_OFF | 27 | | Disable inversing |
| | HIDDEN_OFF | 28 | | Disable conecaling |
| | CROSSLINED_OFF | 29 | | Disable strikethrough |
| | COLOR_OFF | 39 | | Reset foreground color |
| | BG_COLOR_OFF | 49 | | Reset background color |
| | OVERLINED_OFF | 55 | | Disable overlining |

### 6.3.2 Color16 presets

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| **Foreground *default* colors** | | | | | |
| | BLACK | 30 | | #000000 | Black |
| | RED | 31 | | #800000 | Maroon |
| | GREEN | 32 | | #008000 | Green |
| | YELLOW | 33 | | #808000 | Olive |

continues on next page

[1] for this and subsequent items in "Attributes" section: as boolean flags.
[2] as blink.

Table 1 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | BLUE | 34 | | #000080 | Navy |
| | MAGENTA | 35 | | #800080 | Purple |
| | CYAN | 36 | | #008080 | Teal |
| | WHITE | 37 | | #c0c0c0 | Silver |
| **Background *default* colors** | | | | | |
| | BG_BLACK | 40 | | #000000 | Black |
| | BG_RED | 41 | | #800000 | Maroon |
| | BG_GREEN | 42 | | #008000 | Green |
| | BG_YELLOW | 43 | | #808000 | Olive |
| | BG_BLUE | 44 | | #000080 | Navy |
| | BG_MAGENTA | 45 | | #800080 | Purple |
| | BG_CYAN | 46 | | #008080 | Teal |
| | BG_WHITE | 47 | | #c0c0c0 | Silver |
| **High-intensity foreground *default* colors** | | | | | |
| | GRAY | 90 | | #808080 | Grey |
| | HI_RED | 91 | | #ff0000 | Red |
| | HI_GREEN | 92 | | #00ff00 | Lime |
| | HI_YELLOW | 93 | | #ffff00 | Yellow |
| | HI_BLUE | 94 | | #0000ff | Blue |
| | HI_MAGENTA | 95 | | #ff00ff | Fuchsia |
| | HI_CYAN | 96 | | #00ffff | Aqua |
| | HI_WHITE | 97 | | #ffffff | White |
| **High-intensity background *default* colors** | | | | | |
| | BG_GRAY | 100 | | #808080 | Grey |
| | BG_HI_RED | 101 | | #ff0000 | Red |
| | BG_HI_GREEN | 102 | | #00ff00 | Lime |
| | BG_HI_YELLOW | 103 | | #ffff00 | Yellow |
| | BG_HI_BLUE | 104 | | #0000ff | Blue |
| | BG_HI_MAGENTA | 105 | | #ff00ff | Fuchsia |
| | BG_HI_CYAN | 106 | | #00ffff | Aqua |
| | BG_HI_WHITE | 107 | | #ffffff | White |

### 6.3.3 Color256 presets

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_BLACK[3] | 0 | | #000000 | |
| | XTERM_MAROON | 1 | | #800000 | |
| | XTERM_GREEN | 2 | | #008000 | |
| | XTERM_OLIVE | 3 | | #808000 | |
| | XTERM_NAVY | 4 | | #000080 | |
| | XTERM_PURPLE_5 | 5 | | #800080 | **Purple**[4] |
| | XTERM_TEAL | 6 | | #008080 | |
| | XTERM_SILVER | 7 | | #c0c0c0 | |
| | XTERM_GREY | 8 | | #808080 | |
| | XTERM_RED | 9 | | #ff0000 | |
| | XTERM_LIME | 10 | | #00ff00 | |

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Table 2 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_YELLOW | 11 | | #ffff00 | |
| | XTERM_BLUE | 12 | | #0000ff | |
| | XTERM_FUCHSIA | 13 | | #ff00ff | |
| | XTERM_AQUA | 14 | | #00ffff | |
| | XTERM_WHITE | 15 | | #ffffff | |
| | XTERM_GREY_0 | 16 | | #000000 | |
| | XTERM_NAVY_BLUE | 17 | | #00005f | |
| | XTERM_DARK_BLUE | 18 | | #000087 | |
| | XTERM_BLUE_3 | 19 | | #0000af | |
| | XTERM_BLUE_2 | 20 | | #0000d7 | **Blue3** |
| | XTERM_BLUE_1 | 21 | | #0000ff | |
| | XTERM_DARK_GREEN | 22 | | #005f00 | |
| | XTERM_DEEP_SKY_BLUE_7 | 23 | | #005f5f | **DeepSkyBlue4** |
| | XTERM_DEEP_SKY_BLUE_6 | 24 | | #005f87 | **DeepSkyBlue4** |
| | XTERM_DEEP_SKY_BLUE_5 | 25 | | #005faf | **DeepSkyBlue4** |
| | XTERM_DODGER_BLUE_3 | 26 | | #005fd7 | |
| | XTERM_DODGER_BLUE_2 | 27 | | #005fff | |
| | XTERM_GREEN_5 | 28 | | #008700 | **Green4** |
| | XTERM_SPRING_GREEN_4 | 29 | | #00875f | |
| | XTERM_TURQUOISE_4 | 30 | | #008787 | |
| | XTERM_DEEP_SKY_BLUE_4 | 31 | | #0087af | **DeepSkyBlue3** |
| | XTERM_DEEP_SKY_BLUE_3 | 32 | | #0087d7 | |
| | XTERM_DODGER_BLUE_1 | 33 | | #0087ff | |
| | XTERM_GREEN_4 | 34 | | #00af00 | **Green3** |
| | XTERM_SPRING_GREEN_5 | 35 | | #00af5f | **SpringGreen3** |
| | XTERM_DARK_CYAN | 36 | | #00af87 | |
| | XTERM_LIGHT_SEA_GREEN | 37 | | #00afaf | |
| | XTERM_DEEP_SKY_BLUE_2 | 38 | | #00afd7 | |
| | XTERM_DEEP_SKY_BLUE_1 | 39 | | #00afff | |
| | XTERM_GREEN_3 | 40 | | #00d700 | |
| | XTERM_SPRING_GREEN_3 | 41 | | #00d75f | |
| | XTERM_SPRING_GREEN_6 | 42 | | #00d787 | **SpringGreen2** |
| | XTERM_CYAN_3 | 43 | | #00d7af | |
| | XTERM_DARK_TURQUOISE | 44 | | #00d7d7 | |
| | XTERM_TURQUOISE_2 | 45 | | #00d7ff | |
| | XTERM_GREEN_2 | 46 | | #00ff00 | **Green1** |
| | XTERM_SPRING_GREEN_2 | 47 | | #00ff5f | |
| | XTERM_SPRING_GREEN_1 | 48 | | #00ff87 | |
| | XTERM_MEDIUM_SPRING_GREEN | 49 | | #00ffaf | |
| | XTERM_CYAN_2 | 50 | | #00ffd7 | |
| | XTERM_CYAN_1 | 51 | | #00ffff | |
| | XTERM_DARK_RED_2 | 52 | | #5f0000 | **DarkRed** |
| | XTERM_DEEP_PINK_8 | 53 | | #5f005f | **DeepPink4** |
| | XTERM_PURPLE_6 | 54 | | #5f0087 | **Purple4** |
| | XTERM_PURPLE_4 | 55 | | #5f00af | |
| | XTERM_PURPLE_3 | 56 | | #5f00d7 | |
| | XTERM_BLUE_VIOLET | 57 | | #5f00ff | |
| | XTERM_ORANGE_4 | 58 | | #5f5f00 | |
| | XTERM_GREY_37 | 59 | | #5f5f5f | |
| | XTERM_MEDIUM_PURPLE_7 | 60 | | #5f5f87 | **MediumPurple4** |
| | XTERM_SLATE_BLUE_3 | 61 | | #5f5faf | |
| | XTERM_SLATE_BLUE_2 | 62 | | #5f5fd7 | **SlateBlue3** |
| | XTERM_ROYAL_BLUE_1 | 63 | | #5f5fff | |

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Table 2 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_CHARTREUSE_6 | 64 | | #5f8700 | **Chartreuse4** |
| | XTERM_DARK_SEA_GREEN_9 | 65 | | #5f875f | **DarkSeaGreen4** |
| | XTERM_PALE_TURQUOISE_4 | 66 | | #5f8787 | |
| | XTERM_STEEL_BLUE | 67 | | #5f87af | |
| | XTERM_STEEL_BLUE_3 | 68 | | #5f87d7 | |
| | XTERM_CORNFLOWER_BLUE | 69 | | #5f87ff | |
| | XTERM_CHARTREUSE_5 | 70 | | #5faf00 | **Chartreuse3** |
| | XTERM_DARK_SEA_GREEN_8 | 71 | | #5faf5f | **DarkSeaGreen4** |
| | XTERM_CADET_BLUE_2 | 72 | | #5faf87 | **CadetBlue** |
| | XTERM_CADET_BLUE | 73 | | #5fafaf | |
| | XTERM_SKY_BLUE_3 | 74 | | #5fafd7 | |
| | XTERM_STEEL_BLUE_2 | 75 | | #5fafff | **SteelBlue1** |
| | XTERM_CHARTREUSE_4 | 76 | | #5fd700 | **Chartreuse3** |
| | XTERM_PALE_GREEN_4 | 77 | | #5fd75f | **PaleGreen3** |
| | XTERM_SEA_GREEN_3 | 78 | | #5fd787 | |
| | XTERM_AQUAMARINE_3 | 79 | | #5fd7af | |
| | XTERM_MEDIUM_TURQUOISE | 80 | | #5fd7d7 | |
| | XTERM_STEEL_BLUE_1 | 81 | | #5fd7ff | |
| | XTERM_CHARTREUSE_2 | 82 | | #5fff00 | |
| | XTERM_SEA_GREEN_4 | 83 | | #5fff5f | **SeaGreen2** |
| | XTERM_SEA_GREEN_2 | 84 | | #5fff87 | **SeaGreen1** |
| | XTERM_SEA_GREEN_1 | 85 | | #5fffaf | |
| | XTERM_AQUAMARINE_2 | 86 | | #5fffd7 | **Aquamarine1** |
| | XTERM_DARK_SLATE_GRAY_2 | 87 | | #5fffff | |
| | XTERM_DARK_RED | 88 | | #870000 | |
| | XTERM_DEEP_PINK_7 | 89 | | #87005f | **DeepPink4** |
| | XTERM_DARK_MAGENTA_2 | 90 | | #870087 | **DarkMagenta** |
| | XTERM_DARK_MAGENTA | 91 | | #8700af | |
| | XTERM_DARK_VIOLET_2 | 92 | | #8700d7 | **DarkViolet** |
| | XTERM_PURPLE_2 | 93 | | #8700ff | **Purple** |
| | XTERM_ORANGE_3 | 94 | | #875f00 | **Orange4** |
| | XTERM_LIGHT_PINK_3 | 95 | | #875f5f | **LightPink4** |
| | XTERM_PLUM_4 | 96 | | #875f87 | |
| | XTERM_MEDIUM_PURPLE_6 | 97 | | #875faf | **MediumPurple3** |
| | XTERM_MEDIUM_PURPLE_5 | 98 | | #875fd7 | **MediumPurple3** |
| | XTERM_SLATE_BLUE_1 | 99 | | #875fff | |
| | XTERM_YELLOW_6 | 100 | | #878700 | **Yellow4** |
| | XTERM_WHEAT_4 | 101 | | #87875f | |
| | XTERM_GREY_53 | 102 | | #878787 | |
| | XTERM_LIGHT_SLATE_GREY | 103 | | #8787af | |
| | XTERM_MEDIUM_PURPLE_4 | 104 | | #8787d7 | **MediumPurple** |
| | XTERM_LIGHT_SLATE_BLUE | 105 | | #8787ff | |
| | XTERM_YELLOW_4 | 106 | | #87af00 | |
| | XTERM_DARK_OLIVE_GREEN_6 | 107 | | #87af5f | **DarkOliveGreen3** |
| | XTERM_DARK_SEA_GREEN_7 | 108 | | #87af87 | **DarkSeaGreen** |
| | XTERM_LIGHT_SKY_BLUE_3 | 109 | | #87afaf | |
| | XTERM_LIGHT_SKY_BLUE_2 | 110 | | #87afd7 | **LightSkyBlue3** |
| | XTERM_SKY_BLUE_2 | 111 | | #87afff | |
| | XTERM_CHARTREUSE_3 | 112 | | #87d700 | **Chartreuse2** |
| | XTERM_DARK_OLIVE_GREEN_4 | 113 | | #87d75f | **DarkOliveGreen3** |
| | XTERM_PALE_GREEN_3 | 114 | | #87d787 | |
| | XTERM_DARK_SEA_GREEN_5 | 115 | | #87d7af | **DarkSeaGreen3** |
| | XTERM_DARK_SLATE_GRAY_3 | 116 | | #87d7d7 | |

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Table 2 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_SKY_BLUE_1 | 117 | | #87d7ff | |
| | XTERM_CHARTREUSE_1 | 118 | | #87ff00 | |
| | XTERM_LIGHT_GREEN_2 | 119 | | #87ff5f | **LightGreen** |
| | XTERM_LIGHT_GREEN | 120 | | #87ff87 | |
| | XTERM_PALE_GREEN_1 | 121 | | #87ffaf | |
| | XTERM_AQUAMARINE_1 | 122 | | #87ffd7 | |
| | XTERM_DARK_SLATE_GRAY_1 | 123 | | #87ffff | |
| | XTERM_RED_4 | 124 | | #af0000 | **Red3** |
| | XTERM_DEEP_PINK_6 | 125 | | #af005f | **DeepPink4** |
| | XTERM_MEDIUM_VIOLET_RED | 126 | | #af0087 | |
| | XTERM_MAGENTA_6 | 127 | | #af00af | **Magenta3** |
| | XTERM_DARK_VIOLET | 128 | | #af00d7 | |
| | XTERM_PURPLE | 129 | | #af00ff | |
| | XTERM_DARK_ORANGE_3 | 130 | | #af5f00 | |
| | XTERM_INDIAN_RED_4 | 131 | | #af5f5f | **IndianRed** |
| | XTERM_HOT_PINK_5 | 132 | | #af5f87 | **HotPink3** |
| | XTERM_MEDIUM_ORCHID_4 | 133 | | #af5faf | **MediumOrchid3** |
| | XTERM_MEDIUM_ORCHID_3 | 134 | | #af5fd7 | **MediumOrchid** |
| | XTERM_MEDIUM_PURPLE_2 | 135 | | #af5fff | |
| | XTERM_DARK_GOLDENROD | 136 | | #af8700 | |
| | XTERM_LIGHT_SALMON_3 | 137 | | #af875f | |
| | XTERM_ROSY_BROWN | 138 | | #af8787 | |
| | XTERM_GREY_63 | 139 | | #af87af | |
| | XTERM_MEDIUM_PURPLE_3 | 140 | | #af87d7 | **MediumPurple2** |
| | XTERM_MEDIUM_PURPLE_1 | 141 | | #af87ff | |
| | XTERM_GOLD_3 | 142 | | #afaf00 | |
| | XTERM_DARK_KHAKI | 143 | | #afaf5f | |
| | XTERM_NAVAJO_WHITE_3 | 144 | | #afaf87 | |
| | XTERM_GREY_69 | 145 | | #afafaf | |
| | XTERM_LIGHT_STEEL_BLUE_3 | 146 | | #afafd7 | |
| | XTERM_LIGHT_STEEL_BLUE_2 | 147 | | #afafff | **LightSteelBlue** |
| | XTERM_YELLOW_5 | 148 | | #afd700 | **Yellow3** |
| | XTERM_DARK_OLIVE_GREEN_5 | 149 | | #afd75f | **DarkOliveGreen3** |
| | XTERM_DARK_SEA_GREEN_6 | 150 | | #afd787 | **DarkSeaGreen3** |
| | XTERM_DARK_SEA_GREEN_4 | 151 | | #afd7af | **DarkSeaGreen2** |
| | XTERM_LIGHT_CYAN_3 | 152 | | #afd7d7 | |
| | XTERM_LIGHT_SKY_BLUE_1 | 153 | | #afd7ff | |
| | XTERM_GREEN_YELLOW | 154 | | #afff00 | |
| | XTERM_DARK_OLIVE_GREEN_3 | 155 | | #afff5f | **DarkOliveGreen2** |
| | XTERM_PALE_GREEN_2 | 156 | | #afff87 | **PaleGreen1** |
| | XTERM_DARK_SEA_GREEN_3 | 157 | | #afffaf | **DarkSeaGreen2** |
| | XTERM_DARK_SEA_GREEN_1 | 158 | | #afffd7 | |
| | XTERM_PALE_TURQUOISE_1 | 159 | | #afffff | |
| | XTERM_RED_3 | 160 | | #d70000 | |
| | XTERM_DEEP_PINK_5 | 161 | | #d7005f | **DeepPink3** |
| | XTERM_DEEP_PINK_3 | 162 | | #d70087 | |
| | XTERM_MAGENTA_3 | 163 | | #d700af | |
| | XTERM_MAGENTA_5 | 164 | | #d700d7 | **Magenta3** |
| | XTERM_MAGENTA_4 | 165 | | #d700ff | **Magenta2** |
| | XTERM_DARK_ORANGE_2 | 166 | | #d75f00 | **DarkOrange3** |
| | XTERM_INDIAN_RED_3 | 167 | | #d75f5f | **IndianRed** |
| | XTERM_HOT_PINK_4 | 168 | | #d75f87 | **HotPink3** |
| | XTERM_HOT_PINK_3 | 169 | | #d75faf | **HotPink2** |

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Table 2 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_ORCHID_3 | 170 | | #d75fd7 | **Orchid** |
| | XTERM_MEDIUM_ORCHID_2 | 171 | | #d75fff | **MediumOrchid1** |
| | XTERM_ORANGE_2 | 172 | | #d78700 | **Orange3** |
| | XTERM_LIGHT_SALMON_2 | 173 | | #d7875f | **LightSalmon3** |
| | XTERM_LIGHT_PINK_2 | 174 | | #d78787 | **LightPink3** |
| | XTERM_PINK_3 | 175 | | #d787af | |
| | XTERM_PLUM_3 | 176 | | #d787d7 | |
| | XTERM_VIOLET | 177 | | #d787ff | |
| | XTERM_GOLD_2 | 178 | | #d7af00 | **Gold3** |
| | XTERM_LIGHT_GOLDENROD_5 | 179 | | #d7af5f | **LightGoldenrod3** |
| | XTERM_TAN | 180 | | #d7af87 | |
| | XTERM_MISTY_ROSE_3 | 181 | | #d7afaf | |
| | XTERM_THISTLE_3 | 182 | | #d7afd7 | |
| | XTERM_PLUM_2 | 183 | | #d7afff | |
| | XTERM_YELLOW_3 | 184 | | #d7d700 | |
| | XTERM_KHAKI_3 | 185 | | #d7d75f | |
| | XTERM_LIGHT_GOLDENROD_3 | 186 | | #d7d787 | **LightGoldenrod2** |
| | XTERM_LIGHT_YELLOW_3 | 187 | | #d7d7af | |
| | XTERM_GREY_84 | 188 | | #d7d7d7 | |
| | XTERM_LIGHT_STEEL_BLUE_1 | 189 | | #d7d7ff | |
| | XTERM_YELLOW_2 | 190 | | #d7ff00 | |
| | XTERM_DARK_OLIVE_GREEN_2 | 191 | | #d7ff5f | **DarkOliveGreen1** |
| | XTERM_DARK_OLIVE_GREEN_1 | 192 | | #d7ff87 | |
| | XTERM_DARK_SEA_GREEN_2 | 193 | | #d7ffaf | **DarkSeaGreen1** |
| | XTERM_HONEYDEW_2 | 194 | | #d7ffd7 | |
| | XTERM_LIGHT_CYAN_1 | 195 | | #d7ffff | |
| | XTERM_RED_1 | 196 | | #ff0000 | |
| | XTERM_DEEP_PINK_4 | 197 | | #ff005f | **DeepPink2** |
| | XTERM_DEEP_PINK_2 | 198 | | #ff0087 | **DeepPink1** |
| | XTERM_DEEP_PINK_1 | 199 | | #ff00af | |
| | XTERM_MAGENTA_2 | 200 | | #ff00d7 | |
| | XTERM_MAGENTA_1 | 201 | | #ff00ff | |
| | XTERM_ORANGE_RED_1 | 202 | | #ff5f00 | |
| | XTERM_INDIAN_RED_1 | 203 | | #ff5f5f | |
| | XTERM_INDIAN_RED_2 | 204 | | #ff5f87 | **IndianRed1** |
| | XTERM_HOT_PINK_2 | 205 | | #ff5faf | **HotPink** |
| | XTERM_HOT_PINK | 206 | | #ff5fd7 | |
| | XTERM_MEDIUM_ORCHID_1 | 207 | | #ff5fff | |
| | XTERM_DARK_ORANGE | 208 | | #ff8700 | |
| | XTERM_SALMON_1 | 209 | | #ff875f | |
| | XTERM_LIGHT_CORAL | 210 | | #ff8787 | |
| | XTERM_PALE_VIOLET_RED_1 | 211 | | #ff87af | |
| | XTERM_ORCHID_2 | 212 | | #ff87d7 | |
| | XTERM_ORCHID_1 | 213 | | #ff87ff | |
| | XTERM_ORANGE_1 | 214 | | #ffaf00 | |
| | XTERM_SANDY_BROWN | 215 | | #ffaf5f | |
| | XTERM_LIGHT_SALMON_1 | 216 | | #ffaf87 | |
| | XTERM_LIGHT_PINK_1 | 217 | | #ffafaf | |
| | XTERM_PINK_1 | 218 | | #ffafd7 | |
| | XTERM_PLUM_1 | 219 | | #ffafff | |
| | XTERM_GOLD_1 | 220 | | #ffd700 | |
| | XTERM_LIGHT_GOLDENROD_4 | 221 | | #ffd75f | **LightGoldenrod2** |
| | XTERM_LIGHT_GOLDENROD_2 | 222 | | #ffd787 | |

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Table 2 – continued from previous page

| | Name | INT | STY | RGB code | XTerm name |
|---|---|---|---|---|---|
| | XTERM_NAVAJO_WHITE_1 | 223 | | #ffd7af | |
| | XTERM_MISTY_ROSE_1 | 224 | | #ffd7d7 | |
| | XTERM_THISTLE_1 | 225 | | #ffd7ff | |
| | XTERM_YELLOW_1 | 226 | | #ffff00 | |
| | XTERM_LIGHT_GOLDENROD_1 | 227 | | #ffff5f | |
| | XTERM_KHAKI_1 | 228 | | #ffff87 | |
| | XTERM_WHEAT_1 | 229 | | #ffffaf | |
| | XTERM_CORNSILK_1 | 230 | | #ffffd7 | |
| | XTERM_GREY_100 | 231 | | #ffffff | |
| | XTERM_GREY_3 | 232 | | #080808 | |
| | XTERM_GREY_7 | 233 | | #121212 | |
| | XTERM_GREY_11 | 234 | | #1c1c1c | |
| | XTERM_GREY_15 | 235 | | #262626 | |
| | XTERM_GREY_19 | 236 | | #303030 | |
| | XTERM_GREY_23 | 237 | | #3a3a3a | |
| | XTERM_GREY_27 | 238 | | #444444 | |
| | XTERM_GREY_30 | 239 | | #4e4e4e | |
| | XTERM_GREY_35 | 240 | | #585858 | |
| | XTERM_GREY_39 | 241 | | #626262 | |
| | XTERM_GREY_42 | 242 | | #6c6c6c | |
| | XTERM_GREY_46 | 243 | | #767676 | |
| | XTERM_GREY_50 | 244 | | #808080 | |
| | XTERM_GREY_54 | 245 | | #8a8a8a | |
| | XTERM_GREY_58 | 246 | | #949494 | |
| | XTERM_GREY_62 | 247 | | #9e9e9e | |
| | XTERM_GREY_66 | 248 | | #a8a8a8 | |
| | XTERM_GREY_70 | 249 | | #b2b2b2 | |
| | XTERM_GREY_74 | 250 | | #bcbcbc | |
| | XTERM_GREY_78 | 251 | | #c6c6c6 | |
| | XTERM_GREY_82 | 252 | | #d0d0d0 | |
| | XTERM_GREY_85 | 253 | | #dadada | |
| | XTERM_GREY_89 | 254 | | #e4e4e4 | |
| | XTERM_GREY_93 | 255 | | #eeeeee | |

## Sources

1. https://en.wikipedia.org/wiki/ANSI_escape_code
2. https://www.ditig.com/256-colors-cheat-sheet

[3] First 16 colors are effectively the same as colors in *default* 16-color mode and share with them the same color values (and depend on terminal color scheme as well).

[4] XTerm name list contains duplicates; variable names for these were slightly modified (different numbers at the end) to avoid namespace conflicts. Every changed name is displayed with **bold** font.

## 6.4 xterm indexed colors

### 6.4.1 Color16 and Color256 equivalents

*Color16* palette consists of 16 base colors which are listed below. At the same time, they are part of *Color256* palette (the first 16 ones). Actual colors of *Color16* palette depend on user's terminal settings, i.e. the result color of *Color16* is not guaranteed to exactly match the corresponding color. That's why using this color type is discouraged, if you want to be sure that the result will match the expectations.

However, it doesn't mean that `Color16` is useless. Just the opposite – it's ideal for situations when you don't actually **need** to set exact values and it's easier to specify estimation of desired color. I.e. setting color to `'red'` is usually more than enough for displaying an error message – we don't really care about precise values of hue or brightness that will be used to display it.

The instances of `Color256` with an exact `Color16` counterpart have a private property `_color16_equiv`, which is used to determine the result of comparison between two colors – i.e., == opeartor will return *True* for pairs of equivalent colors:

```
>>> col1, col2 = pt.Color256.get_by_code(1), pt.Color16.get_by_code(31)
(<Color256[x1(#800000? maroon)]>, <Color16[c31(#800000? red)]>)
>>> col1 == col2
True
```

At the same time, colors which share the color value, but behave differently due to equivalence mechanics are considered different:

```
>>> col1, col2 = pt.Color256.get_by_code(9), pt.Color256.get_by_code(196)
(<Color256[x9(#ff0000? red)]>, <Color256[x196(#ff0000 red-1)]>)
>>> col1 == col2
False
```

### 6.4.2 Approximation algorithm

The approximation algorithm was explicitly made to ignore these colors because otherwise the results of transforming *RGB* values into e.g. `Color256`, would be unpredictable, in addition to different results for different users, depending on their terminal emulator setup.

---

**Todo:** Approximation algorithm is as simple as iterating through all colors in the *lookup table* (which contains all possible …

---

### 6.4.3 xterm-256 palette

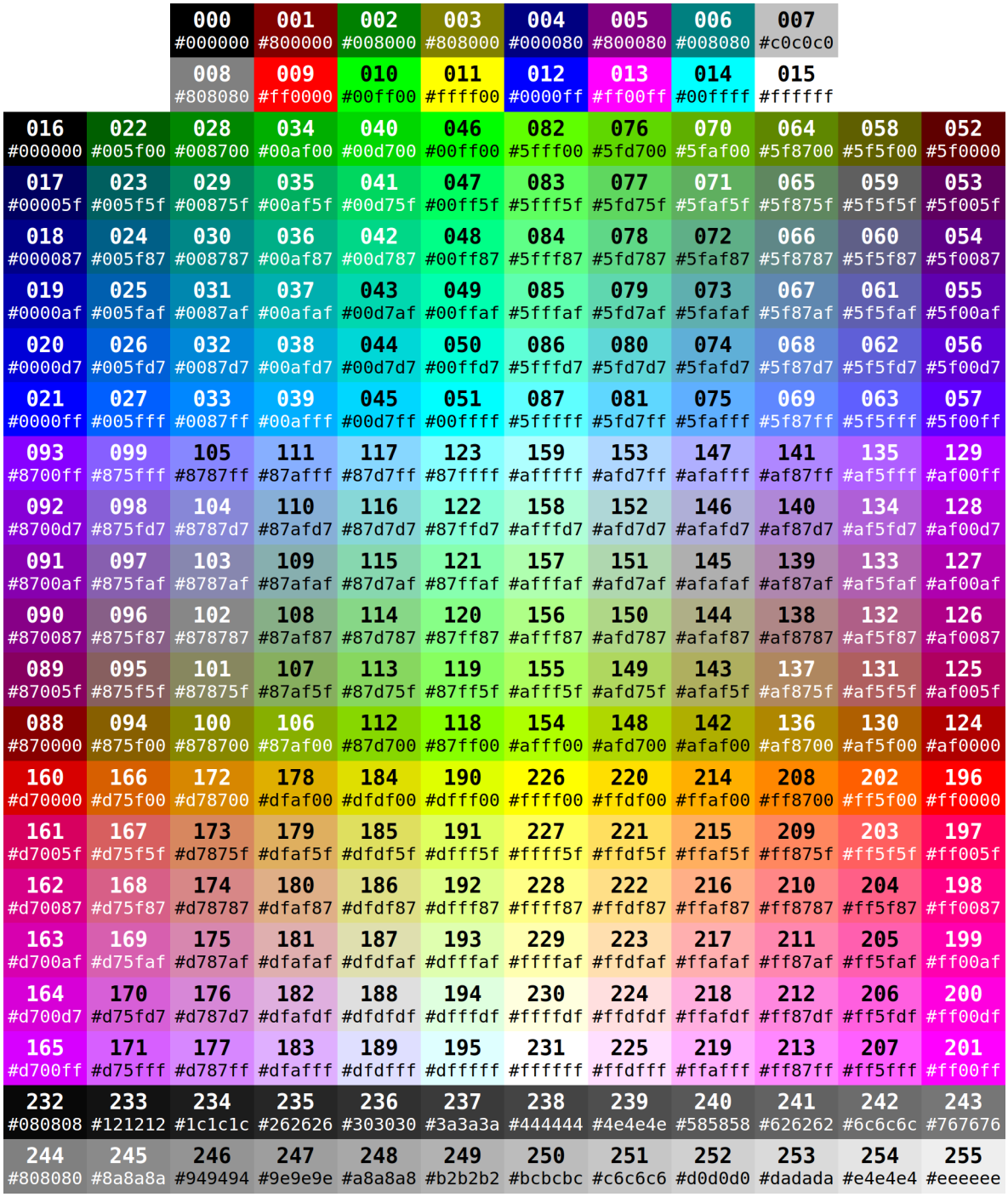


Fig. 3: *Color256* mode palette

#### Sources

1. https://www.tweaking4all.com/software/linux-software/xterm-color-cheat-sheet/

## 6.5 ANSI sequences review

### 6.5.1 Sequence classes

Sequences can be divided to 4 different classes depending on their classifier byte(s); a class indicates the application domain the purpose of the sequence in general. According to ECMA-48 specification the classes are: **nF**, **Fp**, **Fe**, **Fs**.

- **nF** escape sequences are mostly used for ANSI/ISO code-switching mechanisms. All **nF**-class sequences start with ESC plus ASCII byte from the range 0x20-0x2F: ( !"#$%&'()*+\-./ and space ).

  They are represented by *SequenceNf* class without any specific implementations.

- **fP**-class sequences can be used for invoking private control functions. The characteristic property is that the first byte after ESC is always in range 0x30-0x3F (0123456789:;<=>?).

  They are represented by *SequenceFp* class, which, for example, assembles DECSC (Save Cursor) and DECRC (Restore Cursor) sequence types.

- **Fe**-class sequences are the most common ones and 99% of the sequences you will ever encounter will be of **Fe** class. ECMA-48 names them "C1 set sequences", and their *classifier* byte (the one right after escape byte) is from 0x40 to 0x5F range (@[\\]_^ABCDEFGHIJKLMNOPQRSTUVWXYZ).

  These sequences are implemented in *SequenceFe* parent class, which is then subclassed by even more specific classes *SequenceST*, *SequenceOSC*, *SequenceCSI* and *(drums)* *SequenceSGR* – the one responsible for setting the terminal colors and formats (or at least the majority of them), and also the one that's going to be encountered most of the time. The examples include CUP, ED (Erase in Display), aforementioned SGR and much more.

- **Fs**-class sequences …

  **Todo:** This

### 6.5.2 Sequence types

ECMA-48 introduces a list of terminal control functions and contains the implementation details and formats. Each of these usually has a 3+ letters abbreviation (SGR, CSI, EL, etc.) which determines the action that will be performed after the terminal receives control sequence of this function. Let's identify these abbreviations as sequence types.

At the time of writing (v2.75) *ansi* module contains the implementations of about 25 control sequence types (that should be read as "has seperated classes and/or factory methods and is also documented). However, ECMA-48 standard mentions about 160 sequence types.

The main principle of *pytermor* development was the rule *"if I don't see it, it doesn't exist"*, which should be read as "Don't waste days and nights on specs comprehension and implementation of the features no one ever will use".

That's why the only types of sequences implemented are the ones that I personally encountered in the modern environment (and having a practical application, of course).

However, the library was designed to provide an easy way to extend the control sequences class hierarchy; what's more, this includes not only the extendability of the library itself (i.e., improvements in the context of library source code), but also the extra logic in the client code referencing the library classes. In case something important is missed – there is an Issues page on the GitHub, you are welcome to make a feature request.

## 6.6 Parser

## 6.7 Filters

### 6.7.1 Filter class hierarchy

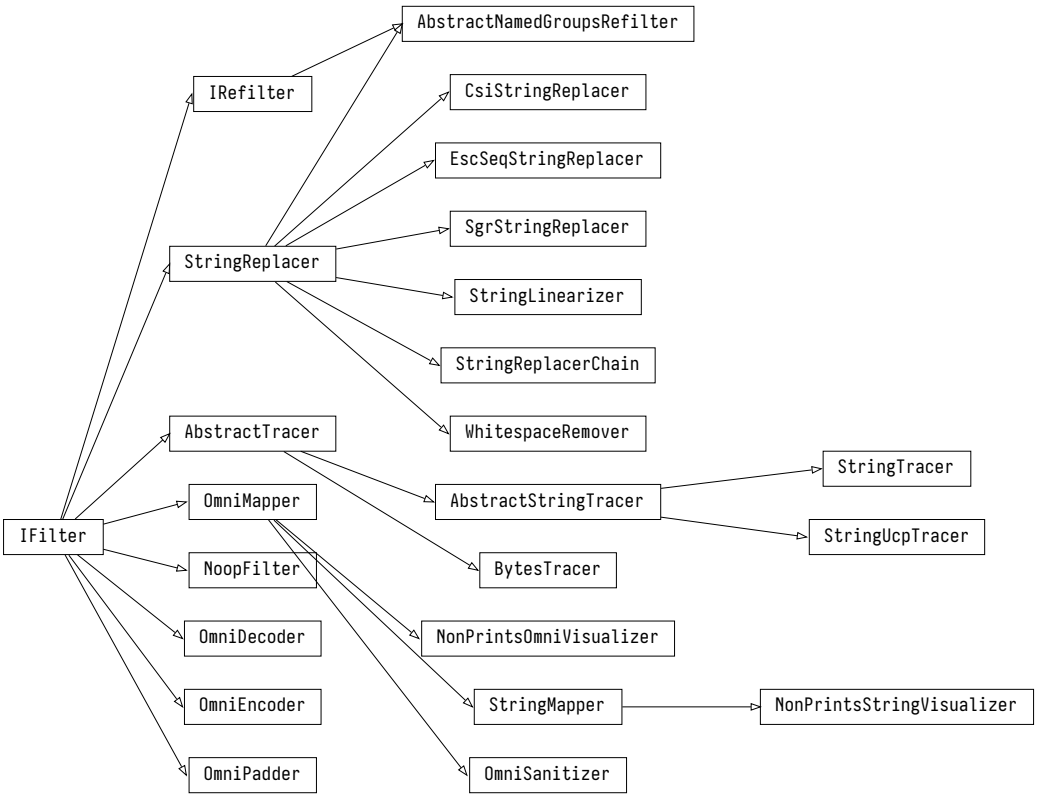


Fig. 4: *IFilter* inheritance tree

## 6.8 Color spaces and transformations

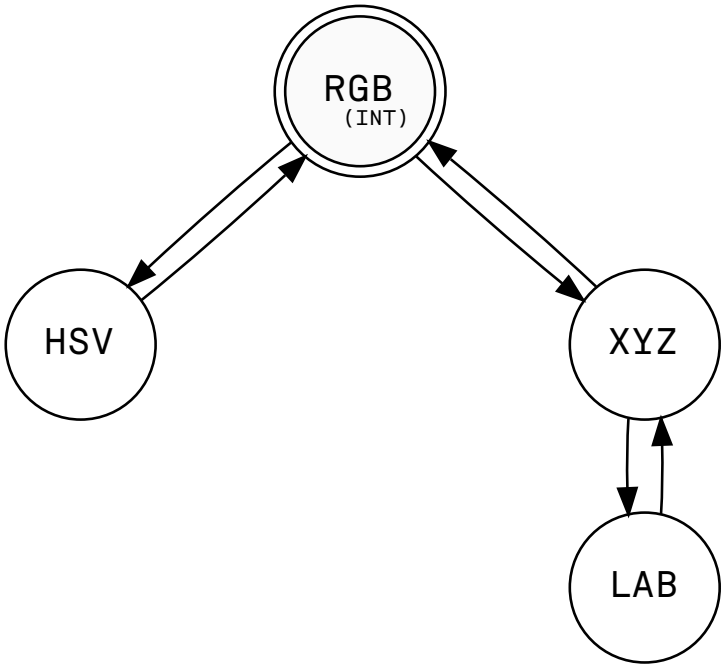


Fig. 5: Supported color spaces and transformations

# 7

# API REFERENCE

**Note:** Almost all public classes are imported into the first package level on its initialization, which makes kind of a contract on library's API. The exceptions include some abstract superclasses or metaclasses, which generally should not be used outside of the library, but still can be imported directly using a full module path.

| | |
|---|---|
| *ansi* | Classes for working with ANSI escape sequences on a lower level. |
| *color* | Abstractions for color definitions in three primary modes: 4-bit, 8-bit and 24-bit (`xterm-16`, `xterm-256` and `True Color/RGB`, respectively). |
| *common* | |
| *config* | Library fine tuning module. |
| *cval* | Color preset list: |
| *exception* | |
| *filter* | Formatters for prettier output and utility classes to avoid writing boilerplate code when dealing with escape sequences. |
| *numfmt* | utilnum |
| *renderer* | Renderers transform *Style* instances into lower-level abstractions like *SGR sequences*, tmux-compatible directives, HTML markup etc., depending on renderer type. |
| *style* | Reusable data classes that control the appearance of the output -- colors (text/background/underline) and attributes (*bold*, *underlined*, *italic*, etc.). |
| *template* | |
| *term* | A |
| *text* | "Front-end" module of the library. |

## 7.1 pytermor.ansi

Classes for working with ANSI escape sequences on a lower level. Can be used for creating a variety of sequences including:

- SGR sequences (text and background coloring, other text formatting and effects);
- CSI sequences (cursor management, selective screen clearing);
- OSC (Operating System Command) sequences (various system commands).

Provides a bunch of ready-to-use sequence makers, as well as core method *get_closing_seq()* that queries SGR pairs registry and composes "counterpart" sequence for a specified one: every attribute that the latter modifies, will be changed back by the one that's being created, while keeping the other attributes untouched. This method is used by *SgrRenderer* and is essential for nested style processing, as regular *RESET* sequence cancels all the formatting applied to the output at the moment it's getting introduced to a terminal emulator, and is near to impossible to use because of that (at least when there is a need to perform partial attribute termination, e.g. for overlapping styles rendering).

### Module Attributes

| | |
|---|---|
| *NOOP_SEQ* | Special sequence in case one *has to* provide one or another SGR, but does not want any control sequences to be actually included in the output. |
| *ESCAPE_SEQ_REGEX* | Regular expression that matches all classes of escape sequences. |

### Functions

| | |
|---|---|
| *contains_sgr*(string, *codes) | Return the first match of *SGR* sequence in `string` with specified `codes` as params, strictly inside a single sequence in specified order, or *None* if nothing was found. |
| *enclose*(opening_seq, string) | **param opening_seq** |
| *get_closing_seq*(opening_seq) | **param opening_seq** |
| `get_resetter_codes`() | |
| *parse*(string) | **param string** |
| `seq_from_dict`(groupdict) | |

### Classes

| | |
|---|---|
| *ColorTarget*(value) | An enumeration. |
| *ISequence*(classifier[, interm, final, abbr]) | Abstract ancestor of all escape sequences. |
| *IntCode*(value) | Complete or almost complete list of reliably working SGR param integer codes. |
| *SeqIndex*() | Registry of static sequences that can be utilized without implementing an extra logic. |
| *SequenceCSI*([final, interm, abbr]) | Class representing CSI-type ANSI escape sequence. |
| *SequenceFe*(classifier, *params[, interm, ...]) | C1 set sequences -- a wide range of sequences that includes *CSI*, *OSC* and more. |
| *SequenceFp*(classifier[, abbr]) | Sequence class representing private control functions. |
| *SequenceFs*(classifier[, abbr]) | Sequences referred by ECMA-48 as "independent control functions". |
| *SequenceNf*(classifier, final[, interm, abbr]) | Escape sequences mostly used for ANSI/ISO code-switching mechanisms. |
| *SequenceOSC*(*params) | OSC-type sequence. |
| *SequenceSGR*(*params) | Class representing SGR-type escape sequence with varying amount of parameters. |
| *SequenceST*() | String Terminator sequence (ST). |
| SubtypedParam(value, subtype) | |

**class** pytermor.ansi.**ISequence**(*classifier*, *interm=None*, *final=None*, *abbr='ESC*'*)

Bases: Sized

Abstract ancestor of all escape sequences.

**Parameters**

- **classifier** (*str*) – Classifier char, see *ANSI sequences review*.
- **interm** (*str*) – Intermediate chars.
- **final** (*str*) – Final char.
- **abbr** (*str*) – Abbreviation for debug purposes.

**class** pytermor.ansi.**SequenceNf**(*classifier*, *final*, *interm=None*, *abbr='nF'*)

Bases: *ISequence*

Escape sequences mostly used for ANSI/ISO code-switching mechanisms.

All **nF**-class sequences start with ESC plus ASCII byte from the range 0x20-0x2F (space, !, ", #, $, %, &, ', (, ), *, +, ,, -, ., /).

**Parameters**

- **classifier** (*str*) – Classifier char (0x20-0x2F)
- **final** (*str*) – Final char (0x30-0x7E)
- **interm** (*str*) – intermediate chars (0x20-0x2F)
- **abbr** – Abbreviation for debug purposes.

**assemble**()

Build up actual byte sequence and return as an ASCII-encoded string.

**Return type**
str

class pytermor.ansi.**SequenceFp**(*classifier*, *abbr='Fp'*)

Bases: *ISequence*

Sequence class representing private control functions.

All **Fp**-class sequences start with ESC plus ASCII byte in the range 0x30-0x3F (0-9, :, ;, <, =, >, ?).

**Parameters**

- **classifier** (*str*) – Classifier char (0x30-0x3F)
- **abbr** – Abbreviation for debug purposes.

class pytermor.ansi.**SequenceFs**(*classifier*, *abbr='Fs'*)

Bases: *ISequence*

Sequences referred by ECMA-48 as "independent control functions".

All **Fs**-class sequences start with ESC plus a byte in the range 0x60-0x7E (`, a-z, {, |, }).

**Parameters**

- **classifier** (*str*) – Classifier char (0x60-0x7E)
- **abbr** – Abbreviation for debug purposes.

class pytermor.ansi.**SequenceFe**(*classifier*, **params*, *interm=None*, *final=None*, *abbr='Fe'*)

Bases: *ISequence*

C1 set sequences – a wide range of sequences that includes *CSI*, *OSC* and more.

All **Fe**-class sequences start with ESC plus ASCII byte from 0x40 to 0x5F (@, [, \, ], _, ^ and capital letters A-Z).

**Parameters**

- **classifier** (*str*) – Classifier char (0x40-0x5F)
- **params** (*int | str*) – Parameter chars (0x30-0x3F)
- **interm** (*str*) – Intermediate chars (0x20-0x2F)
- **final** (*str*) – Final char (0x40-0x7E)
- **abbr** – Abbreviation for debug purposes.

class pytermor.ansi.**SequenceST**

Bases: *SequenceFe*

String Terminator sequence (ST). Terminates strings in other control sequences. Encoded as ESC \ (0x1B 0x5C).

class pytermor.ansi.**SequenceOSC**(**params*)

Bases: *SequenceFe*

OSC-type sequence. Starts a control string for the operating system to use. Encoded as ESC ], plus params separated by ;. The control string can contain bytes from ranges 0x08-0x0D, 0x20-0x7E and is usually terminated by *ST*.

**Parameters**

**params** (*int | str*) – Parameter chars (0x30-0x3F)

class pytermor.ansi.**SequenceCSI**(*final=None*, **params*, *interm=None*, *abbr='CSI'*)

Bases: *SequenceFe*

Class representing CSI-type ANSI escape sequence. All subtypes of this sequence start with ESC [.

Sequences of this type are used to control text formatting, change cursor position, erase screen and more.

```
>>> from pytermor import *
>>> make_clear_line().assemble()
'[2K'
```

**Parameters**

- **final** (*str*) – Final char (0x40-0x7E)
- **params** (*int*) – Parameter chars (0x30-0x3F)
- **interm** (*str*) – Intermediate chars. (0x21/0x3F)
- **abbr** (*str*) – Abbreviation for debug purposes.

**class** pytermor.ansi.**SequenceSGR**(**params*)

Bases: *SequenceCSI*

Class representing SGR-type escape sequence with varying amount of parameters. SGR sequences allow to change the color of text or/and terminal background (in 3 different color spaces) as well as set decorate text with italic style, underlining, overlining, cross-lining, making it bold or blinking etc.

```
>>> SequenceSGR(IntCode.HI_CYAN, 'underlined', 1)
<SGR[96;4;1m>
```

To encode into control sequence byte-string invoke *assemble()* method or cast the instance to *str*, which internally does the same (this actually applies to all children of *ISequence*):

```
>>> SequenceSGR('blue', 'italic').assemble()
'[34;3m'
>>> str(SequenceSGR('blue', 'italic'))
'[34;3m'
```

The latter also allows fluent usage in f-strings:

```
>>> f'{SeqIndex.RED}should be red{SeqIndex.RESET}'
'[31mshould be red[0m'
```

---

**Note:** *SequenceSGR* with zero params `ESC [m` is interpreted by terminal emulators as `ESC [0m`, which is *hard* reset sequence. The empty-string-sequence is predefined at module level as *NOOP_SEQ*.

---

---

**Note:** The module doesn't distinguish "single-instruction" sequences from several ones merged together, e.g. `Style(fg='red', bold=True)` produces only one opening SequenceSGR instance:

```
>>> SequenceSGR(IntCode.BOLD, IntCode.RED).assemble()
'[1;31m'
```

...although generally speaking it is two of them (`ESC [1m` and `ESC [31m`). However, the module can automatically match terminating sequences for any form of input SGRs and translate it to specified format.

---

It is possible to add of one SGR sequence to another, resulting in a new one with merged params:

```
>>> SequenceSGR('blue') + SequenceSGR('italic')
<SGR[34;3m>
```

**Parameters**

**params** (*str | int | SubtypedParam | SequenceSGR*) – Sequence params. Resulting param order is the same as an argument order. Each argument can be specified as:

- *str* – any of *IntCode* names, case-insensitive;
- *int* – *IntCode* instance or plain integer;
- *SubtypeParam*
- another *SequenceSGR* instance (params will be extracted).

**property params: List[int | pytermor.ansi.SubtypedParam]**

**Returns**
Sequence params as integers.

**class** pytermor.ansi.**IntCode**(*value*)

Bases: IntEnum

Complete or almost complete list of reliably working SGR param integer codes. Fully interchangeable with plain *int*. Suitable for *SequenceSGR* default constructor.

---

**Note:** *IntCode* predefined constants are omitted from documentation to avoid useless repeats and save space, as most of the time "higher-level" class *SeqIndex* will be more appropriate, and on top of that, the constant names are literally the same for *SeqIndex* and *IntCode*.

---

**classmethod resolve**(*name*)

**Parameters**
**name** (*str*) –

**Return type**
IntCode

**class** pytermor.ansi.**SeqIndex**

Registry of static sequences that can be utilized without implementing an extra logic.

**RESET = <SGR[0m]>**

Hard reset sequence.

**BOLD = <SGR[1m]>**

Bold or increased intensity.

**DIM = <SGR[2m]>**

Faint, decreased intensity.

**ITALIC = <SGR[3m]>**

Italic *(not widely supported)*.

**UNDERLINED = <SGR[4m]>**

Underline.

**CURLY_UNDERLINED = <SGR[4:3m]>**

Curly underline.

**BLINK_SLOW = <SGR[5m]>**

Set blinking to < 150 cpm.

**BLINK_FAST = <SGR[6m]>**

Set blinking to 150+ cpm *(not widely supported)*.

**INVERSED = <SGR[7m]>**

Swap foreground and background colors.

**HIDDEN = <SGR[8m]>**

Conceal characters *(not widely supported)*.

**CROSSLINED = <SGR[9m]>**

Strikethrough.

**DOUBLE_UNDERLINED = <SGR[21m]>**

Double-underline. *On several terminals disables BOLD instead.*

**FRAMED = <SGR[51m]>**

Rectangular border *(not widely supported, to say the least)*.

**OVERLINED = <SGR[53m]>**

Overline *(not widely supported)*.

**BOLD_DIM_OFF = <SGR[22m]>**

Disable BOLD and DIM attributes.

*Special aspects... It's impossible to reliably disable them on a separate basis.*

**ITALIC_OFF = <SGR[23m]>**

Disable italic.

**UNDERLINED_OFF = <SGR[24m]>**

Disable underlining.

**BLINK_OFF = <SGR[25m]>**

Disable blinking.

**INVERSED_OFF = <SGR[27m]>**

Disable inversing.

**HIDDEN_OFF = <SGR[28m]>**

Disable conecaling.

**CROSSLINED_OFF = <SGR[29m]>**

Disable strikethrough.

**FRAMED_OFF = <SGR[54m]>**

Disable border.

**OVERLINED_OFF = <SGR[55m]>**

Disable overlining.

**UNDERLINE_COLOR_OFF = <SGR[59m]>**

Reset underline color.

**BLACK = <SGR[30m]>**

Set text color to 0x000000.

**RED = <SGR[31m]>**

Set text color to 0x800000.

**GREEN = <SGR[32m]>**

Set text color to 0x008000.

**YELLOW = <SGR[33m]>**

Set text color to 0x808000.

**BLUE = <SGR[34m]>**

Set text color to 0x000080.

**MAGENTA = <SGR[35m]>**

Set text color to 0x800080.

**CYAN = <SGR[36m]>**
Set text color to 0x008080.

**WHITE = <SGR[37m]>**
Set text color to 0xc0c0c0.

**COLOR_OFF = <SGR[39m]>**
Reset foreground color.

**BG_BLACK = <SGR[40m]>**
Set background color to 0x000000.

**BG_RED = <SGR[41m]>**
Set background color to 0x800000.

**BG_GREEN = <SGR[42m]>**
Set background color to 0x008000.

**BG_YELLOW = <SGR[43m]>**
Set background color to 0x808000.

**BG_BLUE = <SGR[44m]>**
Set background color to 0x000080.

**BG_MAGENTA = <SGR[45m]>**
Set background color to 0x800080.

**BG_CYAN = <SGR[46m]>**
Set background color to 0x008080.

**BG_WHITE = <SGR[47m]>**
Set background color to 0xc0c0c0.

**BG_COLOR_OFF = <SGR[49m]>**
Reset background color.

**GRAY = <SGR[90m]>**
Set text color to 0x808080.

**HI_RED = <SGR[91m]>**
Set text color to 0xff0000.

**HI_GREEN = <SGR[92m]>**
Set text color to 0x00ff00.

**HI_YELLOW = <SGR[93m]>**
Set text color to 0xffff00.

**HI_BLUE = <SGR[94m]>**
Set text color to 0x0000ff.

**HI_MAGENTA = <SGR[95m]>**
Set text color to 0xff00ff.

**HI_CYAN = <SGR[96m]>**
Set text color to 0x00ffff.

**HI_WHITE = <SGR[97m]>**
Set text color to 0xffffff.

**BG_GRAY = <SGR[100m]>**
Set background color to 0x808080.

**BG_HI_RED = <SGR[101m]>**
Set background color to 0xff0000.

**BG_HI_GREEN = <SGR[102m]>**
Set background color to 0x00ff00.

**BG_HI_YELLOW = <SGR[103m]>**
Set background color to 0xffff00.

**BG_HI_BLUE = <SGR[104m]>**
Set background color to 0x0000ff.

**BG_HI_MAGENTA = <SGR[105m]>**
Set background color to 0xff00ff.

**BG_HI_CYAN = <SGR[106m]>**
Set background color to 0x00ffff.

**BG_HI_WHITE = <SGR[107m]>**
Set background color to 0xffffff.

class pytermor.ansi.**ColorTarget**(*value*)
Bases: Enum

An enumeration.

pytermor.ansi.**get_closing_seq**(*opening_seq*)

**Parameters**
**opening_seq** (SequenceSGR) –

**Returns**

**Return type**
SequenceSGR

pytermor.ansi.**enclose**(*opening_seq*, *string*)

**Parameters**

- **opening_seq** (SequenceSGR) –
- **string** (*str*) –

**Returns**

**Return type**
str

pytermor.ansi.**NOOP_SEQ = <SGR/NOP>**
Special sequence in case one *has to* provide one or another SGR, but does not want any control sequences to be actually included in the output.

`NOOP_SEQ.assemble()` returns empty string, `NOOP_SEQ.params` returns empty list:

```
>>> NOOP_SEQ.assemble()
''
>>> NOOP_SEQ.params
[]
```

**Important:** Casting to *bool* results in **False** for all NOOP instances in the library (*NOOP_SEQ*, NOOP_COLOR and *NOOP_STYLE*). This is intended.

Can be safely added to regular *SequenceSGR* from any side, as internally *SequenceSGR* always makes a new instance with concatenated params from both items, rather than modifies state of either of them:

```
>>> NOOP_SEQ + SequenceSGR(1)
<SGR[1m]>
>>> SequenceSGR(3) + NOOP_SEQ
<SGR[3m]>
```

pytermor.ansi.**ESCAPE_SEQ_REGEX**

Regular expression that matches all classes of escape sequences.

More specifically, it recognizes **nF**, **Fp**, **Fe** and **Fs**[1] classes. Useful for removing the sequences as well as for granular search thanks to named match groups, which include:

**escape_byte**
first byte of every sequence – ESC, or 0x1B.

**data**
remaining bytes of the sequence (without escape byte) represented as one of the following groups: `nf_class_seq`, `fp_class_seq`, `fe_class_seq` or `fs_class_seq`; each of these splits further to even more specific subgroups:

- `nf_classifier`, `nf_interm` and `nf_final` as parts of **nF**-class sequences,
- `fp_classifier` for **Fp**-class sequences,
- `st_classifier`, `osc_classifier`, `osc_param`, `csi_classifier`, `csi_interm`, `csi_param`, `csi_final`, `fe_classifier`, `fe_param`, `fe_interm` and `fe_final` for **Fe**-class generic sequences and subtypes (including *SGRs*),
- `fs_classifier` for **Fs**-class sequences.

pytermor.ansi.**contains_sgr**(*string*, **codes*)

Return the first match of *SGR* sequence in `string` with specified `codes` as params, strictly inside a single sequence in specified order, or *None* if nothing was found.

The match object has one group (or, technically, two):

- Group #0: the whole matched SGR sequence;
- Group #1: the requested params bytes only.

Example regex used for searching: `x1b[(?:|[d;]*;)(48;5)(?:|;[d;]*)m`.

```
>>> contains_sgr(make_color_256(128).assemble(), 38)
<re.Match object; span=(0, 11), match='[38;5;128m'>
>>> contains_sgr(make_color_256(84, ColorTarget.BG).assemble(), 48, 5)
<re.Match object; span=(0, 10), match='[48;5;84m'>
```

**Parameters**

- **string** (*str*) – String to search the SGR in.
- **codes** (*int*) – Integer SGR codes to find.

**Return type**
re.Match | None

pytermor.ansi.**parse**(*string*)

**Parameters**
**string** (*str*) –

[1] ECMA-35 specification

**Return type**
*Iterable*[*pytermor.ansi.ISequence* | str]

## 7.2 pytermor.color

Abstractions for color definitions in three primary modes: 4-bit, 8-bit and 24-bit (`xterm-16`, `xterm-256` and `TrueColor/RGB`, respectively). Provides a global registry for color searching by names and codes, as well as approximation algorithms, which are used for output devices with limited advanced color modes support. Renderers do that automatically and transparently for the developer, but the manual control over this process is also an option.

Supports 4 different color spaces: *RGB*, *HSV*, *XYZ* and *LAB*, and also provides methods to covert colors from any space to any other.

### Functions

| | |
|---|---|
| *approximate*(value[, color_type, max_results]) | Search for nearest to `value` colors of specified `color_type` and return the first `max_results` of them. |
| *find_closest*(value[, color_type]) | Search and return nearest to `value` instance of specified `color_type`. |
| *resolve_color*(subject[, color_type, ...]) | Suggested usage is to transform the user input in a free form in an attempt to find any matching color. |

### Classes

| | |
|---|---|
| *ApxResult*(color, distance) | Approximation result. |
| *Color16*(*args, **kwargs) | Variant of a `Color` operating within the most basic color set -- **xterm-16**. |
| *Color256*(*args, **kwargs) | Variant of a `Color` operating within relatively modern **xterm-256** indexed color table. |
| *ColorRGB*(*args, **kwargs) | Variant of a `Color` operating within RGB color space. |
| *DefaultColor*() | Special `Color` instance rendering to SGR sequence telling the terminal to reset fg or bg color; same for *TmuxRenderer*. Useful when you inherit some *Style* with fg or bg color that you don't need, but at the same time you don't actually want to set up any color whatsoever::. |
| *DynamicColor*(*args, **kwargs) | Color that returns different values depending on internal class-level state that can be altered globally for all instances of a concrete implementation. |
| *HSV*(hue, saturation, value) | Initially HSV is a transformation of RGB color space; color is stored as 3 floats representing Hue channel, Saturation channel and Value channel correspondingly. |
| `IColorValue`() | |
| *LAB*(lum, a, b) | Color value in a *uniform* color space, CIELAB, which expresses color as three values: L* for perceptual lightness and a* and b* for the four unique colors of human vision: red, green, blue and yellow. |
| *NoopColor*() | Special `Color` class always rendering into empty string. |
| *RGB*(value) | Color value stored internally as an 24-bit integer. |
| `RealColor`(value) | |
| *RenderColor*() | Abstract superclass for other `Colors`. |
| *ResolvableColor*(*args, **kwargs) | Mixin for other `Colors`. |
| *XYZ*(x, y, z) | Color in XYZ space is represented by three floats: Y is the luminance, Z is quasi-equal to blue (of CIE RGB), and X is a mix of the three CIE RGB curves chosen to be nonnegative. |

**class** pytermor.color.**RGB**(*value*)

Bases: `IColorValue`

Color value stored internally as an 24-bit integer. Base for more complex color classes.

**classmethod diff**(*c1*, *c2*)

RGB euclidean distance.

**Return type**
float

**classmethod from_channels**(*red*, *green*, *blue*)

**Parameters**

- **red** –
- **green** –

- **blue** –

**Returns**

**Return type**

**classmethod from_ratios**(*rr*, *gr*, *br*)

d :param rr: :param gr: :param br:

**Return type**
RGB

**property red: int**

Red channel value [0;255]

**property green: int**

Green channel value [0;255]

**property blue: int**

Blue channel value [0;255]

**property int: int**

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property rgb: *RGB***

Color value in RGB space (3 × 8-bit ints)

**property hsv: *HSV***

Color value in HSV space (three floats)

**property xyz: *XYZ***

Color value in XYZ space (three floats)

**property lab: *LAB***

Color value in LAB space (three floats)

**class** pytermor.color.**HSV**(*hue*, *saturation*, *value*)

Bases: IColorValue

Initially HSV is a transformation of RGB color space; color is stored as 3 floats representing Hue channel, Saturation channel and Value channel correspondingly. Supports direct (fast) transformation to RGB and indirect (=slow) to all other spaces through using more than one conversion with HSV → RGB being the first one.

**classmethod diff**(*c1*, *c2*)

HSV euclidean distance.

**Return type**
float

**property hue: float**

Hue channel value [0;360]

**property saturation: float**

Saturation channel value [0;1]

**property value: float**

Value channel value [0;1]

**property int: int**

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property rgb:** *RGB*

Color value in RGB space (3 × 8-bit ints)

**property hsv:** *HSV*

Color value in HSV space (three floats)

**property xyz:** *XYZ*

Color value in XYZ space (three floats)

**property lab:** *LAB*

Color value in LAB space (three floats)

**class** pytermor.color.**XYZ**(*x*, *y*, *z*)

Bases: IColorValue

Color in XYZ space is represented by three floats: Y is the luminance, Z is quasi-equal to blue (of CIE RGB), and X is a mix of the three CIE RGB curves chosen to be nonnegative. CIE 1931 XYZ color space was one of the first attempts to produce a color space based on measurements of human color perception. Setting Y as luminance has the useful result that for any given Y value, the XZ plane will contain all possible chromaticities at that luminance.

---

**Note:** *x* and *z* values can be above 100.

---

**classmethod diff**(*c1*, *c2*)

---

**Note:** This one is written on the analogy of other diffs, therefore it can be actually a little bit incorrect or outright wrong.

---

**Return type**
float

**property x:** float

X channel value [0;100)

**property y:** float

Luminance [0;100]

**property z:** float

Quasi-equal to blue [0;100)

**property int:** int

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property rgb:** *RGB*

Color value in RGB space (3 × 8-bit ints)

**property hsv:** *HSV*

Color value in HSV space (three floats)

**property xyz:** *XYZ*

Color value in XYZ space (three floats)

**property lab:** *LAB*

Color value in LAB space (three floats)

class pytermor.color.**LAB**(*lum*, *a*, *b*)

Bases: IColorValue

Color value in a *uniform* color space, CIELAB, which expresses color as three values: L* for perceptual lightness and a* and b* for the four unique colors of human vision: red, green, blue and yellow. CIELAB was intended as a perceptually uniform space, where a given numerical change corresponds to a similar perceived change in color. Like the CIEXYZ space it derives from, CIELAB color space is a device-independent, "standard observer" model.

**classmethod diff**(*c1*, *c2*)

CIE76 E* color difference.

**Return type**
float

**property lum: float**

Luminance [0;100]

**property a: float**

Green–magenta axis, [-100;100] in general, but can be less/more

**property b: float**

Blue–yellow axis, [-100;100] in general, but can be less/more

**property int: int**

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property rgb: *RGB***

Color value in RGB space (3 × 8-bit ints)

**property hsv: *HSV***

Color value in HSV space (three floats)

**property xyz: *XYZ***

Color value in XYZ space (three floats)

**property lab: *LAB***

Color value in LAB space (three floats)

class pytermor.color.**RenderColor**

Abstract superclass for other Colors. Provides interfaces for transforming RGB values to SGRs for different terminal modes.

**abstract to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of Color. Used by *SgrRenderer*.

**Parameters**

- **target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).
- **upper_bound** (*Optional[Type[Color]]*) – Required result Color type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**
SequenceSGR

**abstract to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

class pytermor.color.**ResolvableColor**(**args*, ***kwargs*)

Bases: Generic[_RCT]

Mixin for other Colors. Implements color search by name.

**Return type**
_RCT

**classmethod names**()

All registried colors' names of this type.

**Return type**
*Iterable*[*Tuple*[str]]

**classmethod find_by_name**(*name*)

Case-insensitive search through registry contents.

**See also:**

*resolve_color()* for the details

**Parameters**
**name** (*str*) – Name to search for.

**Return type**
*_RCT*

**classmethod find_closest**(*value*)

Search and return color instance nearest to value.

**See also:**

*color.find_closest()* for the details

**Parameters**
**value** (*pytermor.color.IColorValue | int*) – Target color/color value.

**Return type**
*_RCT*

**classmethod approximate**(*value*, *max_results=1*)

Search for the colors nearest to value and return the first max_results.

**See also:**

*color.approximate()* for the details

**Parameters**

- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **max_results** (*int*) – Result limit.

**Return type**
*List*[ApxResult[*_RCT*]]

**property name: str | None**

Color name, e.g. "navy-blue".

**property available_for_approximation: bool**

All colors should be available for approximations, but there is one exception – *Color256* instances who have a *Color16* counterpart with the same value. Details described in *Color16 and Color256 equivalents*.

**class** pytermor.color.**ApxResult**(*color*, *distance*)

Bases: Generic[_RCT]

Approximation result.

**color: _RCT**

Found Color instance.

**distance: float**

Color difference between this instance and the approximation target.

**final class** pytermor.color.**Color16**(**args*, ***kwargs*)

Bases: RealColor, *RenderColor*, *ResolvableColor*[*Color16*]

Variant of a Color operating within the most basic color set – **xterm-16**. Represents basic color-setting SGRs with primary codes 30-37, 40-47, 90-97 and 100-107 (see guide.ansi-presets.color16).

**Parameters**

- **value** (*int | IColorValue*) – Color value as 24-bit integer in RGB space, or any instance implementing color value interface (e.g. *HSV*).
- **code_fg** (*int*) – Int code for a foreground color setup, e.g. 30.
- **code_bg** (*int*) – Int code for a background color setup. e.g. 40.
- **name** (*str*) – Name of the color, e.g. "red".
- **register** (*bool*) – If *True*, add color to registry for resolving by name and approximation.
- **aliases** (*list[str]*) – Alternative color names (used in *resolve_color()*).

**property code_fg: int**

Int code for a foreground color setup, e.g. 30.

**property code_bg: int**

Int code for a background color setup. e.g. 40.

**classmethod get_by_code**(*code*)

Get a *Color16* instance with specified code. Only *foreground* (=text) colors are indexed, therefore it is not possible to look up for a *Color16* with given background color (on second thought, it *is* actually possible using *find_closest()*).

**Parameters**
**code** (*int*) – Foreground integer code to look up for (see guide.ansi-presets.color16).

**Raises**
**LookupError** – If no color with specified code is found.

**Return type**
Color16

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of Color. Used by *SgrRenderer*.

**Parameters**

- **target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

- **upper_bound** (*Optional[Type[Color]]*) – Required result `Color` type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**
SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

**classmethod approximate**(*value*, *max_results=1*)

Search for the colors nearest to `value` and return the first `max_results`.

**See also:**

*color.approximate()* for the details

**Parameters**

- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **max_results** (*int*) – Result limit.

**Return type**
*List*[ApxResult[*_RCT*]]

**property available_for_approximation: bool**

All colors should be available for approximations, but there is one exception – *Color256* instances who have a *Color16* counterpart with the same value. Details described in *Color16 and Color256 equivalents*.

**classmethod find_by_name**(*name*)

Case-insensitive search through registry contents.

**See also:**

*resolve_color()* for the details

**Parameters**
**name** (*str*) – Name to search for.

**Return type**
*_RCT*

**classmethod find_closest**(*value*)

Search and return color instance nearest to `value`.

**See also:**

*color.find_closest()* for the details

**Parameters**
**value** (*pytermor.color.IColorValue | int*) – Target color/color value.

**Return type**
*_RCT*

**format_value**(*prefix='0x'*)

Format color value as "0xRRGGBB".

**Return type**
str

**property hsv:** *HSV*

Color value in HSV space (three floats)

**property int:** int

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property lab:** *LAB*

Color value in LAB space (three floats)

**property name:** str | None

Color name, e.g. "navy-blue".

**classmethod names**()

All registried colors' names of this type.

**Return type**
*Iterable*[*Tuple*[str]]

**property rgb:** *RGB*

Color value in RGB space (3 × 8-bit ints)

**property xyz:** *XYZ*

Color value in XYZ space (three floats)

**final class** pytermor.color.**Color256**(**args*, ***kwargs*)

Bases: RealColor, *RenderColor*, *ResolvableColor*[*Color256*]

Variant of a Color operating within relatively modern **xterm-256** indexed color table. Represents SGR complex codes 38;5;* and 48;5;* (see *Color256 presets*).

**Parameters**

- **value** (*int | IColorValue*) – Color value as 24-bit integer in RGB space, or any instance implementing color value interface (e.g. *HSV*).
- **code** (*int*) – Int code for a color setup, e.g. 52.
- **name** (*str*) – Name of the color, e.g. "dark-red".
- **register** (*bool*) – If *True*, add color to registry for resolving by name.
- **aliases** (*t.List[str]*) – Alternative color names (used in *resolve_color()*).
- **color16_equiv** (Color16) – *Color16* counterpart (applies only to codes 0-15). For the details see *Color16 and Color256 equivalents*.

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of Color. Used by *SgrRenderer*.

Each Color type represents one SGR type in the context of colors. For example, if upper_bound is set to *Color16*, the resulting SGR will always be one of 16-color index table, even if the original color was of different type – it will be approximated just before the SGR assembling.

The reason for this is the necessity to provide a similar look for all users with different terminal settings/capabilities. When the library sees that user's output device supports 256 colors only, it cannot assemble True Color SGRs, because they will be ignored (if we are lucky), or displayed in a glitchy way, or mess up the output completely. The good news is that the process is automatic and in most cases the library will manage the transformations by itself. If it's not the case, the developer can correct the behaviour by overriding the renderers' output mode. See *SgrRenderer* and *OutputMode* docs.

**Parameters**

- **target** (ColorTarget) –
- **upper_bound** (*Optional[Type[Color]]*) – Required result `Color` type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made.

**Return type**
SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

**property code: int**

Int code for a color setup, e.g. 52.

**classmethod get_by_code**(*code*)

Get a *Color256* instance with specified code (=position in the index).

**Parameters**
**code** (*int*) – Color code to look up for (see *Color256 presets*).

**Raises**
**LookupError** – If no color with specified code is found.

**Return type**
Color256

**property available_for_approximation: bool**

All colors should be available for approximations, but there is one exception – *Color256* instances who have a *Color16* counterpart with the same value. Details described in *Color16 and Color256 equivalents*.

**classmethod approximate**(*value*, *max_results=1*)

Search for the colors nearest to `value` and return the first `max_results`.

**See also:**

*color.approximate()* for the details

**Parameters**
- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **max_results** (*int*) – Result limit.

**Return type**
*List*[ApxResult[*_RCT*]]

**classmethod find_by_name**(*name*)

Case-insensitive search through registry contents.

**See also:**

*resolve_color()* for the details

**Parameters**
**name** (*str*) – Name to search for.

**Return type**
*_RCT*

**classmethod find_closest**(*value*)

Search and return color instance nearest to `value`.

**See also:**

*color.find_closest()* for the details

**Parameters**
**value** (*pytermor.color.IColorValue | int*) – Target color/color value.

**Return type**
*_RCT*

**format_value**(*prefix='0x'*)

Format color value as "0xRRGGBB".

**Return type**
str

**property hsv:** *HSV*

Color value in HSV space (three floats)

**property int:** **int**

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property lab:** *LAB*

Color value in LAB space (three floats)

**property name:** **str | None**

Color name, e.g. "navy-blue".

**classmethod names**()

All registried colors' names of this type.

**Return type**
*Iterable*[*Tuple*[str]]

**property rgb:** *RGB*

Color value in RGB space (3 × 8-bit ints)

**property xyz:** *XYZ*

Color value in XYZ space (three floats)

**final class** pytermor.color.**ColorRGB**(**args*, ***kwargs*)

Bases: `RealColor`, *RenderColor*, *ResolvableColor*[*ColorRGB*]

Variant of a `Color` operating within RGB color space. Presets include `es7s named colors`, a unique collection of colors compiled from several known sources after careful selection. However, it's not limited to aforementioned color list and can be easily extended.

**Parameters**

- **value** (*int|IColorValue*) – Color value as 24-bit integer in RGB space (e.g. 0x73a9c2), or any instance implementing color value interface (e.g. *HSV*).
- **name** (*str*) – Name of the color, e.g. "moonstone-blue".
- **register** (*bool*) – If *True*, add color to registry for resolving by name.
- **aliases** (*t.List[str]*) – Alternative color names (used in *resolve_color()*).
- **variation_map** (*t.Dict[int, str]*) – Mapping {*int*: *str*}, where keys are hex values, and values are variation names.

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of `Color`. Used by *SgrRenderer*.

**Parameters**

- **target** (*ColorTarget*) – Sequence context (FG, BG, UNDERLINE).
- **upper_bound** (*Optional[Type[Color]]*) – Required result `Color` type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**
SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (*ColorTarget*) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

**property base: Optional[_RCT]**

Parent color for color variations. Empty for regular colors.

**property variations: Dict[str, _RCT]**

List of color variations. *Variation* of a color is a similar color with almost the same name, but with differing suffix. The main idea of variations is to provide a basis for fuzzy searching, which will return several results for one query; i.e., when the query matches a color with variations, the whole color family can be considered a match, which should increase searching speed.

**classmethod approximate**(*value*, *max_results=1*)

Search for the colors nearest to `value` and return the first `max_results`.

**See also:**

*color.approximate()* for the details

**Parameters**

- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **max_results** (*int*) – Result limit.

**Return type**
*List*[ApxResult[*_RCT*]]

**property available_for_approximation: bool**

All colors should be available for approximations, but there is one exception – *Color256* instances who have a *Color16* counterpart with the same value. Details described in *Color16 and Color256 equivalents*.

**classmethod find_by_name**(*name*)

Case-insensitive search through registry contents.

**See also:**

*resolve_color()* for the details

**Parameters**
**name** (*str*) – Name to search for.

**Return type**
*_RCT*

**classmethod find_closest**(*value*)

Search and return color instance nearest to `value`.

**See also:**

*color.find_closest()* for the details

**Parameters**
**value** (*pytermor.color.IColorValue | int*) – Target color/color value.

**Return type**
*_RCT*

**format_value**(*prefix='0x'*)

Format color value as "0xRRGGBB".

**Return type**
str

**property hsv: *HSV***

Color value in HSV space (three floats)

**property int: int**

Color value in RGB space (24-bit integer within [0; 0xFFFFFF] range)

**property lab: *LAB***

Color value in LAB space (three floats)

**property name: str | None**

Color name, e.g. "navy-blue".

**classmethod names**()

All registried colors' names of this type.

**Return type**
*Iterable*[*Tuple*[str]]

**property rgb: *RGB***

Color value in RGB space (3 × 8-bit ints)

**property xyz: *XYZ***

Color value in XYZ space (three floats)

**class** pytermor.color.**NoopColor**

Bases: *RenderColor*

Special `Color` class always rendering into empty string.

---

**Important:** Casting to *bool* results in **False** for all `NOOP` instances in the library (*NOOP_SEQ*, `NOOP_COLOR` and *NOOP_STYLE*). This is intended.

---

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of `Color`. Used by *SgrRenderer*.

**Parameters**

- **target** (`ColorTarget`) – Sequence context (FG, BG, UNDERLINE).
- **upper_bound** (*Optional[Type[Color]]*) – Required result `Color` type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**
SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

**class** pytermor.color.**DefaultColor**

Bases: *RenderColor*

Special Color instance rendering to SGR sequence telling the terminal to reset fg or bg color; same for *TmuxRenderer*. Useful when you inherit some *Style* with fg or bg color that you don't need, but at the same time you don't actually want to set up any color whatsoever:

```
>>> from pytermor import *
>>> DEFAULT_COLOR.to_sgr(target=ColorTarget.BG)
<SGR[49m>
```

NOOP_COLOR is treated like a placeholder for parent's attribute value and doesn't change the result:

```
>>> from pytermor import SgrRenderer, render
>>> sgr_renderer = SgrRenderer(OutputMode.XTERM_16)
>>> render("MISMATCH", Style(Styles.INCONSISTENCY, fg=NOOP_COLOR), sgr_renderer)
'[93;101mMISMATCH[39;49m'
```

While DEFAULT_COLOR is actually resetting the color to default (terminal) value:

```
>>> render("MISMATCH", Style(Styles.INCONSISTENCY, fg=DEFAULT_COLOR), sgr_
↪renderer)
'[39;101mMISMATCH[49m'
```

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of Color. Used by *SgrRenderer*.

**Parameters**

- **target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).
- **upper_bound** (*Optional[Type[Color]]*) – Required result Color type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**
SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**
**target** (ColorTarget) – Sequence context (FG, BG, UNDERLINE).

**Return type**
str

**class** pytermor.color.**DynamicColor**(**args*, ***kwargs*)

Bases: *RenderColor*, Generic[_T]

Color that returns different values depending on internal class-level state that can be altered globally for all instances of a concrete implementation. Supposed usage is to make a subclass of *DynamicColor* and define state type, which will be shared between all instances of a new class. Also concrete implementation

of *update()* method is required, which should contain logic for transforming some external parameters into the state. State can be of any type, from plain *RGB* value to complex dictionaries or custom classes.

There is also an `extractor` parameter, which is not shared between instances of same subclass, rather being an instance attribute. This parameter represents the logic of transforming one shared state into several different colors, which therefore can be used as is, or be included as a *fg*/*bg* attributes of *Style* instances.

Full usage example can be found at *Dynamic/deferred colors* docs page.

**Parameters**

**extractor** – Concrete implementation of "state" -> "color" transformation logic. Can be a callable, which will be invoked with a state variable as a first argument, or can be a string, in which case it will be used to extract the color value from the instance itself, with this string as an attribute name, or it can be *None*, in which case it implies that state variable is instance of *Color* or it descendant and it can be returned on extraction without transformation, as is.

**_DEFERRED: ClassVar[bool] = False**

Class variable responsible for enabling deferred mode. In this mode there is a possibility to delay an initialization of the state of a concrete class and to create all dependant entities regardless. When state is still uninitialized, the return color will be `NOOP_COLOR`, which automatically updates to an actual color after state creation. See *Dynamic/deferred colors* for the details.

**classmethod update**(***kwargs*)

Set new internal state for all instances of this class.

**to_sgr**(*target=ColorTarget.FG*, *upper_bound=None*)

Make an *SGR sequence* out of `Color`. Used by *SgrRenderer*.

**Parameters**

- **target** (*ColorTarget*) – Sequence context (FG, BG, UNDERLINE).
- **upper_bound** (*Optional[Type[Color]]*) – Required result `Color` type upper boundary, i.e., the maximum acceptable color class, which will be the basis for SGR being made. See *Color256.to_sgr()* for the details.

**Return type**

SequenceSGR

**to_tmux**(*target=ColorTarget.FG*)

Make a tmux markup directive, which will change the output color to this color's value (after tmux processes and prints it). Used by *TmuxRenderer*.

**Parameters**

**target** (*ColorTarget*) – Sequence context (FG, BG, UNDERLINE).

**Return type**

str

pytermor.color.**resolve_color**(*subject*, *color_type=None*, *approx_cache=True*)

Suggested usage is to transform the user input in a free form in an attempt to find any matching color. The method operates in three different modes depending on arguments: resolving by name, resolving by value and instantiating.

**Resolving by name**: If `subject` is a *str* starting with any character except #, case-insensitive search through the registry of `color_type` colors is performed. In this mode the algorithm looks for the instance which has all the words from `subject` as parts of its name (the order must be the same). Color names are stored in registries as sets of tokens, which allows to use any form of input and get the correct result regardless. The only requirement is to separate the words in any matter (see the example below), so that they could be split to tokens which will be matched with the registry keys.

If `color_type` is omitted, all the registries will be requested in this order: [*Color16*, *Color256*, *ColorRGB*]. Should any registry find a full match, the resolving is stopped and the result is returned.

```
>>> resolve_color('deep-sky-blue-7')
<Color256[x23(#005f5f deep-sky-blue-7)]>
>>> resolve_color('DEEP SKY BLUE 7')
<Color256[x23(#005f5f deep-sky-blue-7)]>
>>> resolve_color('DeepSkyBlue7')
<Color256[x23(#005f5f deep-sky-blue-7)]>
```

```
>>> resolve_color('deepskyblue7')
Traceback (most recent call last):
LookupError: Color 'deepskyblue7' was not found in any registry
```

**Resolving by value** or **instantiating**: if `subject` is specified as:

1) *int* in [0x000000; 0xffffff] range, or
2) *str* in full hexadecimal form: "#RRGGBB", or
3) *str* in short hexadecimal form: "#RGB",

and `color_type` is **present** , the result will be the best `subject` approximation to corresponding color index. Note that this value is expected to differ from the requested one (and sometimes differs a lot). If `color_type` is **missing**, no searching is performed; instead a new nameless *ColorRGB* is instantiated and returned.

---

**Note:** The instance created this way is an "unbound" color, i.e. it does not end up in a registry or an index bound to its type, thus the resolver and approximation algorithms are unaware of its existence. The rationale for this is to keep the registries clean and stateless to ensure that the same input always resolves to the same output.

---

```
>>> resolve_color("#333")
<ColorRGB[#333333]>
>>> resolve_color(0xfafef0)
<ColorRGB[#fafef0]>
```

**Parameters**

- **subject** (*str|int*) – `Color` name or hex value to search for. See *CDT*.
- **color_type** (*Optional[Type[_RCT]]*) – Target color type (*Color16*, *Color256* or *ColorRGB*).
- **approx_cache** – Use the approximation cache for **resolving by value** mode or ignore it. For the details see *find_closest* and *approximate* which are actually invoked by this method under the hood.

**Raises**

**LookupError** – If nothing was found in either of registries.

**Returns**

`Color` instance with specified name or value.

**Return type**

*_RCT*

pytermor.color.**find_closest**(*value*, *color_type=None*)

Search and return nearest to `value` instance of specified `color_type`. If `color_type` is omitted, search for the closest *Color256* element.

**Note:** Distance between two colors is calculated using CIE76 E* color difference formula in LAB color space. This method is considered to be an acceptable tradeoff between sRGB euclidean distance, which doesn't account for differences in human color perception, and CIE94/CIEDE2000, which are more complex and in general excessive for this task.

Method is useful for finding applicable color alternatives if user's terminal is incapable of operating in more advanced mode. Usually it is done by the library automatically and transparently for both the developer and the end-user.

**Important:** This method caches the results, i.e., the same search query will from then onward result in the same return value without the necessity of iterating through the color index. If that's not applicable, use similar method *approximate()*, which is unaware of caching mechanism altogether.

**Parameters**

- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **color_type** (*Optional[Type[_RCT]]*) – Target color type (*Color16*, *Color256* or *ColorRGB*).

**Returns**
Nearest to `value` color instance of specified type.

**Return type**
*_RCT*

pytermor.color.**approximate**(*value*, *color_type=None*, *max_results=1*)

Search for nearest to `value` colors of specified `color_type` and return the first `max_results` of them. If `color_type` is omitted, search for the closest *Color256* instances. This method is similar to the *find_closest()*, although they differ in some aspects:

- *approximate()* can return more than one result;
- *approximate()* returns not just a `Color` instance(s), but also a number equal to squared distance to the target color for each of them;
- *find_closest()* caches the results, while *approximate()* ignores the cache completely.

**Parameters**

- **value** (*pytermor.color.IColorValue | int*) – Target color/color value.
- **color_type** (*Optional[Type[_RCT]]*) – Target color type (*Color16*, *Color256* or *ColorRGB*).
- **max_results** (*int*) – Return no more than `max_results` items.

**Returns**
Pairs of closest `Color` instance(s) found with their distances to the target color, sorted by distance descending, i.e., element at index 0 is the closest color found, paired with its distance to the target; element with index 1 is second-closest color (if any) and corresponding distance value, etc.

**Return type**
*List*[ApxResult[*_RCT*]]

## 7.3 pytermor.common

### Module Attributes

| | |
|---|---|
| *CDT* | CDT (Color descriptor type) represents a RGB color value. |
| *FT* | FT (Format type) is a style descriptor. |
| *RT* | RT (Renderable type) includes regular *str*s as well as *IRenderable* implementations. |
| *filterf* | Shortcut for filtering out falsy values from sequences |
| *filtern* | Shortcut for filtering out Nones from sequences |

### Functions

| | |
|---|---|
| *but*(cls, inp) | Return all elements from `inp` *except* instances of `cls`. |
| *char_range*(start, stop) | Yields all the characters from range of [`c1`; `c2`], inclusive (end character `c2` is **also present**, in contrast with classic `range()`, which excludes `stop` value from the results). |
| *chunk*(items, size) | Split item list into chunks of size `size` and return these |
| *cut*(s, max_len[, align, overflow]) | **param s** |
| *filterfv*(mapping) | Shortcut for filtering out falsy values from mappings |
| *filternv*(mapping) | Shortcut for filtering out None values from mappings |
| *fit*(s, max_len[, align, overflow, fill]) | **param s** |
| *flatten*(items[, level_limit]) | Unpack a list consisting of any amount of nested lists to 1d-array, or flat list, eliminating all the nesting. |
| *flatten1*(items) | Take a list of nested lists and unpack all nested elements one level up. |
| *get_qname*(obj) | Convenient method for getting a class name for the instances as well as for the classes themselves, in case where a variable in question can be both. |
| *get_subclasses*(target) | Traverse the inheritance tree and return a flat list of all descendants of `cls` (full hierarchy). |
| `isiterable`(arg) | |
| *only*(cls, inp) | Return all elements from `inp` that *are* instances of `cls` |
| *others*(cls, inp) | Return all elements from `inp` *except* instances of `cls` and its children classes. |
| *ours*(cls, inp) | Return all elements from `inp` that *are* instances of `cls` or its children classes. |
| *pad*(n) | Convenient method to use instead of `"".ljust(n)`. |
| *padv*(n) | Convenient method to use instead of `"\n" * n`. |

### Classes

| | |
|---|---|
| *Align*(value) | Align type. |
| *ExtendedEnum*(value) | Standard Enum with a few additional methods on top. |

pytermor.common.**CDT**

CDT represents a RGB color value. Primary handler is *resolve_color()*. Valid values include:

- *str* with a color name in any form distinguishable by the color resolver; the color lists can be found at: guide.ansi-presets and guide.es7s-colors;
- *str* starting with a "#" and consisting of 6 more hexadecimal characters, case insensitive (RGB regular form), e.g. "#0b0cca";
- *str* starting with a "#" and consisting of 3 more hexadecimal characters, case insensitive (RGB short form), e.g. "#666";
- *int* in a [0; 0xffffff] range.

alias of TypeVar('CDT', int, str)

pytermor.common.**FT**

FT is a style descriptor. Used as a shortcut precursor for actual styles. Primary handler is *make_style()*.

alias of TypeVar('FT', int, str, IColorValue, Style, None)

pytermor.common.**RT**

RT includes regular *str*s as well as *IRenderable* implementations.

alias of TypeVar('RT', str, IRenderable)

**class** pytermor.common.**ExtendedEnum**(*value*)

Bases: Enum

Standard Enum with a few additional methods on top.

**classmethod list**()

Return all enum values as list.

**Example**
[1, 10]

**Return type**
*List*[_T]

**classmethod dict**()

Return mapping of all enum keys to corresponding enum values.

**Example**
{<ExampleEnum.VAL1: 1>: 1, <ExampleEnum.VAL2: 10>: 10}

**Return type**
*Dict*[str, _T]

**class** pytermor.common.**Align**(*value*)

Bases: str, *ExtendedEnum*

Align type.

pytermor.common.**pad**(*n*)

Convenient method to use instead of "".ljust(n).

**Return type**
str

pytermor.common.**padv**(*n*)

Convenient method to use instead of `"\n" * n`.

**Return type**
str

pytermor.common.**cut**(*s*, *max_len*, *align=Align.LEFT*, *overflow=''*)

**Parameters**

- **s** (*str*) –
- **max_len** (*int*) –
- **align** (pytermor.common.Align | *str*) –
- **overflow** –

**Return type**
str

pytermor.common.**fit**(*s*, *max_len*, *align=Align.LEFT*, *overflow=''*, *fill=' '*)

**Parameters**

- **s** (*str*) –
- **max_len** (*int*) –
- **align** (pytermor.common.Align | *str*) –
- **overflow** (*str*) –
- **fill** (*str*) –

**Return type**
str

pytermor.common.**get_qname**(*obj*)

Convenient method for getting a class name for the instances as well as for the classes themselves, in case where a variable in question can be both.

```
>>> get_qname("aaa")
'str'
>>> get_qname(ExtendedEnum)
'<ExtendedEnum>'
```

**Return type**
str

pytermor.common.**only**(*cls*, *inp*)

Return all elements from `inp` that *are* instances of `cls`

**Return type**
*List*[_T]

pytermor.common.**but**(*cls*, *inp*)

Return all elements from `inp` *except* instances of `cls`.

**Return type**
*List*[_T]

pytermor.common.**ours**(*cls*, *inp*)

Return all elements from `inp` that *are* instances of `cls` or its children classes.

**Return type**
*List*[_T]

pytermor.common.**others**(*cls*, *inp*)

Return all elements from `inp` *except* instances of `cls` and its children classes.

**Return type**
*List*[*_T*]

pytermor.common.**chunk**(*items*, *size*)

Split item list into chunks of size `size` and return these chunks as *tuples*.

```
>>> print(*chunk(range(10), 3), sep='''
```

Block quote ends without a blank line; unexpected unindent.

‘’’)
(0, 1, 2) (3, 4, 5) (6, 7, 8) (9,)

**param items**
Input elements.

**param size**
Chunk size.

**Return type**
*Iterator*[*Tuple*[*_T*, ...]]

pytermor.common.**get_subclasses**(*target*)

Traverse the inheritance tree and return a flat list of all descendants of `cls` (full hierarchy).

```
>>> from pytermor import SequenceCSI, Color16
>>> get_subclasses(SequenceCSI())
[<class 'pytermor.ansi.SequenceSGR'>, <class 'pytermor.ansi._NoOpSequenceSGR'>]
```

```
>>> get_subclasses(Color16)
[]
```

**Return type**
*Iterable*[*Type*[*_T*]]

pytermor.common.**flatten1**(*items*)

Take a list of nested lists and unpack all nested elements one level up.

```
>>> flatten1([1, 2, [3, 4], [[5, 6]]])
[1, 2, 3, 4, [5, 6]]
```

**Return type**
*List*[*_T*]

pytermor.common.**flatten**(*items*, *level_limit=None*)

Unpack a list consisting of any amount of nested lists to 1d-array, or flat list, eliminating all the nesting. Note that nesting can be irregular, i.e. one part of initial list can have deepest elemenets on 3rd level, while the other – on 5th level.

**Attention:** Tracking of visited objects is not performed, i.e., circular references and self-references will be unpacked again and again endlessly, until max recursion depth limit exceeds with a `RecursionError` or until the program eats up all the available RAM (in theory, that is; in practice I personally didn't enconuter that outcome even once). That was the reason of adding `level_limit` parameter (see below).

```
>>> flatten([1, 2, [3, [4, [[5]], [6, 7, [8]]]]])
[1, 2, 3, 4, 5, 6, 7, 8]
```

**Parameters**

- **items** (*Iterable[Union[_T, Iterable[_T]]]*) – N-dimensional iterable to unpack.
- **level_limit** (*Optional[int]*) – Adjust how many levels deep can unpacking proceed, e.g. if set to 1, only 2nd-level elements will be raised up to level 1, but not the deeper ones. If set to 2, the first two levels will be unpacked, while keeping the 3rd and others. 0 disables the limit. *None* is treated like a default value, which is set to 50 empirically.

  Note that altering/disabling this limit doesn't affect max recursion depth limiting mechanism, which will (sooner or later) interrupt the attempt to descent on hierarchy with a self-referencing object or several objects forming a circular reference.

**Return type**
*List*[_T]

pytermor.common.**char_range**(*start*, *stop*)

Yields all the characters from range of [c1; c2], inclusive (end character c2 is **also present**, in contrast with classic `range()`, which excludes `stop` value from the results).

```
>>> ''.join(char_range('₁', '₉'))
'₁₂₃₄₅₆₇₈₉'
```

---

**Note:** In some cases the result will seem to be incorrent, i.e. this: `pt.char_range('¹', '⁴')` yields 8124 characters total. The reason is that the algoritm works with input characters as Unicode codepoints, and '¹', '⁴' are relatively distant from each other: "¹" U+B9, "⁴" Ux2074, which leads to an unexpected results. Character ranges in regular expessetions, e.g. `[A-Z0-9]` work the same way.

---

:param start; Character to start from (inclusive) :param stop; Character to stop at (**inclusive**)

pytermor.common.**filterf = functools.partial(<class 'filter'>, None)**

Shortcut for filtering out falsy values from sequences

pytermor.common.**filtern = functools.partial(<class 'filter'>, <function <lambda>>)**

Shortcut for filtering out Nones from sequences

pytermor.common.**filterfv**(*mapping*)

Shortcut for filtering out falsy values from mappings

**Return type**
dict

pytermor.common.**filternv**(*mapping*)

Shortcut for filtering out None values from mappings

**Return type**
dict

## 7.4 pytermor.config

Library fine tuning module.

### Classes

| | |
|---|---|
| *Config*([renderer_class, force_output_mode, ...]) | Configuration variables container. |
| ConfigManager() | |

**class** pytermor.config.**Config**(*renderer_class=<factory>*, *force_output_mode=<factory>*, *default_output_mode=<factory>*, *trace_renders=<factory>*, *prefer_rgb=<factory>*)

Configuration variables container. Values can be modified in two ways:

1) create new *Config* instance from scratch and activate with `replace_config()`;
2) or preliminarily set the corresponding environment variables to intended values, and the default config instance will catch them up on initialization.

**See also:**

Environment variable list is located in *Configuration* guide section.

**Parameters**

- **renderer_class** (*str*) – Explicitly set renderer class (e.g. *TmuxRenderer*). See *Config.renderer_class*.
- **force_output_mode** (*str*) – Explicitly set output mode (e.g. `xterm_16`; any *value* from *OutputMode* enum is valid). See *Config.force_output_mode*.
- **default_output_mode** (*str*) – Output mode to use as a fallback value when renderer is unsure about user's terminal capabilities (e.g. `xterm_16`; any *value* from *OutputMode* enum is valid). Initial value is `xterm_256`. See *Config.default_output_mode*.
- **prefer_rgb** (*bool*) – By default SGR renderer uses 8-bit color mode sequences for *Color256* instances (as it should), even when the output device supports more advanced 24-bit/True Color mode. With this option set to *True* *Color256* will be rendered using True Color sequences instead, provided the terminal emulator supports them. Most of the time the results from different color modes are indistinguishable from each other, however, there *are* rare cases, when it does matter. See *Config.prefer_rgb*.
- **trace_renders** (*bool*) – Set to *True* to log hex dumps of rendered strings. Note that default handler is `logging.NullHandler` with `WARNING` level, so in order to see the traces attached handler is required. See *Config.trace_renders*.

## 7.5 pytermor.cval

Color preset list:

- 16x *Color16* (16 unique)
- 256x *Color256* (247 unique)
- 2304x *ColorRGB* (2297 unique)

## 7.6 pytermor.exception

### Exceptions

| | |
|---|---|
| *ArgCountError*(actual, *expected) | |
| *ArgTypeError*(arg_value, arg_name, *expected_type) | . |
| *ColorCodeConflictError*(code, existing_color, ...) | |
| *ColorNameConflictError*(key, existing_color, ...) | |
| *ConflictError* | |
| *LogicError* | |
| *NotInitializedError* | |
| *ParseError*(groupdict) | |
| *UserAbort* | |
| *UserCancel* | |

**exception** pytermor.exception.**LogicError**

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ParseError**(*groupdict*)

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ConflictError**

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**NotInitializedError**

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ArgTypeError**(*arg_value*, *arg_name*, **expected_type*, *suggestion=None*)

Bases: Exception

.

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ArgCountError**(*actual*, **expected*)

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**UserCancel**

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**UserAbort**

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ColorNameConflictError**(*key*, *existing_color*, *new_color*)

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

**exception** pytermor.exception.**ColorCodeConflictError**(*code*, *existing_color*, *new_color*)

Bases: Exception

**with_traceback**()

Exception.with_traceback(tb) – set self.__traceback__ to tb and return self.

## 7.7 pytermor.filter

Formatters for prettier output and utility classes to avoid writing boilerplate code when dealing with escape sequences. Also includes several Python Standard Library methods rewritten for correct work with strings containing control sequences.

### Module Attributes

| | |
|---|---|
| *SGR_SEQ_REGEX* | Regular expression that matches *SGR* sequences. |
| *CSI_SEQ_REGEX* | Regular expression that matches CSI sequences (a superset which includes *SGRs*). |
| *CONTROL_CHARS* | Set of ASCII control characters: 0x00-0x08, 0x0E-0x1F and 0x7F. |
| *WHITESPACE_CHARS* | Set of ASCII whitespace characters: 0x09-0x0D and 0x20. |
| *PRINTABLE_CHARS* | Set of ASCII "normal" characters, i.e. non-control and non-space ones: letters, digits and punctuation (0x21-0x7E). |
| *NON_ASCII_CHARS* | Set of bytes that are invalid in ASCII-7 context: 0x80-0xFF. |
| *IT* | input-type |
| *OT* | output-type |
| *PTT* | pattern type |
| *RPT* | replacer type |
| *MPT* | # map |

### Functions

| | |
|---|---|
| *apply_filters*(inp, *args) | Method for applying dynamic filter list to a target string/bytes. |
| *center_sgr*(string, width[, fillchar]) | SGR-formatting-aware implementation of `str.center`. |
| *dump*(data[, tracer_cls, extra, force_width]) | . |
| *get_max_ucs_chars_cp_length*(string) | . |
| *get_max_utf8_bytes_char_length*(string) | cc |
| *ljust_sgr*(string, width[, fillchar]) | SGR-formatting-aware implementation of `str.ljust`. |
| *rjust_sgr*(string, width[, fillchar]) | SGR-formatting-aware implementation of `str.rjust`. |

### Classes

| | |
|---|---|
| *AbstractNamedGroupsRefilter*(*args, **kwargs) | Substitute the input by applying following rules: |
| *AbstractStringTracer*(*args, **kwargs) | |
| *AbstractTracer*(*args, **kwargs) | |
| *BytesTracer*(*args, **kwargs) | str/bytes as byte hex codes, grouped by 4 |
| *CsiStringReplacer*(*args, **kwargs) | Find all *CSI* seqs (i.e., starting with `ESC [`) and replace with given string. |
| *EscSeqStringReplacer*(*args, **kwargs) | , |
| *IFilter*(*args, **kwargs) | Main idea is to provide a common interface for string filtering, that can make possible working with filters like with objects rather than with functions/lambdas. |
| *IRefilter*(*args, **kwargs) | *Refilters* are rendering filters (output is *str* with SGRs). |
| *NonPrintsOmniVisualizer*(*args, **kwargs) | Input type: *str*, *bytes*. |
| *NonPrintsStringVisualizer*(*args, **kwargs) | Input type: *str*. |
| NoopFilter(*args, **kwargs) | |
| OmniDecoder(*args, **kwargs) | |
| OmniEncoder(*args, **kwargs) | |
| *OmniMapper*(*args, **kwargs) | Input type: *str*, *bytes*. |
| *OmniPadder*(*args, **kwargs) | |
| *OmniSanitizer*(*args, **kwargs) | Input type: *str*, *bytes*. |
| *SgrStringReplacer*(*args, **kwargs) | Find all *SGR* seqs (e.g., `ESC [1;4m`) and replace with given string. |
| *StringLinearizer*(*args, **kwargs) | Filter transforms all whitespace sequences in the input string into a single space character, or into a specified string. |
| *StringMapper*(*args, **kwargs) | a |
| *StringReplacer*(*args, **kwargs) | . |
| *StringReplacerChain*(*args, **kwargs) | . |
| *StringTracer*(*args, **kwargs) | str as byte hex codes (UTF-8), grouped by characters |
| *StringUcpTracer*(*args, **kwargs) | str as Unicode codepoints |
| *TracerExtra*([label, addr_shift, hash]) | |
| *WhitespaceRemover*(*args, **kwargs) | Special case of *StringLinearizer*. |

pytermor.filter.**SGR_SEQ_REGEX**

Regular expression that matches *SGR* sequences. Group 3 can be used for sequence params extraction.

pytermor.filter.**CSI_SEQ_REGEX**

Regular expression that matches CSI sequences (a superset which includes *SGRs*).

pytermor.filter.**CONTROL_CHARS**

Set of ASCII control characters: 0x00-0x08, 0x0E-0x1F and 0x7F.

pytermor.filter.**WHITESPACE_CHARS**

Set of ASCII whitespace characters: 0x09-0x0D and 0x20.

pytermor.filter.**PRINTABLE_CHARS**

Set of ASCII "normal" characters, i.e. non-control and non-space ones: letters, digits and punctuation (0x21-0x7E).

pytermor.filter.**NON_ASCII_CHARS**

Set of bytes that are invalid in ASCII-7 context: 0x80-0xFF.

pytermor.filter.**IT**

input-type

alias of TypeVar('IT', str, bytes)

pytermor.filter.**OT**

output-type

alias of TypeVar('OT', str, bytes)

pytermor.filter.**PTT**

pattern type

alias of Union[*IT*, Pattern[*IT*]]

pytermor.filter.**RPT**

replacer type

alias of Union[*OT*, Callable[[Match[*OT*]], *OT*]]

pytermor.filter.**MPT**

# map

alias of Dict[int, *IT*]

**class** pytermor.filter.**IFilter**(**args*, ***kwargs*)

Bases: Generic[*IT*, *OT*]

Main idea is to provide a common interface for string filtering, that can make possible working with filters like with objects rather than with functions/lambdas.

**Return type**
*IFilter*

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**IRefilter**(**args*, ***kwargs*)

Bases: *IFilter*[*IT*, str]

*Refilters* are rendering filters (output is *str* with SGRs).

**Return type**
*IFilter*

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**OmniPadder**(**args*, ***kwargs*)

Bases: *IFilter*[*IT*, *IT*]

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**StringReplacer**(**args*, ***kwargs*)

Bases: *IFilter*[str, str]

.

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**StringReplacerChain**(**args*, ***kwargs*)

Bases: *StringReplacer*

.

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**EscSeqStringReplacer**(**args*, ***kwargs*)

Bases: *StringReplacer*

,

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**SgrStringReplacer**(**args*, ***kwargs*)

Bases: *StringReplacer*

Find all *SGR* seqs (e.g., `ESC [1;4m`) and replace with given string. More specific version of `CsiReplacer`.

**Parameters**
**repl** (*RPT[str]*) – Replacement, can contain regexp groups (see *apply_filters()*).

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**CsiStringReplacer**(**args*, ***kwargs*)

Bases: *StringReplacer*

Find all *CSI* seqs (i.e., starting with ESC [) and replace with given string. Less specific version of SgrReplacer, as CSI consists of SGR and many other sequence subtypes.

**Parameters**
**repl** (*RPT[str]*) – Replacement, can contain regexp groups (see *apply_filters()*).

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**StringLinearizer**(**args*, ***kwargs*)

Bases: *StringReplacer*

Filter transforms all whitespace sequences in the input string into a single space character, or into a specified string. Most obvious application is pre-formatting strings for log output in order to keep the messages one-lined.

**Parameters**
**repl** (*RPT[str]*) – Replacement character(s).

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**WhitespaceRemover**(**args*, ***kwargs*)

Bases: *StringReplacer*

Special case of *StringLinearizer*. Removes all the whitespaces from the input string.

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**AbstractNamedGroupsRefilter**(**args*, ***kwargs*)

Bases: *IRefilter*[str], *StringReplacer*

Substitute the input by applying following rules:

- Named groups which name is found in `group_st_map` keys are replaced with themselves styled as specified in a corresponding map values.
- Regular/unnamed groups are kept as is, unless there is an "" (empty string) key in `group_st_map`, in which case a style corresponding to such key is applied to all these groups.
- Groups with names not present in the map, as well as lookaheads and lookbehinds, are kept as is (unstyled).
- Non-capturing groups' contents and matched characters not belonging to any group are thrown away.
- Not matched parts of the input are kept as is.

```
>>> import pytermor as pt
>>> class SgrNamedGroupsRefilter(AbstractNamedGroupsRefilter):
...     def _render(self, v: IT, st: FT) -> str:
...         return pt.render(v, st, pt.SgrRenderer(pt.OutputMode.XTERM_16))
...
>>> SgrNamedGroupsRefilter(
...     re.compile(r'<?(<)(?P<val>.+?)(>)>?'),
...     {"val": pt.cv.GREEN},
... ).apply("text <<link>> text")
'text <[32mlink[39m> text'
```

**Parameters**
**group_st_map** (*dict[str, FT]*) –

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**OmniMapper**(**args*, ***kwargs*)

Bases: *IFilter*[*IT*, *IT*]

Input type: *str*, *bytes*. Abstract mapper. Replaces every character found in map keys to corresponding map value. Map should be a dictionary of this type: `dict[int, str|bytes]`; moreover, length of *str*/*bytes* must be strictly 1 character (ASCII codepage). If there is a necessity to map Unicode characters, *StringMapper* should be used instead.

```
>>> OmniMapper({0x20: '.'}).apply(b'abc def ghi')
b'abc.def.ghi'
```

For mass mapping it is better to subclass *OmniMapper* and override two methods – `_get_default_keys` and `_get_default_replacer`. In this case you don't have to manually compose a replacement map with every character you want to replace.

**Parameters**
**override** (*MPT*) – a dictionary with mappings: keys must be *ints*, values must be either a single-char *strs* or *bytes*.

**See**
*NonPrintsOmniVisualizer*

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

**class** pytermor.filter.**StringMapper**(**args*, ***kwargs*)

Bases: *OmniMapper*[str]

a

**Return type**
*IFilter*

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

**class** pytermor.filter.**NonPrintsOmniVisualizer**(**args*, ***kwargs*)

Bases: *OmniMapper*

Input type: *str*, *bytes*. Replace every whitespace character with `.`.

**Return type**
*IFilter*

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**NonPrintsStringVisualizer**(**args*, ***kwargs*)

Bases: *StringMapper*

Input type: *str*. Replace every whitespace character with "·", except newlines. Newlines are kept and get prepneded with same char by default, but this behaviour can be disabled with `keep_newlines` = *False*.

```
>>> NonPrintsStringVisualizer(keep_newlines=False).apply("S"+os.linesep+"K")
'SK'
```

**Parameters**
**keep_newlines** (*bool*) – When *True*, transform newline characters into "\n", or into just "" otherwise.

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**
- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**OmniSanitizer**(**args*, ***kwargs*)

Bases: *OmniMapper*

Input type: *str*, *bytes*. Replace every control character and every non-ASCII character (0x80-0xFF) with ".", or with specified char. Note that the replacement should be a single ASCII character, because `Omni-` filters are designed to work with *str* inputs and *bytes* inputs on equal terms.

**Parameters**
**repl** (*IT*) – Value to replace control/non-ascii characters with. Should be strictly 1 character long.

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**
- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**AbstractTracer**(**args*, ***kwargs*)

Bases: *IFilter*[*IT*, `str`]

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**BytesTracer**(**args*, ***kwargs*)

Bases: *AbstractTracer*[bytes]

str/bytes as byte hex codes, grouped by 4

Listing 1: Example output

```
0x00 | 35 30 20 35  34 20 35 35  20 C2 B0 43  20 20 33 39  20 2B 30 20
0x14 | 20 20 33 39  6D 73 20 31  20 52 55 20  20 E2 88 86  20 35 68 20
0x28 | 31 38 6D 20  20 20 EE 8C  8D 20 E2 80  8E 20 2B 32  30 C2 B0 43
0x3C | 20 20 54 68  20 30 31 20  4A 75 6E 20  20 31 36 20  32 38 20 20
0x50 | E2 96 95 E2  9C 94 E2 96  8F 46 55 4C  4C 20
```

**Return type**
*IFilter*

**get_max_chars_per_line**(*inp*, *addr_shift*)

For the details see *Tracers math*.

**Parameters**

- **inp** (*bytes*) –
- **addr_shift** (*int*) –

**Return type**
int

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**AbstractStringTracer**(**args*, ***kwargs*)

Bases: *AbstractTracer*[str]

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string

- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

**class** pytermor.filter.**StringTracer**(**args*, ***kwargs*)

Bases: *AbstractStringTracer*

str as byte hex codes (UTF-8), grouped by characters

Listing 2: Example output

```
  0 |      35      30      20 35 34 20 35      35      20    c2b0 43 20 |50␣54␣55␣°C␣
 12 |      20      33      39 20 2b 30 20      20      20      33 39 6d |␣39␣+0␣␣␣39m
 24 |      73      20      31 20 52 55 20      20 e28886      20 35 68 |s␣1␣RU␣␣␣5h
 36 |      20      31      38 6d 20 20 20 ee8c8d      20 e2808e 20 2b |␣18m␣␣␣␣␣+
 48 |      32      30    c2b0 43 20 20 54      68      20      30 31 20 |20°C␣␣Th␣01␣
 60 |      4a      75      6e 20 20 31 36      20      32      38 20 20 |Jun␣␣16␣28␣␣
 72 | e29695 e29c94 e2968f 46 55 4c 4c      20                       |✓FULL␣
```

**Return type**
*IFilter*

**get_max_chars_per_line**(*inp*, *addr_shift*)

For the details see *Tracers math*.

**Parameters**

- **inp** (*str*) –
- **addr_shift** (*int*) –

**Return type**
int

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

**class** pytermor.filter.**StringUcpTracer**(**args*, ***kwargs*)

Bases: *AbstractStringTracer*

str as Unicode codepoints

Listing 3: Example output

```
  0 |U+   20   34   36 20 34 36 20 34   36   20 B0 43 20 20 33   39 20 2B␣
↪|␣46␣46␣46␣°C␣␣39␣+
 18 |U+   30   20   20 20 35 20 6D 73   20   31 20 52 55 20 20 2206 20 37␣
```

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```
↪|0␣␣␣5␣ms␣1␣RU␣␣␣7
  36 |U+   68   20   32 33 6D 20 20 20 FA93 200E 20 2B 31 33 B0   43 20 20␣
↪|h␣23m␣␣␣␣+13°C␣␣
  54 |U+   46   72   20 30 32 20 4A 75   6E   20 20 30 32 3A 34   38 20 20␣
↪|Fr␣02␣Jun␣␣02:48␣␣
  72 |U+ 2595 2714 258F 46 55 4C 4C 20                              ␣
↪|✓FULL␣
```

**Return type**
*IFilter*

**get_max_chars_per_line**(*inp*, *addr_shift*)

For the details see *Tracers math*.

**Parameters**
**inp** –

**Return type**
int

**apply**(*inp*, *extra=None*)

Apply the filter to input *str* or *bytes*.

**Parameters**

- **inp** (*IT*) – input string
- **extra** (*Optional[Any]*) – additional options

**Returns**
transformed string; the type can match the input type, as well as be different – that depends on filter type.

**Return type**
*OT*

class pytermor.filter.**TracerExtra**(*label: 'str' = ''*, *addr_shift: 'int' = 0*, *hash: 'bool' = False*)

pytermor.filter.**dump**(*data*, *tracer_cls=None*, *extra=None*, *force_width=None*)

.

**Return type**
str

pytermor.filter.**get_max_ucs_chars_cp_length**(*string*)

.

**Return type**
int

pytermor.filter.**get_max_utf8_bytes_char_length**(*string*)

cc

**Return type**
int

pytermor.filter.**ljust_sgr**(*string*, *width*, *fillchar=' '*)

SGR-formatting-aware implementation of `str.ljust`.

Return a left-justified string of length `width`. Padding is done using the specified fill character (default is a space).

**Return type**
str

pytermor.filter.**center_sgr**(*string*, *width*, *fillchar=' '*)

SGR-formatting-aware implementation of `str.center`.

Return a centered string of length `width`. Padding is done using the specified fill character (default is a space).

**Return type**
str

pytermor.filter.**rjust_sgr**(*string*, *width*, *fillchar=' '*)

SGR-formatting-aware implementation of `str.rjust`.

Return a right-justified string of length `width`. Padding is done using the specified fill character (default is a space).

**Return type**
str

pytermor.filter.**apply_filters**(*inp*, **args*)

Method for applying dynamic filter list to a target string/bytes.

Example (will replace all ESC control characters to `E` and thus make SGR params visible):

```
>>> from pytermor import SeqIndex
>>> test_str = f'{SeqIndex.RED}test{SeqIndex.COLOR_OFF}'
>>> apply_filters(test_str, SgrStringReplacer('E\2\3\4'))
'E[31mtestE[39m'

>>> apply_filters('[31mtest[39m', OmniSanitizer)
'.[31mtest.[39m'
```

Note that type of `inp` argument must be same as filter parameterized input type (*IT*), i.e. *StringReplacer* is `IFilter[str, str]` type, so you can apply it only to *str*-type inputs.

**Parameters**

- **inp** (*IT*) – String/bytes to filter.
- **args** (*Union[IFilter, Type[IFilter]]*) – Instance(s) implementing *IFilter* or their type(s).

**Return type**
*OT*

## 7.8 pytermor.numfmt

utilnum

### Module Attributes

| | |
|---|---|
| *PREFIXES_SI_DEC* | Prefix preset used by *format_si()* and *format_bytes_human()*. |

### Functions

| | |
|---|---|
| *format_auto_float*(val, req_len[, allow_exp_form]) | Dynamically adjust decimal digit amount and format to fill up the output string with as many significant digits as possible, and keep the output length strictly equal to `req_len` at the same time. |
| *format_bytes_human*(val[, auto_color]) | Invoke special case of fixed-length SI formatter optimized for processing byte-based values. |
| *format_si*(val[, unit, auto_color]) | Invoke fixed-length decimal SI formatter; format `value` as a unitless value with SI-prefixes; a unit can be provided as an argument of *format()* method. |
| *format_si_binary*(val[, unit, auto_color]) | Invoke fixed-length binary SI formatter which formats `value` as binary size ("KiB", "MiB") with base 1024. |
| *format_thousand_sep*(val[, separator]) | Returns input `val` with integer part split into groups of three digits, joined then with `separator` string. |
| *format_time*(val_sec[, auto_color]) | Invoke dynamic-length general-purpose time formatter, which supports a wide range of output units, including seconds, minutes, hours, days, weeks, months, years, milliseconds, microseconds, nanoseconds etc. |
| *format_time_delta*(val_sec[, max_len, auto_color]) | Format time interval using the most suitable format with one or two time units, depending on `max_len` argument. |
| *format_time_delta_longest*(val_sec[, auto_color]) | Wrapper around *format_time_delta()* with pre-set longest formatter. |
| *format_time_delta_shortest*(val_sec[, auto_color]) | Wrapper around *format_time_delta()* with pre-set shortest formatter. |
| *format_time_ms*(value_ms[, auto_color]) | Invoke a variation of `formatter_time` specifically configured to format small time intervals. |
| *format_time_ns*(value_ns[, auto_color]) | Wrapper for *format_time_ms()* expecting input value as nanoseconds. |
| *highlight*(string) | |

### Classes

| | |
|---|---|
| *BaseUnit*(oom[, unit, prefix, _integer]) | |

| | |
|---|---|
| *DualBaseUnit*(name[, in_next, ...]) | TU |
| *DualFormatter*([fallback, units, auto_color, ...]) | Formatter designed for time intervals. |
| *DualFormatterRegistry*() | Simple DualFormatter registry for storing formatters and selecting the suitable one by max output length. |
| *DynamicFormatter*([fallback, units, ...]) | A simplified version of static formatter for cases, when length of the result string doesn't matter too much (e.g., for log output), and you don't have intention to customize the output (too much). |
| *Highlighter*([dim_units]) | S |
| NumFormatter(auto_color, highlighter) | |
| *StaticFormatter*([fallback, max_value_len, ...]) | Format value using settings passed to constructor. |
| SupportsFallback() | |

pytermor.numfmt.**PREFIXES_SI_DEC = ['q', 'r', 'y', 'z', 'a', 'f', 'p', 'n', 'µ', 'm', None, 'k', 'M', 'G', 'T', 'P', 'E', 'Z', 'Y', 'R', 'Q']**

Prefix preset used by *format_si()* and *format_bytes_human()*. Covers values from $10^{-30}$ to $10^{32}$. Note lower-cased 'k' prefix.

**class** pytermor.numfmt.**Highlighter**(*dim_units=True*)

S

**colorize**(*string*)

parse and highlight

**Parameters**
**string** (*str*) –

**Returns**

**Return type**
Text

**apply**(*intp*, *frac*, *sep*, *pfx*, *unit*)

highlight already parsed

**Parameters**

- **intp** (*str*) –
- **frac** (*str*) –
- **sep** (*str*) –
- **pfx** (*str*) –
- **unit** (*str*) –

**Returns**

**Return type**
*List*[Fragment]

class pytermor.numfmt.**StaticFormatter**(*fallback=None*, ***, *max_value_len=None*, *auto_color=None*, *allow_negative=None*, *allow_fractional=None*, *discrete_input=None*, *unit=None*, *unit_separator=None*, *mcoef=None*, *pad=None*, *legacy_rounding=None*, *prefixes=None*, *prefix_refpoint_shift=None*, *value_mapping=None*, *highlighter=None*)

Bases: `NumFormatter`

Format `value` using settings passed to constructor. The purpose of this class is to fit into specified string length as much significant digits as it's theoretically possible by using multipliers and unit prefixes. Designed for metric systems with bases 1000 or 1024.

The key property of this formatter is maximum length – the output will not excess specified amount of characters no matter what (that's what is "static" for).

You can create your own formatters if you need fine tuning of the output and customization. If that's not the case, there are facade methods *format_si()*, *format_si_binary()* and *format_bytes_human()*, which will invoke predefined formatters and doesn't require setting up.

**Parameters**

- **fallback** (StaticFormatter) – For any (constructing) instance attribute without a value (=*None*): look up for this attribute in `fallback` instance, and if the value is specified, take it and save as yours own; if the attribute is undefined in `fallback` as well, use the default class value for this attribute instead.
- **max_value_len** (*int*) – [default: 4] Target string length. Must be at least **3**, because it's a minimum requirement for formatting values from 0 to 999. Next number to 999 is 1000, which will be formatted as "1k".

  Setting `allow_negative` to *True* increases lower bound to **4** because the values now can be less than 0, and minus sign also occupies one char in the output.

  Setting `mcoef` to anything other than 1000.0 also increases the minimum by 1, to **5**. The reason is that non-decimal coefficients like 1024 require additional char to render as switching to the next prefix happens later: "999 b", "1000 b", "1001 b", ..."1023 b", "1 Kb".
- **auto_color** (*bool*) – [default: *False*] Enable automatic colorizing of the result. Color depends on order of magnitude of the value, and always the same, e.g.: blue color for numbers in $[1000; 10^6)$ and $[10^{-3}; 1)$ ranges (prefixes nearest to 1, kilo- and milli-); cyan for values in $[10^6; 10^9)$ and $[10^{-6}; 10^{-3})$ ranges (next ones, mega-/micro-), etc. The values from $[1; 999]$ are colored in neutral gray. See *Highlighter*.
- **allow_negative** (*bool*) – [default: *True*] Allow negative numbers handling, or (if set to *False*) ignore the sign and round all of them to 0.0. This option effectively increases lower limit of `max_value_len` by 1 (when enabled).
- **allow_fractional** (*bool*) – [default: *True*] Allows the usage of fractional values in the output. If set to *False*, the results will be rounded. Does not affect lower limit of `max_value_len`.
- **discrete_input** (*bool*) – [default: *False*] If set to *True*, truncate the fractional part off the input and do not use floating-point format for *base output*, i.e., without prefix and multiplying coefficient. Useful when the values are originally discrete (e.g., bytes). Note that the same effect could be achieved by setting `allow_fractional` to *False*, except that it will influence prefixed output as well ("1.08 kB" -> "1kB").
- **unit** (*str*) – [default: empty *str*] Unit to apply prefix to (e.g., "m", 'B"). Can be empty.
- **unit_separator** (*str*) – [default: a space] String to place in between the value and the (prefixed) unit. Can be empty.
- **mcoef** (*float*) – [default: 1000.0] Multiplying coefficient applied to the value:

$$V_{out} = V_{in} * b^{(-m/3)},$$

where: $V_{in}$ is an input value, $V_{out}$ is a numeric part of the output, $b$ is `mcoef` (base), and $m$ is the order of magnitude corresponding to a selected unit prefix. For example, in case of default (decimal) formatter and input value equal to 17345989 the selected prefix will be "M" with the order of magnitude = 6:

$$V_{out} = 17345989 * 1000^{(-6/3)} = 17345989 * 10^{-6} = 17.346.$$

- **pad** (*bool* | Align) – [default: *False*] @TODO
- **legacy_rounding** (*bool*) – [default: *False*] @TODO
- **prefixes** (*list[str|None]*) – [default: *PREFIXES_SI_DEC*] Prefix list from min power to max. Reference point (with zero-power multiplier, or 1.0) is determined by searching for *None* in the list provided, therefore it's a requirement for the argument to have at least one *None* value. Prefix list for a formatter without fractional values support could look like this:

```
[None, "k", "M", "G", "T"]
```

  Prefix step is fixed to $log_{10}1000 = 3$, as specified for metric prefixes.
- **prefix_refpoint_shift** (*int*) – [default: 0] Should be set to a non-zero number if input represents already prefixed value; e.g. to correctly format a variable, which stores the frequency in MHz, set prefix shift to 2; the formatter then will render 2333 as "2.33 GHz" instead of incorrect "2.33 kHz".
- **value_mapping** (*t.Dict[float, RT] | t.Callable[[float], RT]*) – @TODO
- **highlighter** (*t.Type[Highlighter] | Highlighter*) – ...

**get_max_len**(*unit=None*)

**Parameters**
**unit** (*Optional[str]*) – Unit override. Set to *None* to use formatter default.

**Returns**
Maximum length of the result. Note that constructor argument is `max_value_len`, which is a different parameter.

**Return type**
int

**format**(*val*, *unit=None*, *auto_color=None*)

**Parameters**

- **val** (*float*) – Input value.
- **unit** (*Optional[str]*) – Unit override. Set to *None* to use formatter default.
- **auto_color** (*Optional[bool]*) – Color mode, *bool* to enable/disable auto-colorizing, *None* to use formatter default value.

**Returns**
Formatted value, *Text* if colorizing is on, *str* otherwise.

**Return type**
*RT*

**class** pytermor.numfmt.**DynamicFormatter**(*fallback=None*, *units=None*, *, *auto_color=None*, *allow_fractional=None*, *unit_separator=None*, *oom_shift=None*, *highlighter=None*)

Bases: `NumFormatter`

A simplified version of static formatter for cases, when length of the result string doesn't matter too much (e.g., for log output), and you don't have intention to customize the output (too much).

**Note:** Mp mp not note

**format**(*val*, *auto_color=False*, *oom_shift=None*)

,,, :param val: :param oom_shift: :param auto_color: :return:

**Return type**
*RT*

class pytermor.numfmt.**BaseUnit**(*oom: 'float'*, *unit: 'str' = ''*, *prefix: 'str' = ''*, *_integer: 'bool' = None*)

class pytermor.numfmt.**DualFormatter**(*fallback=None*, *units=None*, ***, *auto_color=None*, *allow_negative=None*, *allow_fractional=None*, *unit_separator=None*, *pad=None*, *plural_suffix=None*, *overflow_msg=None*, *highlighter=None*)

Bases: NumFormatter

Formatter designed for time intervals. Key feature of this formatter is ability to combine two units and display them simultaneously, e.g. return "3h 48min" instead of "228 mins" or "3 hours", etc.

It is possible to create custom formatters if fine tuning of the output and customization is necessary; otherwise use a facade method *format_time_delta()*, which selects appropriate formatter by specified max length from a preset list.

Example output:

```
"10 secs", "5 mins", "4h 15min", "5d 22h"
```

**Parameters**

- **fallback** (DualFormatter) –
- **units** (*t.List[DualBaseUnit]*) –
- **auto_color** (*bool*) – If *True*, the result will be colorized depending on unit type.
- **allow_negative** (*bool*) –
- **allow_fractional** (*bool*) –
- **unit_separator** (*str*) –
- **pad** (*bool | Align*) – Set to *True* to pad the value with spaces on the left side and ensure it's length is equal to *max_len*, or to *False* to allow shorter result strings.
- **plural_suffix** (*str*) –
- **overflow_msg** (*str*) –
- **highlighter** (*t.Type[Highlighter]*) –

**property max_len: int**

This property cannot be set manually, it is computed on initialization automatically.

**Returns**
Maximum possible output string length.

**format**(*val_sec*, *auto_color=None*)

Pretty-print difference between two moments in time. If input value is too big for the current formatter to handle, return "OVERFLOW" string (or a part of it, depending on max_len).

**Parameters**

- **val_sec** (*float*) – Input value in seconds.
- **auto_color** (*Optional[bool]*) – Color mode, *bool* to enable/disable colorizing, *None* to use formatter default value.

**Returns**
Formatted time delta, *Text* if colorizing is on, *str* otherwise.

**Return type**
*RT*

**format_base**(*val_sec*, *auto_color=None*)

Pretty-print difference between two moments in time. If input value is too big for the current formatter to handle, return *None*.

**Parameters**

- **val_sec** (*float*) – Input value in seconds.
- **auto_color** (*Optional[bool]*) – Color mode, *bool* to enable/disable colorizing, *None* to use formatter default value.

**Returns**
Formatted value as *Text* if colorizing is on; as *str* otherwise. Returns *None* on overflow.

**Return type**
*Optional*[*RT*]

**class** pytermor.numfmt.**DualBaseUnit**(*name*, *in_next=None*, *overflow_after=None*, *custom_short=None*, *collapsible_after=None*)

TU

---

**Important:** `in_next` and `overflow_after` are mutually exclusive, and either of them is required.

---

**Parameters**

- **name** (*str*) – A unit name to display.
- **in_next** (*int*) – The base – how many current units the next (single) unit contains, e.g., for an hour in context of days:

```
CustomBaseUnit("hour", 24)
```

- **overflow_after** (*int*) – Value upper limit.
- **custom_short** (*str*) – Use specified short form instead of first letter of `name` when operating in double-value mode.
- **collapsible_after** (*int*) – Min threshold for double output to become a regular one.

**class** pytermor.numfmt.**DualFormatterRegistry**

Simple DualFormatter registry for storing formatters and selecting the suitable one by max output length.

**register**(**formatters*)

…

**find_matching**(*max_len*)

…

**Return type**
*pytermor.numfmt.DualFormatter* | None

**get_by_max_len**(*max_len*)

...

**Return type**
*pytermor.numfmt.DualFormatter* | None

**get_shortest**()

...

**Return type**
*pytermor.numfmt.DualFormatter* | None

**get_longest**()

...

**Return type**
*pytermor.numfmt.DualFormatter* | None

pytermor.numfmt.**format_thousand_sep**(*val*, *separator=' '*)

Returns input `val` with integer part split into groups of three digits, joined then with `separator` string.

```
>>> format_thousand_sep(260341)
'260 341'
>>> format_thousand_sep(-9123123123.55, ',')
'-9,123,123,123.55'
```

**Max output len**
$(L + max(0, floor(M/3)))$,

where $L$ is `val` length, and $M$ is order of magnitude of `val`

**Parameters**

- **val** (*int | float*) – value to format
- **separator** (*str*) – character(s) to use as thousand separators

**Return type**
str

pytermor.numfmt.**format_auto_float**(*val*, *req_len*, *allow_exp_form=True*)

Dynamically adjust decimal digit amount and format to fill up the output string with as many significant digits as possible, and keep the output length strictly equal to `req_len` at the same time.

For values impossible to fit into a string of required length and when rounding doesn't help (e.g. 12 500 000 and 5 chars) algorithm switches to scientific notation, and the result looks like '1.2e7'. If this feature is explicitly disabled with `allow_exp_form` = *False*, then:

1) if absolute value is less than 1, zeros will be returned ('0.0000');
2) if value is a big number (like $10^9$), `ValueError` will be raised instead.

```
>>> format_auto_float(0.012345678, 5)
'0.012'
>>> format_auto_float(0.123456789, 5)
'0.123'
>>> format_auto_float(1.234567891, 5)
'1.235'
>>> format_auto_float(12.34567891, 5)
'12.35'
>>> format_auto_float(123.4567891, 5)
'123.5'
>>> format_auto_float(1234.567891, 5)
```

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```
' 1235'
>>> format_auto_float(12345.67891, 5)
'12346'
```

**Max output len**
*adjustable*

**Parameters**

- **val** (*float*) – Value to format.
- **req_len** (*int*) – Required output string length.
- **allow_exp_form** (*bool*) – Allow scientific notation usage when that's the only way of fitting the value into a string of required length.

**Raises**
**ValueError** – When value is too long and `allow_exp_form` is *False*.

**Return type**
str

pytermor.numfmt.**format_si**(*val*, *unit=None*, *auto_color=None*)

Invoke fixed-length decimal SI formatter; format `value` as a unitless value with SI-prefixes; a unit can be provided as an argument of *format()* method. Suitable for formatting any SI unit with values from $10^{-30}$ to $10^{32}$.

Total maximum length is `max_value_len + 2`, which is **6** by default (4 from value + 1 from separator and + 1 from prefix). If the unit is defined and is a non-empty string, the maximum output length increases by length of that unit.

Listing 4: Extending the formatter

```
my_formatter = StaticFormatter(formatter_si)
```

```
>>> format_si(1010, 'm²')
'1.01 km²'
>>> format_si(0.223, 'g')
'223 mg'
>>> format_si(1213531546, 'W')  # great scott
'1.21 GW'
>>> format_si(1.22e28, 'eV')  # the Planck energy
'12.2 ReV'
```

**Max output len**
6

**Parameters**

- **val** (*float*) – Input value (unitless).
- **unit** (*Optional[str]*) – A unit override [default unit is an empty string].
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Returns**
Formatted value, *Text* if colorizing is on, *str* otherwise.

**Return type**
*RT*

pytermor.numfmt.**format_si_binary**(*val*, *unit=None*, *auto_color=False*)

Invoke fixed-length binary SI formatter which formats `value` as binary size ("KiB", "MiB") with base 1024. Unit can be customized. Covers values from 0 to $10^{32}$.

While being similar to `formatter_si`, this formatter differs in one aspect. Given a variable with default value = 995, formatting it results in "995 B". After increasing it by 20 it equals to 1015, which is still not enough to become a kilobyte – so returned value will be "1015 B". Only after one more increase (at 1024 and more) the value will morph into "1.00 KiB" form.

That's why the initial `max_value_len` should be at least 5 – because it is a minimum requirement for formatting values from 1023 to -1023. However, The negative values for this formatter are disabled by default and rendered as 0, which decreases the `max_value_len` minimum value back to 4.

Total maximum length of the result is `max_value_len + 4` = **8** (base + 1 from separator + 1 from unit + 2 from prefix, assuming all of them have default values defined in `formatter_si_binary`).

Listing 5: Extending the formatter

```
my_formatter = StaticFormatter(formatter_si_binary)
```

```
>>> format_si_binary(1010)  # 1010 b < 1 kb
'1010 B'
>>> format_si_binary(1080)
'1.05 KiB'
>>> format_si_binary(45200)
'44.1 KiB'
>>> format_si_binary(1.258 * pow(10, 6), 'b')
'1.20 Mib'
```

**Max output len**
8

**Parameters**

- **val** (*float*) – Input value in bytes.
- **unit** (*Optional[str]*) – A unit override [default unit is "B"].
- **auto_color** (*bool*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Returns**
Formatted value, *Text* if colorizing is on, *str* otherwise.

**Return type**
*RT*

pytermor.numfmt.**format_bytes_human**(*val*, *auto_color=False*)

Invoke special case of fixed-length SI formatter optimized for processing byte-based values. Inspired by default stats formatting used in htop. Comprises traits of both preset SI formatters, the key ones being:

- expecting integer inputs;
- prohibiting negative inputs;
- operating in decimal mode with the base of 1000 (not 1024);
- the absence of units and value-unit separators in the output, while prefixes are still present;
- (if colors allowed) utilizing *Highlighter* with a bit customized setup, as detailed below.

Total maximum length is `max_value_len + 1`, which is **5** by default (4 from value + 1 from prefix).

---

**Highlighting options**

Default highlighter for this formatter does not render units (as well as prefixes) dimmed. The main reason for that is the absence of actual unit in the output of this formatter, while prefixes are still there; this allows to format the fractional output this way: [1].57[k], where brackets [] indicate brighter colors.

This format is acceptable because only essential info gets highlighted; however, in case of other formatters with actual units in the output this approach leads to complex and mixed-up formatting; furthermore, it doesn't matter if the highlighting affects the prefix part only or both prefix and unit parts – in either case it's just too much formatting on a unit of surface: [1].53 [Ki]B (looks patchworky).

---

Table 1: Default formatters comparison

| Value | `SI(unit='B')` | `SI_BINARY` | `BYTES_HUMAN` |
|---|---|---|---|
| 1568 | '1.57 kB' | '1.53 KiB' | '1.57k' |
| 218371331 | '218 MB' | '208 MiB' | '218M' |
| 0.25 | '250 mB'[1] | '0 B' | '0' |
| -1218371331232 | '-1.2 TB' | '0 B' | '0' |

Listing 6: Extending the formatter

```
my_formatter = StaticFormatter(formatter_bytes_human, unit_separator=" ")
```

```
>>> format_bytes_human(990)
'990'
>>> format_bytes_human(1010)
'1.01k'
>>> format_bytes_human(45200)
'45.2k'
>>> format_bytes_human(1.258 * pow(10, 6))
'1.26M'
```

**Max output len**
5

**Parameters**

- **val** (*int*) – Input value in bytes.
- **auto_color** (*bool*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Returns**
Formatted value, *Text* if colorizing is on, *str* otherwise.

**Return type**
*RT*

pytermor.numfmt.**format_time**(*val_sec*, *auto_color=None*)

Invoke dynamic-length general-purpose time formatter, which supports a wide range of output units, including seconds, minutes, hours, days, weeks, months, years, milliseconds, microseconds, nanoseconds etc.

Listing 7: Extending the formatter

```
my_formatter = DynamicFormatter(formatter_time, unit_separator=" ")
```

```
>>> format_time(12)
'12.0 s'
>>> format_time(65536)
```

(continues on next page)

[1] 250 millibytes is not something you would see every day

(continued from previous page)

```
'18 h'
>>> format_time(0.00324)
'3.2 ms'
```

**Max output len**
*varying*

**Parameters**

- **val_sec** (*float*) – Input value in seconds.
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Return type**
*RT*

pytermor.numfmt.**format_time_ms**(*value_ms*, *auto_color=None*)

Invoke a variation of `formatter_time` specifically configured to format small time intervals.

Listing 8: Extending the formatter

```
my_formatter = DynamicFormatter(formatter_time_ms, unit_separator=" ")
```

```
>>> format_time_ms(1)
'1ms'
>>> format_time_ms(344)
'344ms'
>>> format_time_ms(0.967)
'967µs'
```

**Parameters**

- **value_ms** (*float*) – Input value in milliseconds.
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Returns**

**Return type**
*RT*

pytermor.numfmt.**format_time_ns**(*value_ns*, *auto_color=None*)

Wrapper for *format_time_ms()* expecting input value as nanoseconds.

```
>>> format_time_ns(1003000)
'1ms'
>>> format_time_ns(3232332224)
'3s'
>>> format_time_ns(9932248284343.32)
'2h'
```

**Parameters**

- **value_ns** (*float*) – Input value in nanoseconds.
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Returns**

**Return type**
*RT*

pytermor.numfmt.**format_time_delta**(*val_sec*, *max_len=None*, *auto_color=None*)

Format time interval using the most suitable format with one or two time units, depending on `max_len` argument. Key feature of this formatter is an ability to combine two units and display them simultaneously, e.g. return "3h 48min" instead of "228 mins" or "3 hours", and on top of that – fixed-length output.

There are predefined formatters with output lengths of **3, 4, 5, 6** and **10** characters. Therefore, you can pass in any value from 3 inclusive and it's guarenteed that result's length will be less or equal to required length. If *max_len* is omitted, longest registred formatter will be used.

---

**Note:** Negative values are supported by formatters 5 and 10 only.

---

```
>>> format_time_delta(10, 3)
'10s'
>>> format_time_delta(10, 6)
'10.0s'
>>> format_time_delta(15350, 4)
'4 h'
>>> format_time_delta(15350)
'4h 15min'
```

**Max output len**
3, 4, 5, 6, 10

**Parameters**

- **val_sec** (*float*) – Input value in seconds.
- **max_len** (*Optional[int]*) – Maximum output string length (total).
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Return type**
*RT*

pytermor.numfmt.**format_time_delta_shortest**(*val_sec*, *auto_color=None*)

Wrapper around *format_time_delta()* with pre-set shortest formatter.

**Max output len**
3

**Parameters**

- **val_sec** (*float*) – Input value in seconds.
- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Return type**
*RT*

pytermor.numfmt.**format_time_delta_longest**(*val_sec*, *auto_color=None*)

Wrapper around *format_time_delta()* with pre-set longest formatter.

**Max output len**
10

**Parameters**

- **val_sec** (*float*) – Input value in seconds.

- **auto_color** (*Optional[bool]*) – Color mode override, *bool* to enable/disable colorizing depending on unit type, *None* to use formatters' setting value [*False* by default].

**Return type**
*RT*

pytermor.numfmt.**highlight**(*string*)

**Todo:** @TODO

**Max output len**
*same as input*

**Parameters**
**string** (*str*) – input text

**Return type**
*RT*

## 7.9 pytermor.renderer

Renderers transform *Style* instances into lower-level abstractions like *SGR sequences*, tmux-compatible directives, HTML markup etc., depending on renderer type. Default global renderer type is *SgrRenderer*.

### Functions

| | |
|---|---|
| *force_ansi_rendering*() | Shortcut for forcing all control sequences to be present in the output of a global renderer. |
| *force_no_ansi_rendering*() | Shortcut for disabling all output formatting of a global renderer. |

### Classes

| | |
|---|---|
| *HtmlRenderer*() | Translate *Styles* attributes into a rudimentary HTML markup. |
| *IRenderer*(*[, allow_cache, allow_format]) | Renderer interface. |
| *NoOpRenderer*() | Special renderer type that does nothing with the input string and just returns it as is (i.e. |
| *OutputMode*(value) | Determines what types of SGR sequences are allowed to use in the output. |
| *RendererManager*() | Class for global rendering mode setup. |
| *SgrDebugger*([output_mode]) | Subclass of regular *SgrRenderer* with two differences -- instead of rendering the proper ANSI escape sequences it renders them with ESC character replaced by "", and encloses the whole sequence into '()' for visual separation. |
| *SgrRenderer*([output_mode, io]) | Default renderer invoked by *Text.render()*. |
| *TmuxRenderer*() | Translates *Styles* attributes into tmux-compatible markup. |

**class** pytermor.renderer.**RendererManager**

Class for global rendering mode setup. For the details and recommendations see *Renderer setup*.

**classmethod set_default**(*renderer=None*)

Select a global renderer. See also: *Default renderers priority*.

**Parameters**

**renderer** (*Optional[Union[IRenderer, Type[IRenderer]]]*) – Default renderer to use globally. Calling this method without arguments will result in library default renderer *SgrRenderer* being set as default.

All the methods with the `renderer` argument (e.g., *text.render()*) will use the global default one if said argument is omitted or set to *None*.

You can specify either the renderer class, in which case manager will instantiate it with the default parameters, or provide already instantiated and set up renderer, which will be registered as global.

**classmethod get_default**()

Get global renderer instance (*SgrRenderer*, or the one provided earlier with *set_default()*).

**Return type**

IRenderer

**class** pytermor.renderer.**IRenderer**(*, *allow_cache=None*, *allow_format=None*)

Renderer interface.

**property is_caching_allowed: bool**

**Returns**

*True* if caching of renderer's results makes any sense and *False* otherwise.

**property is_format_allowed: bool**

**Returns**

*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**abstract render**(*string*, *fmt=None*)

Apply colors and attributes described in `fmt` argument to `string` and return the result. Output format depends on renderer's class, which defines the implementation.

---

**Important:** Renderer's method *IRenderer.render()* can work only with primitive *str* instances. *IRenderable* instances like *Fragment* or *Text* should be rendered using module-level function *render()* or their own instance method *IRenderable.render()*.

---

**Parameters**

- **string** (*str*) – String to format.
- **fmt** (*Optional[FT]*) – Style or color to apply. If `fmt` is a `IColor` instance, it is assumed to be a foreground color. See *FT*.

**Returns**

String with formatting applied, or without it, depending on renderer settings.

**Return type**

str

**clone**(**args*, ***kwargs*)

Make a copy of the renderer with the same setup.

**Return type**

*_T*

class pytermor.renderer.**OutputMode**(*value*)

Bases: *ExtendedEnum*

Determines what types of SGR sequences are allowed to use in the output.

**NO_ANSI = 'no_ansi'**

The renderer discards all color and format information completely.

**XTERM_16 = 'xterm_16'**

16-colors mode. Enforces the renderer to approximate all color types to *Color16* and render them as basic mode selection SGR sequences (`ESC [31m`, `ESC [42m` etc). See `Color.approximate()` for approximation algorithm details.

**XTERM_256 = 'xterm_256'**

256-colors mode. Allows the renderer to use either *Color16* or *Color256* (but RGB will be approximated to 256-color pallette).

**TRUE_COLOR = 'true_color'**

RGB color mode. Does not apply restrictions to color rendering.

**AUTO = 'auto'**

Lets the renderer select the most suitable mode by itself. See *Output mode auto-selection* for the details.

class pytermor.renderer.**SgrRenderer**(*output_mode=OutputMode.AUTO*, *io=<_io.TextIOWrapper name='<stdout>' mode='w' encoding='utf-8'>*)

Bases: *IRenderer*

Default renderer invoked by *Text.render()*. Transforms *Color* instances defined in `fmt` into ANSI control sequence bytes and merges them with input string. Type of resulting *SequenceSGR* depends on type of *Color* instances in `fmt` argument and current output mode of the renderer.

1. *ColorRGB* can be rendered as True Color sequence, 256-color sequence or 16-color sequence depending on specified *OutputMode* and *Config.prefer_rgb*.
2. *Color256* can be rendered as 256-color sequence or 16-color sequence.
3. *Color16* will be rendered as 16-color sequence.
4. Nothing of the above will happen and all formatting will be discarded completely if output device is not a terminal emulator or if the developer explicitly set up the renderer to do so (*OutputMode.NO_ANSI*).

Renderer approximates RGB colors to closest **indexed** colors if terminal doesn't support RGB output. In case terminal doesn't support even 256 colors, it falls back to 16-color palette and picks closest samples again the same way. See *OutputMode* documentation for exact mappings.

```
>>> SgrRenderer(OutputMode.XTERM_256).render('text', Styles.WARNING_LABEL)
'[1;33mtext[22;39m'
>>> SgrRenderer(OutputMode.NO_ANSI).render('text', Styles.WARNING_LABEL)
'text'
```

Detailed *OutputMode.AUTO* algorithm is described in *Output mode auto-selection*.

**Cache allowed**
*True*

**Format allowed**
*False* if `output_mode` is *OutputMode.NO_ANSI*, *True* otherwise.

**Parameters**

- **output_mode** (*str* | *OutputMode*) – can be set up explicitly, or kept at the default value *OutputMode.AUTO*; in the latter case the renderer will select the appropriate mode by itself (see *Output mode auto-selection*).
- **io** (*t.IO*) – specified in order to check if output device is a tty or not and can be omitted when output mode is set up explicitly.

**render**(*string*, *fmt=None*)

Apply colors and attributes described in `fmt` argument to `string` and return the result. Output format depends on renderer's class, which defines the implementation.

---

**Important:** Renderer's method *IRenderer.render()* can work only with primitive *str* instances. *IRenderable* instances like *Fragment* or *Text* should be rendered using module-level function *render()* or their own instance method *IRenderable.render()*.

---

**Parameters**

- **string** (*str*) – String to format.
- **fmt** (*Optional[FT]*) – Style or color to apply. If `fmt` is a `IColor` instance, it is assumed to be a foreground color. See *FT*.

**Returns**
String with formatting applied, or without it, depending on renderer settings.

**Return type**
str

**clone**()

Make a copy of the renderer with the same setup.

**Return type**
SgrRenderer

**property is_caching_allowed: bool**

**Returns**
*True* if caching of renderer's results makes any sense and *False* otherwise.

**property is_format_allowed: bool**

**Returns**
*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**class** pytermor.renderer.**TmuxRenderer**

Bases: *IRenderer*

Translates *Styles* attributes into tmux-compatible markup.[1]

```
>>> TmuxRenderer().render('text',  Style(fg='blue', bold=True))
'#[fg=blue bold]text#[fg=default nobold]'
```

**Cache allowed**
*True*

**Format allowed**
*True*, because tmux markup can be used without regard to the type of output device and its capabilities – all the dirty work will be done by the multiplexer himself.

**render**(*string*, *fmt=None*)

Apply colors and attributes described in `fmt` argument to `string` and return the result. Output format depends on renderer's class, which defines the implementation.

[1] tmux is a commonly used terminal multiplexer.

**Important:** Renderer's method *IRenderer.render()* can work only with primitive *str* instances. *IRenderable* instances like *Fragment* or *Text* should be rendered using module-level function *render()* or their own instance method *IRenderable.render()*.

**Parameters**

- **string** (*str*) – String to format.
- **fmt** (*Optional[FT]*) – Style or color to apply. If `fmt` is a `IColor` instance, it is assumed to be a foreground color. See *FT*.

**Returns**
String with formatting applied, or without it, depending on renderer settings.

**Return type**
str

**clone**(**args*, ***kwargs*)

Make a copy of the renderer with the same setup.

**Return type**
*_T*

**property is_caching_allowed: bool**

**Returns**
*True* if caching of renderer's results makes any sense and *False* otherwise.

**property is_format_allowed: bool**

**Returns**
*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**class** pytermor.renderer.**NoOpRenderer**

Bases: *IRenderer*

Special renderer type that does nothing with the input string and just returns it as is (i.e. raw text without any *Styles* applied. Often used as a default argument value (along with similar "NoOps" like *NOOP_STYLE*, `NOOP_COLOR` etc.)

```
>>> NoOpRenderer().render('text', Style(fg='green', bold=True))
'text'
```

**Cache allowed**
*False*

**Format allowed**
*False*, nothing to apply → nothing to allow.

**render**(*string*, *fmt=None*)

Return the `string` argument untouched, don't mind the `fmt`.

**Parameters**

- **string** (*str*) – String to format ignore.
- **fmt** (*Optional[FT]*) – Style or color to appl discard.

**Return type**
str

**clone**(**args*, ***kwargs*)

Make a copy of the renderer with the same setup.

**Return type**
*_T*

**property is_caching_allowed: bool**

**Returns**
*True* if caching of renderer's results makes any sense and *False* otherwise.

**property is_format_allowed: bool**

**Returns**
*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**class** pytermor.renderer.**HtmlRenderer**

Bases: *IRenderer*

Translate *Styles* attributes into a rudimentary HTML markup. All the formatting is inlined into `style` attribute of the  elements. Can be optimized by extracting the common styles as CSS classes and referencing them by DOM elements instead.

```
>>> HtmlRenderer().render('text', Style(fg='red', bold=True))
'<span style="color: #800000; font-weight: 700">text</span>'
```

**Cache allowed**
*True*

**Format allowed**
*True*, because the capabilities of the terminal have nothing to do with HTML markup meant for web-browsers.

**render**(*string*, *fmt=None*)

Apply colors and attributes described in `fmt` argument to `string` and return the result. Output format depends on renderer's class, which defines the implementation.

---

**Important:** Renderer's method *IRenderer.render()* can work only with primitive *str* instances. *IRenderable* instances like *Fragment* or *Text* should be rendered using module-level function *render()* or their own instance method *IRenderable.render()*.

---

**Parameters**

- **string** (*str*) – String to format.
- **fmt** (*Optional[FT]*) – Style or color to apply. If `fmt` is a `IColor` instance, it is assumed to be a foreground color. See *FT*.

**Returns**
String with formatting applied, or without it, depending on renderer settings.

**Return type**
str

**clone**(**args*, ***kwargs*)

Make a copy of the renderer with the same setup.

**Return type**
*_T*

**property is_caching_allowed: bool**

**Returns**
*True* if caching of renderer's results makes any sense and *False* otherwise.

**property is_format_allowed: bool**

**Returns**
*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**class** pytermor.renderer.**SgrDebugger**(*output_mode=OutputMode.AUTO*)

Bases: *SgrRenderer*

Subclass of regular *SgrRenderer* with two differences – instead of rendering the proper ANSI escape sequences it renders them with ESC character replaced by "", and encloses the whole sequence into '()' for visual separation.

Can be used for debugging of assembled sequences, because such a transformation reliably converts a control sequence into a harmless piece of bytes completely ignored by the terminals.

```
>>> SgrDebugger(OutputMode.XTERM_16).render('text', Style(fg='red', bold=True))
'([1;31m)text([22;39m)'
```

**Cache allowed**
*True*

**Format allowed**
adjustable

**property is_format_allowed: bool**

**Returns**
*True* if renderer is set up to produce formatted output and will do it on invocation, and *False* otherwise.

**render**(*string*, *fmt=None*)

Apply colors and attributes described in `fmt` argument to `string` and return the result. Output format depends on renderer's class, which defines the implementation.

---

**Important:** Renderer's method *IRenderer.render()* can work only with primitive *str* instances. *IRenderable* instances like *Fragment* or *Text* should be rendered using module-level function *render()* or their own instance method *IRenderable.render()*.

---

**Parameters**

- **string** (*str*) – String to format.
- **fmt** (*Optional[FT]*) – Style or color to apply. If `fmt` is a `IColor` instance, it is assumed to be a foreground color. See *FT*.

**Returns**
String with formatting applied, or without it, depending on renderer settings.

**Return type**
str

**clone**()

Make a copy of the renderer with the same setup.

**Return type**
SgrDebugger

**property is_caching_allowed: bool**

**Returns**
*True* if caching of renderer's results makes any sense and *False* otherwise.

**set_format_always**()

Force all control sequences to be present in the output.

**set_format_auto**()

Reset the force formatting flag and let the renderer decide by itself (see *SgrRenderer* docs for the details).

**set_format_never**()

Force disabling of all output formatting.

pytermor.renderer.**force_ansi_rendering**()

Shortcut for forcing all control sequences to be present in the output of a global renderer.

Note that it applies only to the renderer that is set up as default at the moment of calling this method, i.e., all previously created instances, as well as the ones that will be created afterwards, are unaffected.

pytermor.renderer.**force_no_ansi_rendering**()

Shortcut for disabling all output formatting of a global renderer.

## 7.10 pytermor.style

Reusable data classes that control the appearance of the output – colors (text/background/underline) and attributes (*bold*, *underlined*, *italic*, etc.). Instances can inherit attributes from each other, which allows to avoid meaningless definition repetitions; multiple inheritance is also supported.

### Module Attributes

| | |
|---|---|
| *NOOP_STYLE* | Special style passing the text through without any modifications. |

### Functions

| |
|---|
| is_ft(arg) |

| | |
|---|---|
| *make_style*([fmt]) | General *Style* constructor. |
| *merge_styles*([origin, fallbacks, overwrites]) | Bulk style merging method. |

### Classes

| |
|---|
| *FrozenStyle*(*args, **kwargs) |

| | |
|---|---|
| *MergeMode*(value) | An enumeration. |
| *Style*([fallback, fg, bg, frozen, bold, dim, ...]) | Create new text render descriptior. |
| *Styles*() | Some ready-to-use styles which also can be used as examples. |

**class** pytermor.style.**MergeMode**(*value*)

Bases: `str`, `Enum`

An enumeration.

**class** pytermor.style.**Style**(*fallback=None*, *fg=None*, *bg=None*, *frozen=False*, ***, *bold=None*, *dim=None*, *italic=None*, *underlined=None*, *overlined=None*, *crosslined=None*, *double_underlined=None*, *curly_underlined=None*, *underline_color=None*, *inversed=None*, *blink=None*, *framed=None*, *class_name=None*)

Create new text render description.

Both `fg` and `bg` can be specified as existing `Color` instance as well as plain *str* or *int* (for the details see *resolve_color()*).

```
>>> Style(fg='green', bold=True)
<Style[green +BOLD]>
>>> Style(bg=0x0000ff)
<Style[|#0000ff]>
>>> Style(fg='DeepSkyBlue1', bg='gray3')
<Style[x39|x232]>
```

Attribute merging from `fallback` works this way:

- If constructor argument is *not* empty (*True*, *False*, `Color` etc.), keep it as attribute value.
- If constructor argument is empty (*None*, `NOOP_COLOR`), take the value from `fallback`'s corresponding attribute.

See *merge_fallback()* and *merge_overwrite()* methods and take the differences into account. The method used in the constructor is the first one.

---

**Important:** Both empty (i.e., *None*) attributes of type `Color` after initialization will be replaced with special constant `NOOP_COLOR`, which behaves like there was no color defined, and at the same time makes it safer to work with nullable color-type variables. Merge methods are aware of this and trear `NOOP_COLOR` as *None*.

---

---

**Important:** *None* and `NOOP_COLOR` are always treated as placeholders for fallback values, i.e., they can't be used as *resetters* – that's what `DEFAULT_COLOR` is for.

---

**Parameters**

- **fallback** (`Style`) – Copy empty attributes from speicifed fallback style. See *merge_fallback()*.
- **fg** (*CDT* | `RenderColor`) – Foreground (=text) color.
- **bg** (*CDT* | `RenderColor`) – Background color.
- **frozen** (*bool*) – Set to *True* to make an immutable instance.
- **bold** (*bool*) – Bold or increased intensity.
- **dim** (*bool*) – Faint, decreased intensity.
- **italic** (*bool*) – Italic.
- **underlined** (*bool*) – Underline.
- **overlined** (*bool*) – Overline.
- **crosslined** (*bool*) – Strikethrough.
- **double_underlined** (*bool*) – Double underline.
- **curly_underlined** (*bool*) – Curly underline.

- **underline_color** (*CDT | RenderColor*) – Underline color, if applicable.
- **inversed** (*bool*) – Swap foreground and background colors.
- **blink** (*bool*) – Blinking effect.
- **framed** (*bool*) – Enclosed in a rectangle border.
- **class_name** (*str*) – Custom class name for the element.

**property fg:** *RenderColor*

Foreground (i.e., text) color. Can be set as *CDT* or `Color`, stored always as `Color`.

**property bg:** *RenderColor*

Background color. Can be set as *CDT* or `Color`, stored always as `Color`.

**property underline_color:** *RenderColor*

Underline color. Can be set as *CDT* or `Color`, stored always as `Color`.

**bold: bool**

Bold or increased intensity (depending on terminal settings).

**dim: bool**

Faint, decreased intensity.

---

**Terminal-based rendering**

Terminals apply this effect to foreground (=text) color, but when it's used together with *inversed*, they usually make the background darker instead.

Also note that usually it affects indexed colors only and has no effect on RGB-based ones (True Color mode).

---

**italic: bool**

Italic (some terminals may display it as inversed instead).

**underlined: bool**

Underline.

**overlined: bool**

Overline.

**crosslined: bool**

Strikethrough.

**double_underlined: bool**

Double underline.

**curly_underlined: bool**

Curly underline.

**inversed: bool**

Swap foreground and background colors. When inversed effect is active, changing the background color will actually change the text color, and vice versa.

**blink: bool**

Blinking effect. Supported by a limited set of *renderers*.

**framed: bool**

Add a rectangular border around the text; the border color is equal to the text color. Supported by a limited set of *renderers* and (even more) limited amount of terminal emulators.

**class_name: str**

Arbitary string used by some *renderers*, e.g. by `HtmlRenderer`, which will include the value of this property to an output element class list. This property is not inheritable.

**clone**(*frozen=False*)

Make a copy of the instance. Note that a copy is mutable by default even if an original was frozen.

**Parameters**
**frozen** – Set to *True* to make an immutable instance.

**Return type**
Style

**autopick_fg**()

Pick `fg_color` depending on `bg_color`. Set `fg_color` to either 3% gray (almost black) if background is bright, or to 80% gray (bright gray) if it is dark. If background is None, do nothing.

---

**Todo:** check if there is a better algorithm, because current thinks text on #000080 should be black

---

Modifies the instance in-place and returns it as well (for chained calls).

**Return type**
Style

**flip**()

Swap foreground color and background color. Modifies the instance in-place and returns it as well (for chained calls).

**Return type**
Style

**merge**(*mode*, *other*)

Method that allows specifying merging mode as an argument. Initially designed for template substitutions done by `TemplateEngine`. Invokes either of these (depending on `mode` value):

- *merge_fallback()*
- *merge_overwrite()*
- *merge_replace()*

**Parameters**

- **mode** (MergeMode) – Merge mode to use.
- **other** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_fallback**(*fallback*)

Merge current style with specified `fallback` *style*, following the rules:

1. `self` attribute value is in priority, i.e. when both `self` and `fallback` attributes are defined, keep `self` value.
2. If `self` attribute is *None*, take the value from `fallback`'s corresponding attribute, and vice versa.
3. If both attribute values are *None*, keep the *None*.

All attributes corresponding to constructor arguments except `fallback` are subject to merging. `NOOP_COLOR` is treated like *None* (default for *fg* and *bg*).

Modifies the instance in-place and returns it as well (for chained calls).

Listing 9: Merging different values in fallback mode

```
         FALLBACK   BASE(SELF)   RESULT
         +-------+   +------+   +------+
ATTR-1   | False --Ø | True ===>| True |  BASE val is in priority
ATTR-2   | True -----| None |-->| True |  no BASE val, taking FALLBACK val
ATTR-3   | None  |   | True ===>| True |  BASE val is in priority
ATTR-4   | None  |   | None |   | None |  no vals, keeping unset
         +-------+   +------+   +------+
```

**See also:**

*merge_styles* for the examples.

**Parameters**
**fallback** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_overwrite**(*overwrite*)

Merge current style with specified `overwrite` *style*, following the rules:

1. `overwrite` attribute value is in priority, i.e. when both `self` and `overwrite` attributes are defined, replace `self` value with `overwrite` one (in contrast to *merge_fallback()*, which works the opposite way).
2. If `self` attribute is *None*, take the value from `overwrite`'s corresponding attribute, and vice versa.
3. If both attribute values are *None*, keep the *None*.

All attributes corresponding to constructor arguments except `fallback` are subject to merging. `NOOP_COLOR` is treated like *None* (default for *fg* and *bg*).

Modifies the instance in-place and returns it as well (for chained calls).

Listing 10: Merging different values in overwrite mode

```
        BASE(SELF)  OVERWRITE    RESULT
         +------+   +-------+   +-------+
ATTR-1   | True ==Ø | False --->| False |  OVERWRITE val is in priority
ATTR-2   | None |   | True ---->| True  |  OVERWRITE val is in priority
ATTR-3   | True ====| None  |==>| True  |  no OVERWRITE val, keeping BASE val
ATTR-4   | None |   | None  |   | None  |  no vals, keeping unset
         +------+   +-------+   +-------+
```

**See also:**

*merge_styles* for the examples.

**Parameters**
**overwrite** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_replace**(*replacement*)

Not an actual "merge": discard all the attributes of the current instance and replace them with the values from `replacement`. Generally speaking, it makes sense only in `TemplateEngine` context, as style management using the template tags is quite limited, while there are far more elegant ways to do the same from the regular python code.

Modifies the instance in-place and returns it as well (for chained calls).

Listing 11: Merging different values in replace mode

```
        BASE(SELF)   REPLACE     RESULT
         +------+   +-------+  +-------+
ATTR-1   | False =Ø | True --->| True  |  REPLACE val is in priority
ATTR-2   | True ==Ø | False -->| False |  REPLACE val is in priority
ATTR-3   | None |   | False -->| False |  REPLACE val is in priority
ATTR-4   | True ==Ø | None --->| None  |   ... even when it is unset
         +------+   +-------+  +-------+
```

**Parameters**
**replacement** (Style) – Style to merge the attributes with.

**Return type**
Style

class pytermor.style.**FrozenStyle**(**args*, ***kwargs*)

Bases: *Style*

**autopick_fg**()

Pick fg_color depending on bg_color. Set fg_color to either 3% gray (almost black) if background is bright, or to 80% gray (bright gray) if it is dark. If background is None, do nothing.

**Todo:** check if there is a better algorithm, because current thinks text on #000080 should be black

Modifies the instance in-place and returns it as well (for chained calls).

**Return type**
Style

**property bg:** *RenderColor*

Background color. Can be set as *CDT* or Color, stored always as Color.

**clone**(*frozen=False*)

Make a copy of the instance. Note that a copy is mutable by default even if an original was frozen.

**Parameters**
**frozen** – Set to *True* to make an immutable instance.

**Return type**
Style

**property fg:** *RenderColor*

Foreground (i.e., text) color. Can be set as *CDT* or Color, stored always as Color.

**flip**()

Swap foreground color and background color. Modifies the instance in-place and returns it as well (for chained calls).

**Return type**
Style

**merge**(*mode*, *other*)

Method that allows specifying merging mode as an argument. Initially designed for template substitutions done by TemplateEngine. Invokes either of these (depending on mode value):

- *merge_fallback()*
- *merge_overwrite()*

- *merge_replace()*

**Parameters**

- **mode** (MergeMode) – Merge mode to use.
- **other** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_fallback**(*fallback*)

Merge current style with specified `fallback` *style*, following the rules:

1. `self` attribute value is in priority, i.e. when both `self` and `fallback` attributes are defined, keep `self` value.
2. If `self` attribute is *None*, take the value from `fallback`'s corresponding attribute, and vice versa.
3. If both attribute values are *None*, keep the *None*.

All attributes corresponding to constructor arguments except `fallback` are subject to merging. `NOOP_COLOR` is treated like *None* (default for *fg* and *bg*).

Modifies the instance in-place and returns it as well (for chained calls).

Listing 12: Merging different values in fallback mode

```
          FALLBACK   BASE(SELF)   RESULT
          +-------+   +------+   +------+
ATTR-1    | False --Ø | True ===>| True |  BASE val is in priority
ATTR-2    | True -----| None |-->| True |  no BASE val, taking FALLBACK val
ATTR-3    | None  |   | True ===>| True |  BASE val is in priority
ATTR-4    | None  |   | None |   | None |  no vals, keeping unset
          +-------+   +------+   +------+
```

**See also:**

*merge_styles* for the examples.

**Parameters**
**fallback** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_overwrite**(*overwrite*)

Merge current style with specified `overwrite` *style*, following the rules:

1. `overwrite` attribute value is in priority, i.e. when both `self` and `overwrite` attributes are defined, replace `self` value with `overwrite` one (in contrast to *merge_fallback()*, which works the opposite way).
2. If `self` attribute is *None*, take the value from `overwrite`'s corresponding attribute, and vice versa.
3. If both attribute values are *None*, keep the *None*.

All attributes corresponding to constructor arguments except `fallback` are subject to merging. `NOOP_COLOR` is treated like *None* (default for *fg* and *bg*).

Modifies the instance in-place and returns it as well (for chained calls).

Listing 13: Merging different values in overwrite mode

```
        BASE(SELF)  OVERWRITE    RESULT
         +------+   +-------+   +-------+
ATTR-1   | True ==Ø | False --->| False |  OVERWRITE val is in priority
ATTR-2   | None |   | True ---->| True  |  OVERWRITE val is in priority
ATTR-3   | True ====| None  |==>| True  |  no OVERWRITE val, keeping BASE val
ATTR-4   | None |   | None  |   | None  |  no vals, keeping unset
         +------+   +-------+   +-------+
```

**See also:**

*merge_styles* for the examples.

**Parameters**
**overwrite** (Style) – Style to merge the attributes with.

**Return type**
Style

**merge_replace**(*replacement*)

Not an actual "merge": discard all the attributes of the current instance and replace them with the values from `replacement`. Generally speaking, it makes sense only in `TemplateEngine` context, as style management using the template tags is quite limited, while there are far more elegant ways to do the same from the regular python code.

Modifies the instance in-place and returns it as well (for chained calls).

Listing 14: Merging different values in replace mode

```
        BASE(SELF)   REPLACE     RESULT
         +------+   +-------+  +-------+
ATTR-1   | False =Ø | True --->| True  |  REPLACE val is in priority
ATTR-2   | True ==Ø | False -->| False |  REPLACE val is in priority
ATTR-3   | None |   | False -->| False |  REPLACE val is in priority
ATTR-4   | True ==Ø | None --->| None  |   ... even when it is unset
         +------+   +-------+  +-------+
```

**Parameters**
**replacement** (Style) – Style to merge the attributes with.

**Return type**
Style

**property underline_color:** *RenderColor*

Underline color. Can be set as *CDT* or `Color`, stored always as `Color`.

**bold:** **bool**

Bold or increased intensity (depending on terminal settings).

**dim:** **bool**

Faint, decreased intensity.

---

**Terminal-based rendering**

Terminals apply this effect to foreground (=text) color, but when it's used together with *inversed*, they usually make the background darker instead.

Also note that usually it affects indexed colors only and has no effect on RGB-based ones (True Color mode).

---

**italic: bool**

Italic (some terminals may display it as inversed instead).

**underlined: bool**

Underline.

**overlined: bool**

Overline.

**crosslined: bool**

Strikethrough.

**double_underlined: bool**

Double underline.

**curly_underlined: bool**

Curly underline.

**inversed: bool**

Swap foreground and background colors. When inversed effect is active, changing the background color will actually change the text color, and vice versa.

**blink: bool**

Blinking effect. Supported by a limited set of *renderers*.

**framed: bool**

Add a rectangular border around the text; the border color is equal to the text color. Supported by a limited set of *renderers* and (even more) limited amount of terminal emulators.

**class_name: str**

Arbitary string used by some *renderers*, e.g. by `HtmlRenderer`, which will include the value of this property to an output element class list. This property is not inheritable.

pytermor.style.**NOOP_STYLE = <*_NoOpStyle[]>**

Special style passing the text through without any modifications.

---

**Important:** Casting to *bool* results in **False** for all NOOP instances in the library (*NOOP_SEQ*, NOOP_COLOR and *NOOP_STYLE*). This is intended.

---

This class is immutable, i.e. *LogicError* will be raised upon an attempt to modify any of its attributes, which could potentially lead to schrödinbugs:

```
st1.merge_fallback(Style(bold=True), [Style(italic=False)])
```

If st1 is a regular style instance, it's safe to call self-modifying methods, but if it happens to be a *NOOP_STYLE*, the statement could have been alter the internal state of the style, which is referenced all over the library, which could lead to the changes appearing in an unexpected places.

To be safe from this outcome one could merge styles via frontend method *merge_styles*, which always makes a copy of origin argument and thus cannot lead to such results.

**class** pytermor.style.**Styles**

Some ready-to-use styles which also can be used as examples. All instances are immutable.

**WARNING = <*Style[yellow]>**

**WARNING_LABEL = <*Style[yellow +BOLD]>**

**WARNING_ACCENT = <*Style[hi-yellow]>**

**ERROR = <*Style[red]>**

**ERROR_LABEL = <*Style[red +BOLD]>**

**ERROR_ACCENT = <*Style[hi-red]>**

**CRITICAL = <*Style[hi-white|x160]>**

**CRITICAL_LABEL = <*Style[hi-white|x160 +BOLD]>**

**CRITICAL_ACCENT = <*Style[hi-white|x160 +BLIN +BOLD]>**

**INCONSISTENCY = <*Style[hi-yellow|x160]>**

pytermor.style.**make_style**(*fmt=None*)

General *Style* constructor. Accepts a variety of argument types:

- ***CDT* (*str* or *int*)**
  This argument type implies the creation of basic *Style* with the only attribute set being *fg* (i.e., text color). For the details on color resolving see *resolve_color()*.
- ***Style***
  Existing style instance. Return it as is.
- ***None***
  Return *NOOP_STYLE*.

**Parameters**
**fmt** (*FT*) – See *FT*.

**Return type**
Style

pytermor.style.**merge_styles**(*origin=<*_NoOpStyle[]>*, *, *fallbacks=()*, *overwrites=()*)

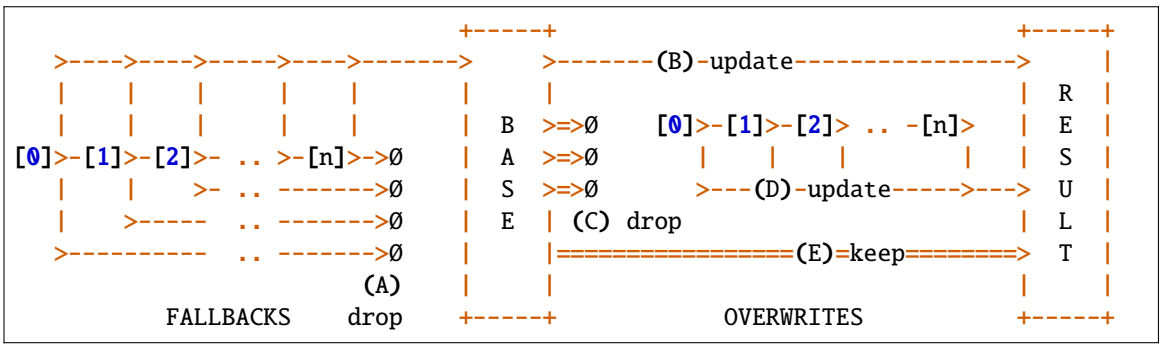
Bulk style merging method. First merge `fallbacks` `styles` with the `origin` in the same order they are iterated, using *merge_fallback()* algorithm; then do the same for `overwrites` styles, but using *merge_overwrite()* merge method.

---

**Important:** The original `origin` is left untouched, as all the operations are performed on its clone. To make things clearer the name of the argument differs from the ones that are modified in-place (`base` and `origin`).

---

Listing 15: Dual mode merge diagram




The key actions are marked with (**A**) to (**E**) letters. In reality the algorithm works in slightly different order, but the exact scheme would be less illustrative.

**(A),(B)**
Iterate `fallback` styles one by one; discard all the attributes of a current `fallback` style, that are already set in `origin` style (i.e., that are not *Nones*). Update all `origin` style empty attributes with corresponding `fallback` values, if they exist and are not empty. Repeat these steps for the next `fallback` in the list, until the list is empty.

Listing 16: Fallback merge algorithm example №1

```
>>> origin = Style(fg='red')
...
>>> fallbacks = [Style(fg='blue'), Style(bold=True),␣
↪Style(bold=False)]
...
>>> merge_styles(origin, fallbacks=fallbacks)
<Style[red +BOLD]>
```

In the example above:

- the first fallback will be ignored, as *fg* is already set;
- the second fallback will be applied (`origin` style will now have *bold* set to *True*;
- which will make the handler ignore third fallback completely; if third fallback was encountered earlier than the 2nd one, `origin` *bold* attribute would have been set to *False*, but alas.

---

**Note:** Fallbacks allow to build complex style conditions, e.g. take a look into *Highlighter.colorize()* method:

```
int_st = merge_styles(st, fallbacks=[Style(bold=True)])
```

Instead of using `Style(st, bold=True)` the merging algorithm is invoked. This changes the logic of "bold" attribute application – if there is a necessity to explicitly forbid bold text at origin/parent level, one could write:

```
STYLE_NUL = Style(STYLE_DEFAULT, cv.GRAY, bold=False)
STYLE_PRC = Style(STYLE_DEFAULT, cv.MAGENTA)
STYLE_KIL = Style(STYLE_DEFAULT, cv.BLUE)
...
```

As you can see, resulting `int_st` will be bold for all styles other than `STYLE_NUL`.

Listing 17: Fallback merge algorithm example №2

```
>>> merge_styles(Style(fg=cv.BLUE), fallbacks=[Style(bold=True)])
<Style[blue +BOLD]>
>>> merge_styles(Style(fg=cv.GRAY, bold=False),␣
↪fallbacks=[Style(bold=True)])
<Style[gray -BOLD]>
```

---

**(C),(D),(E)**
Iterate `overwrite` styles one by one; discard all the attributes of a `origin` style that have a non-empty counterpart in `overwrite` style, and put corresponding `overwrite` attribute values instead of them. Keep `origin` attribute values that have no counterpart in current `overwrite` style (i.e., if attribute value is *None*). Then pick next `overwrite` style from the input list and repeat all these steps.

Listing 18: Overwrite merge algorithm example

```
>>> origin = Style(fg='red')
...
>>> overwrites = [Style(fg='blue'), Style(bold=True),␣
↪Style(bold=False)]
...
>>> merge_styles(origin, overwrites=overwrites)
<Style[blue -BOLD]>
```

In the example above all the `overwrites` will be applied in order they were put into *list*, and the result attribute values are equal to the last encountered non-empty values in `overwrites` list.

**Parameters**

- **origin** (Style) – Initial style, or the source of attributes.
- **fallbacks** (*Iterable[Style]*) – List of styles to be used as a backup attribute storage, or. in other words, to be "merged up" with the origin; affects the unset attributes of the current style and replaces these values with its own. Uses *merge_fallback()* merging strategy.
- **overwrites** (*Iterable[Style]*) – List of styles to be used as attribute storage force override regardless of actual `origin` attribute valuse (so called "merging down" with the origin).

**Returns**

Clone of `origin` style with all specified styles merged into.

**Return type**

Style

## 7.11 pytermor.template

### Functions

| |
|---|
| `render`(tpl, renderer) |
| `substitute`(tpl) |

### Classes

| |
|---|
| `TemplateEngine`([custom_styles, global_style]) |

## 7.12 pytermor.term

A

### Module Attributes

| | |
|---|---|
| *RCP_REGEX* | Regular expression for RCP (Report Cursor Position) sequence parsing. |

### Functions

| | |
|---|---|
| *compose_clear_line_fill_bg*(basis[, line, column]) | **param basis** |
| *compose_hyperlink*(url[, label]) | Syntax: `(OSC 8 ; ;) (url) (ST) (label) (OSC 8 ; ;) (ST)`, where *OSC* is `ESC ]`. |
| *confirm*([attempts, default, keymap, prompt, ...]) | Ensure the next action is manually confirmed by user. |
| *decompose_report_cursor_position*(string) | Parse RCP sequence that usually comes from a terminal as a response to *QCP* sequence and contains a cursor's current line and column. |
| *get_char_width*(char, block) | General-purpose method for getting width of a character in terminal columns. |
| *get_preferable_wrap_width*([force_width]) | Return preferable terminal width for comfort reading of wrapped text (max=120). |
| *get_terminal_width*([fallback, pad]) | Return current terminal width with an optional "safety buffer", which ensures that no unwanted line wrapping will happen. |
| *guess_char_width*(c) | Determine how many columns are needed to display a character in a terminal. |
| *make_clear_display*() | Create ED sequence that clears an entire screen. |
| *make_clear_display_after_cursor*() | Create ED sequence that clears a part of the screen from cursor to the end of the screen. |
| *make_clear_display_before_cursor*() | Create ED sequence that clears a part of the screen from cursor to the beginning of the screen. |
| *make_clear_history*() | Create ED sequence that clears history, i.e., invisible lines on the top that can be scrolled back down. |
| *make_clear_line*() | Create EL sequence that clears an entire line at the cursor position. |
| *make_clear_line_after_cursor*() | Create EL sequence that clears a part of the line from cursor to the end of the same line. |
| *make_clear_line_before_cursor*() | Create EL sequence that clears a part of the line from cursor to the beginning of the same line. |
| *make_color_256*(code[, target]) | Wrapper for creation of *SequenceSGR* that sets foreground (or background) to one of 256-color palette value.: |
| *make_color_rgb*(r, g, b[, target]) | Wrapper for creation of *SequenceSGR* operating in True Color mode (16M). Valid values for `r`, `g` and `b` are in range of [0; 255]. This range linearly translates into [0x00; 0xFF] for each channel. The result value is composed as "#RRGGBB". For example, a sequence with color of #ff3300 can be created with::. |
| *make_disable_alt_screen_buffer*() | C |
| *make_enable_alt_screen_buffer*() | C |

continues on next page

Table 2 – continued from previous page

| | |
|---|---|
| make_erase_in_display([mode]) | Create ED sequence that clears a part of the screen or the entire screen. |
| make_erase_in_line([mode]) | Create EL sequence that clears a part of the line or the entire line at the cursor position. |
| make_hide_cursor() | C |
| make_hyperlink() | Create a hyperlink in the text *(supported by limited amount of terminals)*. |
| make_move_cursor_down([lines]) | Create CUD (Cursor Down) sequence that moves the cursor down by specified amount of `lines`. |
| make_move_cursor_down_to_start([lines]) | Create CNL (Cursor Next Line) sequence that moves the cursor to the beginning of the line and down by specified amount of `lines`. |
| make_move_cursor_left([columns]) | Create CUB (Cursor Back) sequence that moves the cursor left by specified amount of `columns`. |
| make_move_cursor_right([columns]) | Create CUF (Cursor Forward) sequence that moves the cursor right by specified amount of `columns`. |
| make_move_cursor_up([lines]) | Create CUU (Cursor Up) sequence that moves the cursor up by specified amount of `lines`. |
| make_move_cursor_up_to_start([lines]) | Create CPL (Cursor Previous Line) sequence that moves the cursor to the beginning of the line and up by specified amount of `lines`. |
| make_query_cursor_position() | Create QCP (Query Cursor Position) sequence that requests an output device to respond with a structure containing current cursor coordinates (RCP). |
| make_reset_cursor() | Create CUP sequence without params, which moves the cursor to top left corner of the screen. |
| make_restore_cursor_position() | **example**<br>ESC 8 |
| make_restore_screen() | C |
| make_save_cursor_position() | **example**<br>ESC 7 |
| make_save_screen() | C |
| make_set_cursor([line, column]) | Create CUP sequence that moves the cursor to specified amount `line` and `column`. |
| make_set_cursor_column([column]) | Create CHA (Cursor Character Absolute) sequence that sets cursor horizontal position to `column`. |
| make_set_cursor_line([line]) | Create VPA (Vertical Position Absolute) sequence that sets cursor vertical position to `line`. |
| make_show_cursor() | C |
| measure_char_width(char[, clear_after]) | Low-level function that returns the exact character width in terminal columns. |
| wait_key([block]) | Wait for a key press on the console and return it. |

pytermor.term.**RCP_REGEX**

Regular expression for RCP sequence parsing. See *decompose_report_cursor_position()*.

pytermor.term.**make_color_256**(*code*, *target=ColorTarget.FG*)

Wrapper for creation of *SequenceSGR* that sets foreground (or background) to one of 256-color palette value.:

```
>>> make_color_256(141)
<SGR[38;5;141m>
```

**See also:**

*Color256* class.

**Parameters**

- **code** (*int*) – Index of the color in the palette, 0 – 255.
- **target** (ColorTarget) –

**Example**
ESC [38;5;141m

**Return type**
SequenceSGR

pytermor.term.**make_color_rgb**(*r*, *g*, *b*, *target=ColorTarget.FG*)

Wrapper for creation of *SequenceSGR* operating in True Color mode (16M). Valid values for `r`, `g` and `b` are in range of [0; 255]. This range linearly translates into [0x00; 0xFF] for each channel. The result value is composed as "#RRGGBB". For example, a sequence with color of #ff3300 can be created with:

```
>>> make_color_rgb(255, 51, 0)
<SGR[38;2;255;51;0m>
```

**See also:**

*ColorRGB* class.

**Parameters**

- **r** (*int*) – Red channel value, 0 – 255.
- **g** (*int*) – Blue channel value, 0 – 255.
- **b** (*int*) – Green channel value, 0 – 255.
- **target** (ColorTarget) –

**Example**
ESC [38;2;255;51;0m

**Return type**
SequenceSGR

pytermor.term.**make_reset_cursor**()

Create CUP sequence without params, which moves the cursor to top left corner of the screen. See *make_set_cursor()*.

**Example**
ESC [H

**Return type**
SequenceCSI

pytermor.term.**make_set_cursor**(*line=1*, *column=1*)

Create CUP sequence that moves the cursor to specified amount `line` and `column`. The values are 1-based, i.e. (1; 1) is top left corner of the screen.

---

**Note:** Both sequence params are optional and defaults to 1 if omitted, e.g. ESC [;3H is effectively ESC [1;3H, and ESC [4H is the same as ESC [4;H or ESC [4;1H.

---

**Example**
ESC [9;15H

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_up**(*lines=1*)

Create CUU sequence that moves the cursor up by specified amount of `lines`. If the cursor is already at the top of the screen, this has no effect.

**Example**
ESC [2A

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_down**(*lines=1*)

Create CUD sequence that moves the cursor down by specified amount of `lines`. If the cursor is already at the bottom of the screen, this has no effect.

**Example**
ESC [3B

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_left**(*columns=1*)

Create CUB sequence that moves the cursor left by specified amount of `columns`. If the cursor is already at the left edge of the screen, this has no effect.

**Example**
ESC [4D

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_right**(*columns=1*)

Create CUF sequence that moves the cursor right by specified amount of `columns`. If the cursor is already at the right edge of the screen, this has no effect.

**Example**
ESC [5C

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_up_to_start**(*lines=1*)

Create CPL sequence that moves the cursor to the beginning of the line and up by specified amount of `lines`.

**Example**
ESC [2F

**Return type**
SequenceCSI

pytermor.term.**make_move_cursor_down_to_start**(*lines=1*)

Create CNL sequence that moves the cursor to the beginning of the line and down by specified amount of `lines`.

**Example**
ESC [3E

**Return type**
SequenceCSI

pytermor.term.**make_set_cursor_line**(*line=1*)

Create VPA sequence that sets cursor vertical position to `line`.

**Example**
`ESC [9d`

**Return type**
SequenceCSI

pytermor.term.**make_set_cursor_column**(*column=1*)

Create CHA sequence that sets cursor horizontal position to `column`.

**Parameters**
**column** (*int*) – New cursor horizontal position.

**Example**
`ESC [15G`

**Return type**
SequenceCSI

pytermor.term.**make_query_cursor_position**()

Create QCP sequence that requests an output device to respond with a structure containing current cursor coordinates (RCP).

> **Warning:** Sending this sequence to the terminal may **block** infinitely. Consider using a thread or set a timeout for the main thread using a signal.

**Example**
`ESC [6n`

**Return type**
SequenceCSI

pytermor.term.**make_erase_in_display**(*mode=0*)

Create ED sequence that clears a part of the screen or the entire screen. Cursor position does not change.

**Parameters**
**mode** (*int*) – Sequence operating mode.

- If set to 0, clear from cursor to the end of the screen.
- If set to 1, clear from cursor to the beginning of the screen.
- If set to 2, clear the entire screen.
- If set to 3, clear terminal history (xterm only).

**Example**
`ESC [0J`

**Return type**
SequenceCSI

pytermor.term.**make_clear_display_after_cursor**()

Create ED sequence that clears a part of the screen from cursor to the end of the screen. Cursor position does not change.

**Example**
`ESC [0J`

**Return type**
SequenceCSI

pytermor.term.**make_clear_display_before_cursor**()

Create ED sequence that clears a part of the screen from cursor to the beginning of the screen. Cursor position does not change.

**Example**
ESC [1J

**Return type**
SequenceCSI

pytermor.term.**make_clear_display**()

Create ED sequence that clears an entire screen. Cursor position does not change.

**Example**
ESC [2J

**Return type**
SequenceCSI

pytermor.term.**make_clear_history**()

Create ED sequence that clears history, i.e., invisible lines on the top that can be scrolled back down. Cursor position does not change. This is a xterm extension.

**Example**
ESC [3J

**Return type**
SequenceCSI

pytermor.term.**make_erase_in_line**(*mode=0*)

Create EL sequence that clears a part of the line or the entire line at the cursor position. Cursor position does not change.

**Parameters**
**mode** (*int*) – Sequence operating mode.

- If set to 0, clear from cursor to the end of the line.
- If set to 1, clear from cursor to the beginning of the line.
- If set to 2, clear the entire line.

**Example**
ESC [0K

**Return type**
SequenceCSI

pytermor.term.**make_clear_line_after_cursor**()

Create EL sequence that clears a part of the line from cursor to the end of the same line. Cursor position does not change.

**Example**
ESC [0K

**Return type**
SequenceCSI

pytermor.term.**make_clear_line_before_cursor**()

Create EL sequence that clears a part of the line from cursor to the beginning of the same line. Cursor position does not change.

**Example**
ESC [1K

**Return type**
SequenceCSI

pytermor.term.**make_clear_line**()

Create EL sequence that clears an entire line at the cursor position. Cursor position does not change.

**Example**
ESC [2K

**Return type**
SequenceCSI

pytermor.term.**make_show_cursor**()

C

**Return type**
SequenceCSI

pytermor.term.**make_hide_cursor**()

C

**Return type**
SequenceCSI

pytermor.term.**make_save_screen**()

C

**Return type**
SequenceCSI

pytermor.term.**make_restore_screen**()

C

**Return type**
SequenceCSI

pytermor.term.**make_enable_alt_screen_buffer**()

C

**Return type**
SequenceCSI

pytermor.term.**make_disable_alt_screen_buffer**()

C

**Return type**
SequenceCSI

pytermor.term.**make_hyperlink**()

Create a hyperlink in the text *(supported by limited amount of terminals)*. Note that a complete set of commands to define a hyperlink consists of 4 oh them (two *OSC-8* and two *ST*).

**See also:**

compose_hyperlink()`.

**Return type**
SequenceOSC

pytermor.term.**make_save_cursor_position**()

**Example**
ESC 7

**Return type**
SequenceFp

pytermor.term.**make_restore_cursor_position**()

**Example**
ESC 8

**Return type**
SequenceFp

pytermor.term.**compose_clear_line_fill_bg**(*basis*, *line=None*, *column=None*)

**Parameters**

- **basis** (SequenceSGR) –
- **line** (*Optional[int]*) –
- **column** (*Optional[int]*) –

**Return type**
str

pytermor.term.**compose_hyperlink**(*url*, *label=None*)

Syntax: `(OSC 8 ; ;) (url) (ST) (label) (OSC 8 ; ;) (ST)`, where *OSC* is `ESC ]`.

**Parameters**

- **url** (*str*) –
- **label** (*Optional[str]*) –

**Example**
`ESC ]8;;http://localhost ESC \Text ESC ]8;; ESC \`

**Return type**
str

pytermor.term.**decompose_report_cursor_position**(*string*)

Parse RCP sequence that usually comes from a terminal as a response to *QCP* sequence and contains a cursor's current line and column.

**Todo:** make a separate Seq class for this?

```
>>> decompose_report_cursor_position('[9;15R')
(9, 15)
```

**Parameters**
**string** (*str*) – Terminal response with a sequence.

**Returns**
Current line and column if the expected sequence exists in `string`, *None* otherwise.

**Return type**
*Optional*[*Tuple*[int, int]]

pytermor.term.**get_terminal_width**(*fallback=80*, *pad=2*)

Return current terminal width with an optional "safety buffer", which ensures that no unwanted line wrapping will happen.

**Parameters**

- **fallback** (*int*) – Default value when shutil is unavailable and environment variable COLUMNS is unset.
- **pad** (*int*) – Additional safety space to prevent unwanted line wrapping.

**Return type**
int

pytermor.term.**get_preferable_wrap_width**(*force_width=None*)

Return preferable terminal width for comfort reading of wrapped text (max=120).

**Parameters**
**force_width** (*Optional[int]*) – Ignore current terminal width and use this value as a result.

**Return type**
int

pytermor.term.**wait_key**(*block=True*)

Wait for a key press on the console and return it.

**Parameters**
**block** (*bool*) – Determines setup of O_NONBLOCK flag.

**Return type**
*Optional*[AnyStr]

pytermor.term.**confirm**(*attempts=1*, *default=False*, *keymap=None*, *prompt=None*, *quiet=False*, *required=False*)

Ensure the next action is manually confirmed by user. Print the terminal prompt with `prompt` text and wait for a keypress. Return *True* if user pressed `Y` and *False* in all the other cases (by default).

Valid keys are `Y` and `N` (case insensitive), while all the other keys and combinations are considered invalid, and will trigger the return of the `default` value, which is *False* if not set otherwise. In other words, by default the user is expected to press either `Y` or `N`, and if that's not the case, the confirmation request will be automatically failed.

`Ctrl+C` instantly aborts the confirmation process regardless of attempts count and raises *UserAbort*.

Example keymap (default one):

```
keymap = {"y": True, "n": False}
```

**Parameters**

- **attempts** (*int*) – Set how many times the user is allowed to perform the input before auto-cancellation (or auto-confirmation) will occur. 1 means there will be only one attempt, the first one. When set to -1, allows to repeat the input infinitely.
- **default** (*bool*) – Default value that will be returned when user presses invalid key (e.g. `Backspace`, `Ctrl+Q` etc.) and his `attempts` counter decreases to 0. Setting this to *True* effectively means that the user's only way to deny the request is to press `N` or `Ctrl+C`, while all the other keys are treated as `Y`.
- **keymap** (*Optional[Mapping[str, bool]]*) – Key to result mapping.
- **prompt** (*Optional[str]*) – String to display before each input attempt. Default is: `"Press Y to continue, N to cancel, Ctrl+C to abort: "`
- **quiet** (*bool*) – If set to *True*, suppress all messages to stdout and work silently.
- **required** (*bool*) – If set to *True*, raise *UserCancel* or *UserAbort* when user rejects to confirm current action. If set to *False*, do not raise any exceptions, just return *False*.

**Raises**

- *UserAbort* – On corresponding event, if `required` is *True*.
- *UserCancel* – On corresponding event, if `required` is *True*.

**Returns**
*True* if there was a confirmation by user's input or automatically, *False* otherwise.

**Return type**
bool

pytermor.term.**get_char_width**(*char*, *block*)

General-purpose method for getting width of a character in terminal columns.

Uses *guess_char_width()* method based on `unicodedata` package, or/and QCP-RCP ANSI control sequence communication protocol.

**Parameters**

- **char** (*str*) – Input char.
- **block** (*bool*) – Set to *True* if you prefer slow, but 100% accurate *measuring* (which **blocks** and requires an output tty), or *False* for a device-independent, deterministic and non-blocking *guessing*, which works most of the time, although there could be rare cases when it is not precise enough.

**Return type**
int

pytermor.term.**measure_char_width**(*char*, *clear_after=True*)

Low-level function that returns the exact character width in terminal columns.

The main idea is to reset a cursor position to 1st column, print the required character and *QCP* control sequence; after that wait for the response and `parse` it. Normally it contains the cursor coordinates, which can tell the exact width of a character in question.

After reading the response clear it from the screen and reset the cursor to column 1 again.

---

**Important:** The `stdout` must be a tty. If it is not, consider using *guess_char_width()* instead, or `IOError` will be raised.

---

**Warning:** Invoking this method produces a bit of garbage in the output stream, which looks like this: `[3;2R`. By default, it is hidden using screen line clearing (see `clear_after`).

**Warning:** Invoking this method may **block** infinitely. Consider using a thread or set a timeout for the main thread using a signal if that is unwanted.

**Parameters**

- **char** (*str*) – Input char.
- **clear_after** (*bool*) – Send *EL* control sequence after the terminal response to hide excessive utility information from the output if set to *True*, or leave it be otherwise.

**Raises**
**IOError** – If `stdout` is not a terminal emulator.

**Return type**
int

pytermor.term.**guess_char_width**(*c*)

Determine how many columns are needed to display a character in a terminal.

Returns -1 if the character is not printable. Returns 0, 1 or 2 for other characters.

Utilizes `unicodedata` table. A terminal emulator is unnecessary.

**Parameters**
**c** (*str*) –

**Return type**
int

## 7.13 pytermor.text

"Front-end" module of the library. Contains *renderables* – classes supporting high-level operations such as nesting-aware style application, concatenating and cropping of styled strings before the rendering, text alignment and wrapping, etc. Also provides rendering entrypoints *render()* and *echo()*.

### Functions

| | |
|---|---|
| *apply_style_selective*(regex, string[, st]) | Main purpose: application of under(over\|cross)lined styles to strings containing more than one word. |
| *apply_style_words_selective*(string, st) | . |
| *distribute_padded*() | **param max_len** |
| *echo*([string, fmt, renderer, nl, file, ...]) | . |
| *echoi*([string, fmt, renderer, file, flush]) | echo inline |
| is_rt(arg) | |
| *render*([string, fmt, renderer]) | . |
| *wrap_sgr*(rendered, width[, indent_first, ...]) | A workaround to make standard library `textwrap.wrap()` more friendly to an SGR-formatted strings. |

### Classes

| | |
|---|---|
| *Composite*(*parts) | Simple class-container supporting concatenation of any *IRenderable* instances with each other without extra logic on top of it. |
| *Fragment*([string, fmt, close_this, close_prev]) | <Immutable> |
| *FrozenText*(*fargs[, width, align, fill, ...]) | Multi-fragment text with style nesting support. |
| *IRenderable*() | I |
| *SimpleTable*(*rows[, width, sep, border_st]) | Table class with dynamic (not bound to each other) rows. |
| *Text*(*fargs[, width, align, fill, overflow, ...]) | |

**class** pytermor.text.**IRenderable**

Bases: Sized, ABC

I

**abstract as_fragments**()

a-s

**Return type**
*List*[Fragment]

**abstract raw**()

pass

**Return type**
str

**abstract render**(*renderer=None*)

pass

**Return type**
str

**abstract set_width**(*width*)

raise NotImplementedError

**abstract property has_width: bool**

return self._width is not None

**abstract property allows_width_setup: bool**

return False

**class** pytermor.text.**Fragment**(*string=''*, *fmt=None*, ***, *close_this=True*, *close_prev=False*)

Bases: *IRenderable*

<Immutable>

Can be formatted with f-strings. The text `:s` mode is required. Supported features:

- width [of the result];
- max length [of the content];
- alignment;
- filling.

```
>>> f"{Fragment('1234567890'):*^8.4s}"
'**1234**'
```

**Parameters**

- **string** (*str*) –
- **fmt** (*FT*) –
- **close_this** (*bool*) –
- **close_prev** (*bool*) –

**as_fragments**()

a-s

**Return type**
*List*[Fragment]

**raw**()

pass

**Return type**
str

**property has_width: bool**

return self._width is not None

**property allows_width_setup: bool**

return False

**render**(*renderer=None*)

pass

**Return type**
str

**set_width**(*width*)

raise NotImplementedError

**class** pytermor.text.**FrozenText**(**fargs*, *width=None*, *align=None*, *fill=' '*, *overflow=''*, *pad=0*, *pad_styled=True*)

Bases: *IRenderable*

Multi-fragment text with style nesting support.

**Parameters**
**align** (*str | Align*) – default is left

**as_fragments**()

a-s

**Return type**
*List*[Fragment]

**raw**()

pass

**Return type**
str

**render**(*renderer=None*)

Core rendering method

**Parameters**
**renderer** –

**Returns**

**Return type**

**property allows_width_setup: bool**

return False

**property has_width: bool**

return self._width is not None

**set_width**(*width*)

raise NotImplementedError

class pytermor.text.**Text**(**fargs*, *width=None*, *align=None*, *fill=' '*, *overflow=''*, *pad=0*, *pad_styled=True*)

Bases: *FrozenText*

**set_width**(*width*)

raise NotImplementedError

**property allows_width_setup: bool**

return False

**as_fragments**()

a-s

**Return type**
*List*[Fragment]

**property has_width: bool**

return self._width is not None

**raw**()

pass

**Return type**
str

**render**(*renderer=None*)

Core rendering method

**Parameters**
**renderer** –

**Returns**

**Return type**

class pytermor.text.**Composite**(**parts*)

Bases: *IRenderable*

Simple class-container supporting concatenation of any *IRenderable* instances with each other without extra logic on top of it. Renders parts joined by an empty string.

**Parameters**
**parts** (*RT*) – text parts in any format implementing *IRenderable* interface.

**as_fragments**()

a-s

**Return type**
*List*[Fragment]

**raw**()

pass

**Return type**
str

**render**(*renderer=None*)

pass

**Return type**
str

**set_width**(*width*)

raise NotImplementedError

**property has_width: bool**

return self._width is not None

**property allows_width_setup: bool**

return False

**class** pytermor.text.**SimpleTable**(**rows*, *width=None*, *sep=' '*, *border_st=<*_NoOpStyle[]>*)

Bases: *IRenderable*

Table class with dynamic (not bound to each other) rows. By defualt expands to the maximum width (terminal size).

Allows 0 or 1 dynamic-width cell in each row, while all the others should be static, i.e., be instances of *FrozenText*.

```
>>> echo(
...     SimpleTable(
...     [
...         Text("1", width=1),
...         Text("word", width=6, align='center'),
...         Text("smol string"),
...     ],
...     [
...         Text("2", width=1),
...         Text("padded word", width=6, align='center', pad=2),
...         Text("biiiiiiiiiiiiiiiiiiiiiiiiiiiig string"),
...     ],
...     width=30,
...     sep="|"
... ), file=sys.stdout)
|1| word |smol string        |
|2| padd |biiiiiiiiiiiiiiiiii|
```

Create

**Parameters**

- **rows** (*t.Iterable[RT]*) –
- **width** (*int*) – Table width, in characters. When omitted, equals to terminal size if applicable, and to fallback value (80) otherwise.
- **sep** (*str*) –
- **border_st** (*Style*) –

**as_fragments**()

a-s

**Return type**

*List*[Fragment]

**raw**()

pass

**Return type**

str

**property allows_width_setup: bool**

return False

**property has_width: bool**

return self._width is not None

**render**(*renderer=None*)

pass

**Return type**
str

**set_width**(*width*)

raise NotImplementedError

pytermor.text.**render**(*string=''*, *fmt=<*_NoOpStyle[]>*, *renderer=None*)

.

**Parameters**

- **string** (*Union[RT, Iterable[RT]]*) – 2
- **fmt** (*FT*) – 2
- **renderer** (*Optional[Union[IRenderer, Type[IRenderer]]]*) – 2

**Returns**

**Return type**
*Union*[str, *List*[str]]

pytermor.text.**echo**(*string=''*, *fmt=<*_NoOpStyle[]>*, *renderer=None*, ***, *nl=True*, *file=<_io.TextIOWrapper name='<stdout>' mode='w' encoding='utf-8'>*, *flush=True*, *wrap=False*, *indent_first=0*, *indent_subseq=0*)

.

**Parameters**

- **string** (*Union[RT, Iterable[RT]]*) –
- **fmt** (*FT*) –
- **renderer** (*Optional[IRenderer]*) –
- **nl** (*bool*) –
- **file** (*IO*) –
- **flush** (*bool*) –
- **wrap** (*bool | int*) –
- **indent_first** (*int*) –
- **indent_subseq** (*int*) –

pytermor.text.**echoi**(*string=''*, *fmt=<*_NoOpStyle[]>*, *renderer=None*, ***, *file=<_io.TextIOWrapper name='<stdout>' mode='w' encoding='utf-8'>*, *flush=True*)

echo inline

**Parameters**

- **string** (*Union[RT, Iterable[RT]]*) –
- **fmt** (*FT*) –
- **renderer** (*Optional[IRenderer]*) –
- **file** (*IO*) –

- **flush** (*bool*) –

**Returns**

**Return type**
None

pytermor.text.**distribute_padded**(*max_len: int*, **values: str*, *pad_left: int = 0*, *pad_right: int = 0*) → str

pytermor.text.**distribute_padded**(*max_len: int*, **values: RT*, *pad_left: int = 0*, *pad_right: int = 0*) → *Text*

**Parameters**

- **max_len** –
- **values** –
- **pad_left** –
- **pad_right** –

**Returns**

pytermor.text.**wrap_sgr**(*rendered*, *width*, *indent_first=0*, *indent_subseq=0*)

A workaround to make standard library `textwrap.wrap()` more friendly to an SGR-formatted strings.

The main idea is

**Parameters**

- **rendered** (*str | list[str]*) –
- **width** (*int*) –
- **indent_first** (*int*) –
- **indent_subseq** (*int*) –

**Return type**
str

pytermor.text.**apply_style_words_selective**(*string*, *st*)

...

**Return type**
*Sequence*[Fragment]

pytermor.text.**apply_style_selective**(*regex*, *string*, *st=<*_NoOpStyle[]>*)

Main purpose: application of under(over|cross)lined styles to strings containing more than one word. Although the method can be used with any style and splitting rule provided. The result is a sequence of *Fragments* with styling applied only to specified parts of the original string.

Regex should consist of two groups, first for parts to apply style to, second for parts to return without any style (see *NOOP_STYLE*). This regex is used internally for python's `re.findall()` method.

The example below demonstrates how to color all the capital letters in the string in red color:

```
>>> render([
...     *apply_style_selective(
...         re.compile(R'([A-Z]+)([^A-Z]+|$)'),
...         "A few CAPITALs",
...         Style(fg='red'),
...     )
... ], renderer=SgrRenderer(OutputMode.XTERM_16))
['[31mA[39m', ' few ', '[31mCAPITAL[39m', 's']
```

A few CAPITALs

**Parameters**

- **regex** (*Pattern*) –
- **string** (*str*) –
- **st** (Style) –

**Return type**
*Sequence*[Fragment]

# 8

# APPENDIX

## 8.1 Tracers math

The library provides a few implementations of `AbstractTracer`, each of them having an algorithm that determines the maximum amount of data per line depending on current output device (terminal) width. Some of these algorithms are non-linear and for the clarity listed below.

### 8.1.1 BytesTracer

Display *str*/*bytes* as byte hex codes, grouped by 4.

Listing 1: Example output

```
0x00 | 35 30 20 35  34 20 35 35  20 C2 B0 43  20 20 33 39  20 2B 30 20
0x14 | 20 20 33 39  6D 73 20 31  20 52 55 20  20 E2 88 86  20 35 68 20
0x28 | 31 38 6D 20  20 20 EE 8C  8D 20 E2 80  8E 20 2B 32  30 C2 B0 43
0x3C | 20 20 54 68  20 30 31 20  4A 75 6E 20  20 31 36 20  32 38 20 20
0x50 | E2 96 95 E2  9C 94 E2 96  8F 46 55 4C  4C 20
```

The amount of characters that will fit into one line (with taking into account all the formatting and the fact that chars are displayed in groups of 4) depends on terminal width and on max address value (the latter determines the size of the leftmost field – current line address). Let's express output line length $L_O$ in a general way – through $C_L$ (characters per line) and $L_{adr}$ (length of maximum address value for given input):

$$L_O = L_{spc} + L_{sep} + L_{adr} + L_{hex},$$

$$L_{adr} = 2 + 2 \cdot ceil(\frac{L_{Ihex}}{2}), \qquad (1)$$

$$L_{hex} = 3C_L + floor(\frac{C_L}{4}),$$

where:

- $L_{spc} = 3$ is static whitespace total length,
- $L_{sep} = 1$ is separator ("|") length,
- $L_{Ihex} = len(L_I)$ is *length* of (hexadecimal) *length* of input. Here is an example, consider input data $I$ 10 bytes long:

$$L_I = len(I) = 10_{10} = A_{16},$$

$$L_{Ihex} = len(L_I) = len(A_{16}) = 1,$$

$$L_{adr} = 2 + 2 \cdot ceil(\frac{1}{2}) = 4,$$

  which corresponds to address formatted as 0x0A. One more example – input data 1000 bytes long:

$$L_I = len(I) = 1000_{10} = 3E8_{16},$$

$$L_{Ihex} = len(L_I) = len(3E8_{16}) = 3,$$

$$L_{adr} = 2 + 2 \cdot ceil(\frac{3}{2}) = 6,$$

  which matches the length of an actual address 0x03E8). Note that the expression $2 \cdot ceil(\frac{L_{Ihex}}{2})$ is used for rounding $L_{adr}$ up to next even integer to avoid printing the addresses in 0x301 form, and displaying them more or less aligned instead. The first constant item 2 in $(1)$ represents 0x prefix.

- $L_{hex}$ represents amount of chars required to display $C_L$ hexadecimal bytes. First item $3C_L$ is trivial and corresponds to every byte's hexadecimal value plus a space after (giving us $2 + 1 = 3$, e.g. `"34 "`), while the second one represents one extra space character per each 4-byte group.

Let's introduce $L_T$ as current terminal width, then $\boxed{L_O \leqslant L_T}$, which leads to the following inequation:

$$L_{spc} + L_{sep} + L_{adr} + L_{hex} \leqslant L_T.$$

Substitute the variables:

$$3 + 1 + 2 + 2 \cdot ceil(\frac{L_{Ihex}}{2}) + 3C_L + floor(\frac{C_L}{4}) \leqslant L_T.$$

Suppose we limit $C_L$ values to the integer factor of $4$, then:

$$3C_L + floor(\frac{C_L}{4}) = 3.25C_L \qquad \forall C_L \in [4, 8, 12..), \qquad (2)$$

which gives us:

$$6 + 2 \cdot ceil(\frac{L_{Ihex}}{2}) + 3.25C_L \leqslant L_T,$$

$$3.25C_L \leqslant L_T - 2 \cdot ceil(\frac{L_{Ihex}}{2}) - 6,$$

$$13C_L \leqslant 4L_T - 8 \cdot ceil(\frac{L_{Ihex}}{2}) - 24.$$

Therefore:

$$C_{Lmax} = floor(\frac{4L_T - 4 \cdot ceil(\frac{L_{Ihex}}{2}) - 24}{13}).$$

Last step would be to round the result (down) to the nearest integer factor of $4$ as we have agreed earlier in $(2)$.

### 8.1.2 StringTracer

Display *str* as byte hex codes (UTF-8), grouped by characters.

Listing 2: Example output

```
 0 |    35    30    20 35 34 20 35    35    20   c2b0 43 20 |50␣54␣55␣°C␣
12 |    20    33    39 20 2b 30 20    20    20    33 39 6d |␣39␣+0␣␣␣39m
24 |    73    20    31 20 52 55 20    20 e28886    20 35 68 |s␣1␣RU␣␣␣5h
36 |    20    31    38 6d 20 20 20 ee8c8d    20 e2808e 20 2b |␣18m␣␣␣␣␣+
48 |    32    30   c2b0 43 20 20 54    68    20    30 31 20 |20°C␣␣Th␣01␣
60 |    4a    75    6e 20 20 31 36    20    32    38 20 20 |Jun␣␣16␣28␣␣
72 | e29695 e29c94 e2968f 46 55 4c 4c    20                 |✓FULL␣
```

Calculations for this class are different, although the base formula for output line length $L_O$ is the same:

$$L_O = L_{spc} + L_{sep} + L_{adr} + L_{hex},$$

$$L_{adr} = len(L_I),$$

$$L_{hex} = (2C_{Umax} + 1) \cdot C_L$$

where:

- $L_{spc} = 3$ is static whitespace total length,
- $L_{sep} = 2$ is separators "|" total length,
- $L_{adr}$ is length of maximum address value and is equal to *length* of *length* of input data without any transformations (because the output is decimal, in contrast with `BytesTracer`),
- $L_{hex}$ is hex representation length (2 chars multiplied to $C_{Umax}$ plus 1 for space separator per each character),
- $C_{Umax}$ is maximum UTF-8 bytes amount for a single codepoint encountered in the input (for example, $C_{Umax}$ equals to 1 for input string consisting of ASCII-7 characters only, like "ABCDE", 2 for "", 3 for "" and 4 for "", which is U+10FFFF),
- $L_{chr} = C_L$ is char representation length (equals to $C_L$), and
- $C_L$ is chars per line setting.

Then the condition of fitting the data to a terminal can be written as:

$$L_{spc} + L_{sep} + L_{adr} + L_{hex} + L_{chr} \leqslant L_T,$$

where $L_T$ is current terminal width. Next:

$$3 + 2 + L_{adr} + (2C_{Umax} + 1) \cdot C_L + C_L, \leqslant L_T$$

$$L_{adr} + 5 + (2C_{Umax} + 2) \cdot C_L, \leqslant L_T$$

Express $C_L$ through $L_T$, $L_{adr}$ and $C_{Umax}$:

$$(2C_{Umax} + 2) \cdot C_L \leqslant L_T - L_{adr} - 5,$$

Therefore maximum chars per line equals to:

$$C_{Lmax} = floor(\frac{L_T - L_{adr} - 5}{2C_{Umax} + 2}).$$

#### Example

Consider terminal width is 80, input data is 64 characters long and consists of U+10FFFF codepoints only ($C_{Umax} = 4$). Then:

$$\begin{aligned} L_{adr} &= len(L_I) = len(64) = 2, \\ C_{Lmax} &= floor(\frac{78 - 2 - 5}{8 + 2}), \\ &= floor(7.1) = 7. \end{aligned}$$

**Note:** Max width value used in calculations is slightly smaller than real one, that's why output lines are 78 characters long (instead of 80) – there is a 2-char reserve to ensure that the output will fit to the terminal window regardless of terminal emulator type and implementation.

The calculations always consider the maximum possible length of input data chars, and even if it will consist of the highest order codepoints only, it will be perfectly fine.

Listing 3: Example output of highest order codepoints

```
  0 | f4808080 f4808080 f4808080 f4808080 f4808080 f4808080 f4808080 |
  7 | f4808080 f4808080 f4808080 f4808080 f4808080 f4808080 f4808080 |
 14 | ...
```

### 8.1.3 StringUcpTracer

Display *str* as Unicode codepoints.

Listing 4: Example output

```
  0 |U+   20   34   36 20 34 36 20 34   36   20 B0 43 20 20 33   39 20 2B␣
↪|␣46␣46␣46␣°C␣␣39␣+
 18 |U+   30   20   20 20 35 20 6D 73   20   31 20 52 55 20 20 2206 20 37␣
↪|0␣␣␣5␣ms␣1␣RU␣␣␣7
 36 |U+   68   20   32 33 6D 20 20 20 FA93 200E 20 2B 31 33 B0   43 20 20␣
↪|h␣23m␣␣␣␣+13°C␣␣
 54 |U+   46   72   20 30 32 20 4A 75   6E   20 20 30 32 3A 34   38 20 20␣
↪|Fr␣02␣Jun␣␣02:48␣␣
 72 |U+ 2595 2714 258F 46 55 4C 4C 20                                  |✓FULL␣
```

Calculations for `StringUcpTracer` are almost the same as for `StringTracer`, expect that sum of static parts of $L_O$ equals to 7 instead of 5 (because of "U+" prefix being displayed).

The second difference is using $C_{UCmax}$ instead of $C_{Umax}$; the former variable is the amount of "n" in U+nnnn identifier of the character, while the latter is amount of bytes required to encode the character in UTF-8. Final formula is:

$$C_{Lmax} = floor(\frac{L_T - L_{adr} - 7}{C_{UCmax} + 2}).$$

# 9

# CONFIGURATION

The library initializes it's own config class just after being imported (`init_config()`). There are two ways to customize the setup:

1) create new *`Config`* instance from scratch and activate with `replace_config()`;
2) or preliminarily set the corresponding environment variables to intended values, and the default config instance will catch them up on initialization. Environment variable names are rendered in the documentation like this: PYTERMOR_VARIABLE_NAME.

---

**Todo:** check up sphinx's directive "envvar" and same text role (or whats its name…)

---

## 9.1 Variables

**Config.renderer_class**
: Explicitly set default renderer class (e.g. `TmuxRenderer`). Default renderer class is used for rendering if there is no explicitly specified one. Corresponding environment variable is PYTERMOR_RENDERER_CLASS. See also: *Default renderers priority*.

**Config.force_output_mode**
: is a standard for in-band signaling to control cursor location, color, font styling, and other options on video text terminals and terminal emulators. Certain sequences of bytes, most starting with an ASCII escape character and a bracket character, are embedded into text. The terminal interprets these sequences as commands, rather than text to display verbatim. Corresponding environment variable is PYTERMOR_FORCE_OUTPUT_MODE.

**Config.default_output_mode**
: is a standard for in-band signaling to control cursor location, color, font styling, and other options on video text terminals and terminal emulators. Certain sequences of bytes, most starting with an ASCII escape character and a bracket character, are embedded into text. The terminal interprets these sequences as commands, rather than text to display verbatim. Corresponding environment variable is PYTERMOR_DEFAULT_OUTPUT_MODE.

**Config.prefer_rgb**
: is a standard for in-band signaling to control cursor location, color, font styling, and other options on video text terminals and terminal emulators. Certain sequences of bytes, most starting with an ASCII escape character and a bracket character, are embedded into text. The terminal interprets these sequences as commands, rather than text to display verbatim. Corresponding environment variable is PYTERMOR_PREFER_RGB.

**Config.trace_renders**
: is a standard for in-band signaling to control cursor location, color, font styling, and other options on video text terminals and terminal emulators. Certain sequences of bytes, most starting with an ASCII escape character and a bracket character, are embedded into text. The terminal interprets these sequences as commands, rather than text to display verbatim. yare-yare-daze Corresponding environment variable is PYTERMOR_TRACE_RENDERS.

# 10

# CLI USAGE

Commands like the ones below can be used for quick experimenting without loading the IDE:

- One-liner for system-wide installation (which is not recommended):

```
$ python -c "import pytermor as pt; pt.echo('RED', 'red')"
```

red text

- One-liner for virtual environment (`venv`) with *pytermor* pre-installed (see **`install`**_) (note that the library source code root folder should be used as current working directory):

```
$ PYTHONPATH=. venv/bin/python -c "import pytermor as pt; pt.echo('GREEN', 'green
↪')"
```

green text

- Interactive mode for virtual environment with *pytermor* pre-installed (again, current working directory should be sources root dir):

```
$ PYTHONSTARTUP=.run-startup.py PYTHONPATH=. venv/bin/python -qi
```

```
python 3.8.10
pytermor 2.41.1-dev1
>>> pt.echo("This is warning, be warned", pt.Styles.WARNING)
```

This is warning, be warned

# 11

# CHANGELOG

## 11.1 Releases

This project uses Semantic Versioning – https://semver.org *(starting from v2.0)*

### 11.1.1 pending

- …
- changelog update
- [FIX] noop color .id read
- [FIX] legacy virtual SequenceSGR descendants
- [NEW] `DynamicColor`
- [REFACTOR] split color hierarchy into `ResolvableColor`, `RenderColor` and `RealColor`
- [FIX] restricted `DynamicColor` to `RenderColor` functionally
- [REFACTOR] `DynamicColor` deferred mechanism
- [FIX] missing imports
- [DOCS] update
- |U|pdate README.md

  Inline substitution_reference start-string without end-string.
- |U|pdate README.md

  Inline substitution_reference start-string without end-string.
- [NEW] deferred `cval` instantiating
- [DOCS] colored LaTeX output
- [DOCS] examples
- [DOCS] features WIP

- [DOCS] index rewrite
- [REFACTOR] latex configuration files
- [DOCS] bgcolor latex custom class
- [FIX] color16_equiv approximation issue
- [REFACTOR] made *Color256* non-deferred

### 11.1.2 2.99-dev

Aug 23

- [CI/CD] artifact uploading
- [DOCS] `Renderers` and `ANSI sequences review` pages
- [DOCS] library structure diagram optimized for dark mode
- [FIX] logging
- [FIX] *format_auto_float* edge case
- [FIX] *DualFormatter* tuning
- [FIX] imports
- [FIX] *template* splitter mode
- [FIX] *compose_clear_line_fill_bg* now correctlyl handle requests to fill line from the middle
- [FIX] *SequenceNf* assembling
- docker image based on python 3.10 <- 3.8
- test dependencies
- missing imports
- [NEW] *common* helpers: *only*, *but*, *ours*, *others*, `isiterable`, *flatten*, *char_range*
- [NEW] auto-normalization of RGB values
- [NEW] substitute, is_rt, cut, fit
- [NEW] AbstractNamedGroupsRefilter, AbstractRegexValRefilter, AbstractStringTracer, AbstractTracer, IRefilter, OmniPadder
- [NEW] highlighter._multiapply
- [NEW] *Text* constructor fragment in args autodetect
- [NEW] TestSgrVisualizer
- [NEW] automated customizing of library structure diagram generation
- [NEW] added tuple support into fargs-parsing
- [NEW] http colors
- [NEW] *template* option STYLE_WORDS_SELECTIVE_COMMA
- [NEW] +16 named colors
- [NEW] +1 more named color
- [NEW] addr_offset param for `Tracers`
- [NEW] *fit* support for `fillchar` customizing
- [NEW] `Tracers` handling empty input
- [NEW] +1 named color

- [NEW] `TempateEngine` `global_style` argument `TempalteEngine.render()` method
- [NEW] color difference formula updated to CIE76 E*
- [NEW] `xkcd` named colors
- [NEW] fargs now support arbitrary order of arguments independent of their types
- [REFACTOR] transferred `make_*` methods from *ansi* to *term*. and `parser` to *ansi*
- [REFACTOR] moved `trace()` from *filter* to `log`
- [REFACTOR] render tracing log level
- [REFACTOR] simplified *ArgTypeError*
- [REFACTOR] optimized imports
- [REFACTOR] `TemplateEngine`
- [REFACTOR] `measure` *fit*
- [REFACTOR] merged `conv` and *color* modules into sole *color*, also merged two class hierarchies into one
- [REFACTOR] color transformation methods
- [REMOVE] `AbstractRegexValRefilter`, `StringAligner`
- [REMOVE] `TemplateRenderer`
- [TESTS] *common* module
- [TESTS] covered *filter* module
- [TESTS]
- [TESTS] *template*
- [TESTS] 99% coverage
- [TESTS] 100% coverage
- [TESTS] fix params
- [TESTS] 100% coverage again

### 11.1.3 v2.75-dev

Jun 23

- [DOCS] fixed pydoc escaped spaces to stop python's warnings whining that breaks the CI
- [FIX] *ESCAPE_SEQ_REGEX*
- [FIX] `ESC_SEQ_REGEX`
- [FIX] *filter.AbstractTracer* faulty offset rendering
- [FIX] `flake8`
- [FIX] `make_clear_display_and_history()` -> *make_clear_history()*
- [FIX] *numfmt* exports
- [FIX] `pydeps` invocation
- [FIX] *template* options parsing issue
- add `__updated__` field to init file
- add `updated` field in _version.py
- CI coverage now running on python 3.10 (was 3.8)

- cleanup
- disabled verbose mode on CI
- pdf documentation
- replaced GITHUB_TOKEN secret to COVERALLS_REPO_TOKEN
- upload to coveralls debug mode !@#$
- [NEW] *IRenderable.raw()* method
- [NEW] `Text.split_by_spaces()`, *Composite*
- [NEW] "frozen" *Style* attribute
- [NEW] 'skylight-blue' named color
- [NEW] +3 base sequence classes, +26 preset sequences
- [NEW] `__str__` methods override for named tuples *RGB*, *HSV*
- [NEW] *contains_sgr* method
- [NEW] *cval* atlassian colors
- [NEW] `parser` module
- [NEW] *force_ansi_rendering*, *force_no_ansi_rendering*
- [NEW] *LAB*, *XYZ* named tuples + conversions
- [NEW] *StringReplacerChain* filter
- [NEW] *Style*, *SgrRenderer* and *TmuxRenderer* support of all the above
- [NEW] `TemplateEngine` comment support
- [NEW] `Tracers` auto-width mode
- [NEW] `utilmisc` color transform methods overloaded
- [NEW] add *ColorTarget* enum as there are three extended color modes instead of two
- [NEW] add `SubtypedParam` support that allows specifying SGRs with subparams like 'ESC[4:3m'
- [NEW] implement missing 1st-level sequence classes
- [NEW] IntCodes: `FRAMED` (+``_OFF``), `UNDERLINE_COLOR_EXTENDED` (+``_OFF``)
- [NEW] math rendering as png
- [NEW] SeqIndex: `CURLY_UNDERLINED`, `FRAMED`, `FRAMED_OFF`
- [REFACTOR] split `commons` into `log` and `excepiton` modules
- [REFACTOR] `TemplateEngine`
- [REFACTOR] color resolver
- [REFACTOR] made `measure` and `trace` private
- [REFACTOR] sequence internal composition
- [REFACTOR] split `PYTERMOR_OUTPUT_MODE` env var into `PYTERMOR_FORCE_OUTPUT_MODE` and `PYTERMOR_AUTO_OUTPUT_MODE`
- [REWORK] `util*` -> *numfmt*, *filter*, `conv`
- [REWORK] doc pages tree
- [TESTS] 83% coverage
- [TESTS] *Style*/`IColor` reprs
- [TESTS] coverage 87%

- [TESTS] moar
- [UPDATE] Update coverage.yml

### 11.1.4 v2.48-dev

Apr 23

- [DOCS] small fixes
- [DOCS] updated changelog
- [FIX] *measure_char_width* and *get_char_width* internal logic
- [FIX] pipelines
- [FIX] *AbstractTracer* failure on empty input
- [FIX] *StaticFormatter* padding
- [FIX] bug in *SimpleTable* renderer when row is wider than a terminal
- [FIX] debug logging
- coverage git ignore
- `cli-docker` make command
- `Dockerfile` for repeatable builds
- `hatch` as build backend
- copyrights update
- host system/docker interchangable building automations
- [NEW] *format_time*, *format_time_ms*, *format_time_ns*
- [NEW] `Hightlighter` from static methods to real class
- [NEW] `lab_to_rgb()`
- [NEW] numeric formatters fallback mechanics
- [REFACTOR] `TDF_REGISTRY` -> `dual_registry`- ``FORMATTER_` constants from top-level imports
- [REFACTOR] `utilnum._TDF_REGISTRY` -> `TDF_REGISTRY`
- [REFACTOR] edited highlighter styles
- [REFACTOR] naming:
  - `CustomBaseUnit` -> *DualBaseUnit*
  - `DynamicBaseFormatter` -> *DynamicFormatter*
  - `StaticBaseFormatter` -> *StaticFormatter*
- [TESTS] numeric formatters colorizing
- [UPDATE] README
- [UPDATE] license is now Lesser GPL v3

### 11.1.5 v2.40-dev

Feb 23

- [DOCS] `changelog` update
- [DOCS] `utilnum` module
- [DOCS] rethinking of references style
- [FIX] *`parse`* method of TemplateEngine
- [FIX] *`Highlighter`*
- [FIX] critical *`Styles`* color
- 2023 copytight update
- [NEW] `coveralls.io` integration
- [NEW] *`echoi`*, *`flatten`*, *`flatten1`* methods; *`SimpleTable`* class
- [NEW] *`StringLinearizer`*, *`WhitespaceRemover`*
- [NEW] *`text`* Fragments validation
- [NEW] *Configuration* class
- [NEW] `hex` rst text role
- [NEW] `utilnum.format_bytes_human()`
- [NEW] add `es7s C45/Kalm` to rgb colors list
- [NEW] methods `percentile` and `median` ; `render_benchmark` example
- [REFACTOR] *`IRenderable`* rewrite
- [REFACTOR] *`distribute_padded`* overloads
- [REFACTOR] attempt to break cyclic dependency of `util.*` modules
- [REFACTOR] moved color transformations and type vars from `_commons`
- [TESTS] additional coverage for `utilnum`

### 11.1.6 v2.32-dev

Jan 23

- [DOCS] `utilnum` update
- [DOCS] docstrings, typing
- [DOCS] `utilnum` module
- [FIX] `format_prefixed` and *`format_auto_float`* inaccuracies
- [FIX] `Text.prepend` typing
- [FIX] *`TmuxRenderer`* RGB output
- [NEW] *`Color256`* aliases “colorNN”
- [NEW] *`Highlighter`* from `es7s`, colorizing options of `utilnum` helpers
- [NEW] *`IRenderable`* result caching
- [NEW] *`pad`*, *`padv`* helpers
- [NEW] `prefix_refpoint_shift` argument of PrefixedUnitFormatter
- [NEW] `PrefixedUnitFormatter` inheritance

- [NEW] `String` and `FixedString` base renderables
- [NEW] *style.merge_styles()*
- [NEW] `Renderable` __eq__ methods
- [NEW] `StyledString`
- [NEW] `utilmisc` get_char_width(), guess_char_width(), measure_char_width()
- [NEW] style merging strategies: *merge_fallback()*, *merge_overwrite*
- [NEW] subsecond delta support for `TimeDeltaFormatter`
- [TESTS] `utilnum` update
- [TESTS] integrated in-code doctests into pytest

### 11.1.7 v2.23-dev

- [FIX] `OmniHexPrinter` missed out newlines
- [NEW] *dump* printer caching
- [NEW] `Printers` and `Mappers`
- [NEW] *SgrRenderer* now supports non-default IO stream specifying
- [NEW] `utilstr.StringHexPrinter` and `utilstr.StringUcpPrinter`
- [NEW] add missing `hsv_to_rgb` function
- [NEW] extracted *resolve*, *approximate*, *find_closest* from *Color* class to module level, as well as color transform functions
- [NEW] split *Text* to *Text* and *FrozenText*

### 11.1.8 v2.18-dev

- [FIX] Disabled automatic rendering of *echo()* and *render()*.
- [NEW] *ArgCountError* migrated from `es7s/core`.
- [NEW] `black` code style.
- [NEW] *cval* autobuild.
- [NEW] Add `OmniHexPrinter` and *chunk()* helper.
- [NEW] Typehinting.

### 11.1.9 v2.14-dev

Dec 22

- [DOCS] Docs design fixes.
- [NEW] *confirm()* helper command.
- [NEW] `EscapeSequenceStringReplacer` filter.
- [NEW] `examples/terminal_benchmark` script.
- [NEW] `StringFilter` and `OmniFilter` classes.
- [NEW] Minor core improvements.
- [NEW] RGB and variations full support.
- [TESTS] Tests for *color* module.

### 11.1.10 v2.6-dev

Nov 22

- [NEW] `TemplateEngine` implementation.
- [NEW] *`Text`* nesting.
- [REFACTOR] Changes in `ConfigurableRenderer.force_styles` logic.
- [REFACTOR] Got rid of `Span` class.
- [REFACTOR] Package reorganizing.
- [REFACTOR] Rewrite of *`color`* module.

### 11.1.11 v2.2-dev

Oct 22

- [NEW] *`TmuxRenderer`*
- [NEW] *`wait_key()`* input helper.
- [NEW] Color config.
- [NEW] IRenderable` interface.
- [NEW] Named colors list.

### 11.1.12 v2.1-dev

Aug 22

- [NEW] Color presets.
- [TESTS] More unit tests for formatters.

### 11.1.13 v2.0-dev

Jul 22

- [REWORK] Complete library rewrite.
- [DOCS] `sphinx` and `readthedocs` integraton.
- [NEW] High-level abstractions *`Color`*, *`Renderer`* and *`Style`*.
- [TESTS] `pytest` and `coverage` integration.
- [TESTS] Unit tests for formatters and new modules.

### 11.1.14 v1.8

Jun 22

- [NEW] `format_prefixed_unit` extended for working with decimal and binary metric prefixes.
- [NEW] `sequence.NOOP` SGR sequence and `span.NOOP` format.
- [NEW] *`format_time_delta`* extended with new settings.
- [NEW] Added 3 formatters: `format_prefixed_unit`, *`format_time_delta`*, *`format_auto_float`*.
- [NEW] Max decimal points for `auto_float` extended from (2) to (max-2).
- [REFACTOR] Utility classes reorganization.

- [REFACTOR] Value rounding transferred from *format_auto_float* to format_prefixed_unit.
- [TESTS] Unit tests output formatting.

### 11.1.15 v1.7

May 22

- [FIX] Print reset sequence as \e[m instead of \e[0m.
- [NEW] Span constructor can be called without arguments.
- [NEW] Added span.BG_BLACK format.
- [NEW] Added *ljust_sgr*, *rjust_sgr*, *center_sgr* util functions to align strings with SGRs correctly.
- [NEW] Added SGR code lists.

### 11.1.16 v1.6

- [REFACTOR] Renamed code module to sgr because of conflicts in PyCharm debugger (pydevd_console_integration.py).
- [REFACTOR] Ridded of EmptyFormat and AbstractFormat classes.
- [TESTS] Excluded tests dir from distribution package.

### 11.1.17 v1.5

- [REFACTOR] Removed excessive EmptySequenceSGR – default SGR class was specifically implemented to print out as empty string instead of \e[m if constructed without params.

### 11.1.18 v1.4

- [NEW] Span.wrap() now accepts any type of argument, not only *str*.
- [NEW] Added equality methods for *SequenceSGR* and Span classes/subclasses.
- [REFACTOR] Rebuilt Sequence inheritance tree.
- [TESTS] Added some tests for fmt.* and seq.* classes.

### 11.1.19 v1.3

- [NEW] Added span.GRAY and span.BG_GRAY format presets.
- [REFACTOR] Interface revisioning.

### 11.1.20 v1.2

- [NEW] EmptySequenceSGR and EmptyFormat classes.
- [NEW] opening_seq and closing_seq properties for Span class.

### 11.1.21 v1.1

Apr 22

- [NEW] Autoformat feature.

### 11.1.22 v1.0

- First public version.

### 11.1.23 v0.90

Mar 22

- First commit.

# 12

# LICENSE

```
                    Version 3, 29 June 2007

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       Library.  A suitable mechanism is one that (a) uses at run time
       a copy of the Library already present on the user's computer
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# 13

# DOCS GUIDELINES

(mostly as a reminder for myself)

## 13.1 General

- Basic types and built-in values should be surrounded with asterisks:

  `*True*` → *True*

  `*None*` → *None*

  `*int*` → *int*

- Library classes, methods, etc. should be enclosed in single backticks in order to become a hyperlinks:

  `` `SgrRenderer.render()` `` → *SgrRenderer.render()*

  If class name is ambiguous (e.g., there is a glossary term with the same name), the solution is to specify the type explicitly:

  `:class:`.Style`` → *Style*

- Argument names and string literals that include escape sequences or their fragments should be wrapped in double backticks:

  ``` ``arg1`` ``` → `arg1`

  ``` ``ESC [31m ESC [m`` ``` → `ESC [31m ESC [m`

  On the top of that, ESC control char should be padded with spaces for better readability. This also triggers automatic application of custom style for even more visual difference.

- Any formula should be formatted using LaTeX syntax (`:math:` role or `.. math::` directive):

$$d_{min} = 350 * 10^{-3}$$

## 13.2 Hexadecimals

Hexadecimal numbers should be displayed using `:hex:` role (applies to all examples below except the last one). In general, when the characters are supposed to be typed manually, or when the result length is 6+ chars, it's better to use lower case; when the numbers are distinct or "U+" notation is used, the upper case is acceptable:

**separate bytes**
: 0x1B 0x23 0x88

**Unicode codepoints**
: U+21BC ; U+F0909

**hex dump**
: "0x 00 AF 00 BB 11 BD AA B5"

**UTF-8**
: e0a489 efbfbe efbfaf f0af8cb3

**RGB colors (*int*/*str* forms)**
: 0xeb0c0c ; #ff00ff

escaped strings

```
"\u21bc", "\U000f0909", re.compile(R"\x1b\[[0-9;]*m")
```

## 13.3 References

| | | |
|---|---|---|
| External pages | github and gitlab | `` `github`_ and `gitlab <//gitlab.com>`_ ``<br><br>`.. _github: //github.com` |
| External pydoc | `re.Match` | `:class:`re.Match`` |
| Internal page | *Guide · Low-level* or *high-level* | `` `guide-lo` or `high-level <guide-hi>` `` |
| Internal page setup [1] | `.. _guide.core-api-1:` | |
| Internal pydoc | *wait_key()*, *Style* | `` `wait_key()`, :class:`.Style` `` |
| Internal anchor | *References* | `` `References`_ `` |
| Term in glossary | *rendering* | `:term:`rendering`` |
| Inlined definition | classifier for 1st time …<br>… or *classifier* later | `:def:`classifier` for 1st time ...`<br>`... or *classifier* later` |
| Abbreviation | EL | `:abbr:`EL (Erase in Line)`` |

## 13.4 Headers

### 13.4.1 Section header

#### Subsection header

##### Paragraph header

###### Rubric

```
##########################
Docs guidelines
##########################
.. part header

=================
```

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```
Headers
================
.. chapter header

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Section header
---------------

Subsection header
-------------------

Paragraph header
""""""""""""""""""""

.. rubric:: Rubric

.. code-block:: rst

   ...
```

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