

pytermor

Release 2.108.0

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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.

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

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 terminal emulators;
- *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 control 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.

Contents

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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

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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)

This is red This is white This is black on yellow
```

2.2 Content-aware format nesting

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

```
import pytermor as pt

s = ":[fg=red]fg :[bg=blue]and bg :[fg=black]formatting with:[-] overlap:[-] support"
pt.echo(pt.TemplateEngine().substitute(s))

fg and bg formatting with overlap support
```

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. A color defined in any of these can be transparently translated into any other:

```
import pytermor as pt

col = pt.RGB(0xDA9AC4)
st = pt.Style(fg=col)
for v in [col.rgb, col.hsv, col.xyz, col.lab]:
    pt.echo(repr(v), st)

RGB[#DA9AC4][R=218 G=154 B=196]
HSV[H=321° S=29% V=85%]
XYZ[X=50.43 Y=42.00% Z=57.66]
LAB[L=70.872% a=30.339 b=-12.031]
```

2.5 Named colors collection

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

```
$ /run-cli examples/list_named_rgb.py
                        blood
                        crimson
                        blood-red
                        sangria
                        alabama-crimson
                        crimson-glory
                        ue-red
                        vivid-crimson
                        utah-crimson
    2458
                        carmine m-p
    2459
                        cadmium-red
                        nintendo-red
                        spanish-red
                        ku-crimson
    2463
                        red munsell
                        fire-engine-red
    2464
                        ruddy
```

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:

```
This is red This is white This is black on yellow

<span style="color: #800000">This is red </span><span style="">This is white
</span><span style="background-color: #ffff00; color: #000000">This is black on
yellow</span>

#[fg=red]This is red #[fg=default]This is white #[fg=black bg=#ffff00]This is black
on yellow#[fg=default bg=default]

(.[31m)This is red (.[39m)This is white (.[30;48;5;11m)This is black on
yellow(.[39;49m))
```

2.7 Number formatters

Set of highly customizable helpers, see *numfmt*.

format_si() output sample

306	961	3.02 k	306	961		
9.49 k	29.8 k	93.6 k				
294 k	924 k	2.90 M			2.90 M	
9.12 M	28.7 M	90.0 M	9.12 M	28. 7 M	90.0 M	
283 M	889 M	2.79 G	283 M	889 M	2.79 G	

format_time_ns() output samples

3 µs	961 ns	306 ns	3µs	961ns	306ns
93 μs	29 μs	9 µs	93µs	29µs	9µs
	924 µs	294 µs	2ms	924µs	294µs
			90ms	28ms	9ms
2 s			2s	888ms	282ms
	27 s	8 s	1 m	27s	8s
			44m	14m	4 m
23 h	7 h	2 h	23h	7h	2h
4 w	1 w	3 d	4 w	1w	3d
	9 mo	3 mo	2yr	9mo	3mo

format_time_delta() output sample

9.87s	31.0s	1 min	9. 87s	31. 0s	
5 mins	16 mins	50 mins			
2h 38min	8h 16min	1d 2h	2 h 38min	8 h 1 6min	1d 2h
3d 9h	10 days	1 month	3 d 9 h	10 days	1 month
3 months	11 months	2 years	3 months	11 months	

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 <code>dump()</code> 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
```

Listing 2: Decomposition into UTF-8 sequences by StringTracer

0	ī	3d	efbfbd	39	05	efbfbd	54	efbfbd	efbfbd	 =9⋅T
8	l	efbfbd	$\pmb{\text{efbfbd}}$	efbfbd	4c	efbfbd	$\pmb{\text{efbfbd}}$	75	ddbc	Lu
16	l	02	0 d	0a	7a	efbfbd	$\pmb{\text{efbfbd}}$	40	76	·z@v
24	ı	4 b	36	1c	00	efbfbd	02	efbfbd	61	K6···a
32	l	45	${\tt efbfbd}$	efbfbd	cdb6	71	02	4f	52	Eq · OR

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```
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 |\\u00fc\u00e4\u00e4\u00e4\u00e4

88 | efbfbd 30 efbfbd 6a efbfbd 74 efbfbd efbfbd |0jt

96 | 4a 30 4f efbfbd 38 71 dfb2 39 |J008q9

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
```

Listing 3: Decomposition into Unicode codepoints by StringUcpTracer

```
3D FFFD 39
                       05 FFFD 54 FFFD FFFD FFFD FFFD |=9·T
  0 U+
        4C FFFD FFFD 75 77C 02 0D 0A 7A FFFD FFFD |Lu \cdot z|
 11 | U+
 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 41 72 54 6D 2B UMArTm+
 66 IU+
         03 FFFD FFFD FFFD 28 FFFD 3E FFFD FFFD 4E | (>N
 77 | U+ 30 5C 6B 5C D9 FFFD FFFD 24 FFFD 43 | 0\k\\\0000$\cdot\0000$C88 | U+ FFFD 30 FFFD 6A FFFD 74 FFFD FFFD 4A 30 4F | 0jtJ00 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
                                                        0n
-----(124)
```

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EXAMPLES

Most basic example:

```
import pytermor as pt

pt.force_ansi_rendering()
pt.echo('RED', 'red')
pt.echo('GREEN', pt.cv.GREEN)
pt.echo("This is warning, be warned", pt.Styles.WARNING)

red text
green text
This is warning, be warned
```

For more advanced ones proceed to the next section.

3.1 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.

3.1.1 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 ways 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 (highlighted line). 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 (continues on next page)
```

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```
data = [
        ("clone", "Clone a repository into a new directory"),
5
        ("init", "Create an empty Git repository or reinitialize an existing one"),
6
    1
    st = pt.Style(fg=pt.cv.GREEN)
    for name, desc in data:
10
        frag = pt.Fragment(name.ljust(16), st)
11
        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
2
   data = [
       ("bisect", "Use binary search to find the commit that introduced a bug"),
       ("diff", "Show changes between commits, commit and working tree, etc"),
5
       ("grep", "Print lines matching a pattern"),
6
   ]
   st = pt.Style(fg=pt.cv.GREEN)
   for name, desc in data:
10
       frag = pt.Fragment(name, st)
11
       pt.echo(f" {frag:<16s}</pre>
                                   {desc}")
       bisect
                          Use binary search to find the commit that introduced a bug
       diff
                          Show changes between commits, commit and working tree, etc
                          Print lines matching a pattern
       grep
```

Texts & FrozenTexts

3.1. Rendering

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 preceding 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,
    ")"
```

(continues on next page)

10

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```
pt.echo(text)
work on the current change (see also: git help everyday)
```

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
2
    data = [
3
        ("add", "Add file contents to the index"),
        ("mv", "Move or rename a file, a directory, or a symlink"),
        ("restore", "Restore working tree files"),
6
    1
    st = pt.Style(fg=pt.cv.GREEN)
8
    for name, desc in data:
10
        pt.echo([pt.FrozenText(" ", name, st, width=18, pad=4), desc])
11
       add
                          Add file contents to the index
                          Move or rename a file, a directory, or a symlink
       mv
                          Restore working tree files
       restore
```

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 <code>text.echo()</code> accepts a single <code>RT</code> as a first argument, it also accepts a sequence of them, which allows us to call echo just once. <code>common.RT</code> is a type var including <code>str</code> type and all <code>IRenderable</code> 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]
3
   :[st]grow, mark and tweak your common history:[-]
     :[cmd]branch:[-]
                                 List, create, or delete branches
     :[cmd]commit:[-]
                                 Record changes to the repository
                                 Join two or more development histories together
     :[cmd]merge:[-]
  pt.echo(pt.TemplateEngine().substitute(s))
      branch
                         List, create, or delete branches
       commit
                         Record changes to the repository
                         Join two or more development histories together
      merge
```

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 = """
                           Download objects and refs from another repository
       fetch
                           Fetch from and integrate with another repository or a local.
      pull
    ⇔branch
      push
                           Update remote refs along with associated objects
8
   regex = re.compile(r''^(\S+)(\S+)(.+)\$'')
10
   for line in s.splitlines():
11
        pt.echo(
12
            regex.sub(
13
                 pt.render(r''\setminus 1'' + pt.Fragment(r''\setminus 2'', pt.cv.GREEN) + r''\setminus 3''),
14
                 line,
15
            )
16
        )
17
        fetch
                            Download objects and refs from another repository
                            Fetch from and integrate with another repository or a local
        pull
     branch
        push
                            Update remote refs along with associated objects
```

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 **filters**) 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 = """
4
                         Reset current HEAD to the specified state
5
      reset
                         Switch branches
      switch
                         Create, list, delete or verify a tag object signed with GPG
8
9
   class SgrNamedGroupsRefilter(pt.AbstractNamedGroupsRefilter):
10
       def _render(self, v: pt.IT, st: pt.FT) -> str:
11
            return pt.render(v, st, pt.SgrRenderer)
12
13
   f = SgrNamedGroupsRefilter(
14
        re.compile(r''(\s+)(?P<\cmd>\s+)(.+)''),
15
        {"cmd": pt.cv.GREEN},
16
17
   )
18
   pt.echo(pt.apply_filters(s, f))
19
                           Reset current HEAD to the specified state
        reset
        switch
                           Switch branches
                           Create, list, delete or verify a tag object signed with GPG
```

3.1.2 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 ready-to-print strings as if they were rendered by *SgrRenderer*. Methods with names starting with make_ return single sequence instance each, while methods named compose_* return *str*ings which are several sequences rendered and concatenated.

In the next example we create an SGR which sets background color to #008787 (highlighted line) by specifying xterm-256 code 30 (see *xterm-256 palette*), then compose a string which includes:

- CUP (Cursor Position) instruction: ESC [1;1H;
- SGR instruction with our color: ESC [48;5;30m;
- EL (Erase in Line) instruction: ESC [OK.

Effectively this results in a whole terminal line colored with a specified color, 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 \sim 10-20 characters of input instead of 120+ (average terminal width).

```
import pytermor as pt

col_sgr = pt.make_color_256(30, pt.ColorTarget.BG)
seq = pt.compose_clear_line_fill_bg(col_sgr)
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 <code>ansi.enclose()</code>, 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")
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="")
imported rich.inspect
```

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:

```
import pytermor as pt

print(pt.SequenceCSI("J", 2).assemble(), end="")

# which is equivalent to:
print(pt.make_erase_in_display(2).assemble(), end="")
```

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.

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[1;1H\x1b[41m\x1b[0K', end="(00)")
```

...things get worse pretty fast:

```
print('\x1b[1;1H\x1b[38;2;232;232;22m\x1b[1;41m\x1b[0K', end="(°°)")
```

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

```
import pytermor as pt
print(
   pt.make_reset_cursor(),
   pt.make_color_rgb(232, 232, 22),
   pt.ansi.SeqIndex.BOLD,
   pt.ansi.SeqIndex.BG_RED,
   pt.make_erase_in_line(),
   sep="", end="(°~°)",
   )
}
```

Or doing the same with high-level abstractions instead:

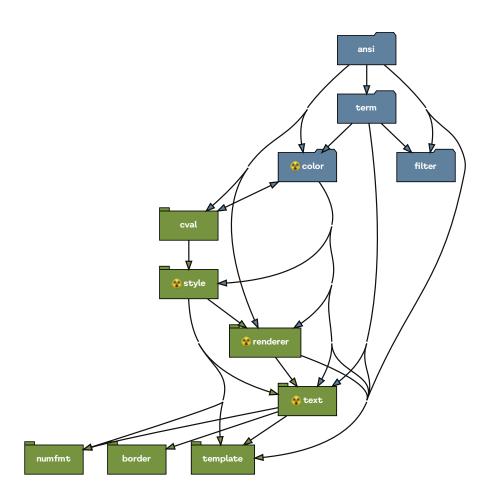
```
import pytermor as pt
st = pt.Style(fg=0xe8e816, bg='red', bold=True)
fill = pt.compose_clear_line_fill_bg(st.fg.to_sgr())
pt.echo(fill + "(°v°)", st)

(°v°)
```

Note: The last example also automatically resets the terminal back to normal state, so that the text that is printed afterwards doesn't have any formatting, in contrast with other examples requiring to assemble and print <code>SeqIndex.COLOR_OFF</code> and <code>SeqIndex.BG_COLOR_OFF</code> (or just <code>SeqIndex.RESET</code>) at the end (which is omitted).

LIBRARY STRUCTURE

ansi	Classes for working with ANSI escape sequences on a lower level.
border	
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 <i>Style</i> instances into lower-level abstractions like <i>SGR sequences</i> , 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.



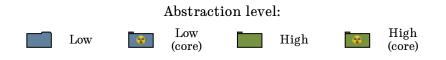


Fig. 1: Module dependency graph $^{\rm Page~19,~2}$

 $[\]overline{}^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 $\underline{}$.

5

GUIDE · **HIGH-LEVEL**

5.1 Core APII

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,])	
	•
<pre>color.resolve_color(subject[, color_type,])</pre>	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

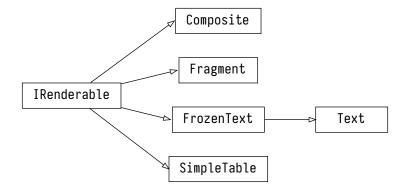


Fig. 1: IRenderable inheritance diagram

5.2. Text fragments

5.3 Styles

5.4 Colors

5.4.1 Color mode fallbacks

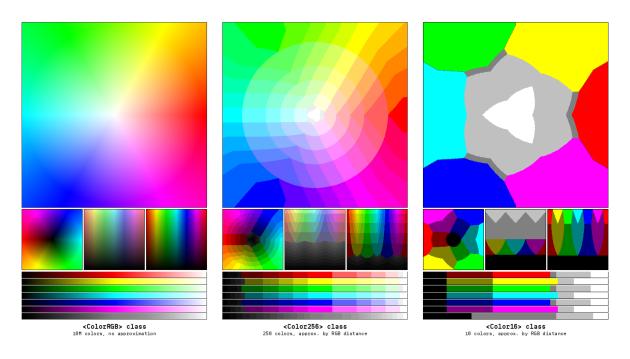


Fig. 2: Color approximations for indexed modes

5.3. Styles 22

5.4.2 Color class hierarchy

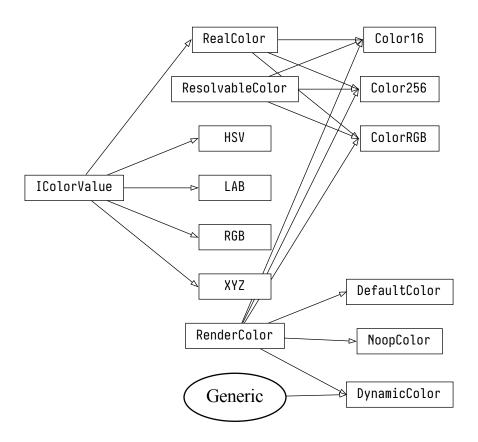


Fig. 3: Color inheritance diagram

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 <code>RendererManager.set_default()</code> sets the default renderer globally. After that calling <code>render()</code> will automatically invoke a said renderer and apply the required formatting (but only if

5.5. fargs syntax 23

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></any>			Config.force_output_mode ²
No	<any></any>		NO_ANSI
Yes	xterm-256color	24bit, truecolor	TRUE_COLOR
	*-256color ³	<any></any>	XTERM_256
	xterm-color	<any></any>	XTERM_16
	xterm	<any></any>	NO_ANSI
	<any other=""></any>	<any></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).

5.6. Renderers 24

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.

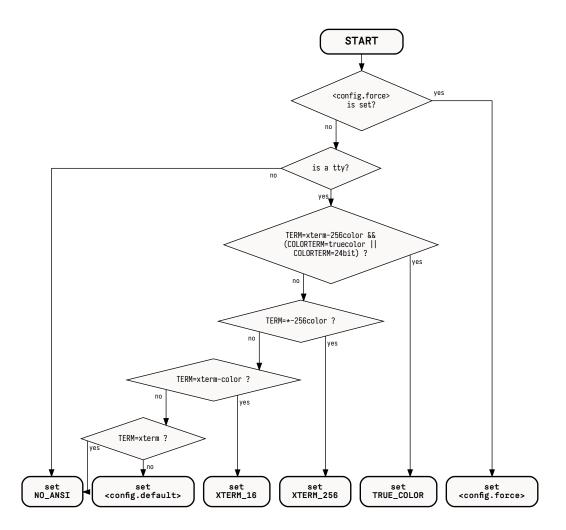


Fig. 4: Auto output mode algorithm

5.6. Renderers 25

5.6.4 🚠 Renderer class hierarchy

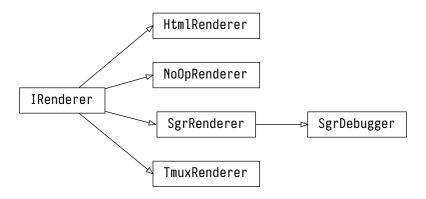


Fig. 5: IRenderer inheritance tree

5.7 Templates

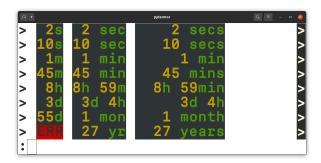
5.8 Number formatters

Todo: The library contains @TODO

5.8.1 Auto-float formatter

5.8.2 Prefixed-unit formatter

5.8.3 Time delta formatter



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5.8.4 🚠 Formatter class hierarchy

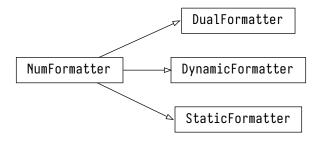


Fig. 6: NumFormatter inheritance tree

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 vary-
		ing 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 lin-
		early translates into [0x00; 0xFF] for each chan-
		nel. The result value is composed as "#RRGGBB".
		For example, a sequence with color of #ff3300
		can be created with::.
color.Color256.to_sgr([target,	up-	Make an SGR sequence out of Color.
per_bound])		
<pre>color.find_closest(value[, color_type])</pre>		Search and return nearest to value instance of
		specified color_type.

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:

We put these pieces together to create a SCR command. Thus, ESC[1m] specifies bold (or bright) text, and ESC[31m] specifies red foreground text. We can chain together parameters; for example, ESC[32;47m] specifies green foreground text on a white background.

The following diagram shows a complete example for rendering the word "text" in red with a single underline.

Sec. character

Final Byte

Sec. character

Parameters

In Hex ASCI

Notes

For terminals that support bright foreground colors, ESC[3;38m] is usually equivalent to ESC[80m] (where x is a digit in 0-7), However, the reverse does not seem to hold, at least anecdotally: ESC[2;38m] usually does not render the same as ESC[30m].

Not all terminals support every effect.

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*.

```
> ()]
> b'(\x1b[4;7m)'
> 28:1b:5b:34:3b:37:6d:29
> :
```

- 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

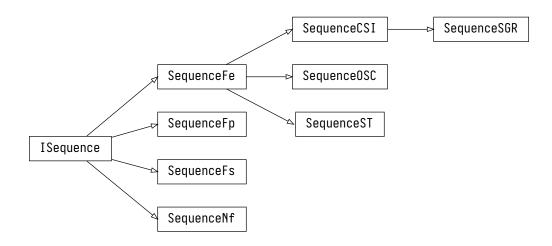


Fig. 2: ISequence inheritance tree

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
leta			
NOOP		V	No-operation; always assembled as empty string
RESET	0		Reset all attributes and colors
ttributes			
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	\mathbf{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
esetters	·		
BOLD_DIM_OFF	22	T	Disable BOLD and DIM attributes. Special aspects
2022_211_011			It's impossible to reliably disable them on a separat
			hasis.
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
DG_COLOIL_OI I	13		Disable overlining

6.3.2 Color16 presets

	Name	INT	STY	RGB code	XTerm name					
For	Foreground default colors									
	BLACK	30		#000000	Black					
	RED	31		#800000	Maroon					
	GREEN	32		#008000	Green					

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
YELLOW	33		#808000	Olive
BLUE	34		#000080	Navy
MAGENTA	35		#800080	Purple
CYAN	36		#008080	Teal
WHITE	37		#c0c0c0	Silver
Background <i>default</i> 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
	fault colors			
High-intensity foreground <i>det</i>	fault colors		#808080	Grey
High-intensity foreground def			#808080 #ff0000	Grey Red
High-intensity foreground <i>det</i>	90			
High-intensity foreground det GRAY HI_RED	90 91		#ff0000	Red
High-intensity foreground def GRAY HI_RED HI_GREEN	90 91 92		#ff0000 #00ff00	Red Lime
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW	90 91 92 93		#ff0000 #00ff00 #ffff00	Red Lime Yellow
High-intensity foreground det GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE	90 91 92 93 94		#ff0000 #00ff00 #ffff00 #0000ff	Red Lime Yellow Blue
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA	90 91 92 93 94 95		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff	Red Lime Yellow Blue Fuchsia
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE	90 91 92 93 94 95 96		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff	Red Lime Yellow Blue Fuchsia Aqua
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN	90 91 92 93 94 95 96		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff	Red Lime Yellow Blue Fuchsia Aqua
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def	90 91 92 93 94 95 96 97		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff #ffffff	Red Lime Yellow Blue Fuchsia Aqua White
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def BG_GRAY	90 91 92 93 94 95 96 97 efault colors		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff #ffffff	Red Lime Yellow Blue Fuchsia Aqua White
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def BG_GRAY BG_HI_RED	90 91 92 93 94 95 96 97 efault colors		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff #ffffff #808080 #ff0000	Red Lime Yellow Blue Fuchsia Aqua White Grey Red
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def BG_GRAY BG_HI_RED BG_HI_GREEN	90 91 92 93 94 95 96 97 efault colors		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff #ffffff #808080 #ff0000 #00ff00	Red Lime Yellow Blue Fuchsia Aqua White Grey Red Lime
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def BG_GRAY BG_HI_RED BG_HI_RED BG_HI_GREEN BG_HI_YELLOW	90 91 92 93 94 95 96 97 efault colors 100 101 102 103		#ff0000 #00ff00 #ffff00 #0000ff #ff00ff #00ffff #00ffff #ffffff #808080 #ff0000 #00ff00 #ffff00	Red Lime Yellow Blue Fuchsia Aqua White Grey Red Lime Yellow
High-intensity foreground def GRAY HI_RED HI_GREEN HI_YELLOW HI_BLUE HI_MAGENTA HI_CYAN HI_WHITE High-intensity background def BG_GRAY BG_HI_RED BG_HI_RED BG_HI_SELUE BG_HI_BLUE	90 91 92 93 94 95 96 97 efault colors 100 101 102 103		#ff0000 #00ff00 #ffff00 #ffff00 #0000ff #ff00ff #00ffff #ffffff #808080 #ff0000 #00ff00 #0000ff	Red Lime Yellow Blue Fuchsia Aqua White Grey Red Lime Yellow Blue

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	

Table 2 – continued from previous page

Name	INT	STY	RGB code	XTerm name
XTERM_LIME	10		#00ff00	
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		#5 f00 87	Purple4
XTERM_PURPLE_4	55		#5f00af	
XTERM_PURPLE_3	56		#5 f00 d7	
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

Table 2 – continued from previous page

Name	? – continu	STY	RGB code	XTerm name
XTERM_ROYAL_BLUE_1	63	011	#5f5fff	A Term manie
XTERM_CHARTREUSE_6	64		#5f8700	Chartreuse4
XTERM_DARK_SEA_GREEN_9	65		#5f875f	DarkSeaGreen4
XTERM_PALE_TURQUOISE_4	66		#5f8787	Darkseagreen+
XTERM_STEEL_BLUE	67		#5f87af	
XTERM_STEEL_BLUE_3	68		#5f87d7	
XTERM_CORNFLOWER_BLUE	69		#518747 #5f87ff	
XTERM_CHARTREUSE_5	70		#5faf00	Chartreuse3
XTERM_DARK_SEA_GREEN_8	70		#5faf5f	DarkSeaGreen4
XTERM_CADET_BLUE_2	72		#5faf87	CadetBlue
XTERM_CADET_BLUE	73		#5fafaf	Gauetblue
XTERM_SKY_BLUE_3	73		#5fafd7	
XTERM_STEEL_BLUE_2	75		#5fafff	SteelBlue1
				Chartreuse3
XTERM_CHARTREUSE_4	76		#5fd700	
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		#87 00 5f	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		#875 f00	Orange4
XTERM_LIGHT_PINK_3	95		#875 f 5f	LightPink4
XTERM_PLUM_4	96		#875 f 87	
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	<u> </u>
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

Table 2 – continued from previous page

Name	INT	STY	n previous page RGB code	XTerm name
XTERM_DARK_SLATE_GRAY_3	116	SIY	#87d7d7	A Termi manne
XTERM_SKY_BLUE_1	117		#87d7ff	
XTERM_CHARTREUSE_1	117		#87ff00	
XTERM_LIGHT_GREEN_2	119		#87ff5f	LightGreen
	119			LightGreen
XTERM_LIGHT_GREEN			#87ff87	
XTERM_PALE_GREEN_1	121		#87ffaf	
XTERM_AQUAMARINE_1	122		#87ffd7	
XTERM_DARK_SLATE_GRAY_1	123		#87ffff	D . 10
XTERM_RED_4	124		#af0000	Red3
XTERM_DEEP_PINK_6	125		#af005f	DeepPink4
XTERM_MEDIUM_VIOLET_RED	126		#af0087	N.F O
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
VIEVLITINDIWIN KEN 2	107		#U/ JIJI	HotPink3

Table 2 – continued from previous page

Name	INT	STY	RGB code	XTerm name
XTERM_HOT_PINK_3	169		#d75faf	HotPink2
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	1	#d7d75f	
XTERM_LIGHT_GOLDENROD_3	186	1	#d7d787	LightGoldenrod2
XTERM_LIGHT_YELLOW_3	187		#d7d7af	Zigin Gorucin ouz
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	Darkonvedreen
XTERM_DARK_SEA_GREEN_2	193		#d7ffaf	DarkSeaGreen1
XTERM_HONEYDEW_2	194		#d7ffd7	DarkSeagreen
XTERM_LIGHT_CYAN_1	195		#d7ffff	
XTERM_RED_1	196		#ff0000	
XTERM_DEEP_PINK_4	190		#ff005f	DeepPink2
XTERM_DEEP_PINK_2	197		#110031 #ff0087	DeepPink1
XTERM_DEEP_PINK_1	198		#110007 #ff00af	Беергикт
XTERM_MAGENTA_2	200		#ff00d7	
XTERM_MAGENTA_1	201		#ff00ff	
XTERM_ORANGE_RED_1	202		#ff5f00	
XTERM_INDIAN_RED_1	203		#ff5f5f	7 1' D 11
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

Table 2 – continued from previous page

Name	INT	STY	RGB code	XTerm name
XTERM_LIGHT_GOLDENROD_2	222		#ffd787	
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

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

		000	001	002	003	004	005	006	007		
		#000000	#800000	#008000	#808000 011	#000080 012	#800080 013	#008080	#c0c0c0 015		
					#ffff00			#00ffff			
016 #000000	022 #005f00	028 #008700	034 #00af00	040 #00d700	046 #00ff00	082 #5fff00	076 #5fd700	070 #5faf00	064 #5f8700	058 #5f5f00	052 #5f0000
017 #00005f	023 #005f5f	029 #00875f	035 #00af5f	041 #00d75f	047 #00ff5f	083 #5fff5f	077 #5fd75f	071 #5faf5f	065 #5f875f	059 #5f5f5f	053 #5f005f
018 #000087	024 #005f87	030 #008787	036 #00af87	042 #00d787	048 #00ff87	084 #5fff87	078 #5fd787	072 #5faf87	066 #5f8787	060 #5f5f87	054 #5f0087
019 #0000af	025 #005faf	031 #0087af	037 #00afaf	043 #00d7af	049 #00ffaf	085 #5fffaf	079 #5fd7af	073 #5fafaf	067 #5f87af	061 #5f5faf	055 #5f00af
020 #0000d7	026 #005fd7	032 #0087d7	038 #00afd7	044 #00d7d7	050 #00ffd7	086 #5fffd7	080 #5fd7d7	074 #5fafd7	068 #5f87d7	062 #5f5fd7	056 #5f00d7
021 #0000ff	027 #005fff	033 #0087ff	039 #00afff	045 #00d7ff	051 #00ffff	087 #5fffff	081 #5fd7ff	075 #5fafff	069 #5f87ff	063 #5f5fff	057 #5f00ff
093	099	105	111	117	123	159	153	147	141	135	129
#8700ff		#8787ff									
092 #8700d7	098 #875fd7	104 #8787d7	110 #87afd7	116 #87d7d7	122 #87ffd7	158 #afffd7	152 #afd7d7	146 #afafd7	140 #af87d7	134 #af5fd7	128 #af00d7
091 #8700af	097 #875faf	103 #8787af	109 #87afaf	115 #87d7af	121 #87ffaf	157 #afffaf	151 #afd7af	145 #afafaf	139 #af87af	133 #af5faf	127 #af00af
090 #870087	096 #875f87	102 #878787	108 #87af87	114 #87d787	120 #87ff87	156 #afff87	150 #afd787	144 #afaf87	138 #af8787	132 #af5f87	126 #af0087
089 #87005f	095 #875f5f	101 #87875f	107 #87af5f	113 #87d75f	119 #87ff5f	155 #afff5f	149 #afd75f	143 #afaf5f	137 #af875f	131 #af5f5f	125 #af005f
088	094	100 #878700	106	112	118	154	148	142	136	130	124
160	166	172	178	184	190	226	220	214	208	202	196
		#d78700									
161 #d7005f	167 #d75f5f	173 #d7875f	179 #dfaf5f	185 #dfdf5f	191 #dfff5f	227 #ffff5f	221 #ffdf5f	215 #ffaf5f	209 #ff875f	203 #ff5f5f	197 #ff005f
162 #d70087	168 #d75f87	174 #d78787	180 #dfaf87	186 #dfdf87	192 #dfff87	228 #ffff87	222 #ffdf87	216 #ffaf87	210 #ff8787	204 #ff5f87	198 #ff0087
163 #d700af	169 #d75faf	175 #d787af	181 #dfafaf	187 #dfdfaf	193 #dfffaf	229 #ffffaf	223 #ffdfaf	217 #ffafaf	211 #ff87af	205 #ff5faf	199 #ff00af
164	170	176	182	188 #dfdfdf	194	230	224 #ffdfdf	218 #ffafdf	212 #ff87df	206	200
#d700d7	#u/51u/	#d787d7	183	189	195	231	225	219	213	207	201
		#d787ff									
232	233	234	235	236	237	238	239	240	241	242	243
		#1c1c1c									
244 #808080	245 #8a8a8a	246 #949494	247 #9e9e9e	248 #a8a8a8	249 #b2b2b2	250 #bcbcbc	251 #c6c6c6	252 #d0d0d0	253 #dadada	254 #e4e4e4	255 #eeeeee

Fig. 3: Color256 mode palette

Sources

 ${\bf 1.\ https://www.tweaking4all.com/software/linux-software/xterm-color-cheat-sheet/}$

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-cla	ss sec	mend	es	_	_	_
	I b Clu	00 000	lucii	-	•	•	•

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

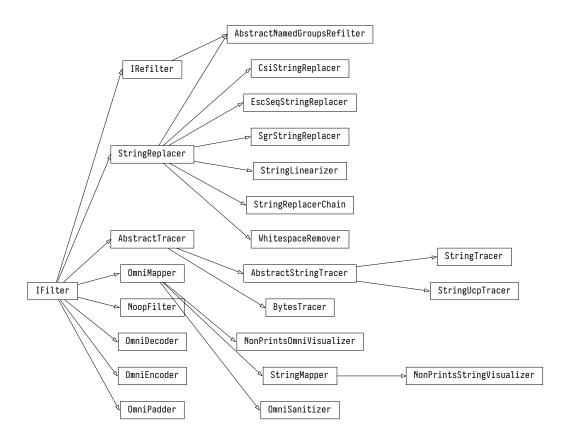


Fig. 4: *IFilter* inheritance tree

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6.8 Color spaces

6.8.1 🚠 Color space transitions

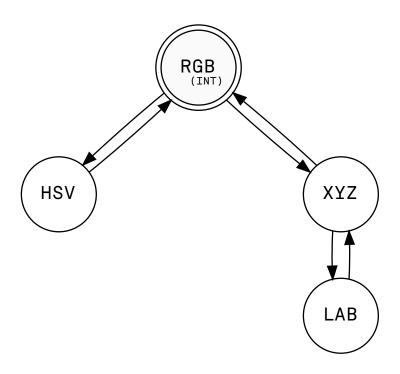


Fig. 5: Supported color spaces transition map

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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.
border	
color	Abstractions for color definitions in three primary modes: 4-bit, 8-bit and 24-bit (<i>xterm-16</i> , <i>xterm-256</i> and <i>True Color/RGB</i> , 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	Various general-purpose numeric formatters and highlighters with prefix auto-select suitable for any SI unit or a unitless value as well, plus dedicated methods for formatting time intervals from femtoseconds to years.
renderer	Renderers transform <i>Style</i> instances into lower-level abstractions like <i>SGR</i> sequences, tmux-compatible directives, HTML markup etc., depending on a 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 containing ren- derables classes that support high-level opera- tions such as nesting-aware style application, con- catenating and cropping of styled strings before the rendering, text alignment and wrapping, etc.

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).

A Sequence class hierarchy

Provides a bunch of ready-to-use sequence makers, as well as core method <code>get_closing_seq()</code> 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 <code>SgrRenderer</code> and is essential for nested style processing, as regular <code>RESET</code> 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 <i>has to</i> 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 es-
	cape sequences.

Functions

<pre>contains_sgr(string, *codes)</pre>	Return the first match of <i>SGR</i> sequence in string
	with specified codes as params, strictly inside a
	single sequence in specified order, or <i>None</i> if noth-
	ing was found.
enclose(opening_seq, string)	
	param opening seq
	purum opening_seq
not alonium ann(amamina ann)	
<pre>get_closing_seq(opening_seq)</pre>	
	param opening_seq
get_resetter_codes()	
parse(string)	
puz s (cumg)	norom atrina
	param string
<pre>seq_from_dict(groupdict)</pre>	

Classes

ColorTarget(value)	An enumeration.	
<pre>ISequence(classifier[, interm, final, abbr])</pre>	Abstract ancestor of all escape sequences.	
IntCode(value)	Complete or almost complete list of reliably work-	
	ing 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 se-	
	quence.	
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 func-	
	tions.	
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 \setminus (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 <code>assemble()</code> method or cast the instance to <code>str</code>, which internally does the same (this actually applies to all children of <code>ISequence</code>):

```
>>> 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 = \langle SGR[0m] \rangle
```

Hard reset sequence.

 $BOLD = \langle SGR[1m] \rangle$

Bold or increased intensity.

 $DIM = \langle SGR[2m] \rangle$

Faint, decreased intensity.

ITALIC = <SGR[3m]>

Italic (not widely supported).

 $UNDERLINED = \langle SGR[4m] \rangle$

Underline.

CURLY_UNDERLINED = <SGR[4:3m]>

Curly underline.

 $BLINK_SLOW = \langle SGR[5m] \rangle$

Set blinking to < 150 cpm.

 $BLINK_FAST = \langle SGR[6m] \rangle$

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

```
INVERSED = \langle SGR[7m] \rangle
```

Swap foreground and background colors.

$HIDDEN = \langle SGR[8m] \rangle$

Conceal characters (not widely supported).

$CROSSLINED = \langle SGR[9m] \rangle$

Strikethrough.

DOUBLE_UNDERLINED = <SGR[21m]>

Double-underline. On several terminals disables BOLD instead.

$FRAMED = \langle SGR[51m] \rangle$

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.

$BLINK_OFF = \langle SGR[25m] \rangle$

Disable blinking.

INVERSED_OFF = <SGR[27m]>

Disable inversing.

${\tt HIDDEN_OFF} \ = \ {\tt <SGR[28m]>}$

Disable conecaling.

CROSSLINED_OFF = <SGR[29m]>

Disable strikethrough.

$FRAMED_OFF = \langle SGR[54m] \rangle$

Disable border.

OVERLINED_OFF = <SGR[55m]>

Disable overlining.

UNDERLINE_COLOR_OFF = <SGR[59m]>

Reset underline color.

$BLACK = \langle SGR[30m] \rangle$

Set text color to 0x000000.

$RED = \langle SGR[31m] \rangle$

Set text color to 0x800000.

$GREEN = \langle SGR[32m] \rangle$

Set text color to 0x008000.

$YELLOW = \langle SGR[33m] \rangle$

Set text color to 0x808000.

 $BLUE = \langle SGR[34m] \rangle$

Set text color to 0x000080.

 $MAGENTA = \langle SGR[35m] \rangle$

Set text color to 0x800080.

 $CYAN = \langle SGR[36m] \rangle$

Set text color to 0x008080.

WHITE = $\langle SGR[37m] \rangle$

Set text color to 0xc0c0c0.

 $COLOR_OFF = \langle SGR[39m] \rangle$

Reset foreground color.

 $BG_BLACK = \langle SGR[40m] \rangle$

Set background color to 0x000000.

 $BG_RED = \langle SGR[41m] \rangle$

Set background color to 0x800000.

 $BG_GREEN = \langle SGR[42m] \rangle$

Set background color to 0x008000.

 $BG_YELLOW = \langle SGR[43m] \rangle$

Set background color to 0x808000.

 $BG_BLUE = \langle SGR[44m] \rangle$

Set background color to 0x000080.

 $BG_MAGENTA = \langle SGR[45m] \rangle$

Set background color to 0x800080.

 $BG_CYAN = \langle SGR[46m] \rangle$

Set background color to 0x008080.

 $BG_WHITE = \langle SGR[47m] \rangle$

Set background color to 0xc0c0c0.

 $BG_COLOR_OFF = \langle SGR[49m] \rangle$

Reset background color.

 $GRAY = \langle SGR[90m] \rangle$

Set text color to 0x808080.

 $HI_RED = \langle SGR[91m] \rangle$

Set text color to 0xff0000.

 $HI_GREEN = \langle SGR[92m] \rangle$

Set text color to 0x00ff00.

 $HI_YELLOW = \langle SGR[93m] \rangle$

Set text color to 0xffff00.

 $HI_BLUE = \langle SGR[94m] \rangle$

Set text color to 0x0000ff.

 $HI_MAGENTA = \langle SGR[95m] \rangle$

Set text color to 0xff00ff.

 $HI_CYAN = \langle SGR[96m] \rangle$

Set text color to 0x00ffff.

```
HI_WHITE = \langle SGR[97m] \rangle
           Set text color to 0xffffff.
     BG_GRAY = \langle SGR[100m] \rangle
           Set background color to 0x808080.
     BG_HI_RED = \langle SGR[101m] \rangle
           Set background color to 0xff0000.
     BG_HI_GREEN = \langle SGR[102m] \rangle
          Set background color to 0x00ff00.
     BG_HI_YELLOW = \langle SGR[103m] \rangle
           Set background color to 0xffff00.
     BG_HI_BLUE = \langle SGR[104m] \rangle
           Set background color to 0x0000ff.
     BG_HI_MAGENTA = \langle SGR[105m] \rangle
           Set background color to 0xff00ff.
     BG_HI_CYAN = \langle SGR[106m] \rangle
           Set background color to 0x00ffff.
     BG_HI_WHITE = \langle SGR[107m] \rangle
           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()
```

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>>> 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.

¹ ECMA-35 specification

Return type

re.Match | None

pytermor.ansi.parse(string)

Parameters

string(str) –

Return type

Iterable[pytermor.ansi.ISequence | str]

7.2 pytermor.border

BORDER_ASCII_SINGLE		
BORDER_ASCII_DOUBLE		
BORDER_LINE_SINGLE	•	
BORDER_LINE_SINGLE_ROUND		
BORDER_LINE_BOLD		
BORDER_LINE_DOUBLE	·	
DOINDERCEINE_DOODEE		
BORDER_LINE_DASHED		
BORDER_LINE_DASHED_2		
BORDER_LINE_DASHED_3	•	
BUNDER_LINE_DASHED_3	·	
BORDER_LINE_DASHED_BOLD		
BORDER_LINE_DASHED_BOLD_2		
BORDER_LINE_DASHED_BOLD_3	·	
BONDER_LINE_DASHED_BOLD_3	·	
BORDER_SOLID_18_COMPACT		
BORDER_SOLID_18_REGULAR		
DODDED COLED 10 DEACONAL	•	
BORDER_SOLID_18_DIAGONAL	·	
BORDER_SOLID_12_COMPACT		
BORDER_SOLID_12_REGULAR		
POPPER COLTR 12 PT1/COURT		
BORDER_SOLID_12_DIAGONAL		
BORDER_SOLID_12_EXTENDED		
Zorpytermor-border		5

BORDER_DOTTED_COMPACT

Classes

```
Border([l, lt, t, rt, lb, b, rb, r])

Attribute diagram.
```

class pytermor.border.Border($l='\xa0'$, $l='\xa0'$, $t='\xa0'$, $r='\xa0'$, $r='\xa0'$, $r='\xa0'$, $r='\xa0'$)

Attribute diagram:

```
LT T RT 3\times T

L R \rightarrow '''

LB B RB 3\times B
```

```
pytermor.border.BORDER_ASCII_SINGLE = Border(l='|', lt='+', t='-', rt='+', lb='+',
b='-', rb='+', r='|')
pytermor.border.BORDER_ASCII_DOUBLE = Border(l='#', lt='*', t='=', rt='*', lb='*',
b='=', rb='*', r='#')
pytermor.border.BORDER_LINE_SINGLE = Border(l='', lt='', t='', rt='', lb='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_SINGLE_ROUND = Border(l='', lt='', t='', rt='', lb='',
b='', rb='', r='')
pytermor.border.BORDER_LINE_BOLD = Border(l='', lt='', t='', rt='', lb='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_DOUBLE = Border(l='', lt='', t='', rt='', lb='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_DASHED = Border(1='', 1t='', t='', rt='', 1b='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_DASHED_2 = Border(l='', lt='', t='', rt='', lb='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_DASHED_3 = Border(1='', 1t='', t='', rt='', 1b='', b='',
rb='', r='')
pytermor.border.BORDER_LINE_DASHED_BOLD = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
```

```
pytermor.border.BORDER_LINE_DASHED_BOLD_2 = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
pytermor.border.BORDER_LINE_DASHED_BOLD_3 = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
pytermor.border.BORDER_SOLID_18_COMPACT = Border(1='', lt='\xa0', t='', rt='\xa0',
lb='\xa0', b='', rb='\xa0', r='')
pytermor.border.BORDER_SOLID_18_REGULAR = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
pytermor.border.BORDER_SOLID_18_DIAGONAL = Border(1='', 1t='\ue0bd', t='',
rt='\ue0bf', lb='\ue0bf', b='', rb='\ue0bd', r='')
pytermor.border.BORDER_SOLID_12_COMPACT = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
pytermor.border.BORDER_SOLID_12_REGULAR = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
pytermor.border.BORDER_SOLID_12_DIAGONAL = Border(1='', lt='', t='', rt='', lb='',
b='', rb='', r='')
pytermor.border.BORDER_SOLID_12_EXTENDED = Border(1=' ', 1t=' ', t=' ', rt=' ', 1b=' ',
b='', rb=' ', r=' ')
pytermor.border.BORDER_SOLID_FULL = Border(1=' ', 1t=' ', rt=' ', 1b=' ',
b=' ', rb=' ', r=' ')
pytermor.border.BORDER_DOTTED_COMPACT = Border(1='', 1t='', t='', rt='', 1b='', b='',
rb='', r='')
pytermor.border.BORDER_DOTTED_REGULAR = Border(1='', 1t='', t='', rt='', 1b='', b='',
rb='', r='')
pytermor.border.BORDER_DOTTED_DOUBLE = Border(l='', lt='', t='', rt='', lb='', b='',
rb='', r='')
pytermor.border.BORDER_DOTTED_DOUBLE_SEMI = Border(1='', 1t='', t='', rt='', 1b='',
b='', rb='', r='')
```

7.3 pytermor.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). 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.

♣ Color class hierarchy

♣ Color space transitions

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

Functions

<pre>approximate(value[, color_type, max_results])</pre>	Search for nearest to value colors of specified
	<pre>color_type and return the first max_results of</pre>
	them.
<pre>find_closest(value[, color_type])</pre>	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.

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Classes

ApxResult(color, distance)	Approximation result.
Color16(value, code_fg, code_bg[, name,])	Variant of a Color operating within the most ba-
coror ro (varae, code_18, code_58[, name,])	sic color set xterm-16 .
Color256(value, code[, name, approx,])	Variant of a Color operating within relatively
cororago (varae, codel, hame, upprox,)	modern xterm-256 indexed color table.
ColorRGB(value[, name, approx, register,])	Variant of a Color operating within RGB color
-, 11 , 6 , -	space.
DefaultColor()	Special Color instance rendering to SGR sequence telling the terminal to reset fg or bg color; same for <i>TmuxRenderer</i> . Useful when you inherit some <i>Style</i> 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 [0;360], Saturation channel [0;1] and Value channel [0;1] correspondingly.
IColorValue()	
LAB(lum, a, b)	Color value in a <i>uniform</i> color space, CIELAB, which expresses color as three values: L* for perceptual lightness [0;100] and a* [-100;100] and b* [-100;100] 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)	, c
RenderColor()	Abstract superclass for other Colors.
ResolvableColor(name, approx, register,)	Mixin for other Colors.
<i>XYZ</i> (x, y, z)	Color in XYZ space is represented by three floats: Y is the luminance [0;100], Z is quasi-equal to blue [0;100) (of CIE RGB), and X is a mix of the three CIE RGB curves chosen to be nonnegative [0;100).

class pytermor.color.RGB(value)

Bases: IColorValue

Color value stored internally as an 24-bit integer. Base for more complex color classes. Channels' values are within [0;255] range.

Initialize an instance with one integer value.

Parameters

value (*int*) – 24-bit integer in 0xRRGGBB format.

classmethod diff(c1, c2)

RGB euclidean distance

Return type float

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classmethod from_channels(red, green, blue)

Initialize a new instance with integer channel values.

Parameters

- red (int) Red channel value [0;255]
- green (int) Green channel value [0;255]
- blue (int) Blue channel value [0;255]

Return type

RGB

classmethod from_ratios(rr, gr, br)

Initialize a new instance with floating-point channel values.

Parameters

- rr (float) Red channel value [0;1]
- gr (float) Green channel value [0;1]
- **br** (*float*) Blue channel value [0;1]

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 [0;360], Saturation channel [0;1] and Value channel [0;1] correspondingly. Supports direct (fast) transformation to RGB and indirect (=slow) to all other spaces through using more than one conversion with HSV \rightarrow 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 [0;100], Z is quasi-equal to blue [0;100) (of CIE RGB), and X is a mix of the three CIE RGB curves chosen to be nonnegative [0;100). 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)

Color distance in XYZ space.

Warning: This one is written on the analogy of other diffs, just for the completeness, therefore it can actually be a little bit incorrect or even 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 \times 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 percep-
     tual lightness [0;100] and a* [-100;100] and b* [-100;100] 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 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 \times 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**(name, approx, register, code, aliases, variation_map=None)

```
Bases: Generic[_RCT]
```

Mixin for other Colors. Implements color searching by name and approximation (i.e., determining closest to specified value color from a set).

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 Result limit.

Return type

List[ApxResult[RCT]]

property name: str | None

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

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.

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).

Important: In general, you should not create your own instances of this class; it's possible, but meaningless, because all possible color values and SGR code mappings are created on library initialization by the library itself (see cv). What's more, this probably would cause value or code collisions with existing instances.

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".
- **approx** (*bool*) Allow to use this color for approximations.
- **register** (*bool*) Allow to resolve this color by name.
- **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 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 \times 8-bit ints)
     property xyz: XYZ
          Color value in XYZ space (three floats)
final class pytermor.color.Color256(value, code, name=None, *, approx=False, register=False,
                                         aliases=None, color16 equiv=None)
     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".
                • approx (bool) – Allow to use this color for approximations.
                • register (bool) – Allow to resolve this color 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

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 Result limit.

Return type

List[ApxResult[RCT]]

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```
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 \times 8-bit ints)
     property xyz: XYZ
          Color value in XYZ space (three floats)
final class pytermor.color.ColorRGB(value, name=None, *, approx=False, register=False,
                                         aliases=None, variation_map=None)
     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.

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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".
- approx (bool) Allow to use this color for approximations.
- register (bool) Allow to resolve this color 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 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 \times 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.
                   Casting to bool results in False for all NOOP instances in the library (NOOP_SEQ,
     Important:
```

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:

```
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 <code>DynamicColor</code> and define state type, which will be shared between all instances of a new class. Also concrete implementation of <code>update()</code> method is required, which should contain logic for transforming some external parameters into the state. State can be of any type, from plain <code>RGB</code> 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('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 immutable to ensure that the same input always resolves to the same output.

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

- **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 <code>find_closest</code> and <code>approximate</code> 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.

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 <code>approximate()</code>, which is unaware of caching mechanism altogether.

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.

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.

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

 $\verb|pytermor.color.approximate| (value, color_type=None, max_results=1)|$

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() returns list of results instead of the closest one;
- approximate() results also contain numeric distances from the target color to found ones;
- find_closest() caches the results, while approximate() ignores the cache completely.

- 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]]

7.4 pytermor.common

Module Attributes

CDT	CDT (Color descriptor type) represents a RGB
	color value.
CXT	:todo:`TODO`
FT	FT (Format type) is a style descriptor.
RT	RT (Renderable type) includes regular strs as well
	as IRenderable implementations.
filterf	Shortcut for filtering out falsy values from se-
	quences
filtern	Shortcut for filtering out Nones from sequences

Functions

but(cls, inp)	Return all elements from inp except instances of
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
<pre>cut(s, max_len[, align, overflow])</pre>	param s
filterfv(mapping)	Shortcut for filtering out falsy values from mappings
filternv(mapping)	Shortcut for filtering out None values from mappings
<pre>fit(s, max_len[, align, overflow, fill])</pre>	param s
<pre>flatten(items[, level_limit])</pre>	Unpack a list consisting of any amount of nested lists to 1d-array, or flat list, eliminating all the nesting.
<pre>flatten1(items)</pre>	Take a list of nested lists and unpack all nested elements one level up.
<pre>get_qname(obj)</pre>	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.
<pre>get_subclasses(target)</pre>	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 <i>are</i> instances of cls
others(cls, inp)	Return all elements from inp <i>except</i> instances of cls and its children classes.
ours(cls, inp)	Return all elements from inp that <i>are</i> 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.CXT
     :todo:`TODO`
     Unknown interpreted text role "todo".
     alias of TypeVar('CXT', int, str, IColorValue, RenderColor, None)
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 strs 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
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

7.5 pytermor.config

Library fine tuning module.

Classes

```
Config([renderer_class, force_output_mode, Configuration variables container.
...])
ConfigManager()
```

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

- 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.

- 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** (*boo1*) 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*.

7.6 pytermor.cval

Color preset list:

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

7.7 pytermor.exception

Exceptions

```
ArgCountError(actual, *expected)
 ArgTypeError(arg value,
                            arg name,
                                          *ex-
 pected_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.
```

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```
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.
```

7.8 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.

Filter class hierarchy

Module Attributes

SGR_SEQ_REGEX	Regular expression that matches <i>SGR</i> 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 punctua-
	tion (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

<pre>apply_filters(inp, *args)</pre>	Method for applying dynamic filter list to a target string/bytes.
<pre>center_sgr(string, width[, fillchar])</pre>	SGR-formatting-aware implementation of str.
	center.
<pre>dump(data[, tracer_cls, extra, force_width])</pre>	
<pre>get_max_ucs_chars_cp_length(string)</pre>	
	•
<pre>get_max_utf8_bytes_char_length(string)</pre>	СС
<pre>ljust_sgr(string, width[, fillchar])</pre>	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 <i>CSI</i> 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.
<pre>IRefilter(*args, **kwargs)</pre>	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.

$\verb"pytermor.filter.SGR_SEQ_REGEX"$

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 punctua-
     tion (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

ОT

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

Bases: IFilter[str, str]

apply(inp, extra=None)

Apply the filter to input str or bytes.

- 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

$\textbf{class} \ \ \textbf{pytermor.filter.WhitespaceRemover} (\textit{*args}, \textit{**kwargs})$

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*

 $\textbf{class} \ \ \textbf{pytermor.filter.AbstractNamedGroupsRefilter} (\textit{*args}, \textit{**kwargs})$

```
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.

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

ΟT

```
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 <code>OmniMapper</code> and override two methods <code>-_get_default_keys</code> and <code>_get_default_replacer</code>. 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.

- 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	T	35	30	20	35	34	20	35	35	20	c2b0	43	20	50_54_55_°C_
12	1	20	33	39	20	2b	30	20	20	20	33	39	6d	_39_+039m
24	1	73	20	31	20	52	55	20	20	e28886	20	35	68	s_1_RU5h
36	1	20	31	38	6d	20	20	20	ee8c8d			20	2b	_18m+
48	1	32	30	c2b0	43	20	20	54	68	20	30	31	20	20°CTh_01_
60	1	4 a	75	6e	20	20	31	36	20			20	20	Jun 16_28
72	I	e29695	e29c94	e2968f	46	55	4 c	4 c	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.

- 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<sub>4</sub>
\hookrightarrow | _{\square}46_{\square}46_{\square}46_{\square}^{\circ}C_{\square}39_{\square}+
  18 U+
               30
                    20
                             20 20 35 20 6D 73
                                                          20
                                                                  31 20 52 55 20 20 2206 20 37
\rightarrow 0_{\cup\cup\cup}5_{\cup}ms_{\cup}1_{\cup}RU_{\cup\cup\cup}7
                             32 33 6D 20 20 20 FA93 200E 20 2B 31 33 B0
  36 | U+
               68
                     20
                                                                                               43 20 20 _
\hookrightarrow h_23m_2+13°C_2
                             20 30 32 20 4A 75
  54 U+
               46
                    72
                                                           6E
                                                                  20 20 30 32 3A 34
                                                                                               38 20 20<sub>L</sub>
\rightarrow | Fr_02_Jun_02:48_0
 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)
          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
```

7.9 pytermor.numfmt

Various general-purpose numeric formatters and highlighters with prefix auto-select suitable for any SI unit or a unitless value as well, plus dedicated methods for formatting time intervals from femtoseconds to years.

h Formatter class hierarchy

Module Attributes

PREFIXES_SI_DEC	Prefix	preset	used	by	<pre>format_si()</pre>	and
	format	_bytes_	human().		

Functions

	D : 11 1: 4 1 : 1 1: 4
format_auto_float(val, req_len[, al-	Dynamically adjust decimal digit amount and for-
low_exp_form])	mat to fill up the output string with as many sig-
	nificant digits as possible, and keep the output
	length strictly equal to req_len at the same time.
<pre>format_bytes_human(val[, auto_color])</pre>	Invoke special case of fixed-length SI formatter
	optimized for processing byte-based values.
<pre>format_si(val[, unit, auto_color])</pre>	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.
<pre>format_si_binary(val[, unit, auto_color])</pre>	Invoke fixed-length binary SI formatter which for-
	mats value as binary size ("KiB", "MiB") with base
	1024.
<pre>format_thousand_sep(val[, separator])</pre>	Returns input val with integer part split
	into groups of three digits, joined then with
	separator string.
<pre>format_time(val_sec[, auto_color])</pre>	Invoke dynamic-length general-purpose time for-
	matter, which supports a wide range of output
	units, including seconds, minutes, hours, days,
	weeks, months, years, milliseconds, microsec-
	onds, nanoseconds etc.
<pre>format_time_delta(val_sec[, max_len,</pre>	Format time interval using the most suitable for-
auto_color])	mat with one or two time units, depending on
	max_len argument.
<pre>format_time_delta_longest(val_sec[,</pre>	Wrapper around format_time_delta() with pre-
auto_color])	set longest formatter.
<pre>format_time_delta_shortest(val_sec[,</pre>	Wrapper around format_time_delta() with pre-
auto_color])	set shortest formatter.
<pre>format_time_ms(value_ms[, auto_color])</pre>	Invoke a variation of formatter_time specifically
	configured to format small time intervals.
<pre>format_time_ns(value_ns[, auto_color])</pre>	Wrapper for <pre>format_time_ms()</pre> 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).
<pre>Highlighter([dim_units])</pre>	S
NumFormatter(auto_color, highlighter)	
StaticFormatter([fallback, max_value_len,])	Format value using settings passed to constructor.
SupportsFallback()	
Prefix preset used by <pre>format_si()</pre> and <pre>format</pre> Note lower-cased 'k' prefix. <pre>class pytermor.numfmt.Highlighter(dim_units=</pre>	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units= S colorize(string)	-True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units= S	-True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units= S colorize(string)	-True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units= S colorize(string) parse and highlight Parameters	-True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = S colorize(string) parse and highlight Parameters string (str) -	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = S colorize(string) parse and highlight Parameters string (str) - Returns Return type	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = S colorize(string) parse and highlight Parameters string (str) - Returns Return type Text apply(intp, frac, sep, pfx, unit)	-True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = S colorize(string) parse and highlight Parameters string(str) - Returns Return type Text apply(intp, frac, sep, pfx, unit) highlight already parsed	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = S colorize(string) parse and highlight Parameters string (str) - Returns Return type Text apply(intp, frac, sep, pfx, unit) highlight already parsed Parameters	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = 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) -	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = 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) -	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = 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) -	True)
Note lower-cased 'k' prefix. class pytermor.numfmt.Highlighter(dim_units = 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) -	True)

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 <code>format_si()</code>, <code>format_si_binary()</code> and <code>format_bytes_human()</code>, which will invoke predefined formatters and doesn't require setting up.

- **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 (boo1) [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; 10⁶) and [10⁻³; 1) ranges (prefixes nearest to 1, kilo- and milli-); cyan for values in [10⁶; 10⁹) 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 (boo1) [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:

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

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

class pytermor.numfmt.BaseUnit(oom: 'float', unit: 'str' = ", prefix: 'str' = ", _integer: 'bool' = 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 <code>format_time_delta()</code>, which selects appropriate formatter by specified max length from a preset list.

Example output:

```
"10 secs", "5 mins", "4h 15min", "5d 22h"
```

- 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]

TU

Important: in_next and overflow_after are mutually exclusive, and either of them is required.

- 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.

Returns input val with integer part split into groups of three digits, joined then

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)
'1235'
>>> format_auto_float(1234.567891, 5)
' 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).

		•	
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'

Table 1: Default formatters comparison

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].

¹ 250 millibytes is not something you would see every day

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)
'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)
'967us'
```

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

7.10 pytermor.renderer

Renderers transform *Style* instances into lower-level abstractions like *SGR sequences*, tmux-compatible directives, HTML markup etc., depending on a renderer type. Default global renderer type is *SgrRenderer*.

A Renderer class hierarchy

Functions

<pre>force_ansi_rendering()</pre>	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.
<pre>IRenderer(*[, allow_cache, allow_format])</pre>	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 al-
	lowed to use in the output.
RendererManager()	Class for global rendering mode setup.
SgrDebugger([output_mode])	Subclass of regular SgrRenderer with two differ-
	ences instead of rendering the proper ANSI es-
	cape sequences it renders them with ESC char-
	acter replaced by "", and encloses the whole se-
	quence 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 <code>OutputMode</code> 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 Output Mode . 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.10*) 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.

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

 $_{-}T$

¹ tmux is a commonly used terminal multiplexer.

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 \rightarrow 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.

$\verb|pytermor.renderer.force_no_ansi_rendering()|\\$

Shortcut for disabling all output formatting of a global renderer.

7.11 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.
<pre>merge_styles([origin, fallbacks, overwrites])</pre>	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.

Create new text render descriptior.

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 <code>merge_fallback()</code> and <code>merge_overwrite()</code> 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** (*CXT*) Foreground (=text) color.
- **bg** (*CXT*) 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** (*CXT*) 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
                   | True ===> | True | BASE val is in priority
        None
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:

- 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
                  +----+
         True ==0 | False --->| False |
                                        OVERWRITE val is in priority
ATTR-1
ATTR-2
        None
                  | True --->| True |
                                        OVERWRITE val is in priority
                                        no OVERWRITE val, keeping BASE val
ATTR-3
        | True ==== | None | ==> | True |
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
                  +----+
                            +----+
        | False =0 | True --->| True |
ATTR-1
                                       REPLACE val is in priority
ATTR-2
                                       REPLACE val is in priority
        | True ==0 | False -->| False |
ATTR-3
        | None | | False -->| False |
                                       REPLACE val is in priority
ATTR-4
        | True ==0 | 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)

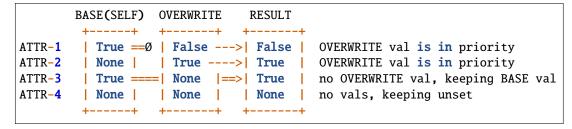
Merge current style with specified overwrite *style*, following the rules:

- 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 <code>merge_fallback()</code>, 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



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 <code>TemplateEngine</code> 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 =0 | True --->| True |
                                       REPLACE val is in priority
ATTR-2
        | True ==0 | False --> | False | REPLACE val is in priority
ATTR-3
        | None | | False -->| False |
                                       REPLACE val is in priority
ATTR-4
        | True ==0 | 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 +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 <code>merge_fallback()</code> algorithm; then do the same for overwrites styles, but using <code>merge_overwrite()</code> 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 N1

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

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 un-

set 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 values (so called "merging down" with the origin).

Returns

Clone of origin style with all specified styles merged into.

Return type

Style

7.12 pytermor.template

Module Attributes

substitute(tpl)	yes
render(tpl, renderer)	yes yes

Functions

render(tpl, renderer)	yes yes
substitute(tpl)	yes

Classes

```
TemplateEngine([custom_styles, global_style]) @TODO
```

```
\label{local_custom_styles} \textbf{class} \ \ \text{pytermor.template}. \\ \textbf{TemplateEngine} (\textit{custom\_styles} = None, \textit{global\_style} = < *\_NoOpStyle[] >) \\ \text{@TODO}
```

```
\label{eq:pytermor.template.substitute} \begin{picture}(tpl) \\ yes \\ Return\ type \end{picture}
```

pytermor.template.render(tpl, renderer)

yes yes

Return type

Text

str

7.13 pytermor.term

Α

Module Attributes

RCP_REGEX	Regular expression for RCP (Report Cursor Posi-
	tion) sequence parsing.

Functions

<pre>compose_clear_line_fill_bg(basis[, line, col- umn])</pre>	param basis
compose_hyperlink(url[, label])	Syntax: (OSC 8;;) (url) (ST) (label) (OSC 8;;) (ST), where <i>OSC</i> is ESC].
<pre>confirm([attempts, default, keymap, prompt,])</pre>	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 <i>QCP</i> sequence and contains a cursor's current line and column.
<pre>get_char_width(char, block)</pre>	General-purpose method for getting width of a character in terminal columns.
<pre>get_preferable_wrap_width([force_width])</pre>	Return preferable terminal width for comfort reading of wrapped text (max=120).
<pre>get_terminal_width([fallback, pad])</pre>	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.
<pre>make_clear_display_after_cursor()</pre>	Create ED sequence that clears a part of the screen from cursor to the end of the screen.
<pre>make_clear_display_before_cursor()</pre>	Create ED sequence that clears a part of the screen from cursor to the beginning of the screen.
<pre>make_clear_history()</pre>	Create ED sequence that clears history, i.e., invisible lines on the top that can be scrolled back down.
<pre>make_clear_line()</pre>	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 <i>SequenceSGR</i> that sets foreground (or background) to one of 256-color palette value.:

continues on next page

Table 2 – continue	d from previous page
make_color_rgb(r, g, b[, target])	Wrapper for creation of <i>SequenceSGR</i> 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::.
<pre>make_disable_alt_screen_buffer()</pre>	С
<pre>make_enable_alt_screen_buffer()</pre>	С
<pre>make_erase_in_display([mode])</pre>	Create ED sequence that clears a part of the screen or the entire screen.
<pre>make_erase_in_line([mode])</pre>	Create EL sequence that clears a part of the line or the entire line at the cursor position.
make_hide_cursor()	С
<pre>make_hyperlink()</pre>	Create a hyperlink in the text (supported by limited amount of terminals).
<pre>make_move_cursor_down([lines])</pre>	Create CUD (Cursor Down) sequence that moves
	the cursor down by specified amount of lines.
<pre>make_move_cursor_down_to_start([lines])</pre>	Create CNL (Cursor Next Line) sequence that moves the cursor to the beginning of the line and down by specified amount of lines.
<pre>make_move_cursor_left([columns])</pre>	Create CUB (Cursor Back) sequence that moves
	the cursor left by specified amount of columns.
<pre>make_move_cursor_right([columns])</pre>	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.
<pre>make_move_cursor_up_to_start([lines])</pre>	Create CPL (Cursor Previous Line) sequence that moves the cursor to the beginning of the line and up by specified amount of lines.
<pre>make_query_cursor_position()</pre>	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.
<pre>make_restore_cursor_position()</pre>	example ESC 8
make_restore_screen()	C
make_save_cursor_position()	
mane_save_carsor_posteron()	example ESC 7
make_save_screen()	С
<pre>make_set_cursor([line, column])</pre>	Create CUP sequence that moves the cursor to specified amount line and column.
<pre>make_set_cursor_column([column])</pre>	Create CHA (Cursor Character Absolute) sequence that sets cursor horizontal position to column.
<pre>make_set_cursor_line([line])</pre>	Create VPA (Vertical Position Absolute) sequence that sets cursor vertical position to line.
make_show_cursor()	С
	continues on next page

7.13. pytermor.term

Table 2 - continued from previous page

<pre>measure_char_width(char[, clear_after])</pre>	Low-level function that returns the exact charac-
	ter 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 <code>make_set_cursor()</code>.

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 Γ15G

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 [OK
         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?
```

(9, 15)

>>> decompose_report_cursor_position('[9;15R')

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]

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 <code>guess_char_width()</code> 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 <code>guess_char_width()</code> instead, or <code>IOError</code> 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
```

7.14 pytermor.text

"Front-end" module of the library containing *renderables* – classes that support 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()*.

h Fragment class hierarchy

Functions

<pre>apply_style_selective(regex, string[, st])</pre>	Main purpose: application of under(over cross)lined styles to strings containing more than one word.
<pre>apply_style_words_selective(string, st)</pre>	
distribute_padded()	param max_len
echo([string, fmt, renderer, nl, file,])	
echoi([string, fmt, renderer, file, flush]) is_rt(arg)	echo inline
render([string, fmt, renderer])	
<pre>wrap_sgr(rendered, width[, indent_first,])</pre>	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.
<pre>Fragment([string, fmt, close_this, close_prev])</pre>	<immutable></immutable>
FrozenText(*fargs[, width, align, fill,])	Multi-fragment text with style nesting support.
<pre>IRenderable()</pre>	Ī
<pre>SimpleTable(*rows[, width, sep, border_st])</pre>	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**<sup>'</sup>
          Parameters
               • string (str) -
               • fmt (FT) -
               • close_this (bool) -
               • close_prev (bool) -
     as_fragments()
          a-s
              Return type
                 List[Fragment]
     raw()
          pass
              Return type
     property has_width: bool
          return self. width is not None
     property allows_width_setup: bool
          return False
     render(renderer=None)
          pass
              Return type
                 str
```

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```
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
     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]
```

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```
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.
             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
     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
```

Allows 0 or 1 dynamic-width cell in each row, while all the others should be static, i.e., be instances

width (terminal size).

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),
     . . .
                 . . .
             ],
     . . .
             width=30,
     . . .
             sep="|"
     ...), file=sys.stdout)
     |1| word |smol string
     |2| padd |biiiiiiiiiiiiiii|
     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
     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)
pytermor.text.distribute_padded(max\ len: int, *values: RT, pad\ left: int = 0, pad\ right: int = 0)
                                    \rightarrow Text
          Parameters
               • max_len -
               • values -
               • pad_left -
               • pad_right -
```

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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
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
                                  4A 75 6E 20
                                               20 31 36 20
                                                             32 38 20 20
0x3C | 20 20 54 68
                    20 30 31 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):

$$L_O = L_{spc} + L_{sep} + L_{adr} + L_{hex},$$

$$L_{adr} = 2 + 2 \cdot ceil(\frac{L_{Ihex}}{2}), \tag{1}$$

$$L_{hex} = 3C_L + floor(\frac{C_L}{4}),$$

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 $L_O \leqslant L_T$, 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:

$$3C_L + floor(\frac{C_L}{4}) = 3.25C_L \qquad \forall C_L \in [4, 8, 12..),$$
 (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).

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8.1.2 StringTracer

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

Listing 2: Example output

0	Ī	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_+039m
24		73	20	31	20	52	55	20	20	e28886	20	35	68	s_1_RU5h
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°CTh_01_
60		4 a	75	6e	20	20	31	36	20	32	38	20	20	Jun16_28
72		e29695	e29c94	e2968f	46	55	4 c	4 c	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:

$$L_{spc} + L_{sep} + L_{adr} + L_{hex} + L_{chr} \leq L_T$$

where L_T is current terminal width. Next:

$$3 + 2 + L_{adr} + (2C_{Umax} + 1) \cdot C_L + C_L, \leq L_T$$

$$L_{adr} + 5 + (2C_{Umax} + 2) \cdot C_L, \leqslant L_T$$

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:

$$C_{Lmax} = floor(\frac{L_T - L_{adr} - 5}{2C_{Umax} + 2}). \label{eq:closed}$$

8.1. Tracers math 151

Example

Consider terminal width is 80, input data is 64 characters long and consists of U+10FFFF codepoints only ($C_{Umax} = 4$). Then:

$$L_{adr} = len(L_I) = len(64) = 2,$$

 $C_{Lmax} = floor(\frac{78 - 2 - 5}{8 + 2}),$
 $= floor(7.1) = 7.$

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+
                     36 20 34 36 20 34
                                                20 B0 43 20 20 33
           20
                34
                                                                     39 20 2B<sub>-</sub>
18 | U+
           30
                     20 20 35 20 6D 73
                                           20
                                                31 20 52 55 20 20 2206 20 37
                20
\rightarrow 0 0 0 5 ms 1 RU 0 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
                     20 30 32 20 4A 75
                                           6E
                                                20 20 30 32 3A 34
                                                                     38 20 20...
                72

    → | Fr_02_Jun_02:48_0
 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:

$$C_{Lmax} = floor(\frac{L_T - L_{adr} - 7}{C_{UCmax} + 2}).$$

8.1. Tracers math 152

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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 PYTER-MOR_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.

9.1. Variables

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CHANGELOG

10.1 Releases

This project uses Semantic Versioning – https://semver.org (starting from v2.0)

10.1.1 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
- [DOCS] tracers math
- [REMOVE] log module
- [FIX] conflict color tokens are allowed as long as original names differ
- [FIX] Color16, Color256, ColorRGB hash computation
- pre-build scripts
- [DOCS] LaTeX terminal output examples formatting
- •
- [FIX] pt.fit('N', 1) unexpected results
- [FIX] now highlight() correctly handles strings like 'NNNNNX'
- [NEW] extended unit prefixes (femto, atto-, Exa-)

10.1.2 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

10.1.3 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

10.1.4 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
- $\bullet \ \ [REFACTOR] \ TDF_REGISTRY -> dual_registry- \ ``FORMATTER_` \ constants \ from \ top-level \ imports$
- [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

10.1.5 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

10.1.6 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

10.1.7 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

10.1.8 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.

10.1.9 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.

10.1.10 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.

10.1.11 v2.2-dev

Oct 22

- [NEW] TmuxRenderer
- [NEW] wait_key() input helper.
- [NEW] Color config.
- [NEW] IRenderable` interface.
- [NEW] Named colors list.

10.1.12 v2.1-dev

Aug 22

- [NEW] Color presets.
- [TESTS] More unit tests for formatters.

10.1.13 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.

10.1.14 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.

10.1.15 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.

10.1.16 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.

10.1.17 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.

10.1.18 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.

10.1.19 v1.3

- [NEW] Added span.GRAY and span.BG_GRAY format presets.
- [REFACTOR] Interface revisioning.

10.1.20 v1.2

- [NEW] EmptySequenceSGR and EmptyFormat classes.
- [NEW] opening_seq and closing_seq properties for Span class.

10.1.21 v1.1

Apr 22

• [NEW] Autoformat feature.

10.1.22 v1.0

• First public version.

10.1.23 v0.90

Mar 22

• First commit.

11

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12

DOCS GUIDELINES

(mostly as a reminder for myself)

12.1 General

• Basic types and built-in values should be surrounded with asterisks:

```
*True* \rightarrow True

*None* \rightarrow None

*int* \rightarrow int
```

• Library classes, methods, etc. should be enclosed in single backticks in order to become a hyperlinks:

```
`SgrRenderer.render()` \rightarrow 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`` 
ightarrow arg1
``ESC [31m ESC [m`` 
ightarrow 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):

$$d_{min} = 350 * 10^{-3}$$

12.2 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")
```

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m 1 1	1 .	
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		<pre>:term:`rendering`</pre>
Inlined definition		
	classifier for 1st time	:def:`classifier` for 1st_
	or classifier later	⇒time
	of classific facel	or *classifier* later
Abbreviation	EL	
		:abbr:`EL (Erase in Line)`

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