bdp Documentation

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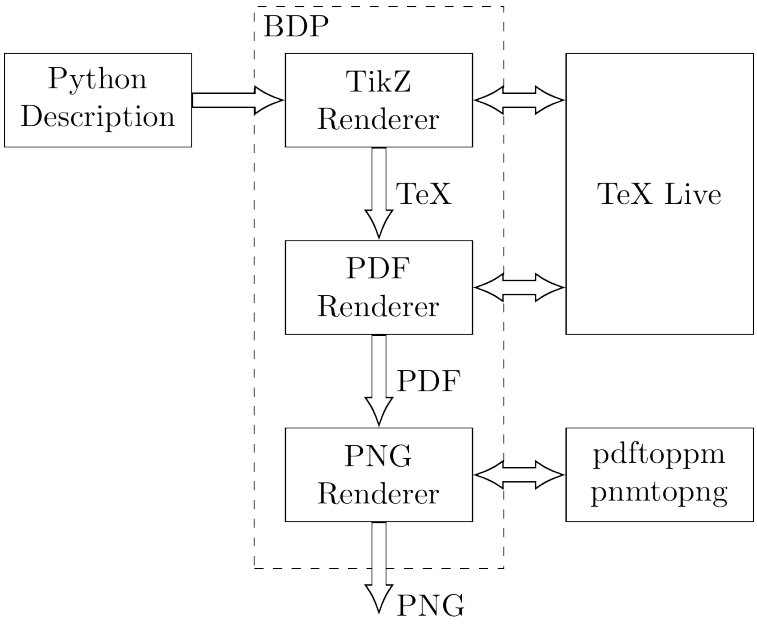
Contents

BDP (Block Diagrams in Python) aims to become a Python fronted for TikZ when it comes to drawing block diagrams in order to facilitate the process. BDP wraps the TikZ statements into the Python objects so that users can describe diagrams in pure Python. However, inserting raw TikZ in BDP is also possible. Figure below shows an BDP example image which represents the BDP compilation process.

Figure can be rendered with the *Python code* provided below, which is also available in repository inside compile_process.py BDP diagram. It can be rendered into the PNG with BDP via command line:




```
# bdp compile_process.py -p
```

For a complete list of command line options please take a look at *Rendering* chapter.

1 Contents

1.1 BDP short tutorial

Block diagrams consist mainly of blocks connected by lines, hence mainly two BDP objects will be used for drawing called *block* and *path*. All drawing objects in BDP are called **templates**. Templates carry descriptions of diagram components in form of many attributes which can be accessed, modified or added as a regular Python object attributes. New templates can be derived from the existing ones by calling them with a list of attributes that are be changed. Finally, the templates can be rendered to the diagram by passing them to the *fig* object.

All examples shown in this tutorial can be found in the bdp/doc/source/images folder of the bdp source code.

A simple block

The following examples shows how to render a simple block with the text using BDP.

```
from bdp import *

# New template called a_template derived from block with text_t attribute set
a_template = block(text_t='A Block')
# Set the color attribute
a_template.color = 'red'

# Render a_template
fig << a_template
```

Resulting in:

The *block* and templates derived from it, render to two *node* TikZ elements, one for the shape and the other for the text. Many *block* template attributes are rendered directly to the options list of a TikZ *node* with the following convention:

node option form	Corresponding BDP template setting	Description
option=value	template.option = value	Set the desired value to the template attribute with the same name as the desired *node* option
option	template.option = True	Set value of the template attribute of the same name as the desired *node* option to the boolean True. To unset the option, set it to False.
option with spaces	template.option_with_spaces	TikZ option with spaces correspond to the template attribute of the same name with spaces replaced by underscores '_'

Some template attributes, however do not translate directly to the TikZ equivalents, and some of them are inferred in certain situations. These attributes include:

Attribute	TikZ equivalent option	Description
p	at (p[0], p[1])	Determines the absolute position of the rendered node
size	minimum width=size[0], minimum height=size[1]	Determines the size of the rendered node
alignment	–	Determines the relative position of the text within a block
border	draw	Determines whether the block template border is drawn

Template *a_template* is rendered to the following two TikZ elements by the rules given above:

```
\node at (20.71pt, 6.47pt) [draw,minimum width=41.42pt,minimum height=12.94pt,color=red,rectangle] {}
\node at (20.71pt, 6.47pt) [align=center,text width=35.42pt,minimum width=41.42pt,minimum height=12.9
```

Block relative position

Next example shows how BDP facilitates the relative positioning of the blocks in diagram.

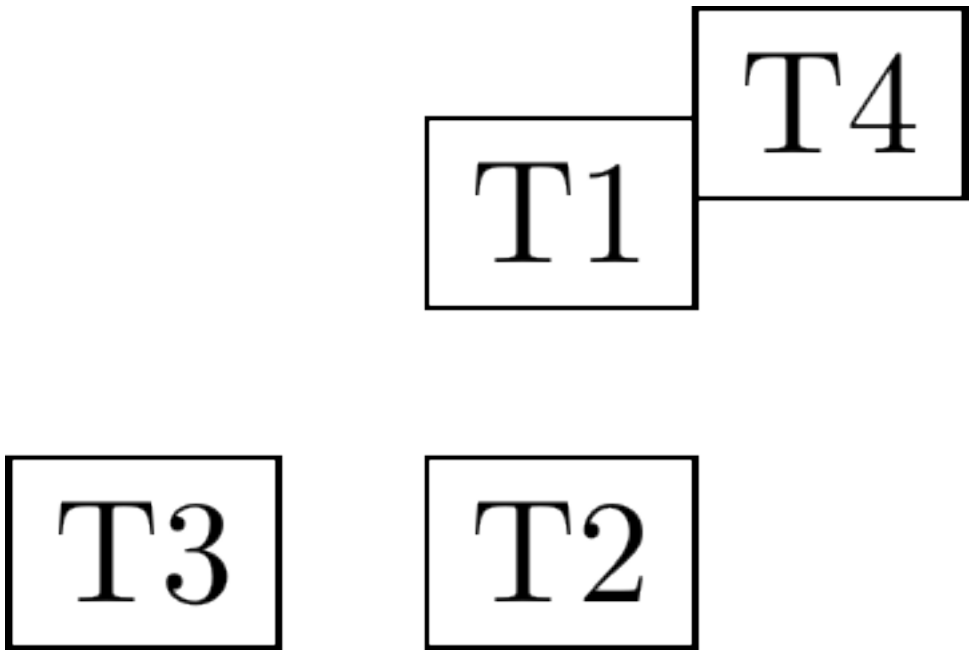
```
from bdp import *

t1 = block('T1')
t2 = block('T2').below(t1)
t3 = block('T3').left(t2)
t4 = block('T4').align(t1.e(0.2), prev().w(1))

fig << t1 << t2 << t3 << t4
```

Resulting in:

There are several helper methods used to position the blocks relatively to one another in diagram. The methods *over*, *right*, *left* and *below* all have the same form:




```
template.method(other, pos=1)
```

These methods will position the *template* over, below, to the right or left of the passed *other* template. The *nodesep* attribute of the *other* template determines the spacing that should be made between the templates. The *nodesep* attribute value is multiplied by the passed *pos* argument.

The method *align* can be used to position two templates in such a way that their points (*other* and *own*) passed as arguments to this method, become overlapped:

```
template.align(other, own)
```

The point relative to the template can be specified using helper methods: *e*, *n*, *s* and *w*

Method	Description
n	Coordinate system with origin in top-left point of the template, with x as primary coordinate
w	Coordinate system with origin in top-right point of the template, with y as primary coordinate
s	Coordinate system with origin in bottom-left point of the template, with x as primary coordinate
e	Coordinate system with origin in top-left point of the template, with y as primary coordinate

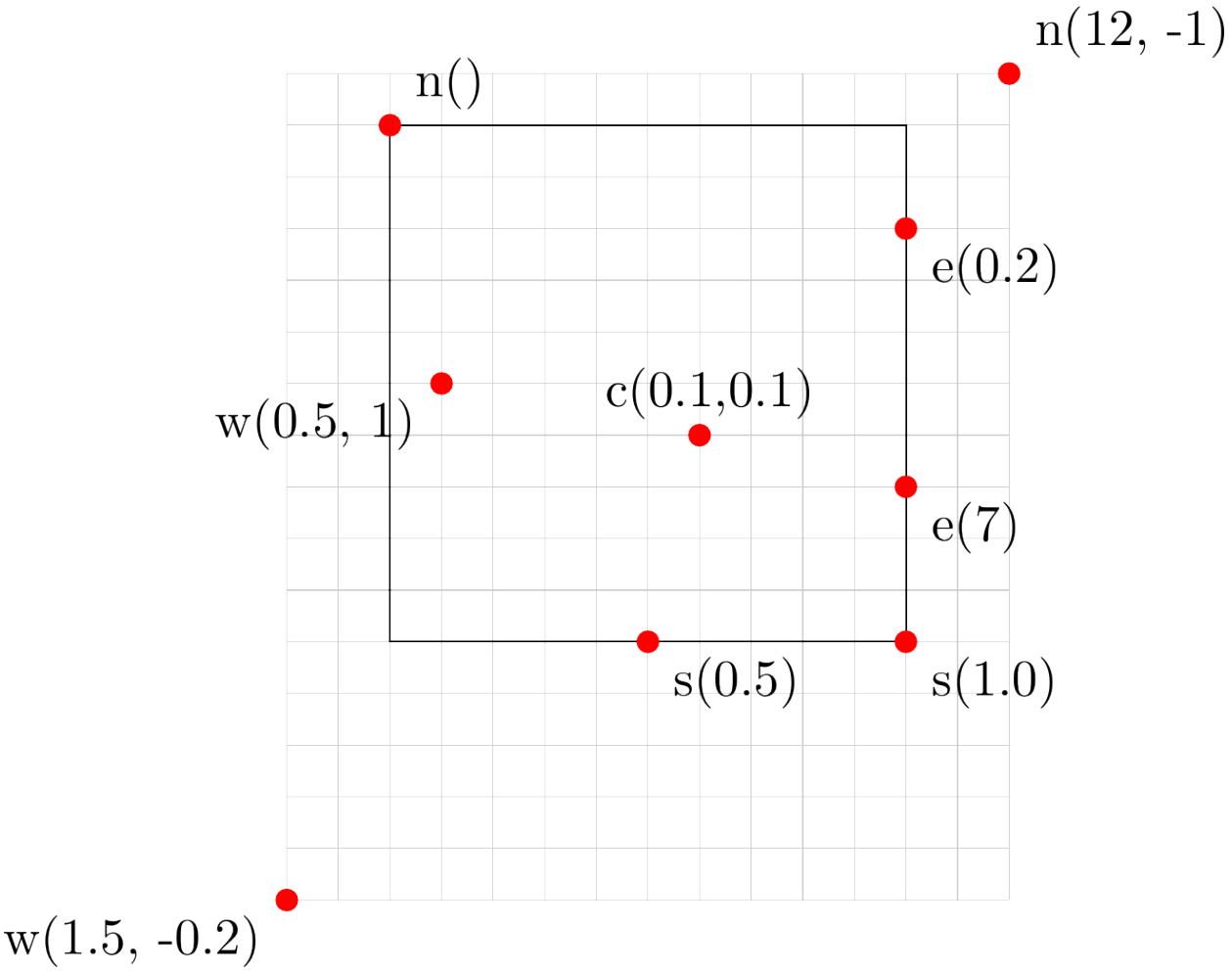
When an **int** value is supplied to these methods as a parameter, the value will be interpreted as an absolute unit. However, when a **float** value is supplied, it will be interpreted as a fraction of template's size. The following example shows how these methods can be used to determine the points relative to the template.

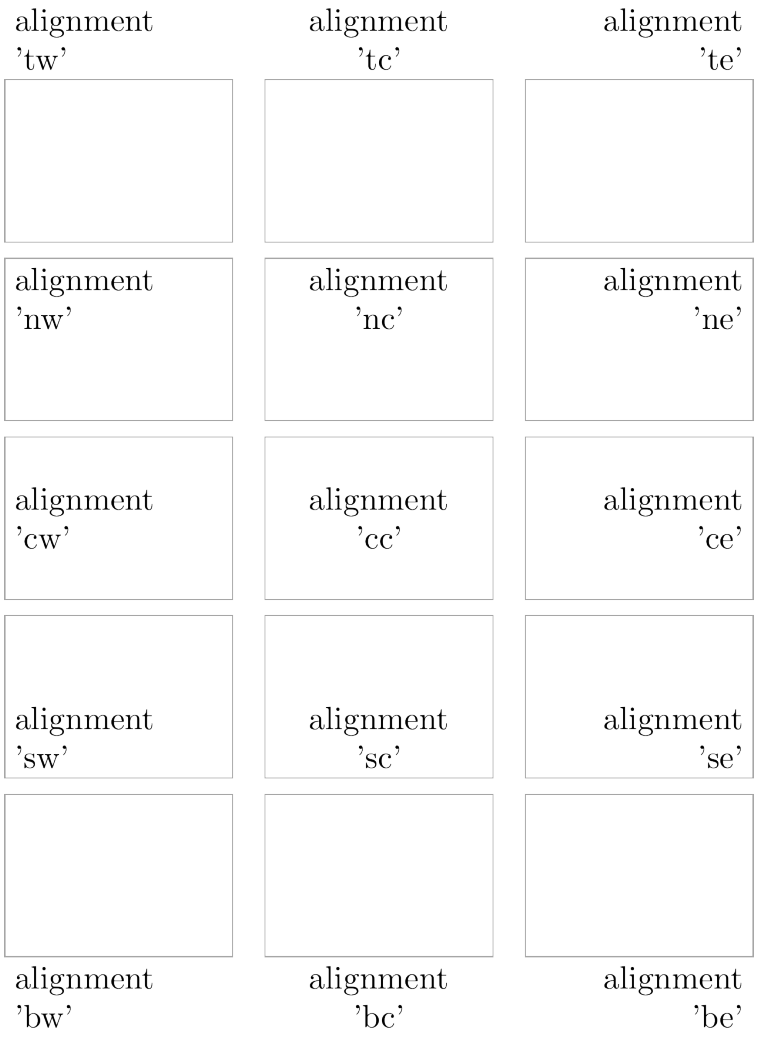
The function *prev* of the BDP package can be used to access the last template that has been derived in the script.

Text alignment within block

Text can be aligned within block using the alignment attribute. String of two characters are expected for the value of the alignment, the first one for the vertical and the second for the horizontal alignment. The following figure shows the available settings for the alignment attribute.

For the alignment setting, all combinations of the first and second character from the table below are valid.


n(12, -1)
n()
e(0.2)
w(0.5, 1)
c(0.1,0.1)
e(7)
s(0.5)
s(1.0)
w(1.5, -0.2)


alignment 'tw'
alignment 'tc'
alignment 'te'
alignment 'nw'
alignment 'nc'
alignment 'ne'
alignment 'cw'
alignment 'cc'
alignment 'ce'
alignment 'sw'
alignment 'sc'
alignment 'se'
alignment 'bw'
alignment 'bc'
alignment 'be'

First character	Vertical text position	Second character	Horizontal text position
‘t’	Above the top edge	‘w’	Left aligned
‘n’	Below the top edge	‘c’	Center aligned
‘c’	Vertically centered	‘e’	Right aligned
‘s’	Above the bottom edge		
‘b’	Below the bottom edge		

Settings text attributes

Text is an attribute of the *block* template and it is itself a template. Text attributes can be thus accessed as *template.text.attr*. Additionally as a shorthand, text attributes can be accessed as *template.text_attr*. The following example shows two ways of accessing text attributes.

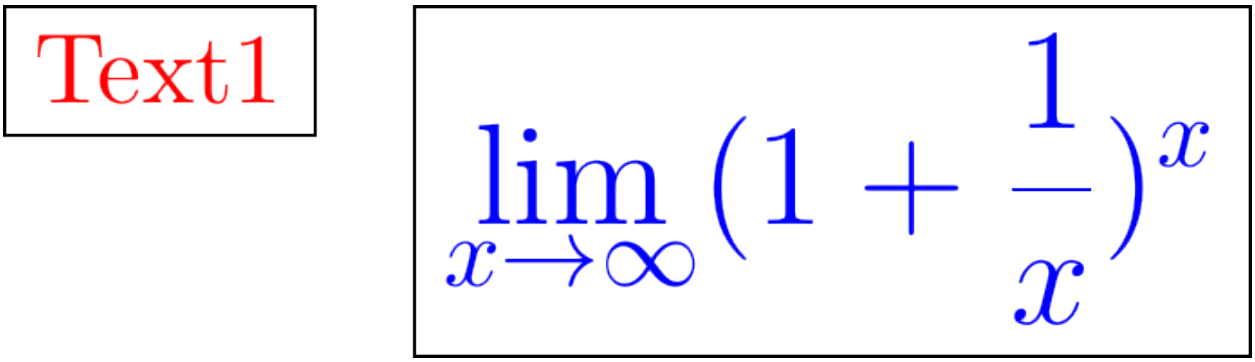
```
from bdp import *

b1 = block('Text1', text_color='red')
b2 = block(r'$\displaystyle\lim_{x\to\infty} (1 + \frac{1}{x})^x$').right(b1)

b2.text_font = r'\Large'
b2.text.color = 'blue'

fig << b1 << b2
```

Resulting in:



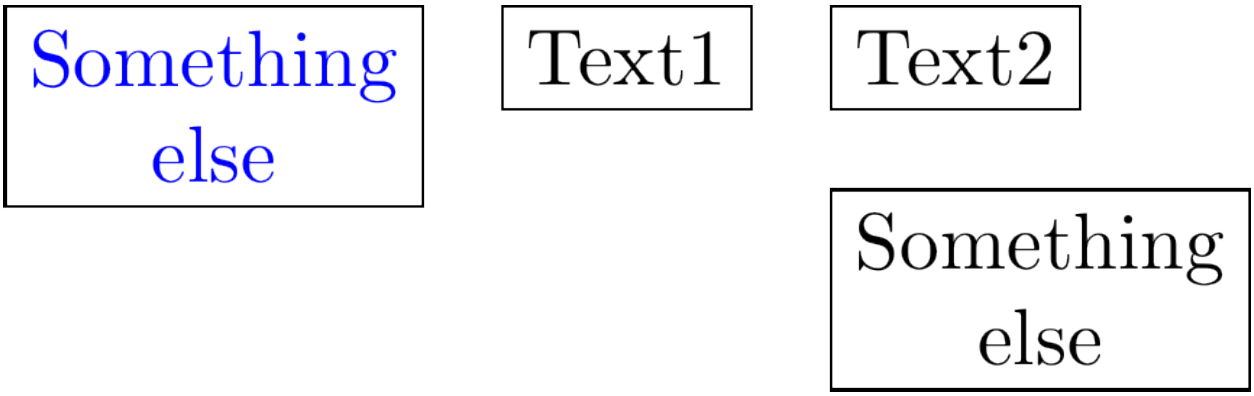
The *fig* object

The *fig* object accepts the BDP templates via ‘<<’ operator and memorizes their TikZ renderings in order to form complete TikZ image. Additionally *fig* memorizes the template objects too, and can be used to reference them. The templates can be referenced via their text attribute, or via order in which they were rendered. Both are done via indexing operator. When referencing via template text, wildcards ‘*’ and ‘?’ can be used. The following example demonstrates the two ways.

```
from bdp import *

fig << block('Text1')
fig << block('Text2').right(fig['Te*'])
fig << block(r'Something \\ else').below(fig[-1])
fig << fig['S*'](text_color='blue').left(fig[0])
```

Resulting in:



When adding a new template to the *fig* object that has the same text as the one added before, the number will be added to the end of the new templates text to form its key in order to make it unique. The *fig* object has following attributes that can be used to customize the TikZ rendering:

Attribute	Description
grid	Scale between the BDP units and points (pt) in TikZ
package	Python set containing package names that should be imported via usepackage statement
tikz_library	Python set containing tikz libraries that should be imported via usetikzlibrary statement
tikz_prolog	Latex statements between the begin{document} and begin{tikzpicture}
options	Global options for TikZ picture
tikz_epilog	Latex statements between the end{tikzpicture} and end{document}

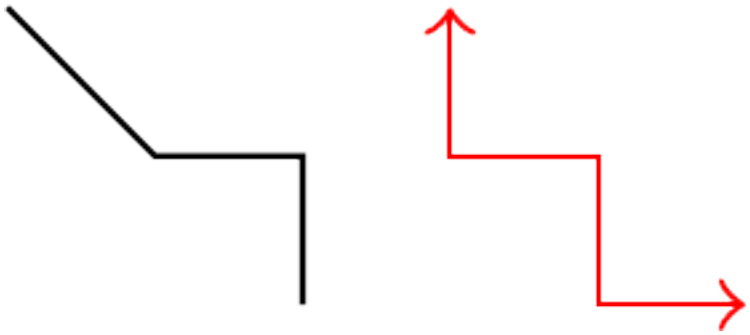
path template

The *path* template is used to render wires in BDP diagrams. The *path* template operates similarly to the *block* and *text* templates. The difference is that it behaves as a container for a list of points that constitute a path and a list of line routing options stored in *route* attribute.

```
from bdp import *

fig << path((0,0), (1,1), (2,2), route=['--', '-|'])
fig << path(fig[-1][0] + p(3,0), poff(1,1), poff(1,1), routedef='|-', style='<->', color='red')
```

Resulting in:



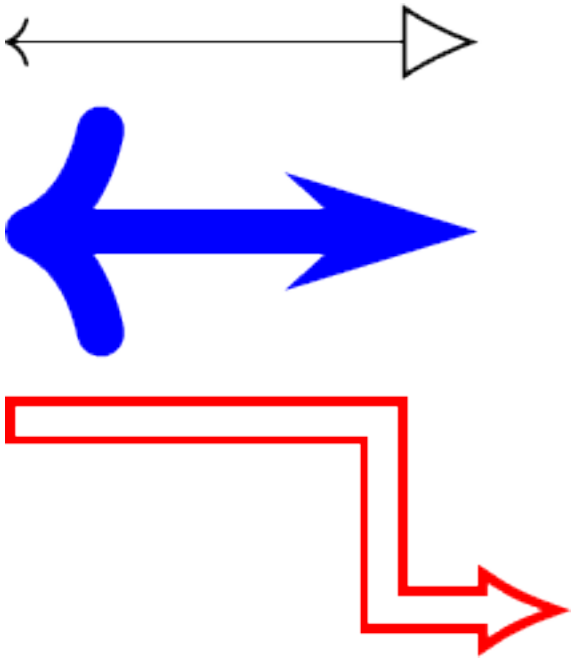
If *route* contains less items than there are point pairs, it is padded with value supplied to the *routedef* attribute.

The *path* template can also use new **arrays.meta** library (TeX Live 2014 contains the library out of the box) via *cap* template.

```
from bdp import *

fig << path((0,0), (5,0), style=('<', cap(width=0.8, length=0.8, open=True)))
fig << path((0,2), (5,2), style=('<', cap(type='Stealth', width=1.2, length=2)), line_width=0.5, colo
fig << path((0,4), (4,6), (6,6), routedef='-|', style=('', cap(width=1, length=1)), line_width=0.5, c
```

Resulting in:



The *group* template

The *group* template behaves completely identical to the *fig* object when it comes to adding new templates to it and referencing them (they share a common superclass). Please refer to chapter *The fig object*. Furthermore *block*, *shape* and *text* templates have the same grouping functionality since they derive from *group* template, so this chapter applies to them as well. The *group* is a template and as such can be rendered. When a group is rendered to a *fig*, all its elements are rendered as well. When a group position is changed, the position of all its elements is shifted as well.

Important attribute of the *group* template is called *group* as well. When it is set to 'tight' (which is default for the *group* template), *group* size and position is recalculated whenever a new element is added in such a way that the *group* tightly encompass its all elements. When *group* attribute is set to None (which is default for*block*, *shape* and *text* templates), position and size of the group is independant of the size and position of its elements.

Resulting in:

images/group_example.png

1.2 Rendering

Command line

BDP package can be run from command line to render the images of the BDP diagrams described in Python.

Depending on the extension of the output file, BDP will generate either PDF or PNG. If output file is not specified, it will have the same name as the input, and generated extension will depend on the [-p] argument value.

```
usage: bdp [-h] [-o OUTPUT] [-d OUTDIR] [-p] [-c] [-r R] input
```

Positional arguments:

input	Input BDP file

Options:

-o=, --output=	Output PDF or PNG file
-d=, --outdir=	Output directory
-p=False	Render PNG
-c=False	Clear intermediate files
-r	Number representing DPI resolution of the generated PNG

From Python

For rendering a BDP figure from the Python script, the *render_fig()* function can be used.

bdp.render.**render_fig**(*fig*, *fout=None*, *outdir=None*, *options={}*)

Renders the BDP figure to PDF or PNG via Latex

Parameters

- **fout** (*str*) – Output PDF or PNG file
- **outdir** (*str*) – Output PDF or PNG file
- **options** (*dict*) – Dictionary of additional options: 'c', 'p' and 'r'. Please take a look at command line arguments for additional info.

1.3 BDP Sphinx Extension

BDP package comprises an extension for embedding BDP diagrams in Sphinx documentation. The extension introduces a singled directive *bdp* which can be used to either embed BDP diagram from external file, or render the supplied BDP description. The *bdp* directive is a subclass of the *figure* directive, so all the options of the *figure* directive can also be applied to the *bdp* directive. In addition *:caption:* option can be used to specify the diagram caption.

Specifying an external file:

```
.. bdp:: images/example_bdp.py
   :caption: This is an example BDP diagram
```

Suplying a BDP description inline:

```
.. bdp::
   :caption: This is an example BDP diagram

   fig << block('Example')
```

```
    fig << block('BDP')
    fig << block('diagram')
```

2 Why BDP?

BDP brings following benefits:

- Diagram description in Python which should render it more readable
- Step-by-step debugging of the diagram description
- Use the tools and design environments available for Python development (debugging, code completion, refactoring, documentation utilities...)
- Use vast Python library of packages

3 BDP features

BDP package comprises:

- Python classes that wrap the Tikz statements
- Class for rendering PDF and PNG images from the Python description
- Shell entry point for rendering BDP images from command line
- Sphinx extensions for embedding BDP images into the Sphinx documents

Image below is a more complex example, which shows how power of Python programming can be used to generate diagrams with BDP. Image shows an UML-like diagram of few major BDP templates.

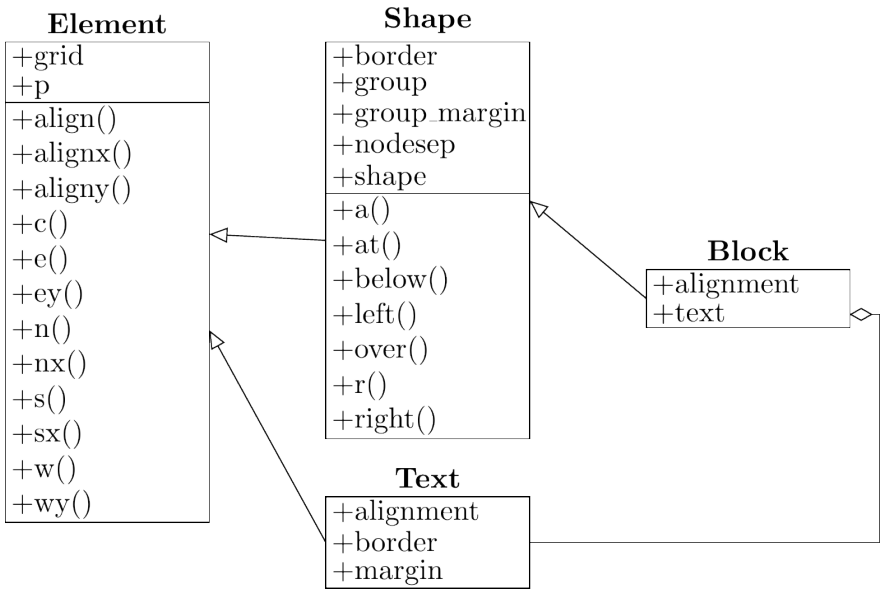


Figure can be rendered with the *Python code* provided below.

4 Where to start?

4.1 Installation

BDP package currently supports only Python 3. Following are alternative ways to install BDP.

Install BDP using pip:

```
pip3 install bdp
```

Install BDP using easy_install:

```
easy_install3 bdp
```

Install BDP from source:

```
python3 setup.py install
```

BDP requires TeX Live, which could be installed on a Debian or a Debian-derived systems, with:

```
# sudo apt-get install texlive
```

For converting PDF to PNG, pdftoppm, pnmcrop and pnmtopng are needed, which could be installed on a Debian or a Debian-derived systems, with:

```
# sudo apt-get install poppler-utils
# sudo apt-get install netpbm
```

4.2 Read the documentation

Start with the short tutorial *BDP short tutorial*

4.3 Checkout the examples

BDP images used in documentation are located in the images repository documentation folder.

4.4 Get involved

Pull your copy from github repository

5 Source codes for the examples

Listing 5.1: BDP description of the compilation process diagram.

```
from bdp import *

block.size=(6,3)
block.nodesep=(3,3)

BDP = block(r"BDP", alignment='nw', group='tight', group_margin=p(1,1.5), dashed=True)
fig << block(r"Python \\ Description")
BDP['tikz'] = prev(r"TikZ \\ Renderer").right()
BDP['pdf'] = prev(r"PDF \\ Renderer").below()
BDP['png'] = prev(r"PNG \\ Renderer").below()
fig << prev(r"TeX Live", size=(6,9)).right(BDP['tikz'])
fig << block(r"pdftoppm \\ pnmtopng").below(fig['Te*'])

fig << BDP

cap.length = 1
cap.width = 1
path.line_width = 0.5
path.double = True

fig << path(fig['Pyt*'].e(0.5), BDP['tikz'].w(0.5), style=('',cap))
fig << path(fig['Tik*'].s(0.5), fig['PDF*'].n(0.5), style=('',cap))
fig << text('TeX').align(fig[-1].pos(0.5), prev().w(0.5, -0.1))

fig << path(fig['PDF*'].s(0.5), fig['PNG*'].n(0.5), style=('',cap))
fig << text('PDF').align(fig[-1].pos(0.5), prev().w(0.5, -0.1))

fig << path(fig['PNG*'].s(0.5), poffy(3), style=('',cap))
fig << text('PNG').align(fig[-1].pos(0.9), prev().w(0.5, -0.1))

fig << path(BDP['tikz'].e(0.5), poffx(3), style=(cap,cap))
fig << path(fig['PDF*'].e(0.5), poffx(3), style=(cap,cap))
fig << path(fig['PNG*'].e(0.5), poffx(3), style=(cap,cap))
```

Listing 5.2: UML-like diagram of few major BDP templates.

```
from bdp import *
from bdp.group import Group
import inspect

def fill_group(group, fields, template):
    for name,text in fields:
        text = text.replace('_', '\_')
        try:
            group[name] = template(text).align(group[-1].s())
        except IndexError:
            group[name] = template(text).align(group.n())

def uml_for_obj(obj, parent=object):

    # extract methods and attributes for diagram
    attrs = [(k, '+' + k) for k in sorted(obj.__dict__) if (k[0] != '_') and (not hasattr(parent, k))
    methods = [(k, '+' + k[0] + '()')
                    for k in inspect.getmembers(obj, predicate=inspect.ismethod)
                        if (k[0][0] != '_') and (not hasattr(parent, k[0]))]
    # populate BDP blocks
    uml = block(r'\textbf{' + obj.__class__.__name__ + '}', alignment='tc', border=False, group='tigh
    field = block(size=(7,None), alignment='cw', border=False, text_margin=(0.2,0.1))

    uml['attrs'] = block(group='tight').align(uml.n())
    fill_group(uml['attrs'], attrs, field)

    uml['methods'] = block(group='tight').align(uml['attrs'].s())
    fill_group(uml['methods'], methods, field)

    return uml

block = block(nodesep = (4,2))

# generate UML components
element_uml = uml_for_obj(group(), Group())
shape_uml = uml_for_obj(shape(), group())
block_uml = uml_for_obj(block(), shape())
text_uml = uml_for_obj(text(), group())

# organize components in the diagram
shape_uml.right(element_uml).aligny(element_uml.n(), shape_uml.w(-1.0))
text_uml.below(shape_uml).aligny(element_uml.s(), text_uml.w(2.0))
block_uml.right(text_uml).aligny(midy(text_uml.n(), shape_uml.n()))

# render the components
fig << element_uml << shape_uml << block_uml << text_uml

# generate and render the wiring
fig << path(text_uml.w(0.5), element_uml.e(0.6), style='-open triangle 45')
fig << path(shape_uml.w(0.5), element_uml.e(0.4), style='-open triangle 45')
fig << path(block_uml.w(0.5), shape_uml.e(0.4), style='-open triangle 45')
fig << path(block_uml['attrs']['text'].e(0.5), poff(1,0), text_uml.e(0.5), style='open diamond-', rou
```

Index

R