The *pyluatex* package

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https://github.com/tndrle/PyLuaTeX

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**Execute Python code on the fly in your \LaTeX documents**

PyLuaTeX allows you to execute Python code and to include the resulting output in your \LaTeX documents in a *single compilation run*. \LaTeX documents must be compiled with Lua\LaTeX for this to work.

1 Example

1. \LaTeX document *example.tex*

```latex
\documentclass{article}
\usepackage{pyluatex}
\begin{python}
import math
import random

random.seed(0)

greeting = 'Hello PyLuaTeX!'
\end{python}
\newcommand{\randint}[2]{\py{random.randint(#1, #2)}}
\begin{document}
\py{greeting}
$\sqrt{371} = \py{math.sqrt(371)}$
\randint{2}{5}
\end{document}
```

**Note:** PyLuaTeX starts Python 3 using the command `python3` by default. If `python3` does not start Python 3 on your system, find the correct command and replace `\usepackage{pyluatex}` with `\usepackage[executable=<your Python command>]{pyluatex}`. For example, `\usepackage[executable=python.exe]{pyluatex}`.
2. Compile using \LaTeX{} (shell escape is required)

\begin{verbatim}
luatatex -shell-escape example.tex
\end{verbatim}

**Note:** Running \LaTeX{} with the shell escape option enabled allows arbitrary code to be executed. For this reason, it is recommended to compile trusted documents only.

### 1.1 Further Examples

The folder example contains additional example documents:

- **beamer.tex**
  Demonstrates the use of PyLu\TeX \ environments and typesetting in BEAMER presentations. In particular, the `fragile` option for frames is highlighted.

- **data-visualization.tex**
  Demonstrates the visualization of data using `pgfplots` and `pandas`

- **matplotlib-external.tex**
  Demonstrates how `matplotlib` plots can be generated and included in a document

- **matplotlib-pgf.tex**
  Demonstrates how `matplotlib` plots can be generated and included in a document using `PGF`

- **readme-example.tex**
  The example above

- **repl.tex**
  Demonstrates how a Python console/REPL can be run and typeset

- **sessions.tex**
  Demonstrates the use of different Python sessions in a document

- **typesetting-example.tex**
  The code typesetting example below

- **typesetting-listings.tex**
  A detailed example for typesetting code and output with the `listings` package

- **typesetting-minted.tex**
  A detailed example for typesetting code and output with the `minted` package

### 2 Installation

PyLu\TeX is available in \TeX\ Live, Mi\TeX, and on CTAN\(^1\) as pyluatex.

To install PyLu\TeX in \TeX\ Live run `tlmgr install pyluatex`.

In Mi\TeX, PyLu\TeX can be installed in the Mi\TeX Console.

\(^1\)https://ctan.org/pkg/pyluatex
3 Reference

PyLuaTeX offers a simple set of options, macros and environments.

Most macros and environments are available as quiet versions as well. They have the suffix \_q in their name, e.g. \pycq or \pyfileq. The quiet versions suppress any output, even if the Python code explicitly calls print(). This is helpful if you want to process code or output further and do your own typesetting. For an example, see the Typesetting Code section.

3.1 Package Options

• executable
  Specifies the path to the Python executable. (default: python3)
  Example: \usepackage[executable=/usr/local/bin/python3]{pyluatex}

• ignoreerrors
  By default, PyLuaTeX aborts the compilation process when Python reports an error. If the ignoreerrors option is set, the compilation process is not aborted.
  Example: \usepackage[ignoreerrors]{pyluatex}

• localimports
  If this option is set, the folder containing the TeX input file is added to the Python path. This allows local Python packages to be imported. (default: true)
  Example: \usepackage[localimports=false]{pyluatex}

• shutdown
  Specifies when the Python process is shut down. (default: veryveryend)
  Options: veryveryend, veryenddocument, off
  PyLuaTeX uses the hooks of the package atveryend to shut down the Python interpreter when the compilation is done. With the option veryveryend, Python is shut down in the \AtVeryVeryEnd hook. With the option veryenddocument, Python is shut down in the \AtVeryEndDocument hook. With the option off, Python is not shut down explicitly. However, the Python process will shut down when the LuaTeX process finishes even if off is selected. Using off on Windows might lead to problems with SyncTeX, though.
  Example: \usepackage[shutdown=veryenddocument]{pyluatex}

• verbose
  If this option is set, Python input and output is written to the \LaTeX log file.
  Example: \usepackage[verbose]{pyluatex}

The package options verbose and ignoreerrors can be changed in the document with the \pyoption command, e.g. \pyoption{verbose}{true} or \pyoption{ignoreerrors}{false}.

3.2 Macros

• \py{<code>}
  Executes (object-like) <code> and writes its string representation to the document.
\begin{itemize}
\item \texttt{\textbackslash pyq\{<code>\}}
\end{itemize}

Executes (object-like) 	exttt{<code>}. Any output is suppressed.

\textit{Example:} \texttt{\textbackslash pyq\{3 + 7\}}

\begin{itemize}
\item \texttt{\textbackslash pyc\{<code>\}}
\end{itemize}

Executes \texttt{<code>}. Output (e.g. from a call to \texttt{print()} ) is written to the document.

\textit{Examples:} \texttt{\textbackslash pyc\{x = 5\}}, \texttt{\textbackslash pyc\{print('hello')\}}

\begin{itemize}
\item \texttt{\textbackslash pycq\{<code>\}}
\end{itemize}

Executes \texttt{<code>}. Any output is suppressed.

\textit{Example:} \texttt{\textbackslash pycq\{x = 5\}}

\begin{itemize}
\item \texttt{\textbackslash pyfile\{<path>\}}
\end{itemize}

Executes the Python file specified by \texttt{<path>}. Output (e.g. from a call to \texttt{print()} ) is written to the document.

\textit{Example:} \texttt{\textbackslash pyfile\{main.py\}}

\begin{itemize}
\item \texttt{\textbackslash pyfileq\{<path>\}}
\end{itemize}

Executes the Python file specified by \texttt{<path>}. Any output is suppressed.

\textit{Example:} \texttt{\textbackslash pyfileq\{main.py\}}

\begin{itemize}
\item \texttt{\textbackslash pysession\{<session>\}}
\end{itemize}

Selects \texttt{<session>} as Python session for subsequent Python code. The session that is active at the beginning is \texttt{default}.

\textit{Example:} \texttt{\textbackslash pysession\{main\}}

\begin{itemize}
\item \texttt{\textbackslash pyo\textbackslash option\{<option>\}\{<value>\}}
\end{itemize}

Assigns \texttt{<value>} to the package option \texttt{<option>} anywhere in the document. For more information consider the Package Options section.

\textit{Example:} \texttt{\textbackslash poyo\textbackslash option\{verbose\}\{true\}}

\begin{itemize}
\item \texttt{\textbackslash pyif\{<test>\}\{<then clause>\}\{<else clause>\}}
\end{itemize}

Evaluates the Python boolean expression \texttt{<test>}, and then executes either the \texttt{\LaTeX} code in \texttt{<then clause>} or the \texttt{\LaTeX} code in \texttt{<else clause>}.

\textit{Example:} \texttt{\textbackslash pyif\{a == 1\}\{a = 1\}\{a \texttt{\textbackslash neq} 1\}}

\section{3.3 Environments}

\begin{itemize}
\item \texttt{\textbackslash python}
\end{itemize}

Executes the provided block of Python code.

The environment handles characters like _, #, $, \, etc.

Code on the same line as \texttt{\begin\{python\}} is ignored, i.e., code must start on the next line.

If leading spaces are present they are gobbled automatically up to the first level of indentation.

\textit{Example:}
\begin{python}
    x = 'Hello PyLuaTeX'
    print(x)
\end{python}

- \texttt{pythonq}
  
  Same as the \texttt{python} environment, but any output is suppressed.

- \texttt{pythonrepl}
  
  Executes the provided block of Python code in an interactive console/REPL. Code and output are stored together in the output buffer and can be typeset as explained in section Typesetting Code or as shown in the example \texttt{repl.tex} in the folder \texttt{example}.

You can create your own environments based on the \texttt{python}, \texttt{pythonq} and \texttt{pythonrepl} environments. However, since they are verbatim environments, you have to use the macro `\texttt{\PyLTVerbatimEnv}` in your environment definition, e.g.

\begin{verbatim}
\newenvironment{custompy}
{\PyLTVerbatimEnv\begin{python}}
{\end{python}}
\end{verbatim}

4 Requirements

- \texttt{LuaLaTeX}
- Python 3
- Linux, macOS or Windows

The automated tests currently use TeX Live 2022 and Python 3.8+ on Ubuntu 20.04, macOS Big Sur 11 and Windows Server 2022.

5 Typesetting Code

Sometimes, in addition to having Python code executed and the output written to your document, you also want to show the code itself in your document. PyLuaTeX does not offer any macros or environments that directly typeset code. However, PyLuaTeX has a \texttt{code and output buffer} which you can use to create your own typesetting functionality. This provides a lot of flexibility for your typesetting.

After a PyLuaTeX macro or environment has been executed, the corresponding Python code and output can be accessed via the Lua functions `pylatex.get_last_code()` and `pylatex.get_last_output()`, respectively. Both functions return a Lua table\footnote{https://www.lua.org/pil/2.5.html} (basically an array) where each table item corresponds to a line of code or output.

A simple example for typesetting code and output using the \texttt{listings} package would be:
Notice that we use the `pythonq` environment, which suppresses any output. After that, the custom macro `\pytypeset` is responsible for typesetting the code and its output.

Using a different code listings package like `minted`, or typesetting inline code is very easy. You can also define your own environments that combine Python code and typesetting. See the `typesetting-*.*.tex` examples in the `example` folder.

To emulate an interactive Python console/REPL, the `pythonrepl` environment can be used.

### 6 How It Works

PyLuaTeX runs a Python `InteractiveInterpreter` (actually several if you use different sessions) in the background for on the fly code execution. Python code from your \LaTeX\ file is sent to the background.

3http://docs.python.org/3/library/code.html#code.InteractiveInterpreter
interpreter through a TCP socket. This approach allows your Python code to be executed and the output to be integrated in your \LaTeX file in a single compilation run. No additional processing steps are needed. No intermediate files have to be written. No placeholders have to be inserted.

7 License

LPPL 1.3c\(^4\) for \LaTeX code and MIT license\(^5\) for Python and Lua code.

We use the great json.lua\(^6\) library under the terms of the MIT license\(^7\).

\(^4\)http://www.latex-project.org/lppl.txt
\(^5\)https://opensource.org/licenses/MIT
\(^6\)https://github.com/rxi/json.lua
\(^7\)https://opensource.org/licenses/MIT