Akademy 2024

The Role of Language Bindings: Pythonizing Qt

Dr. Cristián Maureira-Fredes
@cmaureir

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Why Akademy?

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blogs.kde.org/2010/10/27/tale-chile/

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Chilean Linux Meeting 2010

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btw I use arch since 2009

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Disclaimer

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Qt Language Bindings

Exposing Qt to other languages is nothing new.

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Qt Language Bindings

Binding experience, is also Qt experience.

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Name	Language	Latest version	Last commit	License	Company

(updated on Sep 2nd, 2024)

Other 26 projects (some inactive) in wiki.qt.io/Language_Bindings

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Name	Language	Latest version	Last commit	License	Company
PySide	Python	6.7.2	-	LGPLv3/Commercial	The Qt Company
PyQt	Python	6.7.2	-	GPLv3/Commercial	Riverbank Computing

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PyQt	Python	6.7.2	-	GPLv3/Commercial	Riverbank Computing
CXX-Qt	Rust	6.x*	-	MIT/Apache 2.0	KDAB
qmetaobject-rs	Rust	6.5.0	2024.08.07	MIT	Woboq

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QtJambi	Java/Kotlin	6.7.2	2024.06.25	LGPLv2	Omix Visualization

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QML-zig	Zig	5.15.2	2024.08.11	Apache 2.0	-

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QML-zig	Zig	5.15.2	2024.08.11	Apache 2.0	-
QML.jl	Julia	6.5.2	2024.07.12	MIT	JuliaGraphs

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QML-zig	Zig	5.15.2	2024.08.11	Apache 2.0	-
QML.jl	Julia	6.5.2	2024.07.12	MIT	JuliaGraphs
RingQt	Ring	5.15.15	2024.09.02	MIT	-
NodeGui	Node.js	6.6.0	2024.05.31	MIT	NodeGui
nimqt	Nim	6.4.3	2024.01.27	GPL2	-

(updated on Sep 2nd, 2024)

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Most bindings expose only 1:1 API

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What about improving the Qt ecosystem?

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...or at least offering a little bit more.

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The case of Python

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TIOBE Index for August 2024

August Headline: Python is chasing Java's TIOBE index records

This month, Python has a ranking of more than 18% for the first time in its history. The last time a language hit more than 18% was Java in November 2016. Java is also the language with the highest ranking ever: 26.49% in June 2001. Runner up C++ is now exactly 8% behind Python, and that difference between position #1 and position #2 is also almost a record. The highest difference ever between position #1 and position #2 was in November 2016 when Java was 9.55% ahead of C. In summary, Python's hegemony is now undeniable. It is likely that it is Python's next step to become the most popular programming language ever. Is there any new language expected to come close to Python soon? Possible contenders Rust and Kotlin are approaching the TIOBE index top 10 fast, but it will take a lot of time before they become a real threat to Python. *--Paul Jansen CEO TIOBE Software*

The TIOBE Programming Community index is an indicator of the popularity of programming languages. The index is updated once a month. The ratings are based on the number of skilled engineers world-wide, courses and third party vendors. Popular web sites Google, Amazon, Wikipedia, Bing and more than 20 others are used to calculate the ratings. It is important to note that the TIOBE index is not about the *best* programming language or the language in which *most lines of code* have been written.

The index can be used to check whether your programming skills are still up to date or to make a strategic decision about what programming language should be adopted when starting to build a new software system. The definition of the TIOBE index can be found here.

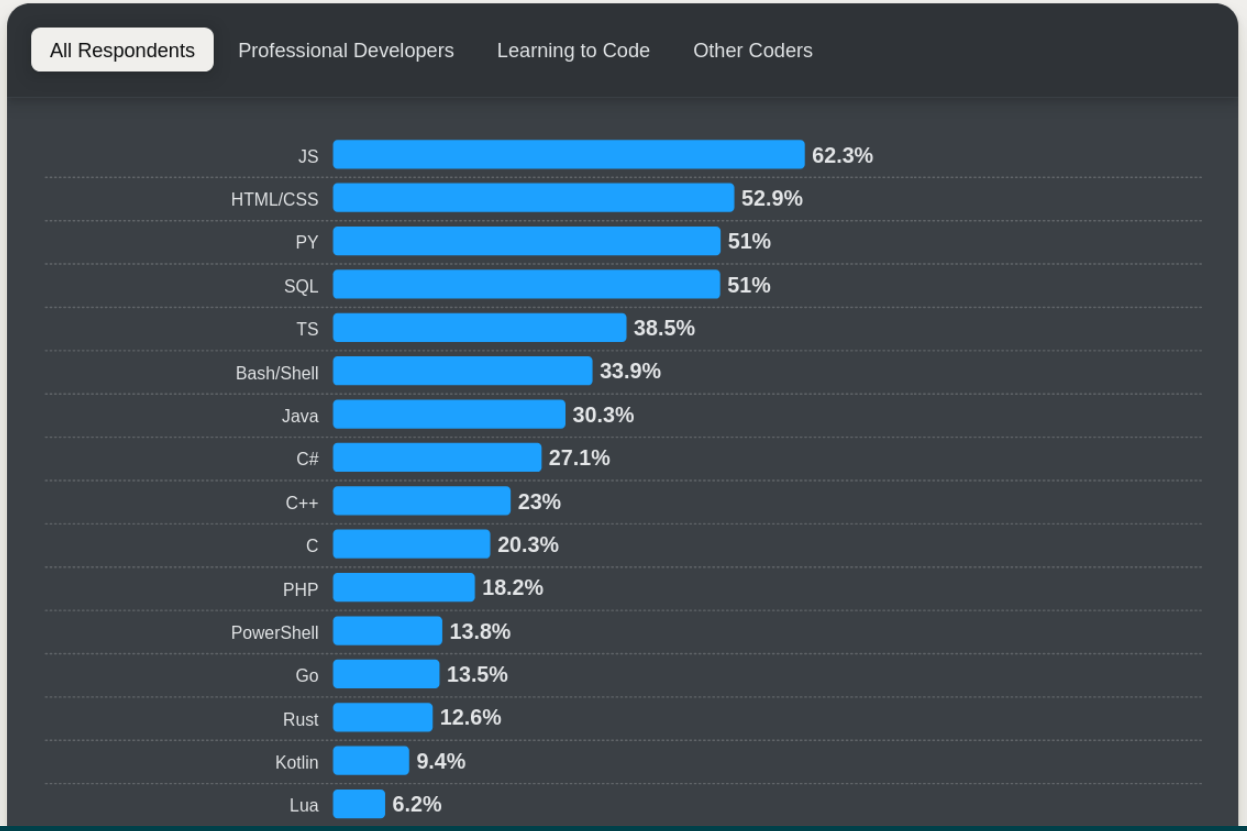
Aug 2024	Aug 2023	Change	Programming Language	Ratings	Change
1	1		Python	18.04%	+4.71%
2	3	↑	C++	10.04%	-0.59%
3	2	↓	C	9.17%	-2.24%
4	4		Java	9.16%	-1.16%
5	5		C#	6.39%	-0.65%
6	6		JavaScript	3.91%	+0.62%
7	8	↑	SQL	2.21%	+0.68%
8	7	↓	Visual Basic	2.18%	-0.45%
9	12	↑	Go	2.03%	+0.87%
10	14	⇈	Fortran	1.79%	+0.75%

Most popular technologies 2.1

Programming, scripting, and markup languages

JavaScript has been a mainstay in the developer survey and on Stack Overflow since our first survey. The most popular programming language has been JavaScript every year we have done the survey except for 2013 and 2014, when SQL was the most popular language.

Which **programming, scripting, and markup languages** have you done extensive development work in over the past year, and which do you want to work in over the next year? (If you both worked with the language and want to continue to do so, please check both boxes in that row.)



StackOverflow Survey 2024 Results

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You can understand

why Python with a few things

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Python's syntax

```
#ifndef MAINWINDOW_H
#define MAINWINDOW_H

#include <QMainWindow>
#include <QPushButton>

class MainWindow : public QMainWindow
{
    Q_OBJECT
    public:
        MainWindow(QWidget *parent = nullptr);
    private slots:
        void handleButton();
    private:
        QPushButton *m_button;
};

#endif // MAINWINDOW_H
```

```
#include "mainwindow.h"

MainWindow::MainWindow(QWidget *parent)
   : QMainWindow(parent)
{
    m_button = new QPushButton("My Button", this);
    connect(m_button, SIGNAL(clicked()), this,
      SLOT(handleButton()));
}

void MainWindow::handleButton()
{
    m_button->setText("Ready");
}
```

```
#include <QApplication>
#include "mainwindow.h"

int main(int argc, char *argv[])
{
    QApplication app(argc, argv);
    MainWindow mainWindow;
    mainWindow.show();
    return app.exec(d);
}
```

```
// don't forget the CMakeLists.txt
```

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Python's syntax

```
#ifndef MAINWINDOW_H
#define MAINWINDOW_H

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```

```
#include <QApplication>
#include "mainwindow.h"

int main(int argc, char *argv[])
{
    QApplication app(argc, argv);
    MainWindow mainWindow;
    mainWindow.show();
    return app.exec(d);
}
```

```
// don't forget the CMakeLists.txt
```

```
import sys
from PySide6.QtCore import Slot
from PySide6.QtWidgets import (
  QApplication, QMainWindow, QPushButton
)

class MainWindow(QMainWindow):
    def __init__(self, parent=None):
        QMainWindow.__init__(self, parent)
        self.b = QPushButton("My Button", self)
        self.b.clicked.connect(self.handle_button)

    @Slot()
    def handle_button(self):
        self.b.setText("Ready")

if __name__ == "__main__":
    app = QApplication(sys.argv)
    mainWindow = MainWindow()
    mainWindow.show()
    sys.exit(app.exec())
```

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Python's heterogeneity

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Python's heterogeneity

Web Development

FastAPI

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Python's heterogeneity

Web Development

Data Science

PyTorch

FastAPI

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Python's heterogeneity

Web Development

Data Science

Embedded systems

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Python: package distribution

```
~ pip install PySide6
Collecting PySide6
  Using cached PySide6-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl.metadata (5.1 kB)
Collecting shiboken6==6.6.0 (from PySide6)
  Using cached shiboken6-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl.metadata (2.3 kB)
Collecting PySide6-Essentials==6.6.0 (from PySide6)
  Using cached PySide6_Essentials-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl.metadata (3.5
 kB)
Collecting PySide6-Addons==6.6.0 (from PySide6)
  Using cached PySide6_Addons-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl.metadata (3.7 kB)
Using cached PySide6-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl (6.7 kB)
Using cached PySide6_Addons-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl (125.2 MB)
Using cached PySide6_Essentials-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl (82.1 MB)
Using cached shiboken6-6.6.0-cp38-abi3-manylinux_2_28_x86_64.whl (169 kB)
Installing collected packages: shiboken6, PySide6-Essentials, PySide6-Addons, PySide6
Successfully installed PySide6-6.6.0 PySide6-Addons-6.6.0 PySide6-Essentials-6.6.0 shibok
en6-6.6.0
~ pip list | grep -i py
```

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qtpip

```
qt ~(env) % pip install qtpip
Collecting qtpip
  Downloading qtpip-0.1-py3-none-manylinux_2_28_x86_64.whl.metadata (975 bytes)
Downloading qtpip-0.1-py3-none-manylinux_2_28_x86_64.whl (4.9 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.9/4.9 MB 19.3 MB/s eta 0:00:00
Installing collected packages: qtpip
Successfully installed qtpip-0.1
qt ~(env) % qtpip install pyside6
[INFO] Commercial License found
[INFO] Starting downloading wheels
[INFO] Downloading wheels (1/5) : "6.6.0-202310171251PySide6-6.6.0.commercial-cp38
-abi3-manylinux_2_28_x86_64.whl.7z"
[INFO] Downloading wheels (2/5) : "6.6.0-202310171251shiboken6-6.6.0.commercial-cp
38-abi3-manylinux_2_28_x86_64.whl.7z"
[INFO] Downloading wheels (3/5) : "6.6.0-202310171251PySide6_M2M-6.6.0.commercial-
cp38-abi3-manylinux_2_28_x86_64.whl.7z"
Downloading ( 83.79%)
```

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qt.io/blog/qtpip-qtforpython-installer

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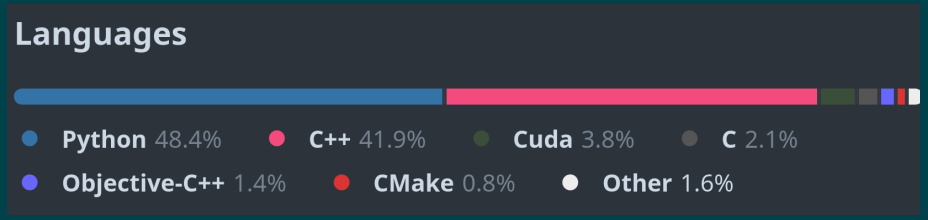
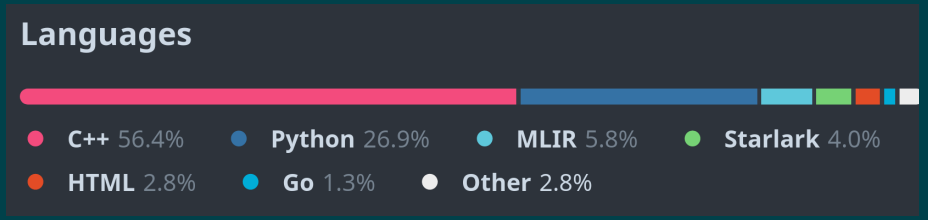
Machine Learning popularity





PyTorch

TensorFlow

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We got the perfect recipe 🏆

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We got the perfect recipe 🏆

A Python user-facing experience with a C++ core.

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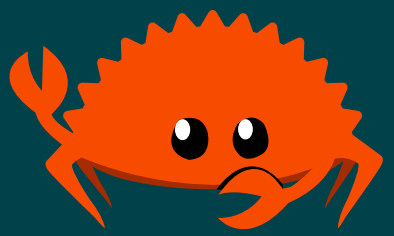
We got the perfect recipe 🏆

A Python user-facing experience with a C++ core.

What about...



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Let's go back to Python and Qt

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PyQt & PySide

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PySide

PyQt

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PySide

- LGPLv3/Commercial

PyQt

- GPLv3/Commercial

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PySide

- LGPLv3/Commercial
- Developed by The Qt Company

PyQt

- GPLv3/Commercial
- Developed by Riverbank Co.

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PySide

- LGPLv3/Commercial
- Developed by The Qt Company
- Support Windows, macOS and Linux.

PyQt

- GPLv3/Commercial
- Developed by Riverbank Co.
- Support Windows, macOS and Linux.

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PySide

- LGPLv3/Commercial
- Developed by The Qt Company
- Support Windows, macOS and Linux.
- Support for Android + Deployment

PyQt

- GPLv3/Commercial
- Developed by Riverbank Co.
- Support Windows, macOS and Linux.
- Support for Android + Deployment

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PySide

- LGPLv3/Commercial
- Developed by The Qt Company
- Support Windows, macOS and Linux.
- Support for Android + Deployment
- Exposes Qt API and more.

PyQt

- GPLv3/Commercial
- Developed by Riverbank Co.
- Support Windows, macOS and Linux.
- Support for Android + Deployment
- Exposes Qt API.

The story of PySide

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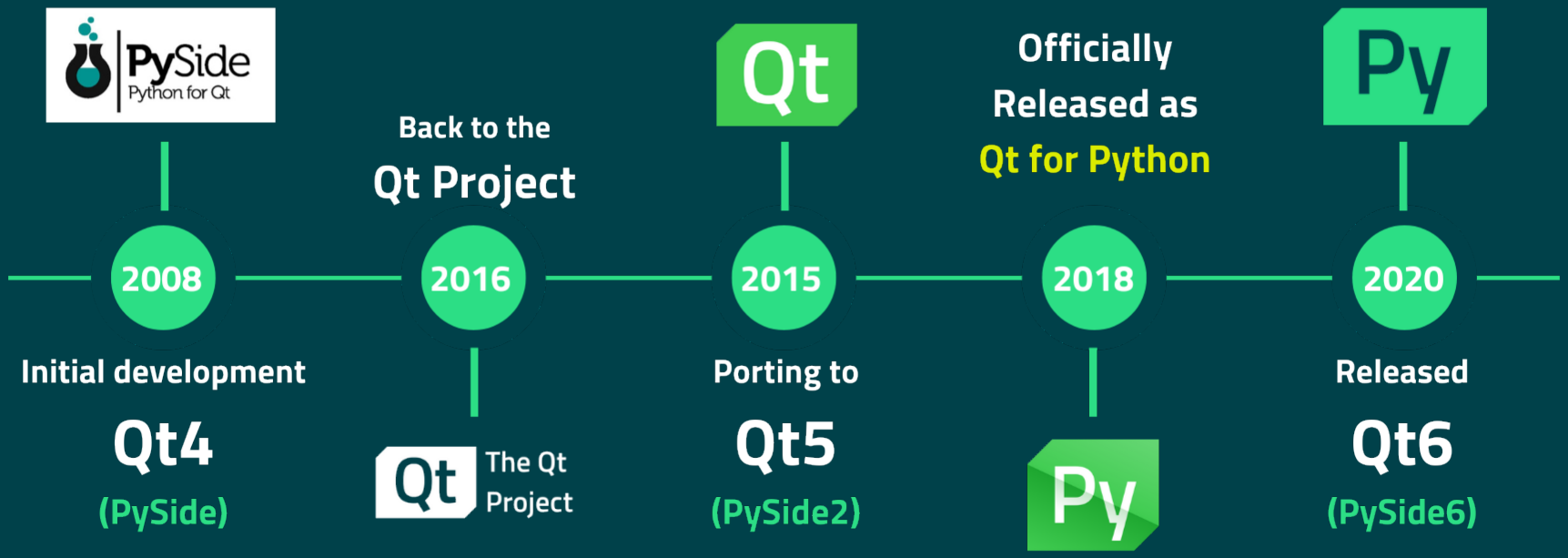

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For PySide

exposing the Qt API (like PyQt)

is not enough

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Searching for new features

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1. Embedding the Python Interpreter

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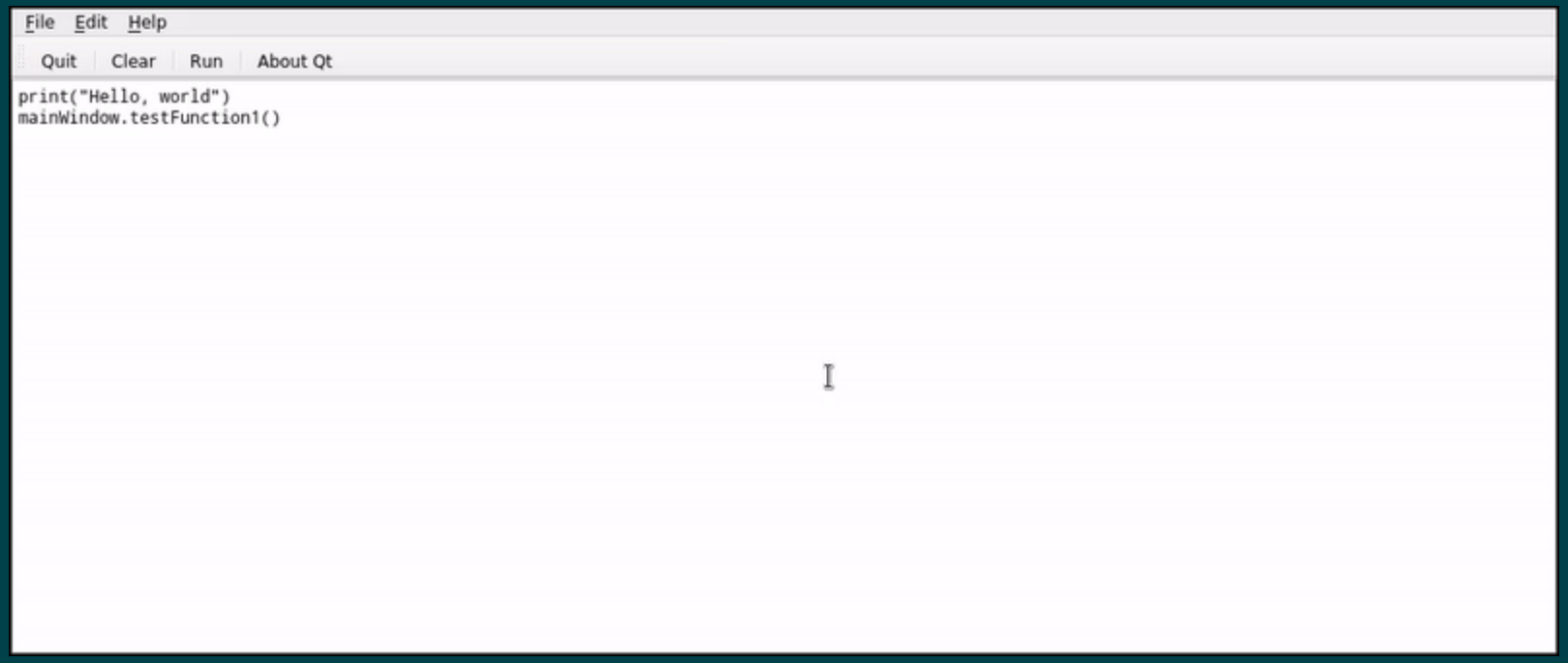

scriptableapplication example

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2. NumPy support

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numpy.org The fundamental package for scientific computing with Python

```
>>> from PySide6.QtGui import QMatrix4x4
>>> import numpy as np
>>> m = np.eye(4)
>>> m.shape = 16
>>> m
array([[1., 0., 0., 0.],
       [0., 1., 0., 0.],
       [0., 0., 1., 0.],
       [0., 0., 0., 1.]])
>>> QMatrix4x4(m)
PySide6.QtGui.QMatrix4x4((1, 0, 0, 0, 0, 1, 0, 0,
```

```
// Also ad-hoc API
QPainter.drawPointsNp(PyArrayObject *x, PyArrayObject *y);

QXYSeries.appendNp(PyArrayObject *x, PyArrayObject *y);
QXYSeries.replaceNp(PyArrayObject *x, PyArrayObject *y);
```

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3. Qt Creator support

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doc.qt.io/qtcreator/creator-python-development.html

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That was not enough 😒

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Adding Python-ish features

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4. snake_case

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```
# Common Qt structure
# - Using setter/getter


table = QTableWidget()
table.setColumnCount(2)

button = QPushButton("Add")
button.setEnabled(False)

layout = QVBoxLayout()
layout.addWidget(table)
layout.addWidget(button)
```

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```
# Common Qt structure
# - Using setter/getter


table = QTableWidget()
table.setColumnCount(2)

button = QPushButton("Add")
button.setEnabled(False)

layout = QVBoxLayout()
layout.addWidget(table)
layout.addWidget(button)
```

```
from __feature__ import (
  snake_case
)

table = QTableWidget()
table.set_column_count(2)

button = QPushButton("Add")
button.set_enabled(False)

layout = QVBoxLayout()
layout.add_widget(table)
layout.add_widget(button)
```

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```
# Common Qt structure
# - Using setter/getter


table = QTableWidget()
table.setColumnCount(2)

button = QPushButton("Add")
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from __feature__ import (
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button = QPushButton("Add")
button.set_enabled(False)

layout = QVBoxLayout()
layout.add_widget(table)
layout.add_widget(button)
```

It might look strange to you, C++ developer.

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5. True properties

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```
# Common Qt structure
# - Using setter/getter
# - No writable properties

table = QTableWidget()
table.setColumnCount(2)

button = QPushButton("Add")
button.setEnabled(False)

layout = QVBoxLayout()
layout.addWidget(table)
layout.addWidget(button)
```

```
from __feature__ import (
  snake_case, true_property
)

table = QTableWidget()
table.column_count = 2

button = QPushButton("Add")
button.enabled = False

layout = QVBoxLayout()
layout.add_widget(table)
layout.add_widget(button)
```

```
# Common Qt structure
# - Using setter/getter
# - No writable properties

table = QTableWidget()
table.setColumnCount(2)

button = QPushButton("Add")
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layout = QVBoxLayout()
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```
from __feature__ import (
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table = QTableWidget()
table.column_count = 2

button = QPushButton("Add")
button.enabled = False

layout = QVBoxLayout()
layout.add_widget(table)
layout.add_widget(button)
```

This was the #1 requested feature

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6. QmlElement

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```python
from PySide6.QtQml import QmlElement
# ...

QML_IMPORT_NAME = "io.qt.some_name"
QML_IMPORT_MAJOR_VERSION = 1


@QmlElement
class Bridge(QObject):

    @Slot(str, result=str)
    def getColor(self, s):
        # ...
```

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```python
from PySide6.QtQml import QmlElement
# ...

QML_IMPORT_NAME = "io.qt.some_name"
QML_IMPORT_MAJOR_VERSION = 1


@QmlElement
class Bridge(QObject):

    @Slot(str, result=str)
    def getColor(self, s):
        # ...
```

```qml
// ...
import io.qt.some_name
// ...
Bridge {
    id: bridge
}

Button {
  id: red
  text: "Red"
  highlighted: true
  Material.accent: Material.Red
  onClicked: {
    label.color = bridge.getColor(red.text)
  }
}
// ...
```

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7. Tooling

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```
# Wrappers
pyside6-assistant
pyside6-designer
pyside6-linguist
pyside6-lrelease
pyside6-lupdate
pyside6-qml
pyside6-qmlcachegen
pyside6-qmlimportscanner
pyside6-qmllint
pyside6-qmlsc
pyside6-qmltyperegistrar
pyside6-rcc
pyside6-uic
```

```
# Utilities
pyside6-genpyi
pyside6-metaobjectdump
```

```
# New tools
pyside6-project
pyside6-deploy
pyside6-android-deploy
```

doc.qt.io/qtforpython-6/tools/index.html

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Moaaaaar features!

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8. Android support

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- Embrace a community project python-for-android
- Rely on the Qt/C++ scope (QtQuick)
- Automate the most from the process (one command line)

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9. QtAsyncio

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QtAsyncio

```python
# ...
import sys
import asyncio
import PySide6.QtAsyncio as QtAsyncio

class MainWindow(QMainWindow):
  def __init__(self):
    super().__init__()
    widget = QWidget()
    self.setCentralWidget(widget)
    layout = QVBoxLayout(widget)
    self.text = QLabel("The answer is 42.")
    layout.addWidget(self.text, alignment=Qt.AlignmentFlag.AlignCenter)

    async_trigger = QPushButton(text="What is the question?")
    async_trigger.clicked.connect(lambda: asyncio.ensure_future(self.set_text()))
    layout.addWidget(async_trigger, alignment=Qt.AlignmentFlag.AlignCenter)

  async def set_text(self):
    await asyncio.sleep(1)
    self.text.setText("What do you get if you multiply six by nine?")
```

```python
if __name__ == "__main__":
    app = QApplication(sys.argv)
    main_window = MainWindow()
    main_window.show()

    QtAsyncio.run(handle_sigint=True)
```

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10. Qt Design Studio

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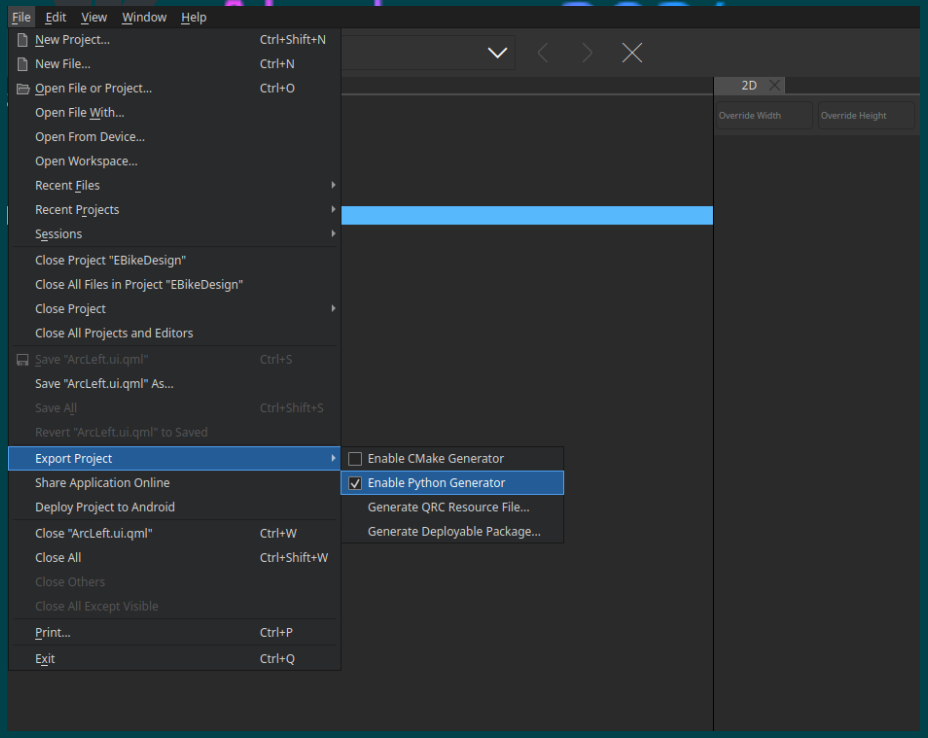


```
% tree Python
Python
├── autogen
│   └── settings.py
└── main.py

2 directories, 2 files
```

```python
# Python/autogen/settings.py

url = "content/App.qml"
import_paths = [
        ".",
        "imports",
        "asset_imports",
]
```

```python
# Python/main.py
# ...
from autogen.settings import url, import_paths

if __name__ == '__main__':
    app = QGuiApplication(sys.argv)
    engine = QQmlApplicationEngine()

    app_dir = Path(__file__).parent.parent

    engine.addImportPath(os.fspath(app_dir))
    for path in import_paths:
        engine.addImportPath(os.fspath(app_dir / path))

    engine.load(os.fspath(app_dir/url))
    if not engine.rootObjects():
        sys.exit(-1)
    sys.exit(app.exec())
```

⭐ To be announced this month.

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11. Lazy loading

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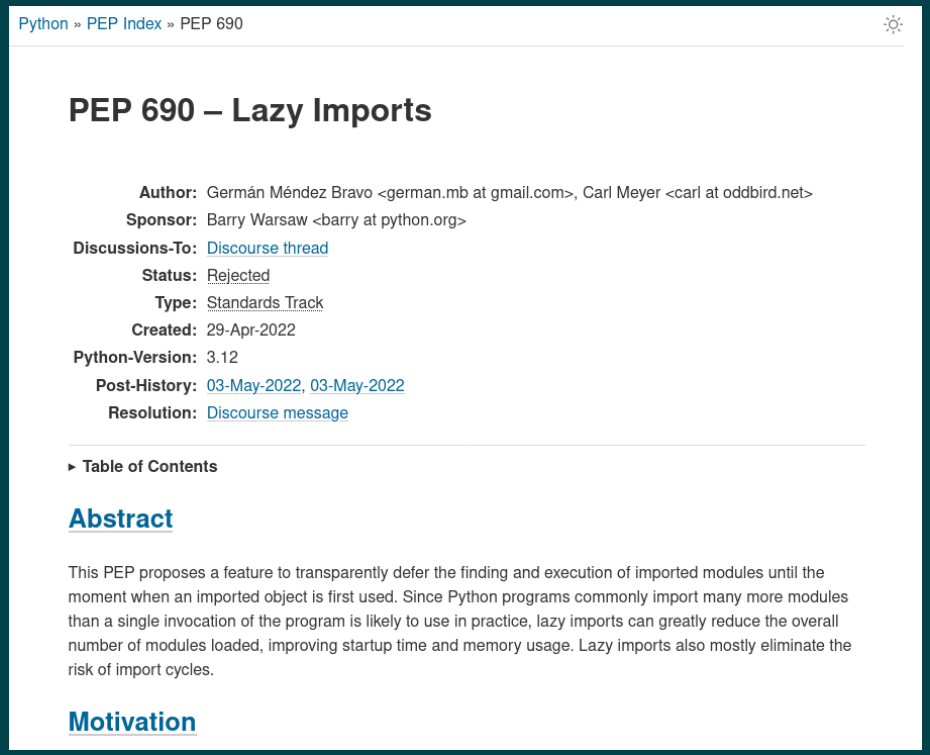

Python » PEP Index » PEP 690

PEP 690 – Lazy Imports

Author: Germán Méndez Bravo <german.mb at gmail.com>, Carl Meyer <carl at oddbird.net>
Sponsor: Barry Warsaw <barry at python.org>
Discussions-To: Discourse thread
Status: Rejected
Type: Standards Track
Created: 29-Apr-2022
Python-Version: 3.12
Post-History: 03-May-2022, 03-May-2022
Resolution: Discourse message

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Abstract

This PEP proposes a feature to transparently defer the finding and execution of imported modules until the moment when an imported object is first used. Since Python programs commonly import many more modules than a single invocation of the program is likely to use in practice, lazy imports can greatly reduce the overall number of modules loaded, improving startup time and memory usage. Lazy imports also mostly eliminate the risk of import cycles.

Motivation

Improve startup time of the PySide modules

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12. QtScript...but Python

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```
static Demo demos[] = {
    {"Main Window",
     R"(# main_win is bound from C++
print("name=", main_win.objectName)
# point is bound from C++
print("point.x,y=", point.x(), point.y())

# Play with properties
main_win.objectName = "TestName"
print("changed name=", main_win.objectName)

# Create a point in Python
python_point = QPoint()
print("python_point.x,y=", python_point.x(),
    python_point.y())
python_point.setX(500)
python_point.setY(500)
)"},
};
```

- Python within C++
- Embed the Python interpreter
- Dynamical bindings
- Bind the Qt/C++ application to the interpreter

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13. Flatpak support

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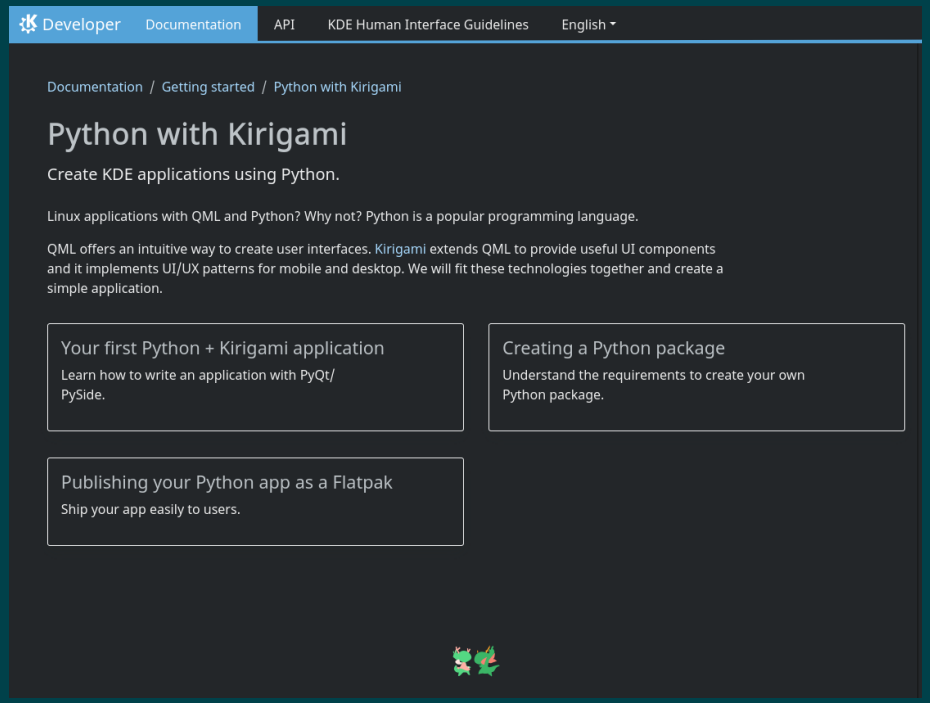

- Enabling users to create Python apps for KDE
- PyQt and PySide are compatible
  - github.com/flathub/io.qt.PySide.BaseApp

develop.kde.org/docs/getting-started/python/

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...since we are talking about KDE

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2024 Program | KDE Community

Contributor

Manuel Alcaraz

Python bindings for KDE Frameworks

Mentors	Organization	Technologies	Topics
Carl Schwan	KDE Community	python, c++, qt, cmake	desktop, ui

KDE Frameworks is a collection of C++ addon libraries to Qt that provide common functionality for desktop applications built with the Qt framework. While Qt itself provides support for developing applications using other programming languages, such as Python, KDE Frameworks does not. This project aims to create Python bindings (along with comprehensive developer documentation) for a subset of the KDE Frameworks using the same technologies (Shiboken) that Qt uses for their Python port.

Merge request: Add Python bindings

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Is that enough 😰?

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Re-writing Python code into a compiled language is faster

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Re-writing Python code into a compiled language is faster

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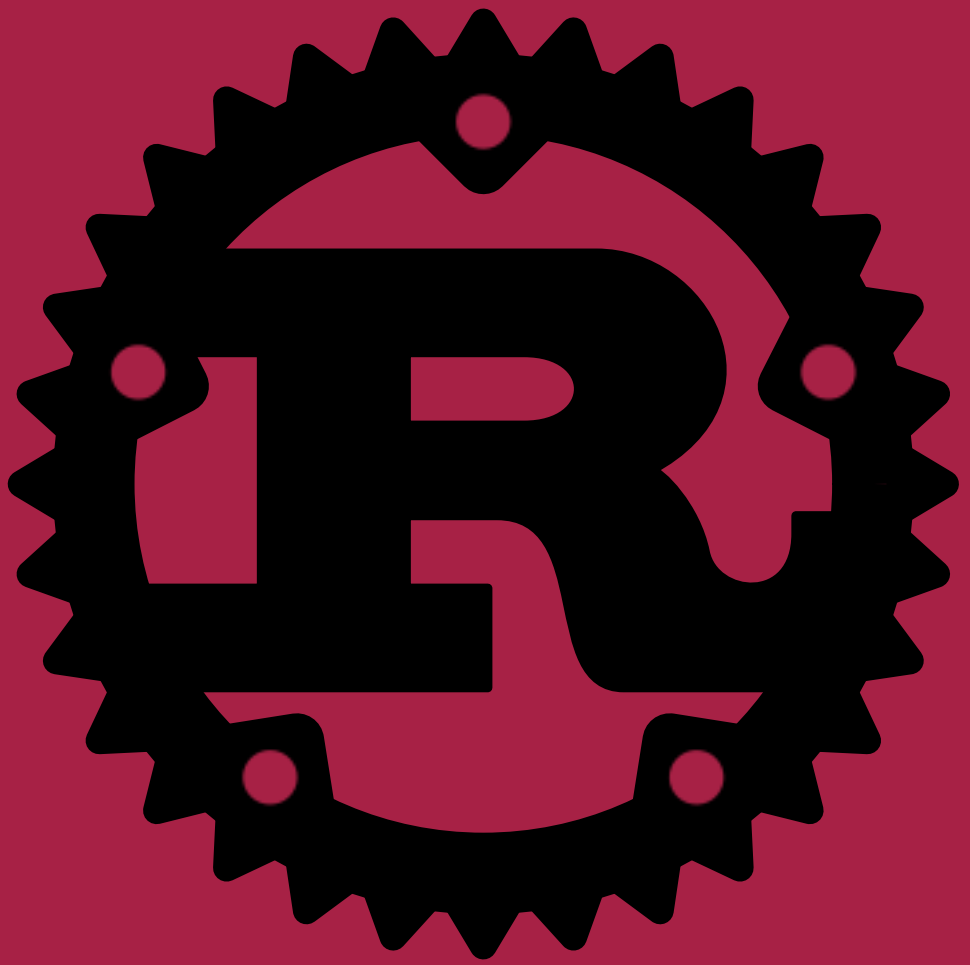

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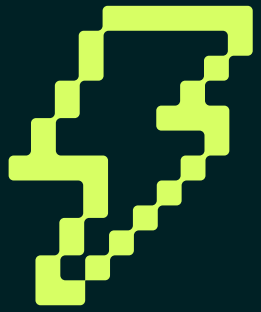

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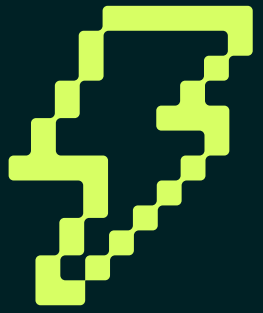

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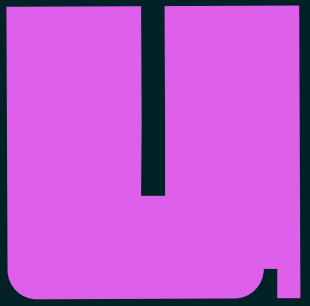

uv.astral.sh

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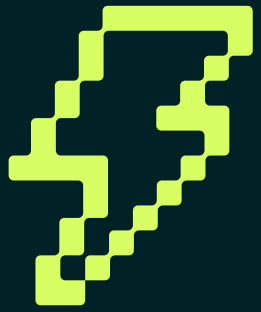

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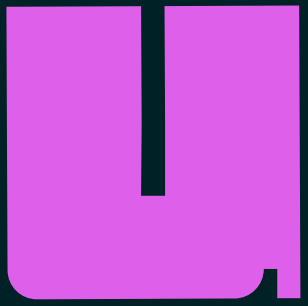

uv.astral.sh

rye

rye.astral.sh

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A different-approach

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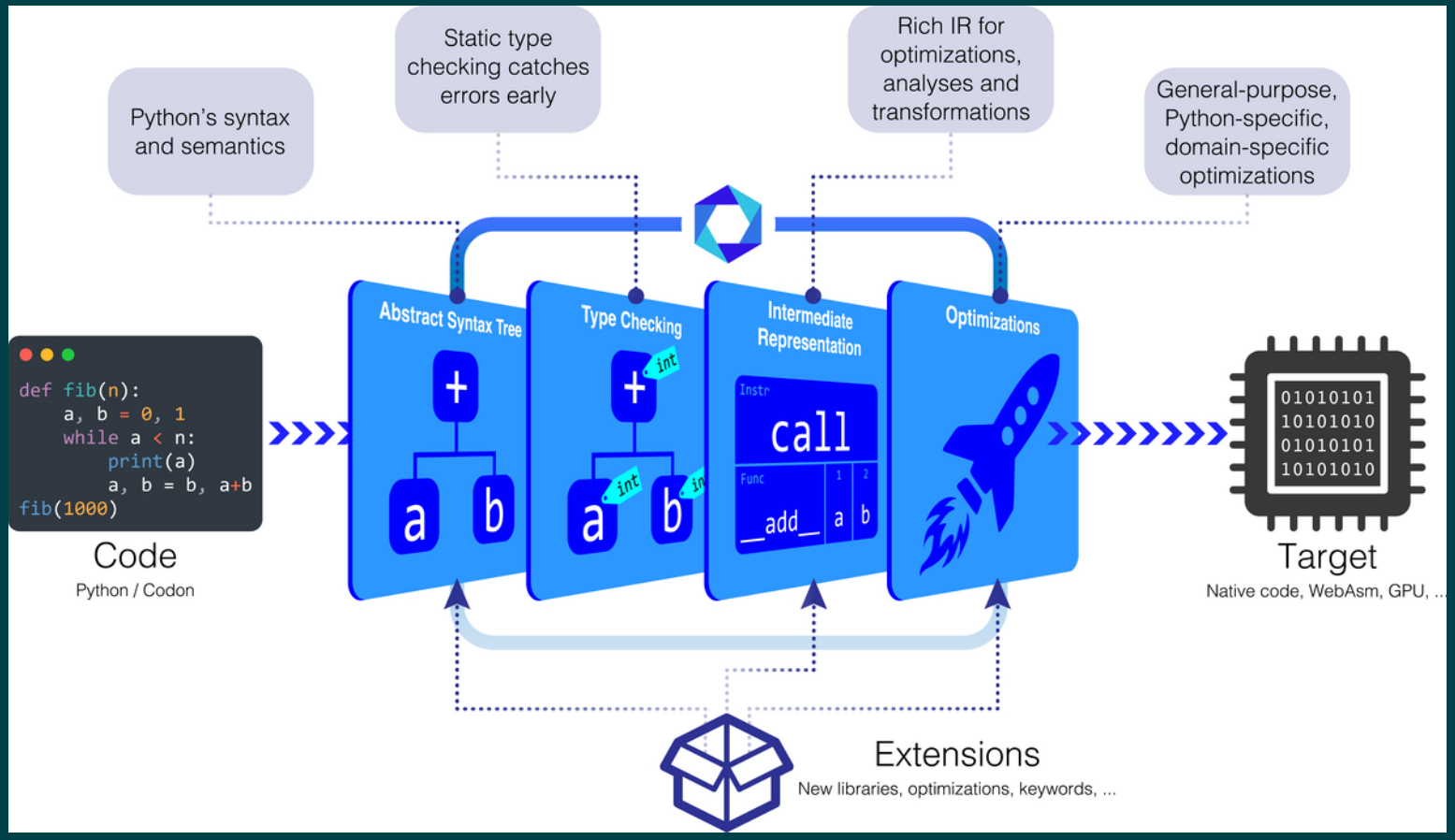
Codon



docs.exaloop.io/codon

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The future of the project

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a. Simplifying User-facing experience

```python
import kimyou
from kimyou import Window, TextField, Button

def main(window: Window):
    window.title = "Testing title"
    window.layout_direction = "vertical"
    name = TextField(value="Enter your name")
    button = Button(text="Click me!",
        on_click=lambda: print(f"Hello {name.value}"))
    button2 = Button(text="Exit", on_click=window.exit)
    # Vertical
    #window.add(name)
    #window.add(button)
    #window.add(button2)
    # Horizontal
    window.add([name, button, button2])

kimyou.app(target=main)
```

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b. Packaging and Tooling

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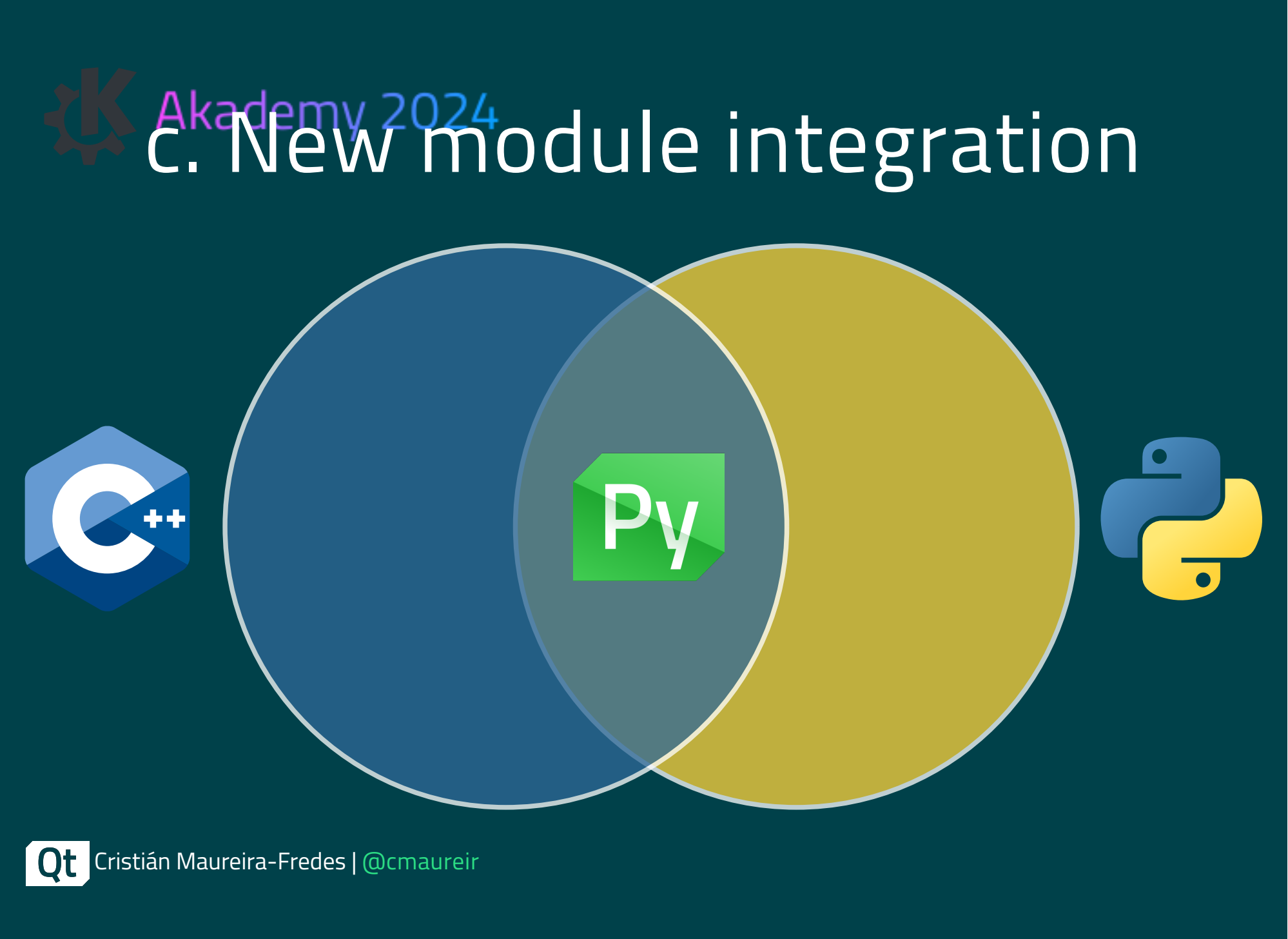
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c. New module integration
C++
Py
Qt
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d. New Python-only Qt modules

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And other features requested by ~~users~~ you

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What's next?

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Embrace the idea of a many-language framework

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Imagine everything we can learn from other languages

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Be boring and

see what works for people

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Q&A

The Role of Language Bindings: Pythonizing Qt

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