



ORACLE

# Python auf GraalVM – eine vielfältige Welt

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## Safe harbor statement



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### **GraalVM Native Image Early Adopter Status**

GraalVM Native Image technology (including SubstrateVM) is Early Adopter technology. It is available only under an early adopter license and remains subject to potentially significant further changes, compatibility testing and certification.



# Agenda



1. Why run Python.  
And why not.

2. What Python on  
GraalVM can do for  
you

3. Getting Started  
with Python on  
GraalVM

# Python: What and Why?



## Scripting language

- Default implementation **CPython** is interpreted
- Popular for system scripting, direct access to system libraries

## Data science language

- Popular C extension libraries – NumPy, SciPy, Pandas, Tensorflow, ...

## Popular with programmers

- Easy to learn and be productive with rich library
- #1 on PYPL and #3 on TIOBE popularity indices

But ...



... there's always a but

# Python Performance



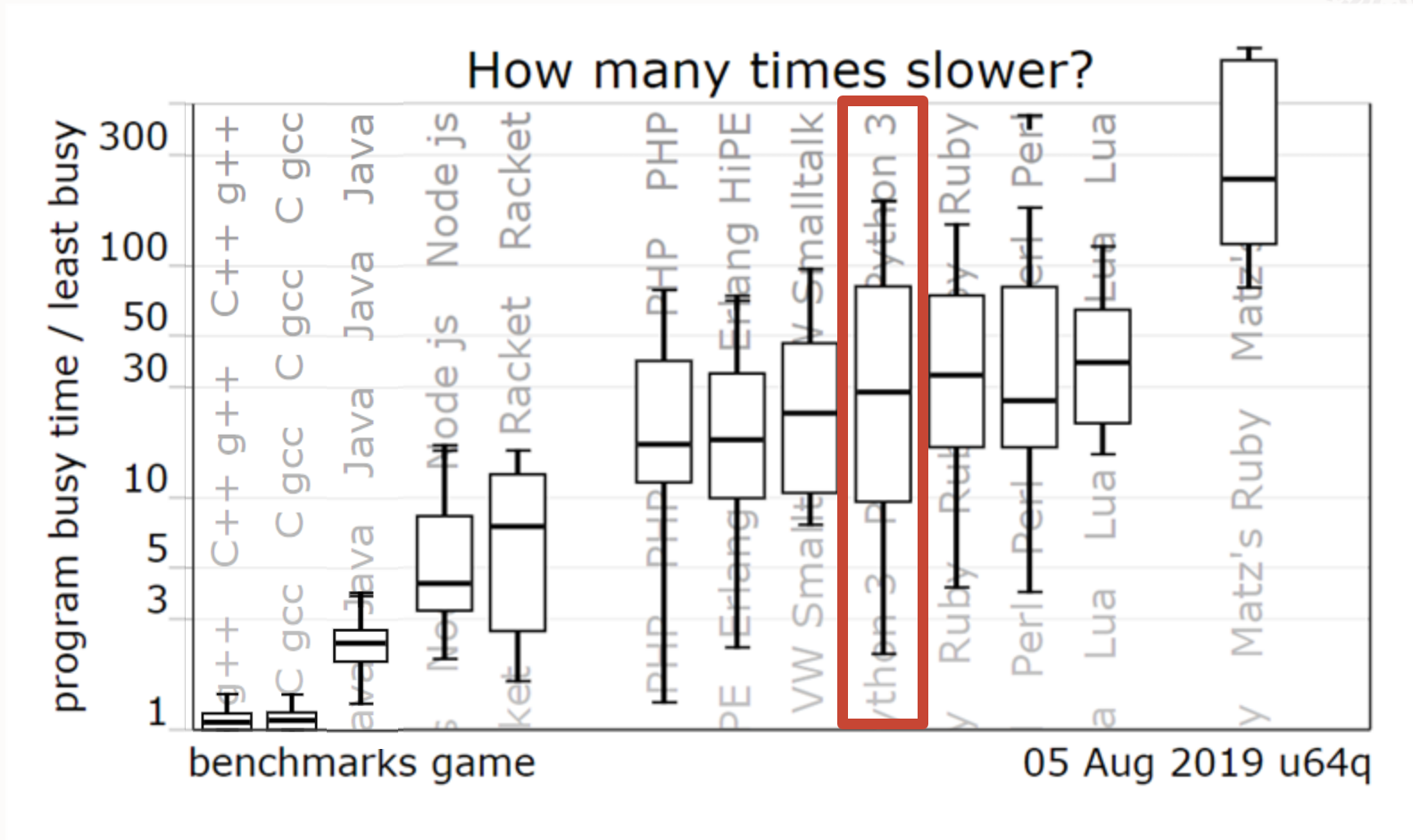
why is python

---

why is python **so slow**  
why is python **slower than Java**  
why is python **slow**  
why is python **slow but popular**



# Python Performance



# Embedding Python



*"enrich your C/C++ application by embedding Python in it"*

- From: <https://docs.python.org/3/extending/embedding.html>



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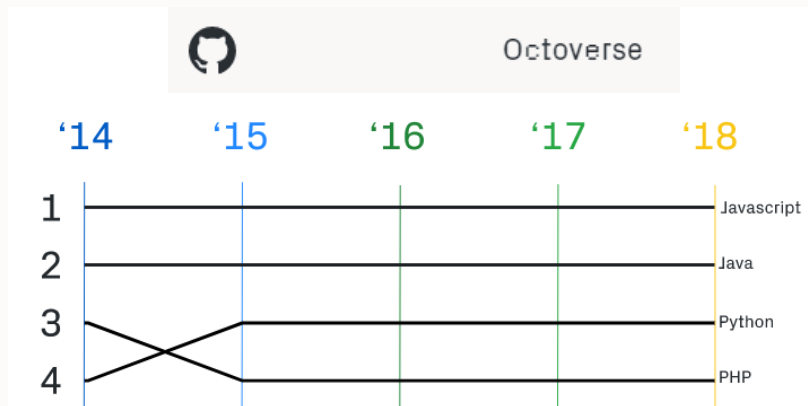
# Embedding Python

"enrich your **C/C++** application by embedding Python in it"

- From: <https://docs.python.org/3/extending/embedding.html>

## TIOBE Index for August 2019

Aug 2019	Aug 2018	Change	Programming Language
1	1		Java



## PYPL Popularity of Programming Language

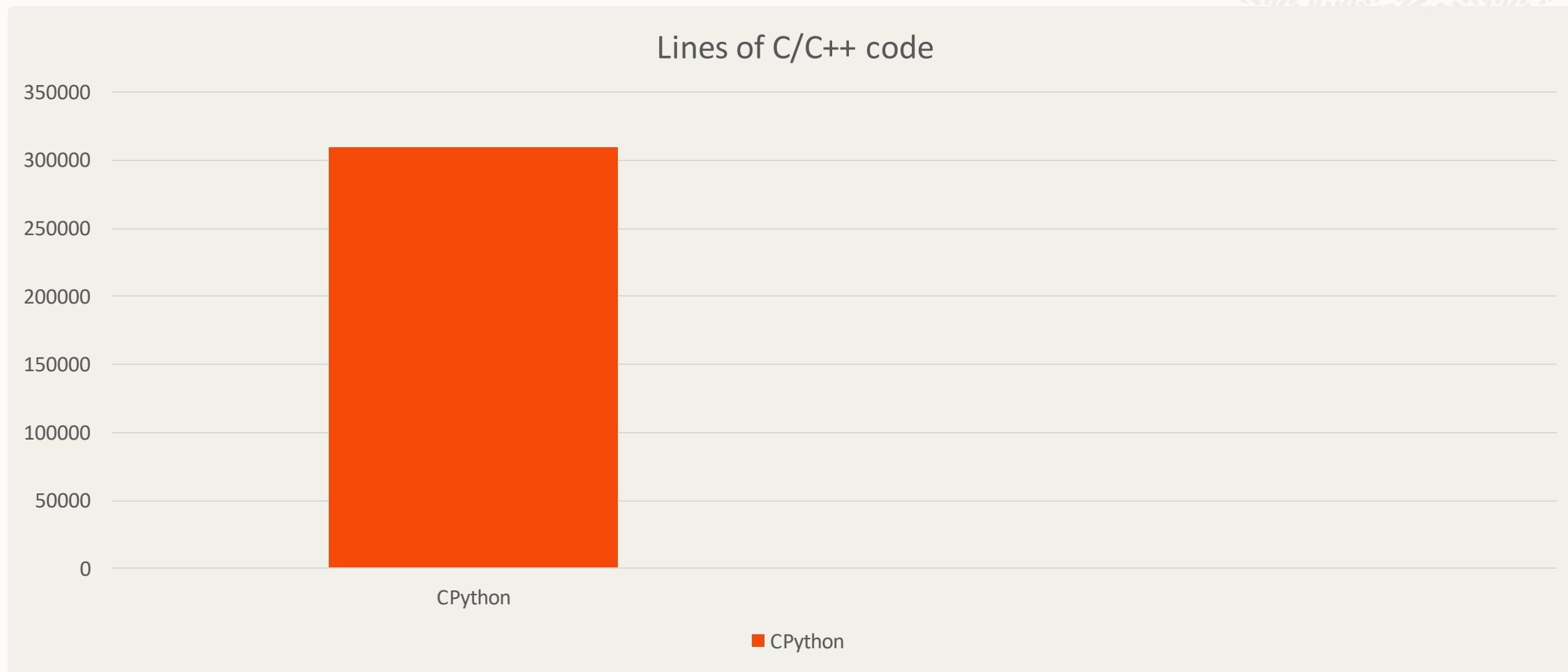
Worldwide, Aug 2019 compared to a year ago:

Rank	Change	Language	Share	Trend
1		Python	28.73 %	+4.5 %
2		Java	20.0 %	-2.1 %
3		Javascript	8.35 %	-0.1 %

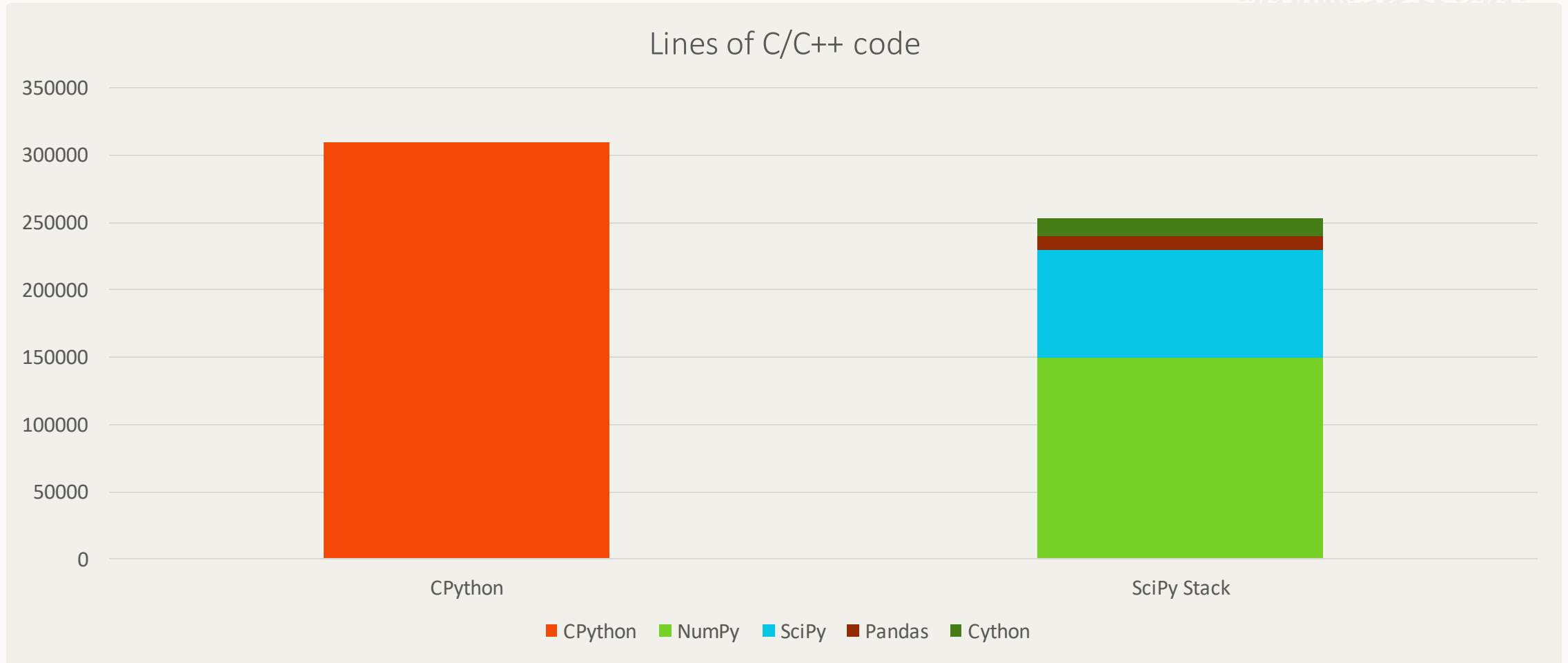
# Trust in Third-Party Native Code



# Trust in Third-Party Native Code



# Trust in Third-Party Native Code



# Trust in Third-Party Native Code



numpy / numpy

Sponsor Used by 238,073 Watch 466 Star 11,559 Fork 3,797

Code Issues 1,734 Pull requests 214 Projects 3 Wiki Security Insights

Filters is:issue segfault Labels 80 Milestones 5 [New issue](#)

Clear current search query, filters, and sorts

36 Open	232 Closed	Author	Labels	Projects	Milestones	Assignee	Sort
<b>Crash in `np.vdot` for array-like object</b> <b>00 - Bug</b>	5						
<b>np.random.permutation(x) where isinstance(x, str) segfaults</b>	3						
<b>Segfault passing b`x`ff` into np.dtype (array underflow)</b> <b>00 - Bug</b> <b>component: numpy.dtype</b> <b>defunct — difficulty: Intermediate</b>	4						
<b>SEGFALT in array fancy indexing</b> <b>57 - Close?</b>	2						
<b>non pure bool causes segfault in nonzero</b> <b>00 - Bug</b> <b>component: numov core</b>	2						



But ...

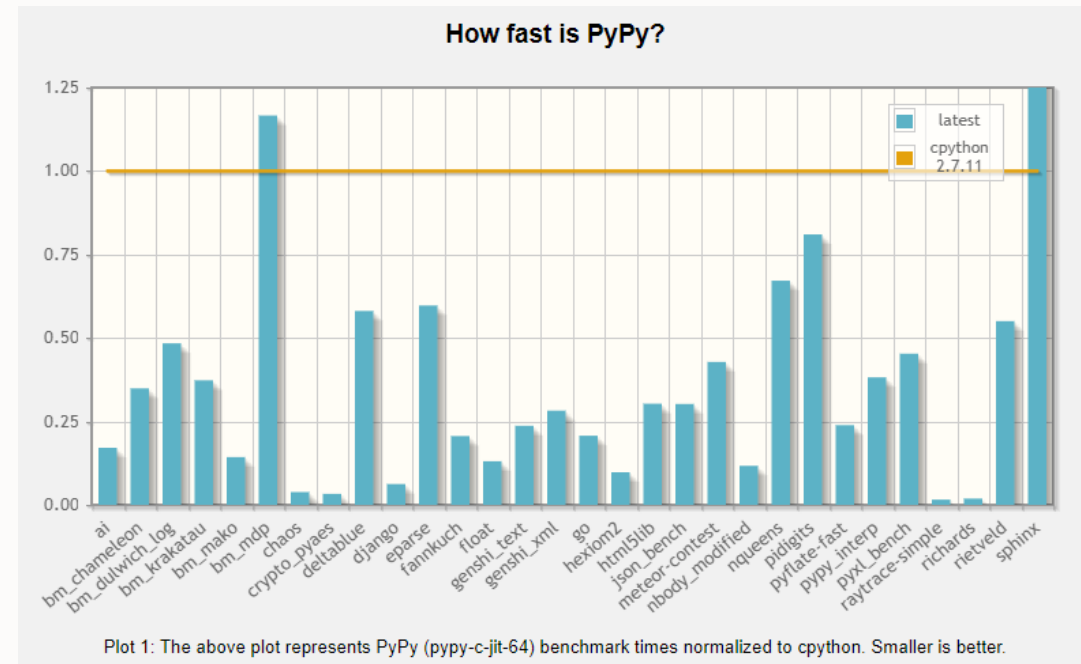


... that's for the CPython implementation

# Fast Python

## PyPy

- On average more than 4x faster than CPython for pure Python code
- Less embeddable than CPython





# Embeddable Python

## Jython & IronPython

- JVM or .NET languages integration
- Support only Python 2
- Projects barely maintained
- No C extension support

The screenshot shows the IronPython website with a dark navigation bar containing links for Home, News, Download, Documentation, Development, and Links. The main content area features a 'News' section with entries for 'New website (October 2018)', 'Jython 2.7.1 Final Released (July 2017)', and 'Jython 2.7.0 Final Released (May 2015)'. A prominent green banner promotes downloading IronPython 2.7, highlighting that it can be tried in a browser without installation. The banner includes a code snippet for a simple quiz program. To the right, a screenshot of the IronPython Interactive environment is shown, displaying a file explorer with various Python modules and a code editor. Below the banner, an 'Announcements' section lists several releases from 2014 to 2018, each with a brief description of the fixes included.

### IronPython

the Python programming language for the .NET Framework

IronPython is an [open-source](#) implementation of the Python programming language which is tightly integrated with the .NET Framework. IronPython can use the .NET Framework and Python libraries, and other .NET languages can use Python code just as easily.

#### News

**New website (October 2018)**  
[...]

**Jython 2.7.1 Final Released (July 2017)**  
[...]

**Jython 2.7.0 Final Released (May 2015)**  
[...]

**Download IronPython 2.7**  
2.7.9 released on 2018-10-09  
[release notes](#) | [source](#)

Quickly run Python code in your browser, without installing IronPython.

```
>>> questions = {'name', 'quest', 'favorite color'}
>>> answers = ['lanolite', 'the holy grail', 'blue']
>>> for q, a in zip(questions, answers):
...     print "What is your %s? It is %s." % (q, a)
...
What is your name? It is lanolite.
What is your quest? It is the holy grail.
What is your favorite color? It is blue.
>>>
```

Experience a more interactive .NET and Python development experience with [Python Tools for Visual Studio](#).

#### Announcements

**February 16, 2018**  
[IronPython 2.7.8](#) is now available!  
This release includes many fixes.

**December 7, 2016**  
[IronPython 2.7.7](#) is now available!  
This release includes many fixes.

**August 20, 2016**  
[IronPython 2.7.6](#) is now available!  
This release includes many fixes.

**December 6, 2014**  
[IronPython 2.7.5](#) is now available!  
This release includes `ensurepip` and many other fixes.



# Safe Python?



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# Python on GraalVM



High  
Performance



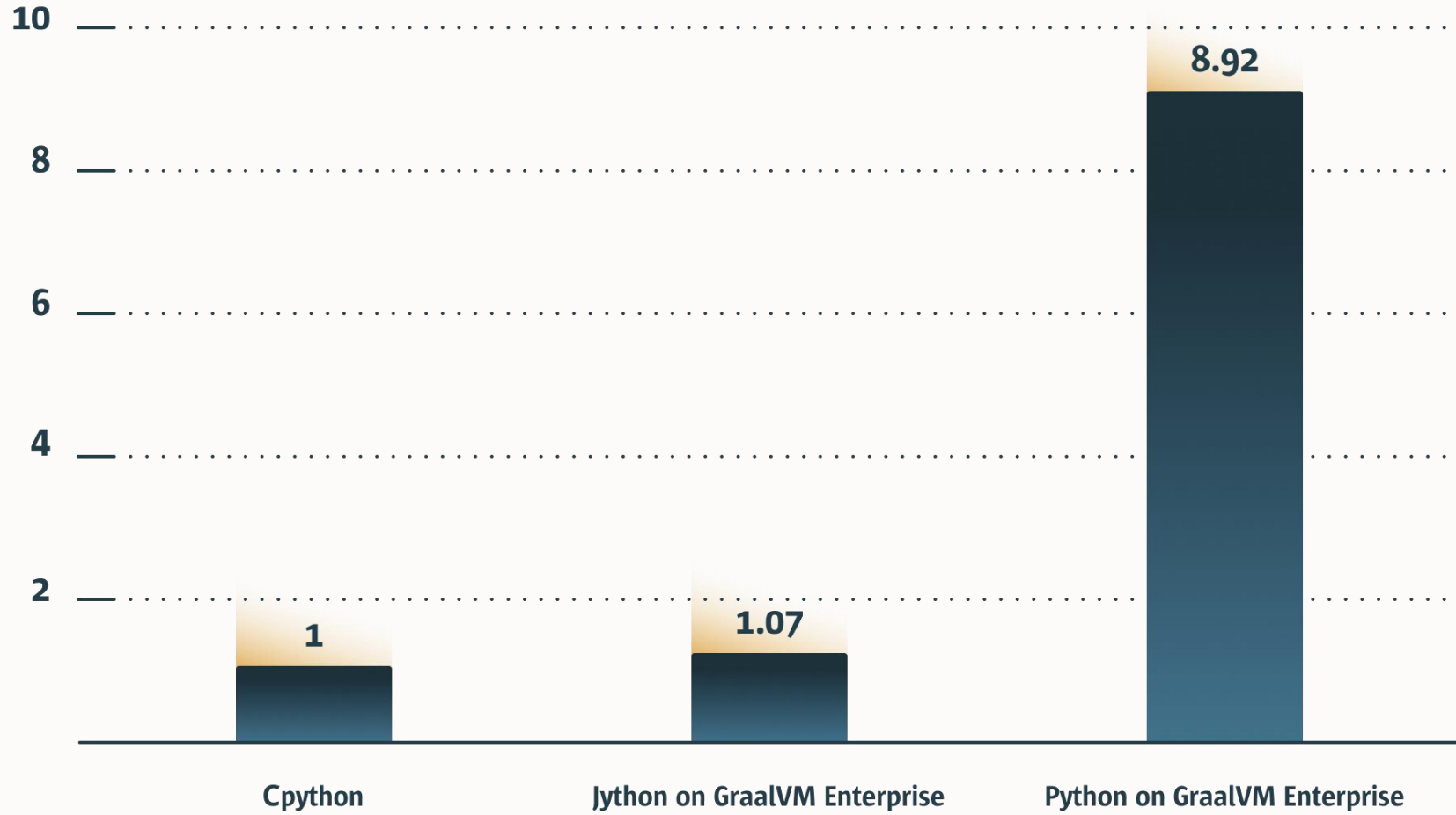
Interoperability



Managed  
Execution



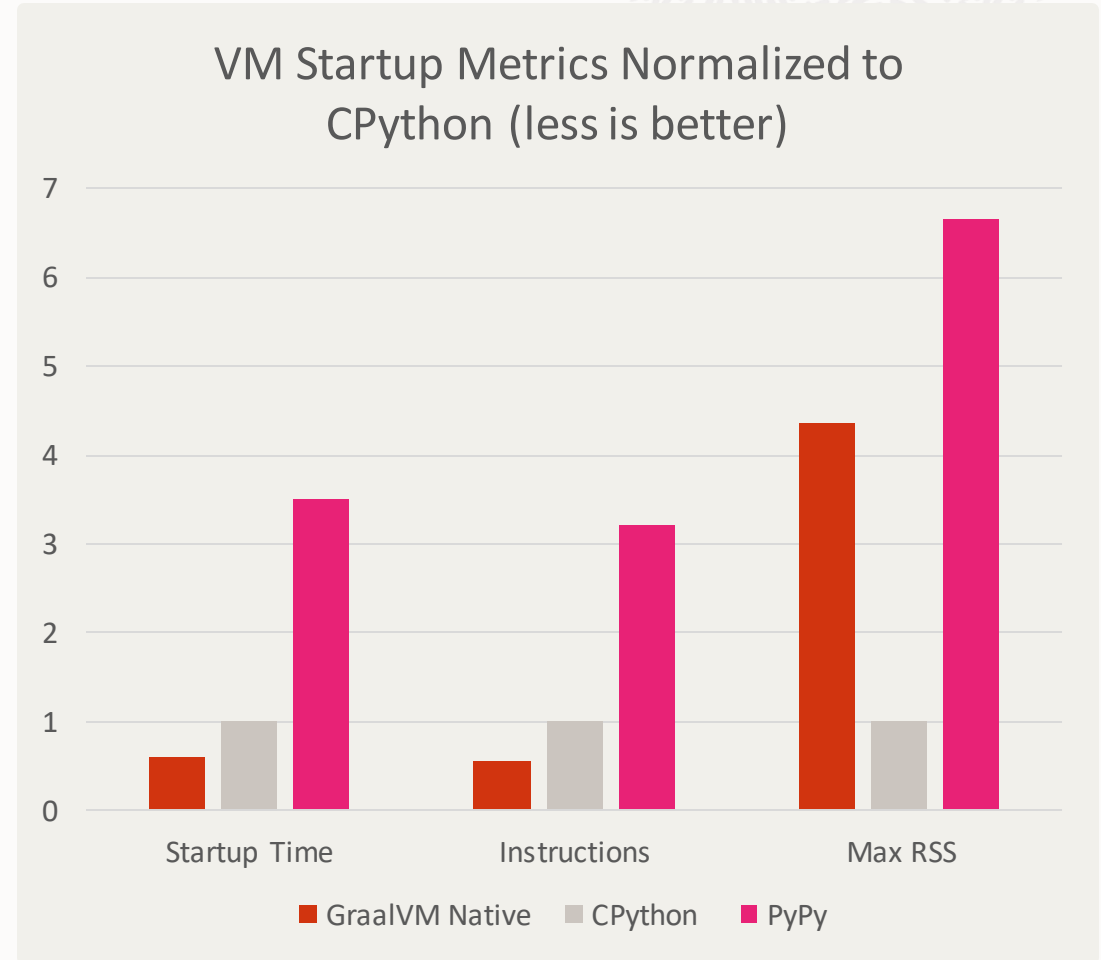
# Performance



# Startup

Native image can warm up code at build time for fast startup

- We're working on RSS 😊



## Interoperability

- Use code from Java or any other GraalVM language
- Embed into JVM languages using GraalVM Embedder API



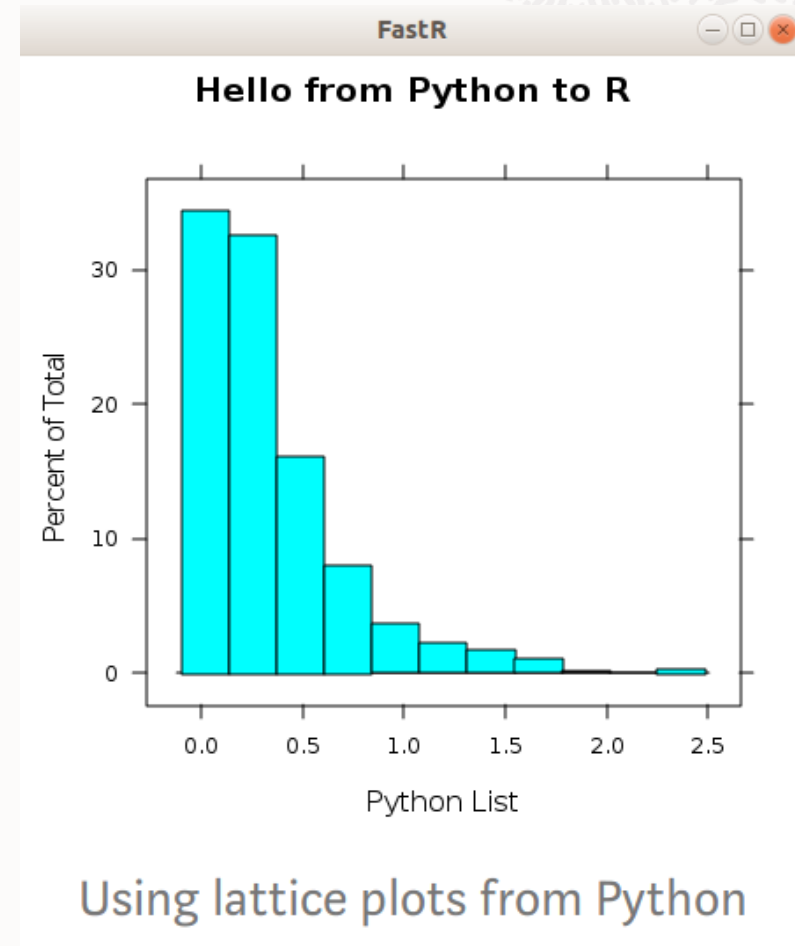
```
# load the R package lattice and open a window for plotting
polyglot.eval(string="library(lattice); awt()", language="R")

# Create R function that draws a histogram
plot = polyglot.eval(string="""
function(y) {
  print(histogram(~as.vector(y),
                  main='Hello from Python to R',
                  xlab='Python List'))
}
""", language="R")

# invoke the R function with data from Python
plot(numpy.array(mydata))
```

# Interoperability

- Use code from Java or any other GraalVM language
- Embed into JVM languages using GraalVM Embedder API



# Managed Execution

Safe and sandboxed execution of native code



LLVM

Graal

LLVM Interpreter on GraalVM

Run native extensions safely

Catch memory errors as exceptions

A screenshot of a GitHub pull request titled "Fix PyArray\_FillFunc function definitions #12419". The pull request is merged and was created by timfel on Nov 19, 2018. It includes a comment from timfel stating that the functions should return an integer as required by the function typedef. The pull request also shows a commit by ENH: Fix PyArray\_FillFunc definitions to return an int as per typedef with commit hash 46e9fd9.

Fix PyArray\_FillFunc function definitions #12419

Merged charris merged 1 commit into numpy:master from timfel:fix-fill-funcs on Nov 24, 2018

Conversation 10 Commits 1 Checks 1 Files changed 2

timfel commented on Nov 19, 2018 Contributor

These should return an integer, as required by the function typedef.

ENH: Fix PyArray\_FillFunc definitions to return an int as per typedef 46e9fd9





But ...



... can I use Python on GraalVM today?

“

It depends.

- *Tim Felgentreff*



## Compatibility

- Unit Tests
  - ~ 58% Python Standard Library
    - Missings things specific to POSIX and Linux, audio, network protocols, encoding, async, implementation specifics like GC, CPython tools
  - > 90% NumPy
  - ~ 10% Pandas
- We are actively working on compatibility
  - Significant improvements on every release
  - Community is helping on GitHub
- **Let us know what you care about!** on <https://github.com/oracle/graalpython>



## Package Support



- Pip installer is already available  
We ship our own installer **ginstall** to ensure compatible versions
- Pandas and NumPy can be installed work for a wide range of code
- A lot of pure Python packages “just work” and compatibility is improving



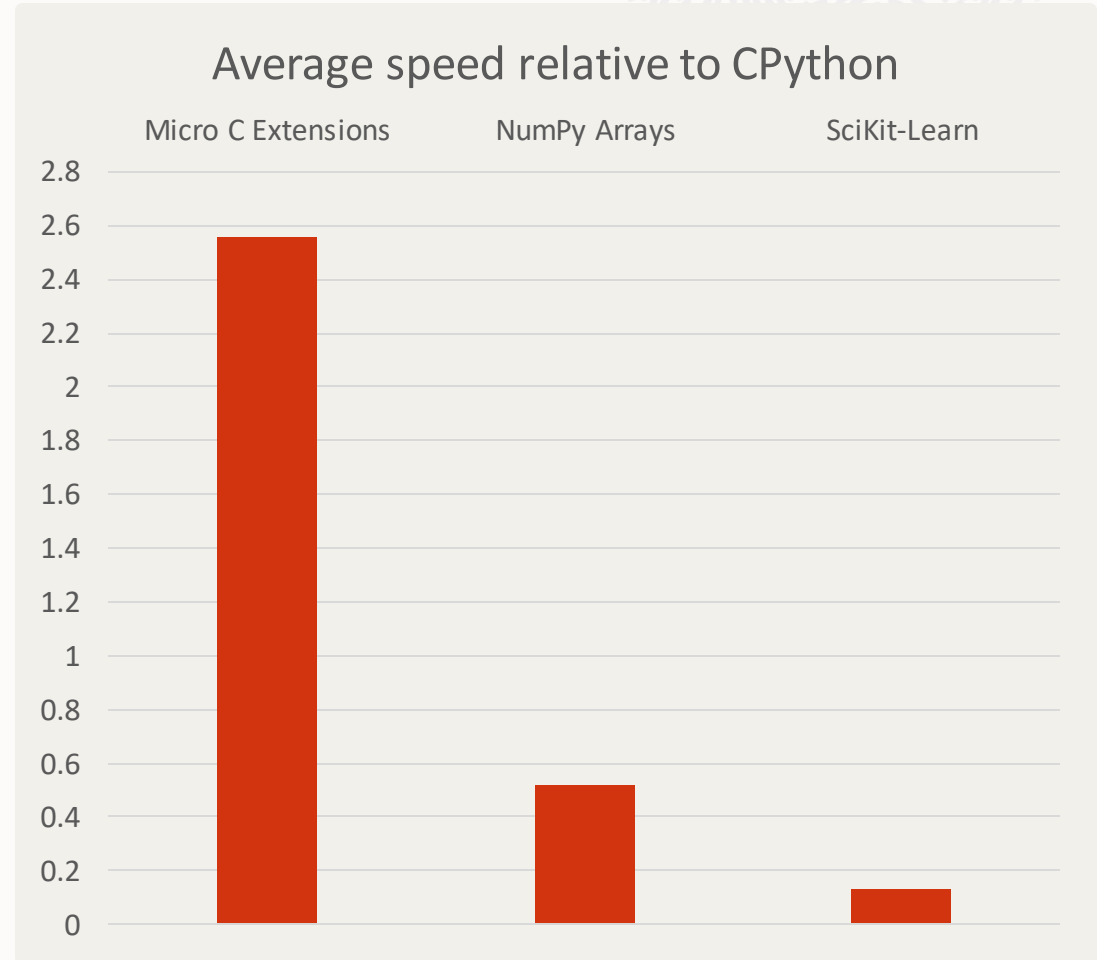
## Jython Replacement



- A “Jython-mode” gives Jython features in Python code  
Direct **import of Java packages** and classes, exception handling with Python and Java exceptions, seamless **interaction with Java objects**
- Language-agnostic GraalVM embedder API replaces Jython-specific APIs
- **Are you using Jython? We’re interested in supporting your use-case!**

# Native Performance

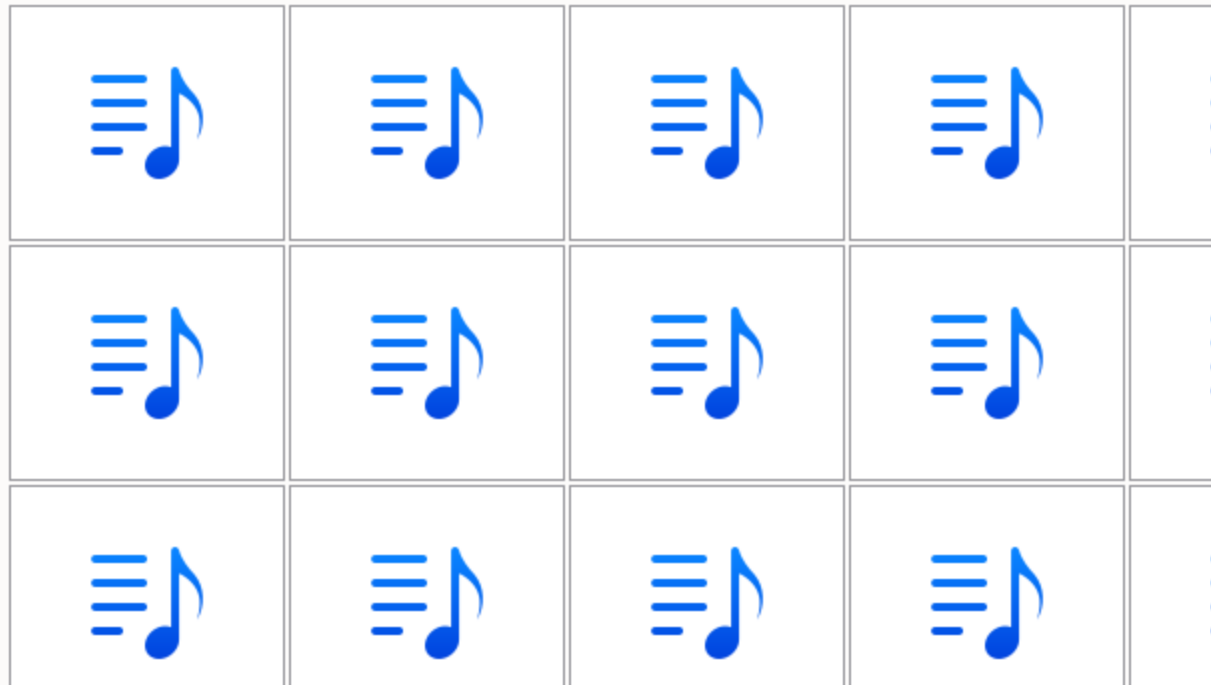
- C code is visible to the JIT and can be inlined
  - Small C extensions get faster than CPython!
- Performance for large examples still WIP
- More examples and use-cases welcome!



# Tooling



- Integration with VSCode for polyglot programming and debugging



## Tooling



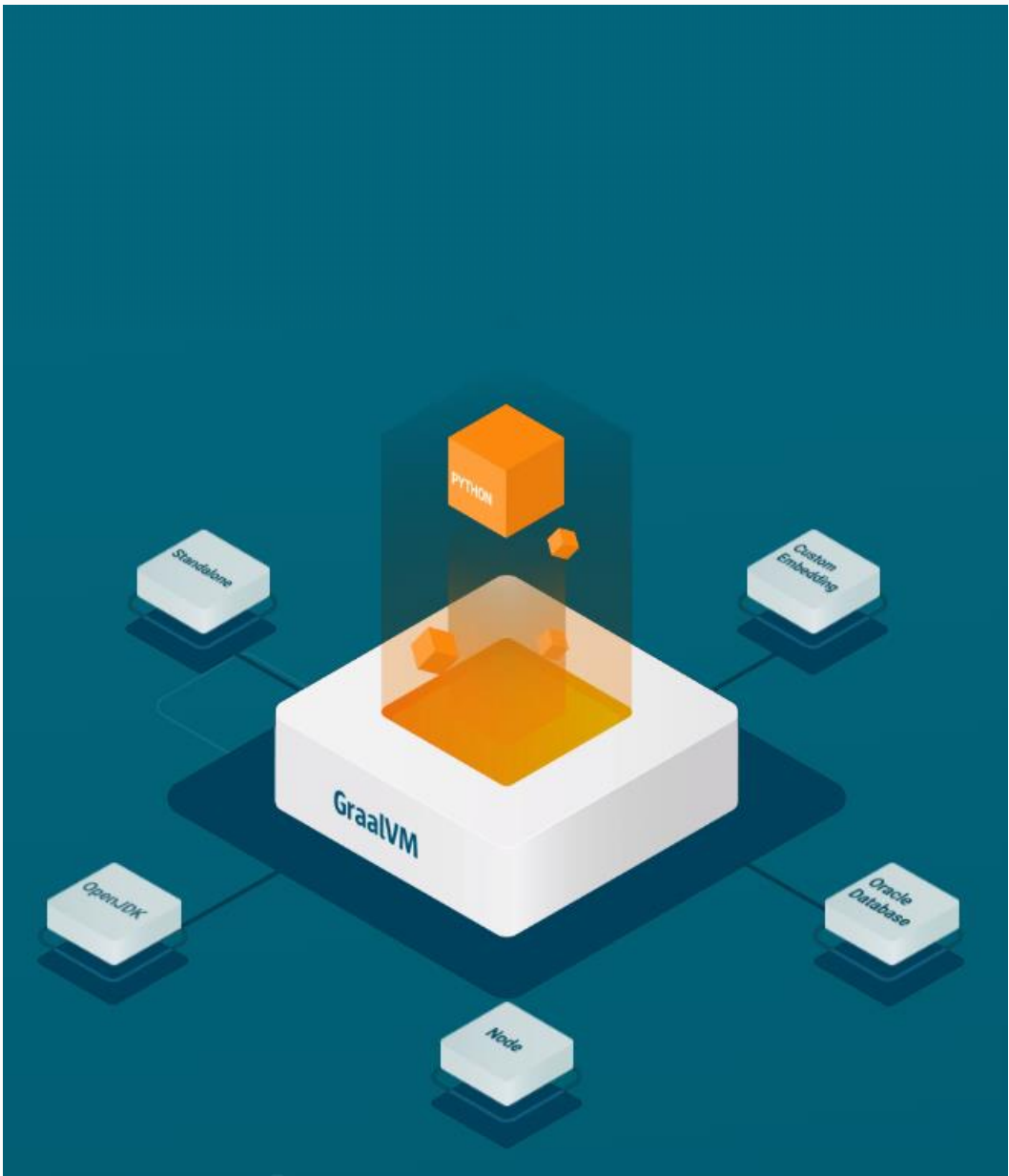
- **Demo: debugging Python with C extensions ...**



# And ...



... how can I get started with  
Python on GraalVM?



1

Download GraalVM from <https://www.graalvm.org/downloads/>

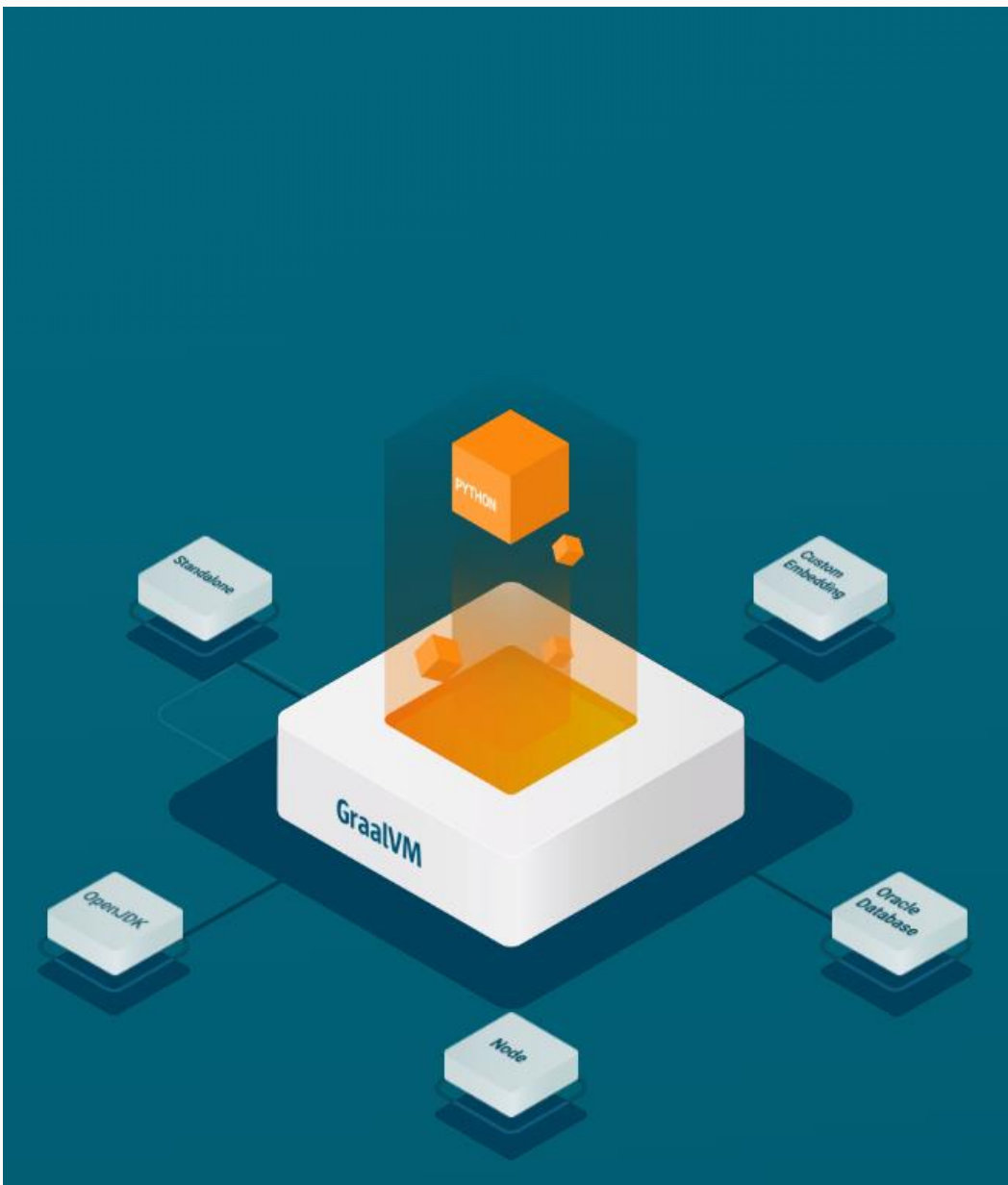


## Oracle GraalVM Enterprise Edition



- Higher performance
- Smaller footprint
- Enhanced security for native code
- Oracle Enterprise Support 7x24x365
- Support directly from the GraalVM Team





1

Download GraalVM from  
<https://www.graalvm.org/downloads/>

2

```
$ gu install python  
$ graalpython -m venv localenv  
$ source localenv/bin/activate
```



1

Download GraalVM from  
<https://www.graalvm.org/downloads/>

2

```
$ gu install python  
$ graalpython -m venv localenv  
$ source localenv/bin/activate
```

3

```
$ pip install numpy==1.16.4  
$ python -c "import numpy"
```



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