Just-in-Time with Numba

Presented by:
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Remote Python Pizza

About me

Ong Chin Hwee 王敬惠

- Data Engineer @ ST Engineering
- Background in aerospace engineering + computational modelling
- Contributor to pandas 1.0 release
- Mentor team at BigDataX

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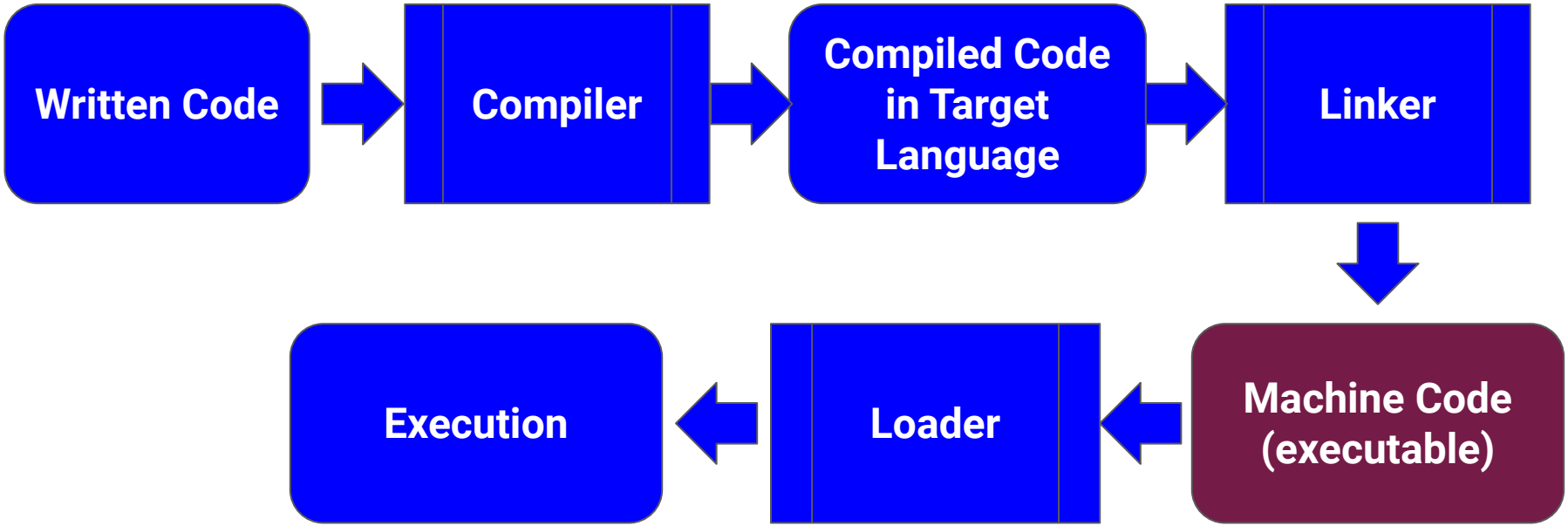
Bottlenecks in a data science project

- Lack of data / Poor quality data
- Data Preprocessing
  - The 80/20 data science dilemma
    - In reality, it’s closer to 90/10
  - Slow processing speeds in Python!
    - Python runs on the **interpreter**, not compiled

Compiled vs Interpreted Languages



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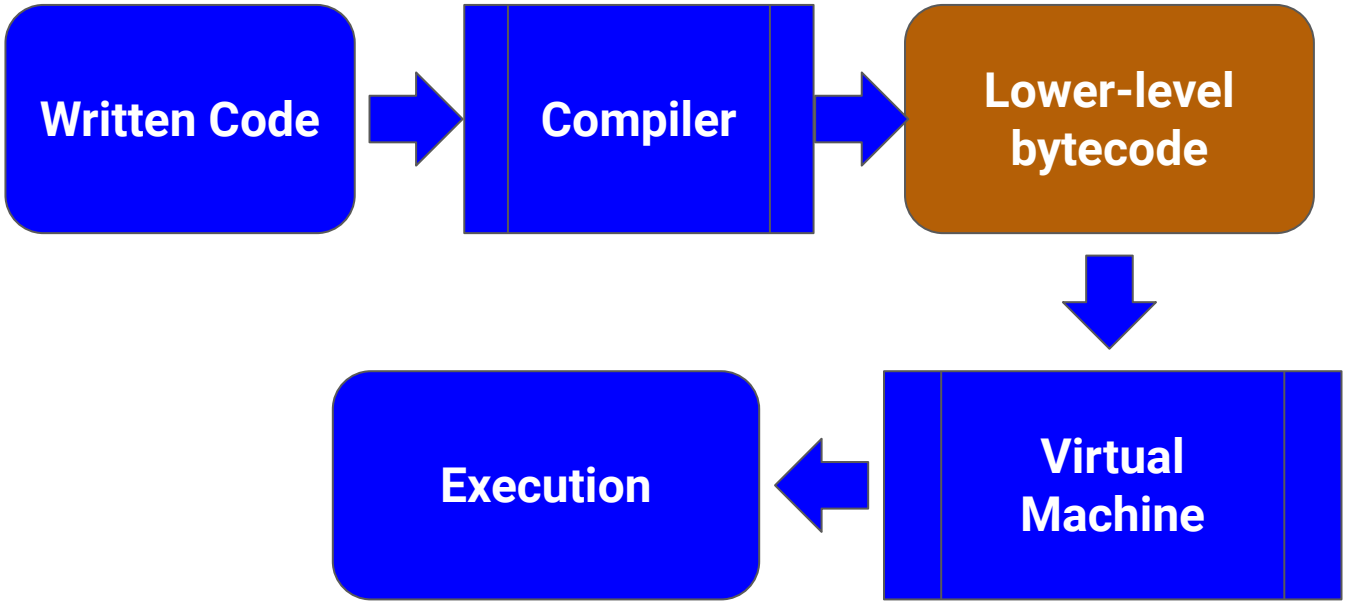
Compiled vs **Interpreted** Languages



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What is Just-in-Time?

Just-In-Time (JIT) compilation

- Converts source code into **native machine code** at runtime
- Is the reason why Java runs on a Virtual Machine (JVM) yet has **comparable performance** to compiled languages (C/C++ etc., Go)

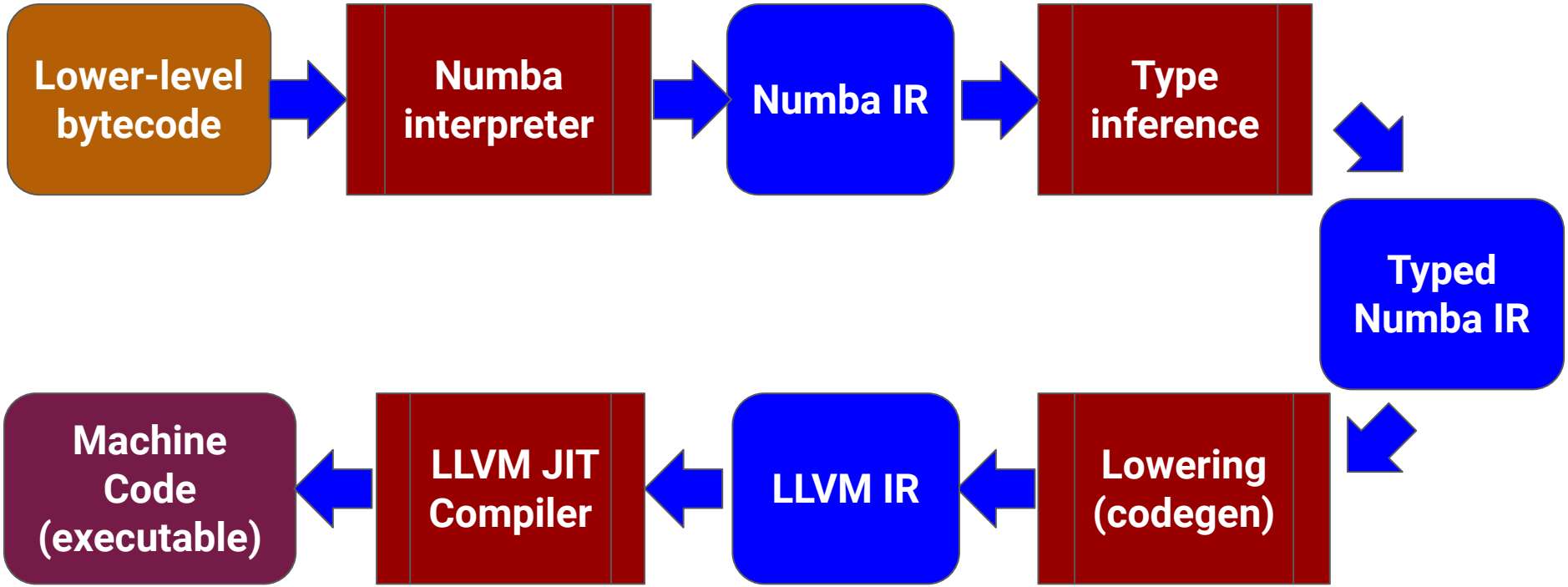
Just-in-Time with Numba

numba module

- **Just-in-Time (JIT) compiler** for Python that converts Python functions into machine code
- Can be used by simply applying **a decorator (a wrapper)** around functions to instruct numba to compile them
- Two modes of execution:
  - *njit* (nopython compilation of Numba-compatible code)
  - *jit* (object mode compilation with “loop-lifting”)

Numba Compiler Architecture

IR: Intermediate Representation



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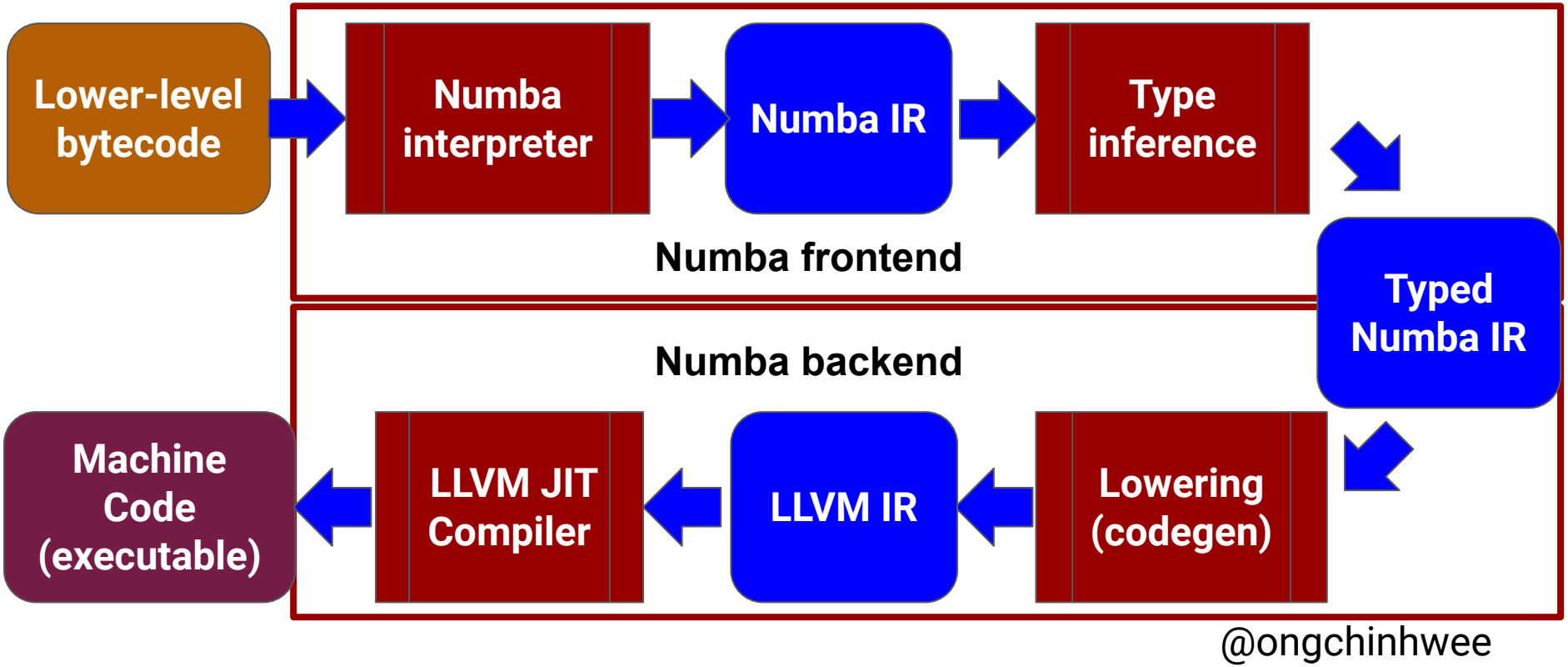
Numba Compiler Architecture

IR: Intermediate Representation



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Practical Implementation

Initialize File List in Directory

```
import numpy as np

import os
import sys
import time

DIR = './chest_xray/train/NORMAL/'
train_normal = [DIR + name for name in os.listdir(DIR)
    if os.path.isfile(os.path.join(DIR, name))]
```

No. of images in 'train/NORMAL': **1431**

With numba

```
from PIL import Image
from numba import jit

@jit
def image_proc(index):
      '''Convert + resize image'''
      im = Image.open(define_imagepath(index))
      im = im.convert("RGB")
      im_resized = np.array(im.resize((64,64)))
      return im_resized
```

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With numba

```
from PIL import Image
from numba import jit


@jit
def image_proc(index):
      '''Convert + resize image'''
      im = Image.open(define_imagepath(index))
      im = im.convert("RGB")
      im_resized = np.array(im.resize((64,64)))
      return im_resized
```

Code runs in object mode (@jit)

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With numba

```
start_cpu_time = time.clock()

listcomp_output = np.array([image_resize(x) for x in
train_normal])

end_cpu_time = time.clock()
total_tpe_time = end_cpu_time - start_cpu_time
sys.stdout.write('List comprehension completed in {}
seconds.\n'.format(
    total_tpe_time))
```

Python-only:
218.1 seconds

After compilation:
169.6 seconds

With numba

```
import numpy as np
from numba import njit

@njit
def square(a_list):
  squared_list = []
  '''Calculate square of number in a_list'''
  for x in a_list:
    squared_list.append(np.square(x))
  return squared_list
```

With numba

```
import numpy as np
from numba import njit


@njit
def square(a_list):
  squared_list = []
  '''Calculate square of number in a_list'''
  for x in a_list:
    squared_list.append(np.square(x))
  return squared_list
```

Code runs in no-Python/native machine mode (@njit or @jit(nopython=true))

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With numba

```
a_list = np.array([i for i in range(1,100000)])
start_cpu_time = time.time()
listcomp_array_output = square(a_list)
end_cpu_time = time.time()
total_tpe_time = end_cpu_time - start_cpu_time
sys.stdout.write(
    'Elapsed (after compilation) {}
seconds.\n'.format(total_tpe_time))
```

Python-only:
0.51544 seconds

After compilation:
0.00585 seconds

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Key Takeaways

Just-in-Time with numba

- **Just-in-Time (JIT) compilation with numba**
  - converts source code from non-compiled languages into **native machine code** at runtime
  - may not work for some functions/modules - these are still run on the interpreter
  - **significantly enhances** speedups provided by optimized numerical codes

Reach out to me!


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: hweecat


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And check out my slides on:


hweecat/talk_jit-numba