NumPy

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Numpy

NumPy is a Python package for general-purpose array-processing. It provides a high-performance multidimensional array object, and tools for working with these arrays.

It is the fundamental package for scientific computing with Python. It contains various features but the most important feature is **vectorization**.

The vectorization results in more “Pythonic” code. Without vectorization, our code would be littered with inefficient and difficult to read for loops.

Numpy

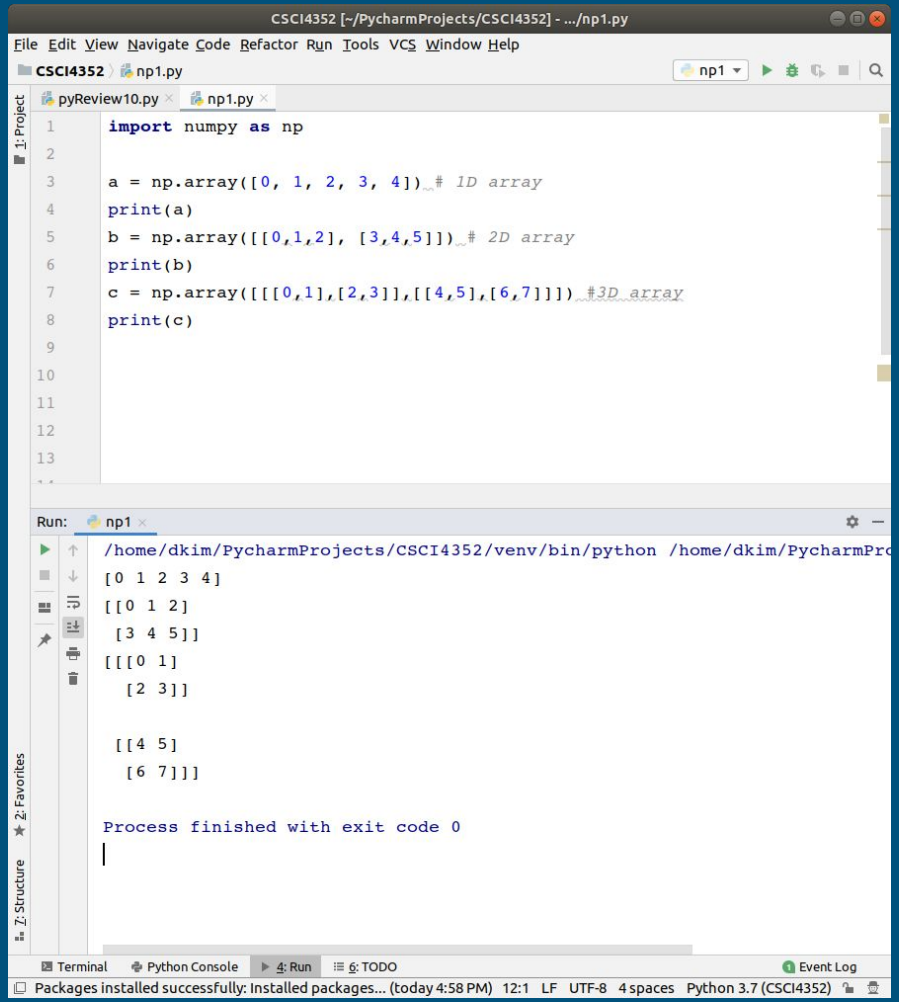
Vectorization describes the absence of any explicit looping, indexing, etc., in the code - these things are taking place, of course, just “behind the scenes” in optimized, pre-compiled C code. Vectorized code has many advantages, among which are:

vectorized code is more concise and easier to read

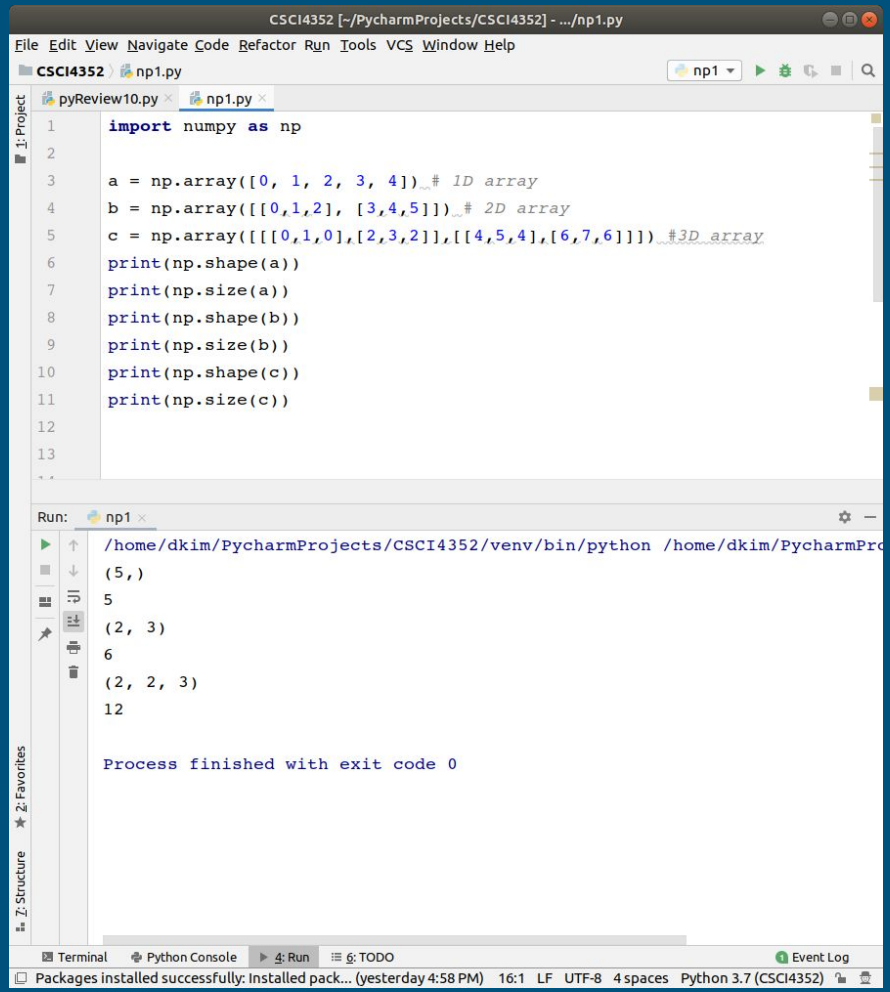
fewer lines of code generally means fewer bugs

the code more closely resembles standard mathematical notation (making it easier, typically, to correctly code mathematical constructs)

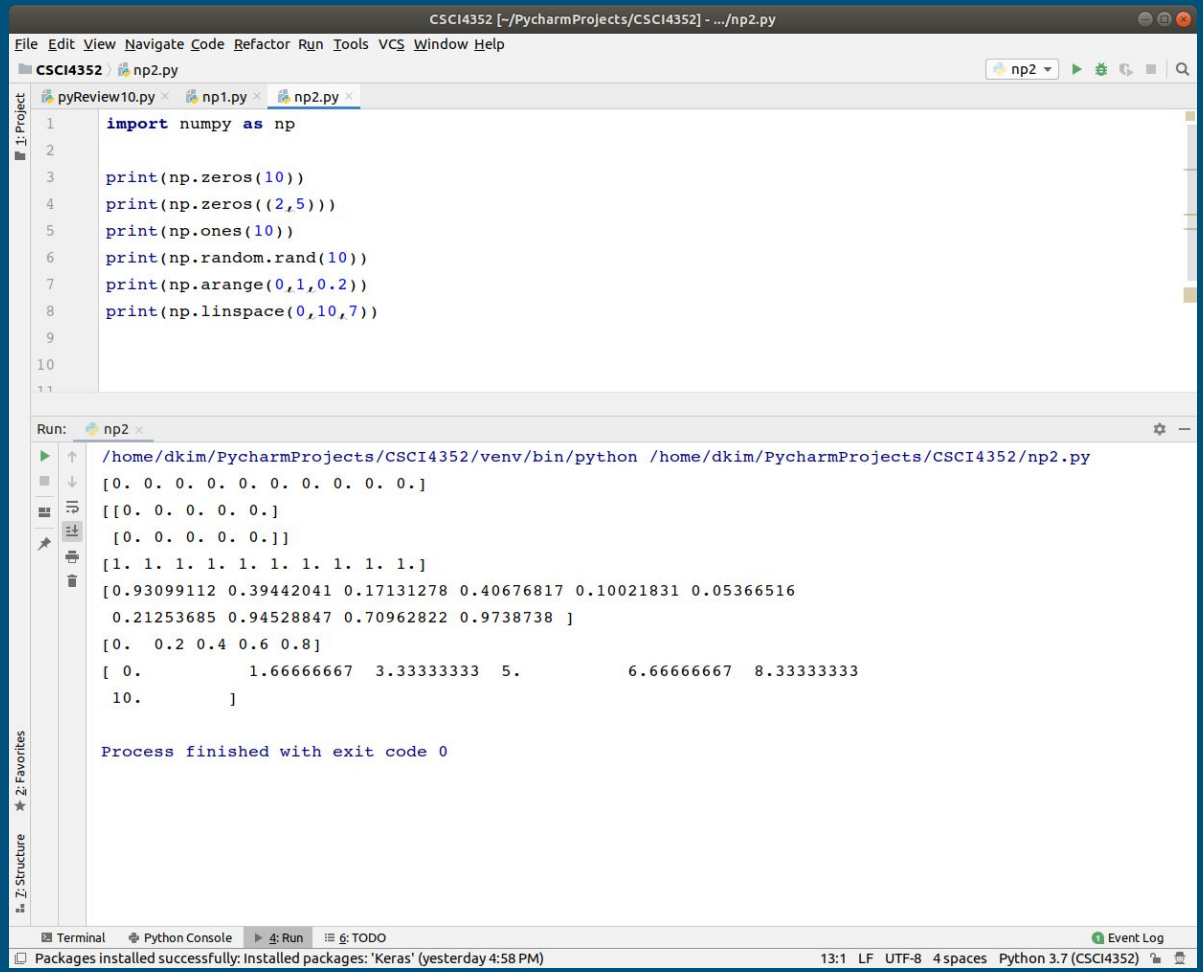
np.array()


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np1.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np1.py
np1
pyReview10.py
np1.py
1: Project
import numpy as np
a = np.array([0, 1, 2, 3, 4]) # 1D array
print(a)
b = np.array([[0,1,2], [3,4,5]]) # 2D array
print(b)
c = np.array([[[0,1],[2,3]],[[4,5],[6,7]]]) #3D array
print(c)
Run: np1
/home/dkim/PycharmProjects/CSCI4352/venv/bin/python /home/dkim/PycharmPro
[0 1 2 3 4]
[[0 1 2]
[3 4 5]]
[[[0 1]
[2 3]]
[[4 5]
[6 7]]]
Process finished with exit code 0
2: Favorites
7: Structure
Terminal
Python Console
4: Run
6: TODO
Event Log
Packages installed successfully: Installed packages... (today 4:58 PM)
12:1 LF UTF-8 4 spaces Python 3.7 (CSCI4352)

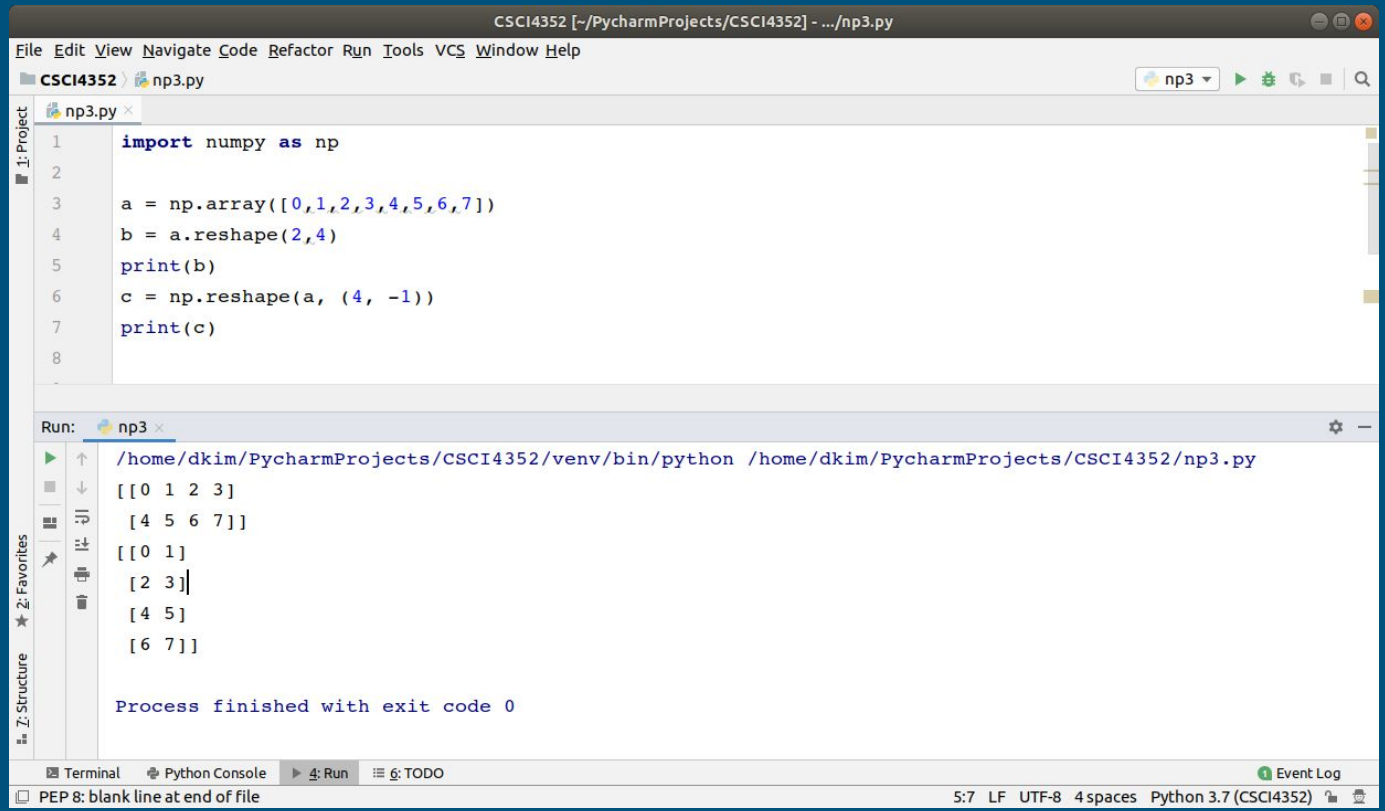
np.shape()
np.size()



```
np.zeros()
np.ones()
np.random.rand()
np.arange()
np.linspace()
```



reshape()


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np3.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1 import numpy as np
2
3 a = np.array([0,1,2,3,4,5,6,7])
4 b = a.reshape(2,4)
5 print(b)
6 c = np.reshape(a, (4, -1))
7 print(c)
8
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/python /home/dkim/PycharmProjects/CSCI4352/np3.py
[[0 1 2 3]
[4 5 6 7]]
[[0 1]
[2 3]
[4 5]
[6 7]]
Process finished with exit code 0
1: Project
2: Favorites
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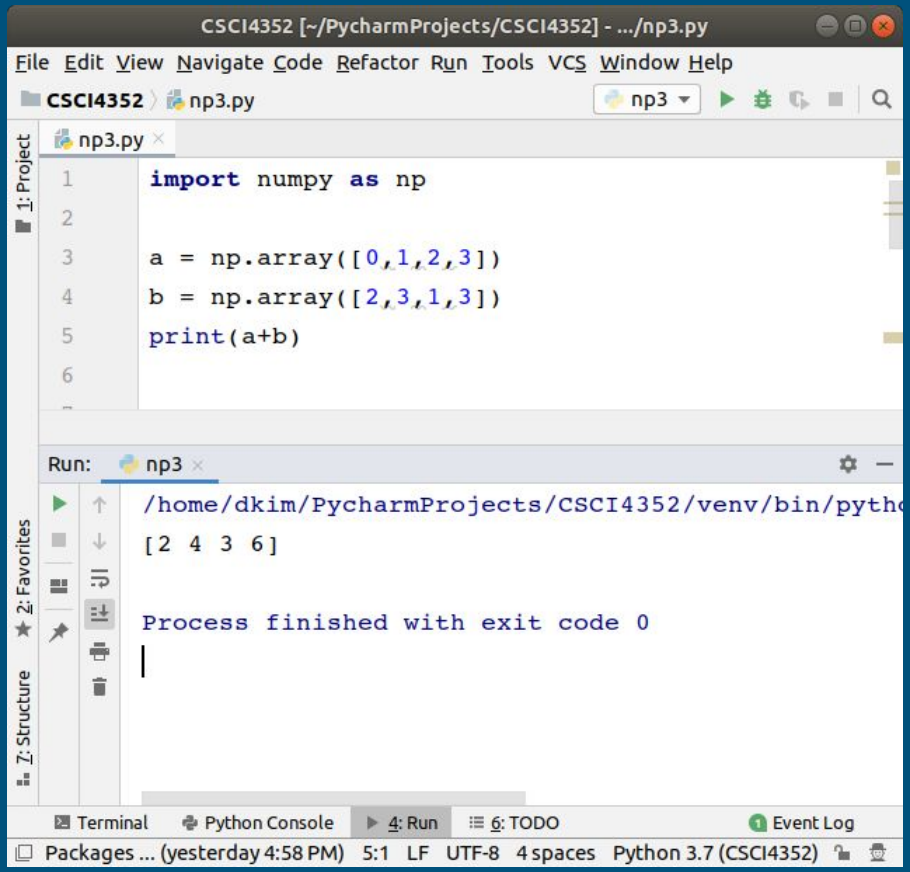
Event Log
PEP 8: blank line at end of file
5:7 LF UTF-8 4 spaces Python 3.7 (CSCI4352)

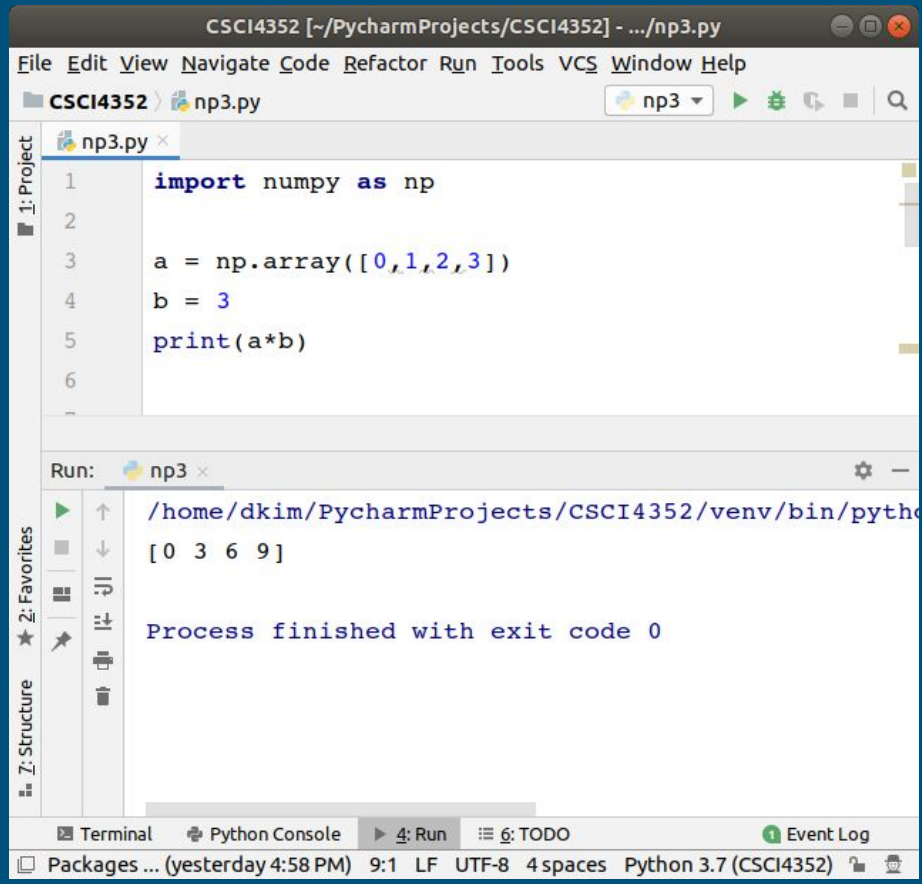
Addition of two vectors (1D array)

$$A+B = [a_1, a_2]^\top + [b_1, b_2]^\top = [a_1+b_1, a_2+b_2]^\top$$

Scalar product

$$A \cdot c = [a_1, a_2]^\top \cdot \ c = [a_1 \cdot c, \ a_2 \cdot c]^\top$$


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np3.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1: Project
2: Favorites
7: Structure
1 import numpy as np
2
3 a = np.array([0,1,2,3])
4 b = np.array([2,3,1,3])
5 print(a+b)
6
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/pytho
[2 4 3 6]
Process finished with exit code 0
Terminal
Python Console
4: Run
6: TODO
Event Log
Packages ... (yesterday 4:58 PM) 5:1 LF UTF-8 4 spaces Python 3.7 (CSCI4352)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File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1: Project
2: Favorites
7: Structure
1 import numpy as np
2
3 a = np.array([0,1,2,3])
4 b = 3
5 print(a*b)
6
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/pytho
[0 3 6 9]
Process finished with exit code 0
Terminal
Python Console
4: Run
6: TODO
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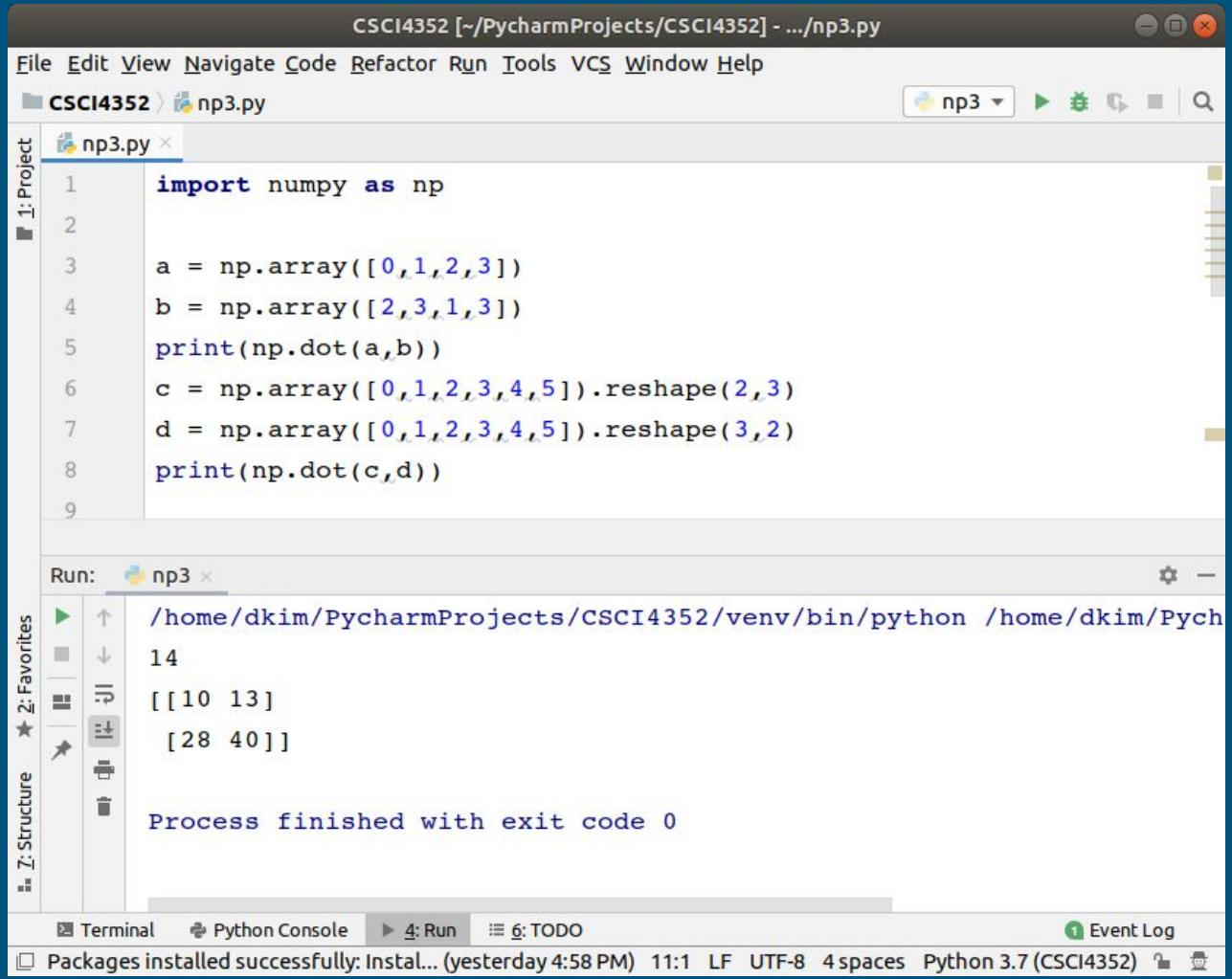
Dot product

$$a \cdot b = \underset{(1 \times n)}{\begin{bmatrix} a_1 & a_2 & a_3 & a_4 & a_5 \end{bmatrix}} \underset{(n \times 1)}{\begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \\ b_5 \end{bmatrix}} = \left\{ a_1b_1 + a_2b_2 + a_3b_3 + a_4b_4 + a_5b_5 \right\}$$

Dot Product


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np3.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1: Project
import numpy as np
a = np.array([0,1,2,3])
b = np.array([2,3,1,3])
print(np.dot(a,b))
c = np.array([0,1,2,3,4,5]).reshape(2,3)
d = np.array([0,1,2,3,4,5]).reshape(3,2)
print(np.dot(c,d))
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/python /home/dkim/Pych
14
[[10 13]
[28 40]]
Process finished with exit code 0
2: Favorites
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Python Console
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6: TODO
Event Log
Packages installed successfully: Instal... (yesterday 4:58 PM)
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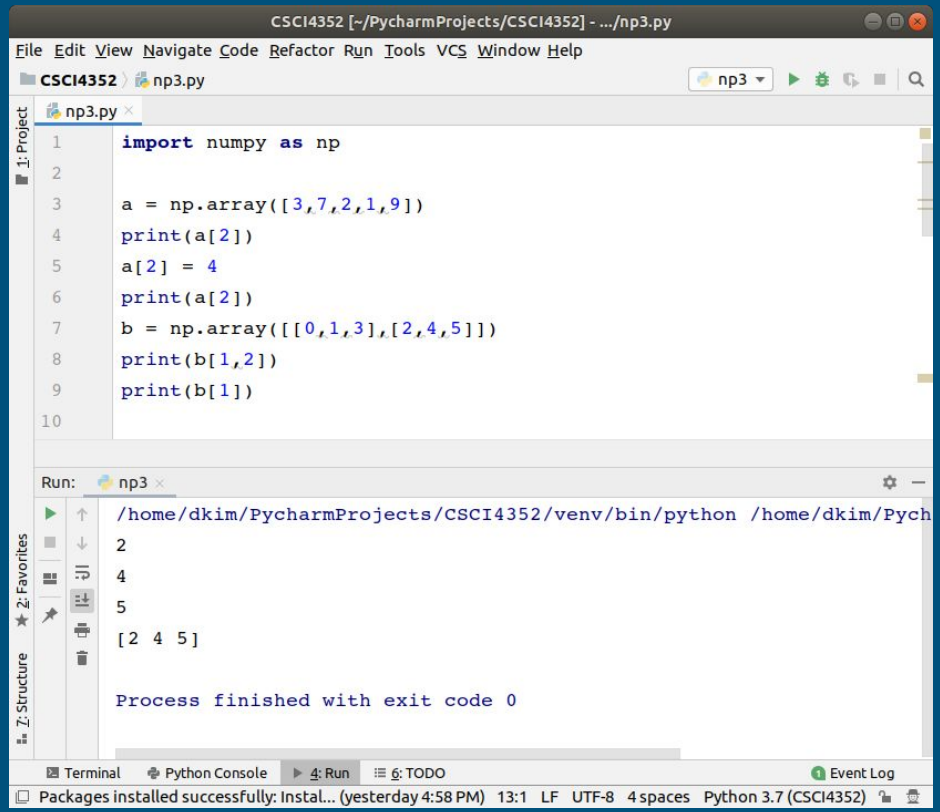
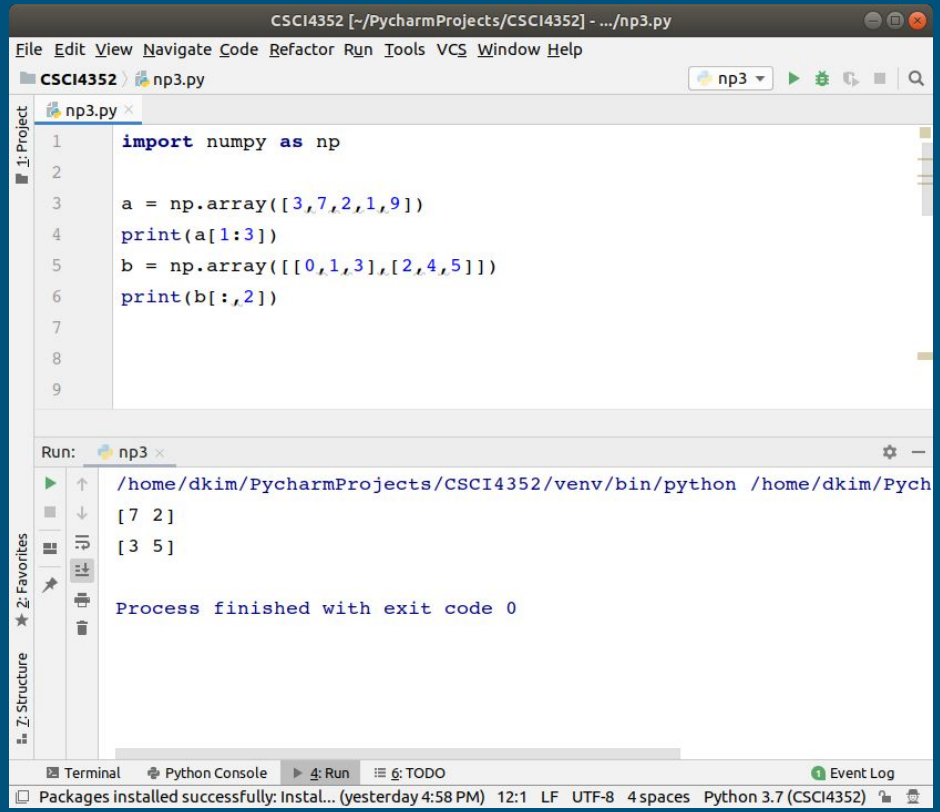
UTF-8
4 spaces
Python 3.7 (CSCI4352)

Access to elements



Slicing


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np3.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1: Project
import numpy as np
a = np.array([3,7,2,1,9])
print(a[1:3])
b = np.array([[0,1,3],[2,4,5]])
print(b[:,2])
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/python /home/dkim/Pych
[7 2]
[3 5]
Process finished with exit code 0
2: Favorites
Z: Structure
Terminal
Python Console
4: Run
6: TODO
Event Log
Packages installed successfully: Instal... (yesterday 4:58 PM)
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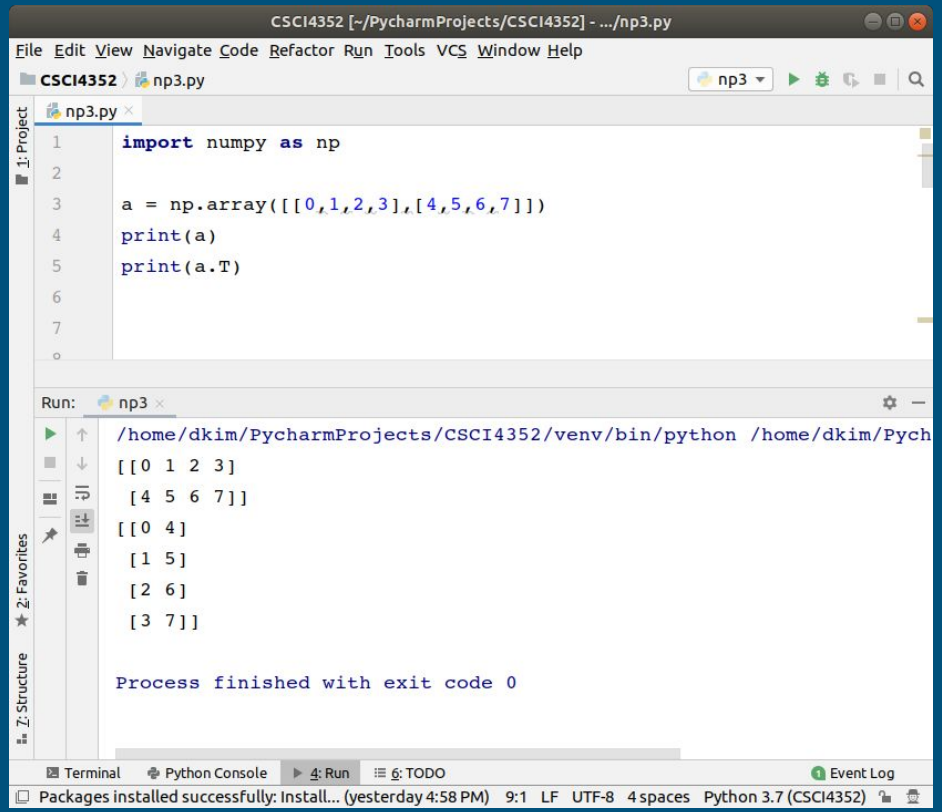
UTF-8
4 spaces
Python 3.7 (CSCI4352)

Transpose


CSCI4352 [~/PycharmProjects/CSCI4352] - .../np3.py
File Edit View Navigate Code Refactor Run Tools VCS Window Help
CSCI4352 np3.py
np3
np3.py
1: Project
1 import numpy as np
2
3 a = np.array([[0,1,2,3],[4,5,6,7]])
4 print(a)
5 print(a.T)
6
7
Run: np3
/home/dkim/PycharmProjects/CSCI4352/venv/bin/python /home/dkim/Pych
[[0 1 2 3]
[4 5 6 7]]
[[0 4]
[1 5]
[2 6]
[3 7]]
Process finished with exit code 0
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Terminal
Python Console
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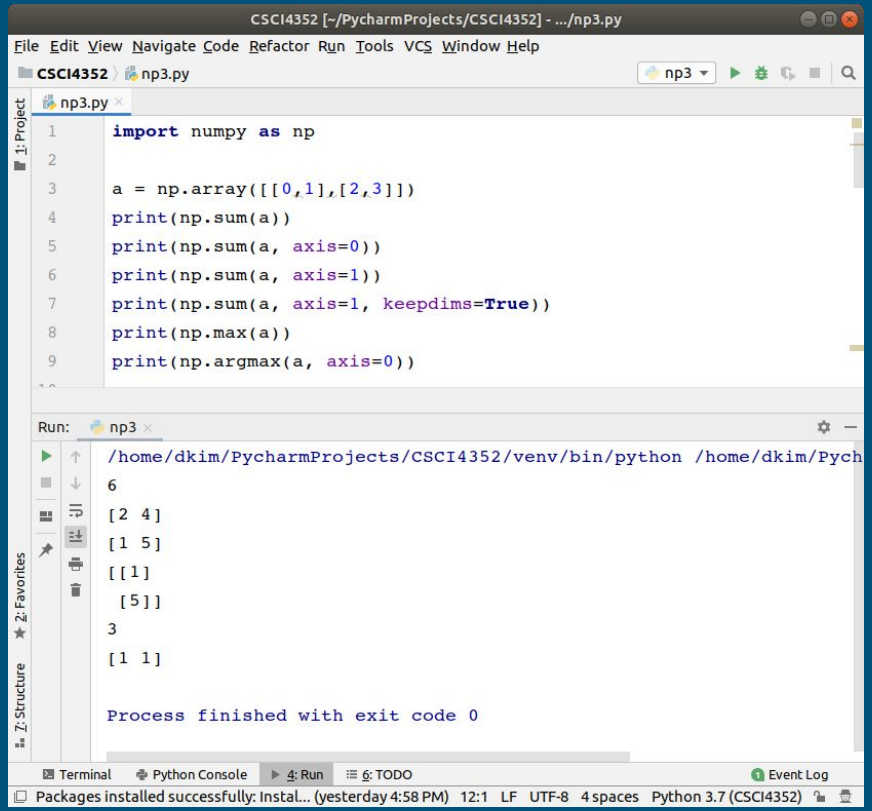
Event Log
Packages installed successfully: Install... (yesterday 4:58 PM)
9:1 LF UTF-8 4 spaces Python 3.7 (CSCI4352)

Numpy functions



Lab 5

Run the example codes and capture screens with outputs.

Submit python files (.py or .ipynb) and captured images of outputs and codes in blackboard.