Assignment 0

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COMP 576 - An Introduction to Deep Learning

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Contents

1 Task 1

```
(deep_learning) qihao@qihaodeMacBook-Pro ~ % conda info

     active environment : deep_learning
    active env location : /opt/anaconda3/envs/deep_learning
            shell level : 2
       user config file : /Users/qihao/.condarc
 populated config files : /Users/qihao/.condarc
          conda version : 24.11.2
    conda-build version : 24.5.1
         python version : 3.12.4.final.0
                 solver : libmamba (default)
       virtual packages : __archspec=1=m1
                          __conda=24.11.2=0
                          __osx=14.4=0
                          __unix=0=0
       base environment : /opt/anaconda3 (writable)
      conda av data dir : /opt/anaconda3/etc/conda
  conda av metadata url : None
           channel URLs : https://repo.anaconda.com/pkgs/main/osx-arm64
                          https://repo.anaconda.com/pkgs/main/noarch
                          https://repo.anaconda.com/pkgs/r/osx-arm64
                          https://repo.anaconda.com/pkgs/r/noarch
          package cache : /opt/anaconda3/pkgs
                          /Users/qihao/.conda/pkgs
       envs directories : /opt/anaconda3/envs
                          /Users/qihao/.conda/envs
               platform : osx-arm64
             user-agent : conda/24.11.2 requests/2.32.2 CPython/3.12.4 Darwin
                /23.4.0 OSX/14.4 solver/libmamba conda-libmamba-solver/24.1.0
                libmambapy/1.5.8 aau/0.4.4 c/6PMS291KB2ESac0vsCdKdg s/
                IpdopgJn9qh4SzdbjGs2Kg e/z8zV5Oz0-TqBYW9WZuYTzg
              UID:GID : 501:20
```

```
            netrc file : None
          offline mode : False
```

2 Task 2

```
a0.shape / b0.shape / v.shape
(21, 9) (21, 9) (9,)

ndims(a0)
2

numel(a0)
189

size(a0)
[21 9]

size(a0,2)
9

np.array([[1,2,3],[4,5,6]])
[[1 2 3]
 [4 5 6]]

np.block([[I,1],[2,3I]])
[[1. 0. 1. 1.]
 [0. 1. 1. 1.]
 [2. 2. 3. 0.]
 [2. 2. 0. 3.]]

a[-1]
[0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]
```

```
a[1,4]
0.14

a[1,:]
[0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18]

a[:5,:]
[[0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09]
 [0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18]
 [0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27]
 [0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35 0.36]
 [0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45]]

a[-5:,:]
[[0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53]
 [0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 ]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]]

a[0:3,4:9]
[[0.05 0.06 0.07 0.08 0.09]
 [0.14 0.15 0.16 0.17 0.18]
 [0.23 0.24 0.25 0.26 0.27]]

a[np.ix_([1,3,4],[0,2])]
[[0.1 0.12]
 [0.28 0.3 ]
 [0.37 0.39]]

a[2:21:2,:]
[[0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27]
 [0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
```

```
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17]
 [0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35]
 [0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]]

a[::2,:]
[[0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09]
 [0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27]
 [0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17]
 [0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35]
 [0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]]

a[::-1,:]
[[0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]
 [0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 ]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62]
 [0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53]
 [0.36 0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44]
 [0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35]
 [0.18 0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26]
 [0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17]
 [0. 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 0.9 ]
```

```
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
 [0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53 0.54]
 [0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45]
 [0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35 0.36]
 [0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27]
 [0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18]
 [0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09]]

a[np.r_[:len(a),0],:]
[[0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09]
 [0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18]
 [0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27]
 [0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35 0.36]
 [0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45]
 [0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53 0.54]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
 [0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72]
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 0.9 ]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0. 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08]
 [0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17]
 [0.18 0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26]
 [0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34 0.35]
 [0.36 0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44]
 [0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53]
 [0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 ]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]
 [0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09]]
```

```
a.T
[[0.01 0.1 0.19 0.28 0.37 0.46 0.55 0.64 0.73 0.82 0.91 0. 0.09 0.18 0.27 0.36
    0.45 0.54 0.63 0.72 0.81]
 [0.02 0.11 0.2 0.29 0.38 0.47 0.56 0.65 0.74 0.83 0.92 0.01 0.1 0.19 0.28
    0.37 0.46 0.55 0.64 0.73 0.82]
 [0.03 0.12 0.21 0.3 0.39 0.48 0.57 0.66 0.75 0.84 0.93 0.02 0.11 0.2 0.29
    0.38 0.47 0.56 0.65 0.74 0.83]
 [0.04 0.13 0.22 0.31 0.4 0.49 0.58 0.67 0.76 0.85 0.94 0.03 0.12 0.21 0.3
    0.39 0.48 0.57 0.66 0.75 0.84]
 [0.05 0.14 0.23 0.32 0.41 0.5 0.59 0.68 0.77 0.86 0.95 0.04 0.13 0.22 0.31
    0.4 0.49 0.58 0.67 0.76 0.85]
 [0.06 0.15 0.24 0.33 0.42 0.51 0.6 0.69 0.78 0.87 0.96 0.05 0.14 0.23 0.32
    0.41 0.5 0.59 0.68 0.77 0.86]
 [0.07 0.16 0.25 0.34 0.43 0.52 0.61 0.7 0.79 0.88 0.97 0.06 0.15 0.24 0.33
    0.42 0.51 0.6 0.69 0.78 0.87]
 [0.08 0.17 0.26 0.35 0.44 0.53 0.62 0.71 0.8 0.89 0.98 0.07 0.16 0.25 0.34
    0.43 0.52 0.61 0.7 0.79 0.88]
 [0.09 0.18 0.27 0.36 0.45 0.54 0.63 0.72 0.81 0.9 0.99 0.08 0.17 0.26 0.35
    0.44 0.53 0.62 0.71 0.8 0.89]]


ac.conj().T
[[ 1.-2.j 2.-0.j 3.-3.j]
 [ 3.+1.j -1.-4.j -2.-1.j]
 [ 0.-1.j 5.+2.j 4.-0.j]]


A @ B
[[ 6. 9. 12.]
 [16. 20. 24.]
 [18. 21. 24.]]


A * B
[[ 2. 2. 0.]
 [ 4. 10. 6.]
 [ 0. 8. 18.]]
```

```
A / B
[[2.  0.5 0.  ]
 [0.25 0.4 0.1667]
 [0.  0.125 0.2222]]

A**3
[[8. 1. 0.]
 [1. 8. 1.]
 [0. 1. 8.]]

(a0 > 0.5)
[[0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 0 0 0]
 [0 0 0 0 0 0 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]
 [1 1 1 1 1 1 1 1 1]]
```

```
np.nonzero(a0>0.5)
[[ 5 5 5 5 6 6 6 6 6 6 6 6 6 7 7 7 7 7 7 7 7 8 8 8 8 8 8 8 8 8 9 9 9 9 9 9 9
    9 9 10 10 10 10 10 10 10 10 10 16 16 16 17 17 17 17 17 17 17 17 17 18 18
   18 18 18 18 18 18 18 19 19 19 19 19 19 19 19 19 20 20 20 20 20 20 20 20 20]
 [ 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6
    7 8 0 1 2 3 4 5 6 7 8 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4 5 6 7 8 0 1 2 3 4
    5 6 7 8 0 1 2 3 4 5 6 7 8]]

a0[:, cols]
[[0.06 0.07 0.08 0.09]
 [0.15 0.16 0.17 0.18]
 [0.24 0.25 0.26 0.27]
 [0.33 0.34 0.35 0.36]
 [0.42 0.43 0.44 0.45]
 [0.51 0.52 0.53 0.54]
 [0.6 0.61 0.62 0.63]
 [0.69 0.7 0.71 0.72]
 [0.78 0.79 0.8 0.81]
 [0.87 0.88 0.89 0.9 ]
 [0.96 0.97 0.98 0.99]
 [0.05 0.06 0.07 0.08]
 [0.14 0.15 0.16 0.17]
 [0.23 0.24 0.25 0.26]
 [0.32 0.33 0.34 0.35]
 [0.41 0.42 0.43 0.44]
 [0.5 0.51 0.52 0.53]
 [0.59 0.6 0.61 0.62]
 [0.68 0.69 0.7 0.71]
 [0.77 0.78 0.79 0.8 ]
 [0.86 0.87 0.88 0.89]]

a0[:, v>0.5]
[[0.06 0.07 0.08 0.09]
 [0.15 0.16 0.17 0.18]
```

```
 [0.24 0.25 0.26 0.27]
 [0.33 0.34 0.35 0.36]
 [0.42 0.43 0.44 0.45]
 [0.51 0.52 0.53 0.54]
 [0.6 0.61 0.62 0.63]
 [0.69 0.7 0.71 0.72]
 [0.78 0.79 0.8 0.81]
 [0.87 0.88 0.89 0.9 ]
 [0.96 0.97 0.98 0.99]
 [0.05 0.06 0.07 0.08]
 [0.14 0.15 0.16 0.17]
 [0.23 0.24 0.25 0.26]
 [0.32 0.33 0.34 0.35]
 [0.41 0.42 0.43 0.44]
 [0.5 0.51 0.52 0.53]
 [0.59 0.6 0.61 0.62]
 [0.68 0.69 0.7 0.71]
 [0.77 0.78 0.79 0.8 ]
 [0.86 0.87 0.88 0.89]]

a[a<0.5]=0
[[0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0.5 0.51 0.52 0.53 0.54]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
 [0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72]
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 0.9 ]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
```

```
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0.5 0.51 0.52 0.53]
 [0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 ]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]]

a0 * (a0>0.5)
[[0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0.51 0.52 0.53 0.54]
 [0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63]
 [0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72]
 [0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 0.81]
 [0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 0.9 ]
 [0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. ]
 [0. 0. 0. 0. 0. 0. 0.51 0.52 0.53]
 [0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62]
 [0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71]
 [0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.8 ]
 [0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89]]

a[:]=3
[[3. 3. 3. 3. 3. 3. 3. 3. 3.]
```

```
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]
 [3. 3. 3. 3. 3. 3. 3. 3. 3.]]

y_view[0] / y_ref[0]
[ 0.1 123.456]

x.flatten()
[ 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 123.456 0.11 0.12 0.13 0.14
   0.15 0.16 0.17 0.18 0.19 0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27 0.28 0.29
   0.3 0.31 0.32 0.33 0.34 0.35 0.36 0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44
   0.45 0.46 0.47 0.48 0.49 0.5 0.51 0.52 0.53 0.54 0.55 0.56 0.57 0.58 0.59
   0.6 0.61 0.62 0.63 0.64 0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72 0.73 0.74
   0.75 0.76 0.77 0.78 0.79 0.8 0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89
   0.9 0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99 0. 0.01 0.02 0.03 0.04
   0.05 0.06 0.07 0.08 0.09 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19
   0.2 0.21 0.22 0.23 0.24 0.25 0.26 0.27 0.28 0.29 0.3 0.31 0.32 0.33 0.34
```

```
   0.35 0.36 0.37 0.38 0.39 0.4 0.41 0.42 0.43 0.44 0.45 0.46 0.47 0.48 0.49
   0.5 0.51 0.52 0.53 0.54 0.55 0.56 0.57 0.58 0.59 0.6 0.61 0.62 0.63 0.64
   0.65 0.66 0.67 0.68 0.69 0.7 0.71 0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79
   0.8 0.81 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89 ]

x.flatten('F')
[ 0.01 123.456 0.19 0.28 0.37 0.46 0.55 0.64 0.73 0.82 0.91 0. 0.09 0.18 0.27
   0.36 0.45 0.54 0.63 0.72 0.81 0.02 0.11 0.2 0.29 0.38 0.47 0.56 0.65 0.74
   0.83 0.92 0.01 0.1 0.19 0.28 0.37 0.46 0.55 0.64 0.73 0.82 0.03 0.12 0.21
   0.3 0.39 0.48 0.57 0.66 0.75 0.84 0.93 0.02 0.11 0.2 0.29 0.38 0.47 0.56
   0.65 0.74 0.83 0.04 0.13 0.22 0.31 0.4 0.49 0.58 0.67 0.76 0.85 0.94 0.03
   0.12 0.21 0.3 0.39 0.48 0.57 0.66 0.75 0.84 0.05 0.14 0.23 0.32 0.41 0.5
   0.59 0.68 0.77 0.86 0.95 0.04 0.13 0.22 0.31 0.4 0.49 0.58 0.67 0.76 0.85
   0.06 0.15 0.24 0.33 0.42 0.51 0.6 0.69 0.78 0.87 0.96 0.05 0.14 0.23 0.32
   0.41 0.5 0.59 0.68 0.77 0.86 0.07 0.16 0.25 0.34 0.43 0.52 0.61 0.7 0.79
   0.88 0.97 0.06 0.15 0.24 0.33 0.42 0.51 0.6 0.69 0.78 0.87 0.08 0.17 0.26
   0.35 0.44 0.53 0.62 0.71 0.8 0.89 0.98 0.07 0.16 0.25 0.34 0.43 0.52 0.61
   0.7 0.79 0.88 0.09 0.18 0.27 0.36 0.45 0.54 0.63 0.72 0.81 0.9 0.99 0.08
   0.17 0.26 0.35 0.44 0.53 0.62 0.71 0.8 0.89 ]

solve(A,b)
[0.5 0. 1.5]

inv(A)
[[ 0.75 -0.5 0.25]
 [-0.5 1. -0.5 ]
 [ 0.25 -0.5 0.75]]

det(A)
4.0

trace(A)
6.0
```

```
rank(A)
3

norms [2, fro, 1, inf]
[3.4142 4. 4. 4. ]

eig(A): w
[3.4142+0.j 2. +0.j 0.5858+0.j]

eig(A): V
[[-0.5 0.7071 0.5 ]
 [-0.7071 0. -0.7071]
 [-0.5 -0.7071 0.5 ]]

svd s
[3.4142 2. 0.5858]

svd U
[[-0.5 0.7071 0.5 ]
 [-0.7071 -0. -0.7071]
 [-0.5 -0.7071 0.5 ]]

svd Vh
[[-0.5 -0.7071 -0.5 ]
 [ 0.7071 0. -0.7071]
 [ 0.5 -0.7071 0.5 ]]

qr R
[[-2.2361 -1.7889 -0.4472]
 [ 0. -1.6733 -1.9124]
 [ 0. 0. 1.069 ]]

cholesky(S)
[[2.4495 1.633 0.4082]
```

```
 [0. 2.0817 1.6013]
 [0. 0. 1.8081]]

pinv(A)
[[ 0.75 -0.5 0.25]
 [-0.5 1. -0.5 ]
 [ 0.25 -0.5 0.75]]
```

code

```
import numpy as np
import scipy.linalg as la

np.set_printoptions(threshold=np.inf, linewidth=10**6, precision=4, suppress=True)

a0 =(np.arange(1, 21*9 +1).reshape(21, 9) % 100) /100.0
b0 =np.flipud(a0)

v =np.linspace(0.1, 0.9, 9)


A =np.array([[2., 1., 0.],
             [1., 2., 1.],
             [0., 1., 2.]])

B =np.array([[1., 2., 3.],
             [4., 5., 6.],
             [7., 8., 9.]])

b =np.array([1., 2., 3.])

ac =np.array([[1+2j, 3-1j, 0+1j],
              [2+0j, -1+4j, 5-2j],
              [3+3j, -2+1j, 4+0j]])

print(a0.shape / b0.shape / v.shape)
```

```
print(a0.shape, b0.shape, v.shape); print()

print(ndims(a0))
print(np.ndim(a0)); print()

print(numel(a0))
print(np.size(a0)); print()

print(size(a0))
print(np.array(a0.shape)); print()

print(size(a0,2))
print(a0.shape[1]); print()

print(np.array([[1,2,3],[4,5,6]]))
print(np.array([[1,2,3],[4,5,6]])); print()

print(np.block([[I,1],[2,3I]]))
print(np.block([[np.eye(2), np.ones((2,2))],
                [2*np.ones((2,2)), 3*np.eye(2)]])); print()

a =a0.copy()

print(a[-1])
print(a[-1]); print()

print(a[1,4])
print(a[1,4]); print()

print(a[1,:])
print(a[1,:]); print()

print(a[:5,:])
print(a[:5,:]); print()

print(a[-5:,:])
print(a[-5:,:]); print()

print(a[0:3,4:9])
```

```
print(a[0:3,4:9]); print()

print(a[np.ix_([1,3,4],[0,2])])
print(a[np.ix_([1,3,4],[0,2])]); print()

print(a[2:21:2,:])
print(a[2:21:2,:]); print()

print(a[::2,:])
print(a[::2,:]); print()

print(a[::-1,:])
print(a[::-1,:]); print()

print(a[np.r_[:len(a),0],:])
print(a[np.r_[:len(a),0],:]); print()

print(a.T)
print(a.T); print()

print(ac.conj().T)
print(np.conjugate(ac).T); print()

print(A @ B)
print(A @ B); print()

print(A * B)
print(A *B); print()

print(A / B)
print(A /B); print()

print(A**3)
print(A**3); print()

print((a0 > 0.5))
print((a0 >0.5).astype(int)); print()

cols =np.nonzero(v >0.5)[0]
```

```
print(np.nonzero(a0>0.5))
print(np.array(np.nonzero(a0>0.5))); print()

print(a0[:, cols])
print(a0[:, cols]); print()

print(a0[:, v>0.5])
print(a0[:, v>0.5]); print()

a =a0.copy()
a[a <0.5] =0
print(a[a<0.5]=0)
print(a); print()

print(a0 * (a0>0.5))
print(a0 *(a0 >0.5)); print()

a =a0.copy()
a[:] =3
print(a[:]=3)
print(a); print()

x =a0.copy()
y_view =x[1,:].copy()
y_ref =x[1,:]
x[1,0] =123.456
print(y_view[0] / y_ref[0])
print(np.array([y_view[0], y_ref[0]])); print()

print(x.flatten())
print(x.flatten()); print()

print(x.flatten('F'))
print(x.flatten('F')); print()

print(solve(A,b))
print(la.solve(A, b)); print()

print(inv(A))
```

```
print(la.inv(A)); print()

print(det(A))
print(la.det(A)); print()

print(trace(A))
print(np.trace(A)); print()

print(rank(A))
print(np.linalg.matrix_rank(A)); print()

print(norms [2, fro, 1, inf])
print(np.array([la.norm(A,2), la.norm(A,'fro'), la.norm(A,1), la.norm(A,np.inf)]));
                                                print()

w, V =la.eig(A)
print(eig(A): w)
print(w); print()

print(eig(A): V)
print(V); print()

U, s, Vh =la.svd(A)
print(svd s)
print(s); print()

print(svd U)
print(U); print()

print(svd Vh)
print(Vh); print()

Q, R =la.qr(A)
print(qr R)
print(R); print()

S =A.T @ A +np.eye(3)
print(cholesky(S))
print(la.cholesky(S)); print()
```

```
print(pinv(A))
print(la.pinv(A)); print()
```

3 Task 3

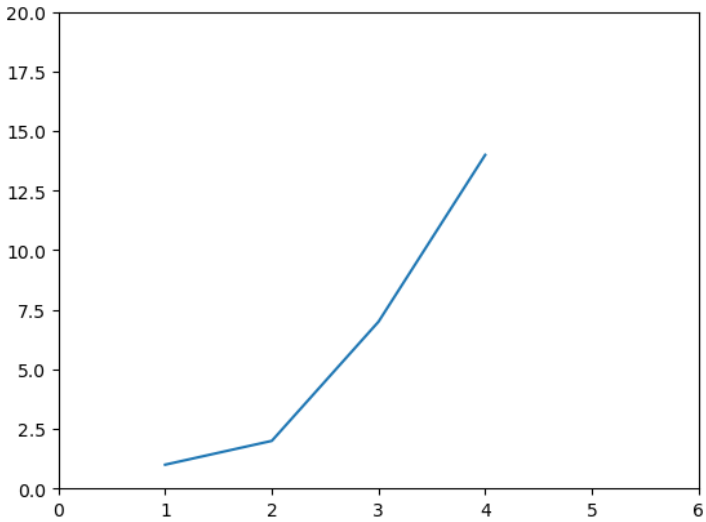

Figure 1: Line plot

code

```
import matplotlib.pyplot as plt

plt.plot([1,2,3,4], [1,2,7,14])
plt.axis([0, 6, 0, 20])
plt.show()
```

4 Task 4

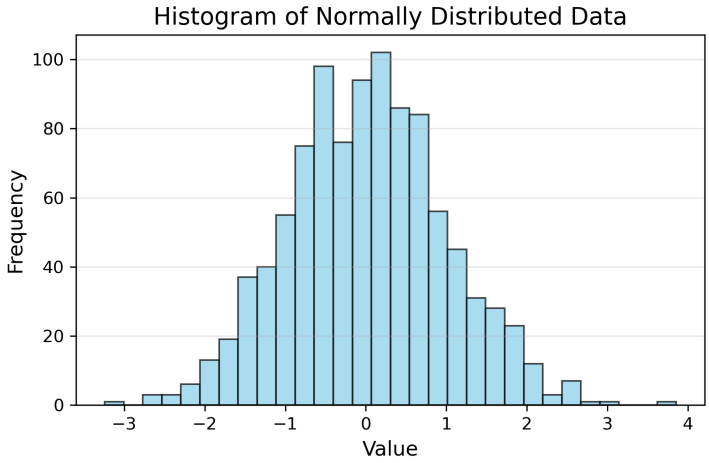

Figure 2: Line plot

```
import numpy as np
import matplotlib.pyplot as plt

np.random.seed(42)
data =np.random.randn(1000)

plt.figure(figsize=(6,4), dpi=300)
plt.hist(data, bins=30, color=skyblue, edgecolor=black, alpha=0.7)
plt.title(Histogram of Normally Distributed Data, fontsize=14)
plt.xlabel(Value, fontsize=12)
plt.ylabel(Frequency, fontsize=12)
plt.grid(axis=y, alpha=0.3)
plt.tight_layout()
plt.savefig(task4_histogram.png, dpi=300)
plt.show()
```

5 Task 5

Github: qih33333

Link: https://github.com/qih33333

6 Task 6

Link: https://github.com/qih33333/An-Introduction-to-Deep-Learning