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]
[0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]
```

```
a[1,4]
0.033585575305464355

a[1,:]
[0.9351 0.8159 0.0027 0.8574 0.0336 0.7297 0.1757 0.8632 0.5415]

a[:5,:]
[[0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.9351 0.8159 0.0027 0.8574 0.0336 0.7297 0.1757 0.8632 0.5415]
 [0.2997 0.4227 0.0283 0.1243 0.6706 0.6472 0.6154 0.3837 0.9972]
 [0.9808 0.6855 0.6505 0.6884 0.3889 0.1351 0.7215 0.5254 0.3102]
 [0.4858 0.8895 0.934 0.3578 0.5715 0.3219 0.5943 0.3379 0.3916]]

a[-5:,:]
[[0.4065 0.91 0.0431 0.8227 0.4154 0.8298 0.01 0.365 0.0786]
 [0.6526 0.2738 0.7027 0.9438 0.1268 0.8648 0.0595 0.3808 0.4298]
 [0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813 0.5107 0.3443]
 [0.9949 0.3159 0.1827 0.8801 0.8123 0.6679 0.9584 0.9257 0.7482]
 [0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]]

a[0:3,4:9]
[[0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.0336 0.7297 0.1757 0.8632 0.5415]
 [0.6706 0.6472 0.6154 0.3837 0.9972]]

a[np.ix_([1,3,4],[0,2])]
[[0.9351 0.0027]
 [0.9808 0.6505]
 [0.4858 0.934 ]]

a[2:21:2,:]
[[0.2997 0.4227 0.0283 0.1243 0.6706 0.6472 0.6154 0.3837 0.9972]
 [0.4858 0.8895 0.934 0.3578 0.5715 0.3219 0.5943 0.3379 0.3916]
 [0.3361 0.1503 0.4503 0.7963 0.2306 0.052 0.4046 0.1985 0.0908]
```

```
 [0.4404 0.9546 0.4999 0.4252 0.6202 0.9951 0.9489 0.46 0.7577]
 [0.9274 0.9679 0.0147 0.8636 0.9812 0.9572 0.1488 0.9726 0.8899]
 [0.0405 0.732 0.6144 0.0284 0.7192 0.016 0.758 0.5128 0.9291]
 [0.8881 0.2259 0.1246 0.2883 0.5861 0.5541 0.8097 0.5605 0.2884]
 [0.4065 0.91 0.0431 0.8227 0.4154 0.8298 0.01 0.365 0.0786]
 [0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813 0.5107 0.3443]
 [0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]]

a[::2,:]
[[0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.2997 0.4227 0.0283 0.1243 0.6706 0.6472 0.6154 0.3837 0.9972]
 [0.4858 0.8895 0.934 0.3578 0.5715 0.3219 0.5943 0.3379 0.3916]
 [0.3361 0.1503 0.4503 0.7963 0.2306 0.052 0.4046 0.1985 0.0908]
 [0.4404 0.9546 0.4999 0.4252 0.6202 0.9951 0.9489 0.46 0.7577]
 [0.9274 0.9679 0.0147 0.8636 0.9812 0.9572 0.1488 0.9726 0.8899]
 [0.0405 0.732 0.6144 0.0284 0.7192 0.016 0.758 0.5128 0.9291]
 [0.8881 0.2259 0.1246 0.2883 0.5861 0.5541 0.8097 0.5605 0.2884]
 [0.4065 0.91 0.0431 0.8227 0.4154 0.8298 0.01 0.365 0.0786]
 [0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813 0.5107 0.3443]
 [0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]]

a[::-1,:]
[[0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]
 [0.9949 0.3159 0.1827 0.8801 0.8123 0.6679 0.9584 0.9257 0.7482]
 [0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813 0.5107 0.3443]
 [0.6526 0.2738 0.7027 0.9438 0.1268 0.8648 0.0595 0.3808 0.4298]
 [0.4065 0.91 0.0431 0.8227 0.4154 0.8298 0.01 0.365 0.0786]
 [0.4129 0.8181 0.6265 0.9591 0.3694 0.5526 0.5939 0.8483 0.1455]
 [0.8881 0.2259 0.1246 0.2883 0.5861 0.5541 0.8097 0.5605 0.2884]
 [0.0661 0.8413 0.0667 0.3443 0.4303 0.9661 0.5622 0.2589 0.2417]
 [0.0405 0.732 0.6144 0.0284 0.7192 0.016 0.758 0.5128 0.9291]
 [0.8224 0.48 0.2324 0.8019 0.9235 0.2661 0.5389 0.4428 0.931 ]
 [0.9274 0.9679 0.0147 0.8636 0.9812 0.9572 0.1488 0.9726 0.8899]
 [0.4974 0.5293 0.7858 0.4147 0.7345 0.7111 0.9321 0.1149 0.729 ]
```

```
 [0.4404 0.9546 0.4999 0.4252 0.6202 0.9951 0.9489 0.46 0.7577]
 [0.5803 0.2987 0.672 0.1995 0.9421 0.3651 0.1055 0.6291 0.9272]
 [0.3361 0.1503 0.4503 0.7963 0.2306 0.052 0.4046 0.1985 0.0908]
 [0.8903 0.2272 0.6232 0.084 0.8326 0.7871 0.2394 0.8765 0.0586]
 [0.4858 0.8895 0.934 0.3578 0.5715 0.3219 0.5943 0.3379 0.3916]
 [0.9808 0.6855 0.6505 0.6884 0.3889 0.1351 0.7215 0.5254 0.3102]
 [0.2997 0.4227 0.0283 0.1243 0.6706 0.6472 0.6154 0.3837 0.9972]
 [0.9351 0.8159 0.0027 0.8574 0.0336 0.7297 0.1757 0.8632 0.5415]
 [0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436]]

a[np.r_[:len(a),0],:]
[[0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.9351 0.8159 0.0027 0.8574 0.0336 0.7297 0.1757 0.8632 0.5415]
 [0.2997 0.4227 0.0283 0.1243 0.6706 0.6472 0.6154 0.3837 0.9972]
 [0.9808 0.6855 0.6505 0.6884 0.3889 0.1351 0.7215 0.5254 0.3102]
 [0.4858 0.8895 0.934 0.3578 0.5715 0.3219 0.5943 0.3379 0.3916]
 [0.8903 0.2272 0.6232 0.084 0.8326 0.7871 0.2394 0.8765 0.0586]
 [0.3361 0.1503 0.4503 0.7963 0.2306 0.052 0.4046 0.1985 0.0908]
 [0.5803 0.2987 0.672 0.1995 0.9421 0.3651 0.1055 0.6291 0.9272]
 [0.4404 0.9546 0.4999 0.4252 0.6202 0.9951 0.9489 0.46 0.7577]
 [0.4974 0.5293 0.7858 0.4147 0.7345 0.7111 0.9321 0.1149 0.729 ]
 [0.9274 0.9679 0.0147 0.8636 0.9812 0.9572 0.1488 0.9726 0.8899]
 [0.8224 0.48 0.2324 0.8019 0.9235 0.2661 0.5389 0.4428 0.931 ]
 [0.0405 0.732 0.6144 0.0284 0.7192 0.016 0.758 0.5128 0.9291]
 [0.0661 0.8413 0.0667 0.3443 0.4303 0.9661 0.5622 0.2589 0.2417]
 [0.8881 0.2259 0.1246 0.2883 0.5861 0.5541 0.8097 0.5605 0.2884]
 [0.4129 0.8181 0.6265 0.9591 0.3694 0.5526 0.5939 0.8483 0.1455]
 [0.4065 0.91 0.0431 0.8227 0.4154 0.8298 0.01 0.365 0.0786]
 [0.6526 0.2738 0.7027 0.9438 0.1268 0.8648 0.0595 0.3808 0.4298]
 [0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813 0.5107 0.3443]
 [0.9949 0.3159 0.1827 0.8801 0.8123 0.6679 0.9584 0.9257 0.7482]
 [0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]
 [0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436]]
```

```
a.T
[[0.637 0.9351 0.2997 0.9808 0.4858 0.8903 0.3361 0.5803 0.4404 0.4974 0.9274
   0.8224 0.0405 0.0661 0.8881 0.4129 0.4065 0.6526 0.4888 0.9949 0.8607]
 [0.2698 0.8159 0.4227 0.6855 0.8895 0.2272 0.1503 0.2987 0.9546 0.5293 0.9679
     0.48 0.732 0.8413 0.2259 0.8181 0.91 0.2738 0.9765 0.3159 0.2471]
 [0.041 0.0027 0.0283 0.6505 0.934 0.6232 0.4503 0.672 0.4999 0.7858 0.0147
    0.2324 0.6144 0.0667 0.1246 0.6265 0.0431 0.7027 0.7757 0.1827 0.1412]
 [0.0165 0.8574 0.1243 0.6884 0.3578 0.084 0.7963 0.1995 0.4252 0.4147 0.8636
    0.8019 0.0284 0.3443 0.2883 0.9591 0.8227 0.9438 0.3089 0.8801 0.6701]
 [0.8133 0.0336 0.6706 0.3889 0.5715 0.8326 0.2306 0.9421 0.6202 0.7345 0.9812
     0.9235 0.7192 0.4303 0.5861 0.3694 0.4154 0.1268 0.2698 0.8123 0.7146]
 [0.9128 0.7297 0.6472 0.1351 0.3219 0.7871 0.052 0.3651 0.9951 0.7111 0.9572
    0.2661 0.016 0.9661 0.5541 0.5526 0.8298 0.8648 0.8631 0.6679 0.1671]
 [0.6066 0.1757 0.6154 0.7215 0.5943 0.2394 0.4046 0.1055 0.9489 0.9321 0.1488
     0.5389 0.758 0.5622 0.8097 0.5939 0.01 0.0595 0.8813 0.9584 0.3956]
 [0.7295 0.8632 0.3837 0.5254 0.3379 0.8765 0.1985 0.6291 0.46 0.1149 0.9726
    0.4428 0.5128 0.2589 0.5605 0.8483 0.365 0.3808 0.5107 0.9257 0.9103]
 [0.5436 0.5415 0.9972 0.3102 0.3916 0.0586 0.0908 0.9272 0.7577 0.729 0.8899
    0.931 0.9291 0.2417 0.2884 0.1455 0.0786 0.4298 0.3443 0.7482 0.5614]]

ac.conj().T
[[0.1731-0.8885j 0.7165-0.5283j 0.9833-0.1701j]
 [0.5864-0.6315j 0.9805-0.2265j 0.837 -0.5772j]
 [0.9584-0.3564j 0.5746-0.7775j 0.7782-0.5359j]]

A @ B
[[0.7407 0.2104 1.1914]
 [0.9923 0.2291 1.2902]
 [1.0265 0.2464 1.2183]]

A * B
[[0.3493 0.0714 0.2899]
 [0.3321 0.1532 0.6483]
 [0.0865 0.004 0.0578]]
```

```
A / B
[[ 0.6239 9.5061 1.5984]
 [ 2.1095 3.7474 0.737 ]
 [ 9.6329 167.9399 0.5545]]

A**3
[[0.1017 0.5595 0.3154]
 [0.5863 0.4348 0.3303]
 [0.761 0.557 0.0057]]

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

```
np.nonzero(a0>0.5)
[[0 0 0 0 0 0 1 1 1 1 1 1 2 2 2 2 3 3 3 3 3 3 4 4 4 4 5 5 5 5 5 6 7 7 7 7 7 8
   8 8 8 8 9 9 9 9 9 9 10 10 10 10 10 10 10 11 11 11 11 11 12 12 12 12 12 12
   13 13 13 14 14 14 14 14 15 15 15 15 15 15 16 16 16 17 17 17 17 18 18 18 18
   18 19 19 19 19 19 19 19 20 20 20 20 20]
 [0 4 5 6 7 8 0 1 3 5 7 8 4 5 6 8 0 1 2 3 6 7 1 2 4 6 0 2 4 5 7 3 0 2 4 7 8 1
    4 5 6 8 1 2 4 5 6 8 0 1 3 4 5 7 8 0 3 4 6 8 1 2 4 6 7 8 1 5 6 0 4 5 6 7 1
    2 3 5 6 7 1 3 5 0 2 3 5 1 2 5 6 7 0 3 4 5 6 7 8 0 3 4 7 8]]

a0[:, cols]
[[0.637 0.8133 0.6066 0.7295]
 [0.9351 0.0336 0.1757 0.8632]
 [0.2997 0.6706 0.6154 0.3837]
 [0.9808 0.3889 0.7215 0.5254]
 [0.4858 0.5715 0.5943 0.3379]
 [0.8903 0.8326 0.2394 0.8765]
 [0.3361 0.2306 0.4046 0.1985]
 [0.5803 0.9421 0.1055 0.6291]
 [0.4404 0.6202 0.9489 0.46 ]
 [0.4974 0.7345 0.9321 0.1149]
 [0.9274 0.9812 0.1488 0.9726]
 [0.8224 0.9235 0.5389 0.4428]
 [0.0405 0.7192 0.758 0.5128]
 [0.0661 0.4303 0.5622 0.2589]
 [0.8881 0.5861 0.8097 0.5605]
 [0.4129 0.3694 0.5939 0.8483]
 [0.4065 0.4154 0.01 0.365 ]
 [0.6526 0.1268 0.0595 0.3808]
 [0.4888 0.2698 0.8813 0.5107]
 [0.9949 0.8123 0.9584 0.9257]
 [0.8607 0.7146 0.3956 0.9103]]

a0[:, v>0.5]
[[0.637 0.8133 0.6066 0.7295]
```

```
 [0.9351 0.0336 0.1757 0.8632]
 [0.2997 0.6706 0.6154 0.3837]
 [0.9808 0.3889 0.7215 0.5254]
 [0.4858 0.5715 0.5943 0.3379]
 [0.8903 0.8326 0.2394 0.8765]
 [0.3361 0.2306 0.4046 0.1985]
 [0.5803 0.9421 0.1055 0.6291]
 [0.4404 0.6202 0.9489 0.46 ]
 [0.4974 0.7345 0.9321 0.1149]
 [0.9274 0.9812 0.1488 0.9726]
 [0.8224 0.9235 0.5389 0.4428]
 [0.0405 0.7192 0.758 0.5128]
 [0.0661 0.4303 0.5622 0.2589]
 [0.8881 0.5861 0.8097 0.5605]
 [0.4129 0.3694 0.5939 0.8483]
 [0.4065 0.4154 0.01 0.365 ]
 [0.6526 0.1268 0.0595 0.3808]
 [0.4888 0.2698 0.8813 0.5107]
 [0.9949 0.8123 0.9584 0.9257]
 [0.8607 0.7146 0.3956 0.9103]]


a[a<0.5]=0
[[0.637 0. 0. 0. 0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.9351 0.8159 0. 0.8574 0. 0.7297 0. 0.8632 0.5415]
 [0. 0. 0. 0. 0.6706 0.6472 0.6154 0. 0.9972]
 [0.9808 0.6855 0.6505 0.6884 0. 0. 0.7215 0.5254 0. ]
 [0. 0.8895 0.934 0. 0.5715 0. 0.5943 0. 0. ]
 [0.8903 0. 0.6232 0. 0.8326 0.7871 0. 0.8765 0. ]
 [0. 0. 0. 0.7963 0. 0. 0. 0. 0. ]
 [0.5803 0. 0.672 0. 0.9421 0. 0. 0.6291 0.9272]
 [0. 0.9546 0. 0. 0.6202 0.9951 0.9489 0. 0.7577]
 [0. 0.5293 0.7858 0. 0.7345 0.7111 0.9321 0. 0.729 ]
 [0.9274 0.9679 0. 0.8636 0.9812 0.9572 0. 0.9726 0.8899]
 [0.8224 0. 0. 0.8019 0.9235 0. 0.5389 0. 0.931 ]
```

```
 [0. 0.732 0.6144 0. 0.7192 0. 0.758 0.5128 0.9291]
 [0. 0.8413 0. 0. 0. 0.9661 0.5622 0. 0. ]
 [0.8881 0. 0. 0. 0.5861 0.5541 0.8097 0.5605 0. ]
 [0. 0.8181 0.6265 0.9591 0. 0.5526 0.5939 0.8483 0. ]
 [0. 0.91 0. 0.8227 0. 0.8298 0. 0. 0. ]
 [0.6526 0. 0.7027 0.9438 0. 0.8648 0. 0. 0. ]
 [0. 0.9765 0.7757 0. 0. 0.8631 0.8813 0.5107 0. ]
 [0.9949 0. 0. 0.8801 0.8123 0.6679 0.9584 0.9257 0.7482]
 [0.8607 0. 0. 0.6701 0.7146 0. 0. 0.9103 0.5614]]

a0 * (a0>0.5)
[[0.637 0. 0. 0. 0.8133 0.9128 0.6066 0.7295 0.5436]
 [0.9351 0.8159 0. 0.8574 0. 0.7297 0. 0.8632 0.5415]
 [0. 0. 0. 0. 0.6706 0.6472 0.6154 0. 0.9972]
 [0.9808 0.6855 0.6505 0.6884 0. 0. 0.7215 0.5254 0. ]
 [0. 0.8895 0.934 0. 0.5715 0. 0.5943 0. 0. ]
 [0.8903 0. 0.6232 0. 0.8326 0.7871 0. 0.8765 0. ]
 [0. 0. 0. 0.7963 0. 0. 0. 0. 0. ]
 [0.5803 0. 0.672 0. 0.9421 0. 0. 0.6291 0.9272]
 [0. 0.9546 0. 0. 0.6202 0.9951 0.9489 0. 0.7577]
 [0. 0.5293 0.7858 0. 0.7345 0.7111 0.9321 0. 0.729 ]
 [0.9274 0.9679 0. 0.8636 0.9812 0.9572 0. 0.9726 0.8899]
 [0.8224 0. 0. 0.8019 0.9235 0. 0.5389 0. 0.931 ]
 [0. 0.732 0.6144 0. 0.7192 0. 0.758 0.5128 0.9291]
 [0. 0.8413 0. 0. 0. 0.9661 0.5622 0. 0. ]
 [0.8881 0. 0. 0. 0.5861 0.5541 0.8097 0.5605 0. ]
 [0. 0.8181 0.6265 0.9591 0. 0.5526 0.5939 0.8483 0. ]
 [0. 0.91 0. 0.8227 0. 0.8298 0. 0. 0. ]
 [0.6526 0. 0.7027 0.9438 0. 0.8648 0. 0. 0. ]
 [0. 0.9765 0.7757 0. 0. 0.8631 0.8813 0.5107 0. ]
 [0.9949 0. 0. 0.8801 0.8123 0.6679 0.9584 0.9257 0.7482]
 [0.8607 0. 0. 0.6701 0.7146 0. 0. 0.9103 0.5614]]

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

y_view[0] / y_ref[0]
[ 0.9351 123.456 ]

x.flatten()
[ 0.637 0.2698 0.041 0.0165 0.8133 0.9128 0.6066 0.7295 0.5436 123.456 0.8159
   0.0027 0.8574 0.0336 0.7297 0.1757 0.8632 0.5415 0.2997 0.4227 0.0283
   0.1243 0.6706 0.6472 0.6154 0.3837 0.9972 0.9808 0.6855 0.6505 0.6884
   0.3889 0.1351 0.7215 0.5254 0.3102 0.4858 0.8895 0.934 0.3578 0.5715 0.3219
    0.5943 0.3379 0.3916 0.8903 0.2272 0.6232 0.084 0.8326 0.7871 0.2394
   0.8765 0.0586 0.3361 0.1503 0.4503 0.7963 0.2306 0.052 0.4046 0.1985 0.0908
    0.5803 0.2987 0.672 0.1995 0.9421 0.3651 0.1055 0.6291 0.9272 0.4404
   0.9546 0.4999 0.4252 0.6202 0.9951 0.9489 0.46 0.7577 0.4974 0.5293 0.7858
```

```
   0.4147 0.7345 0.7111 0.9321 0.1149 0.729 0.9274 0.9679 0.0147 0.8636 0.9812
    0.9572 0.1488 0.9726 0.8899 0.8224 0.48 0.2324 0.8019 0.9235 0.2661 0.5389
    0.4428 0.931 0.0405 0.732 0.6144 0.0284 0.7192 0.016 0.758 0.5128 0.9291
   0.0661 0.8413 0.0667 0.3443 0.4303 0.9661 0.5622 0.2589 0.2417 0.8881
   0.2259 0.1246 0.2883 0.5861 0.5541 0.8097 0.5605 0.2884 0.4129 0.8181
   0.6265 0.9591 0.3694 0.5526 0.5939 0.8483 0.1455 0.4065 0.91 0.0431 0.8227
   0.4154 0.8298 0.01 0.365 0.0786 0.6526 0.2738 0.7027 0.9438 0.1268 0.8648
   0.0595 0.3808 0.4298 0.4888 0.9765 0.7757 0.3089 0.2698 0.8631 0.8813
   0.5107 0.3443 0.9949 0.3159 0.1827 0.8801 0.8123 0.6679 0.9584 0.9257
   0.7482 0.8607 0.2471 0.1412 0.6701 0.7146 0.1671 0.3956 0.9103 0.5614]

x.flatten('F')
[ 0.637 123.456 0.2997 0.9808 0.4858 0.8903 0.3361 0.5803 0.4404 0.4974 0.9274
    0.8224 0.0405 0.0661 0.8881 0.4129 0.4065 0.6526 0.4888 0.9949 0.8607
   0.2698 0.8159 0.4227 0.6855 0.8895 0.2272 0.1503 0.2987 0.9546 0.5293
   0.9679 0.48 0.732 0.8413 0.2259 0.8181 0.91 0.2738 0.9765 0.3159 0.2471
   0.041 0.0027 0.0283 0.6505 0.934 0.6232 0.4503 0.672 0.4999 0.7858 0.0147
   0.2324 0.6144 0.0667 0.1246 0.6265 0.0431 0.7027 0.7757 0.1827 0.1412
   0.0165 0.8574 0.1243 0.6884 0.3578 0.084 0.7963 0.1995 0.4252 0.4147 0.8636
    0.8019 0.0284 0.3443 0.2883 0.9591 0.8227 0.9438 0.3089 0.8801 0.6701
   0.8133 0.0336 0.6706 0.3889 0.5715 0.8326 0.2306 0.9421 0.6202 0.7345
   0.9812 0.9235 0.7192 0.4303 0.5861 0.3694 0.4154 0.1268 0.2698 0.8123
   0.7146 0.9128 0.7297 0.6472 0.1351 0.3219 0.7871 0.052 0.3651 0.9951 0.7111
    0.9572 0.2661 0.016 0.9661 0.5541 0.5526 0.8298 0.8648 0.8631 0.6679
   0.1671 0.6066 0.1757 0.6154 0.7215 0.5943 0.2394 0.4046 0.1055 0.9489
   0.9321 0.1488 0.5389 0.758 0.5622 0.8097 0.5939 0.01 0.0595 0.8813 0.9584
   0.3956 0.7295 0.8632 0.3837 0.5254 0.3379 0.8765 0.1985 0.6291 0.46 0.1149
   0.9726 0.4428 0.5128 0.2589 0.5605 0.8483 0.365 0.3808 0.5107 0.9257 0.9103
    0.5436 0.5415 0.9972 0.3102 0.3916 0.0586 0.0908 0.9272 0.7577 0.729
   0.8899 0.931 0.9291 0.2417 0.2884 0.1455 0.0786 0.4298 0.3443 0.7482
   0.5614]

solve(A,b)
[ 3.3693 -3.1848 -0.0644]
```

```
inv(A)
[[-2.2522 2.145 0.2804]
 [ 2.5024 -2.7968 1.2845]
 [-0.0157 1.9147 -1.7472]]

det(A)
0.19231529667738684

trace(A)
1.4034427932593805

rank(A)
3

norms [2, fro, 1, inf]
[2.0941 2.1576 2.4044 2.2858]

eig(A): w
[ 2.0772+0.j -0.4815+0.j -0.1923+0.j]

eig(A): V
[[-0.5529 -0.4856 0.5076]
 [-0.6339 -0.1522 -0.7526]
 [-0.5407 0.8608 0.4195]]

svd s
[2.0941 0.4833 0.19 ]

svd U
[[-0.5367 0.6007 0.5925]
 [-0.6269 0.1861 -0.7565]
 [-0.5647 -0.7775 0.2767]]
```

```
svd Vh
[[-0.6164 -0.6599 -0.4297]
 [-0.5662 -0.0078 0.8242]
 [-0.5472 0.7513 -0.3689]]

qr R
[[-1.3236 -1.3372 -0.8007]
 [ 0. 0.3766 0.4282]
 [ 0. 0. -0.3858]]

cholesky(S)
[[1.6589 1.0669 0.6388]
 [0. 1.3385 0.4111]
 [0. 0. 1.1816]]

pinv(A)
[[-2.2522 2.145 0.2804]
 [ 2.5024 -2.7968 1.2845]
 [-0.0157 1.9147 -1.7472]]
```

code

```
import numpy as np
import scipy.linalg as la
import contextlib, io

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

def p(name, x):
    print(name)
    if isinstance(x, np.ndarray):
        # full, no ellipsis
        print(np.array2string(x, threshold=np.inf, max_line_width=10**6,
                              precision=4, suppress_small=True))
    else:
```

```
        print(x)
    print()

buf =io.StringIO()
with contextlib.redirect_stdout(buf):
    rng =np.random.default_rng(0)
    a0 =rng.random((21,9)); b0 =rng.random((21,9)); v =rng.random(9)
    A =rng.random((3,3)); B =rng.random((3,3)); b =rng.normal(size=(3,))
    ac =rng.random((3,3)) +1j*rng.random((3,3))

    p(a0.shape / b0.shape / v.shape, np.array([a0.shape, b0.shape, v.shape], dtype=
                                              object))
    p(ndims(a0), np.ndim(a0)); p(numel(a0), np.size(a0)); p(size(a0), np.array(a0.
                                              shape))
    p(size(a0,2), a0.shape[1])

    p(np.array([[1,2,3],[4,5,6]]), np.array([[1,2,3],[4,5,6]]))
    p(np.block([[I,1],[2,3I]]), np.block([[np.eye(2), np.ones((2,2))],
                                          [2*np.ones((2,2)), 3*np.eye(2)]]))

    a =a0.copy()
    p(a[-1], a[-1]); p(a[1,4], a[1,4]); p(a[1,:], a[1,:]); p(a[:5,:], a[:5,:])
    p(a[-5:,:], a[-5:,:]); p(a[0:3,4:9], a[0:3,4:9])
    p(a[np.ix_([1,3,4],[0,2])], a[np.ix_([1,3,4],[0,2])])
    p(a[2:21:2,:], a[2:21:2,:]); p(a[::2,:], a[::2,:]); p(a[::-1,:], a[::-1,:])
    p(a[np.r_[:len(a),0],:], a[np.r_[:len(a),0],:])

    p(a.T, a.T); p(ac.conj().T, np.conjugate(ac).T)

    p(A @ B, A @ B); p(A * B, A *B); p(A / B, A /B); p(A**3, A**3)

    p((a0 > 0.5), (a0 >0.5).astype(int))
    cols =np.nonzero(v >0.5)[0]; p(np.nonzero(a0>0.5), np.array([*np.nonzero(a0>0.5)],
                                                  dtype=object))
    p(a0[:, cols], a0[:, cols]); p(a0[:, v>0.5], a0[:, v>0.5])

    a =a0.copy(); a[a <0.5] =0; p(a[a<0.5]=0, a)
    p(a0 * (a0>0.5), a0 *(a0 >0.5))
    a =a0.copy(); a[:] =3; p(a[:]=3, a)
```

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

    p(x.flatten(), x.flatten()); p(x.flatten('F'), x.flatten('F'))

    p(solve(A,b), la.solve(A,b)); p(inv(A), la.inv(A)); p(det(A), la.det(A))
    p(trace(A), np.trace(A)); p(rank(A), np.linalg.matrix_rank(A))
    p(norms [2, fro, 1, inf], np.array([la.norm(A,2), la.norm(A,'fro'),
                                        la.norm(A,1), la.norm(A,np.inf)]))
    w,V =la.eig(A); p(eig(A): w, w); p(eig(A): V, V)
    U,s,Vh =la.svd(A); p(svd s, s); p(svd U, U); p(svd Vh, Vh)
    Q,R =la.qr(A); p(qr R, R)
    S =A.T@A +np.eye(3); p(cholesky(S), la.cholesky(S))
    p(pinv(A), la.pinv(A))

# write full output (no truncation) to files
text =buf.getvalue()
with open(task2_full_output.txt, w) as f:
    f.write(text)
with open(task2_full_output.tex, w) as f:
    f.write(\\begin{verbatim}\n+text+\\end{verbatim}\n)

print(Saved full outputs to task2_full_output.txt and task2_full_output.tex)
```

3 Task 3

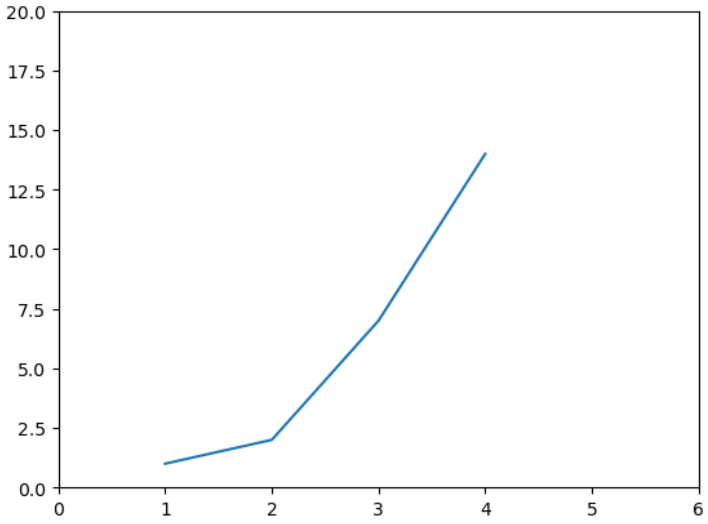

Figure 1: Line plot

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

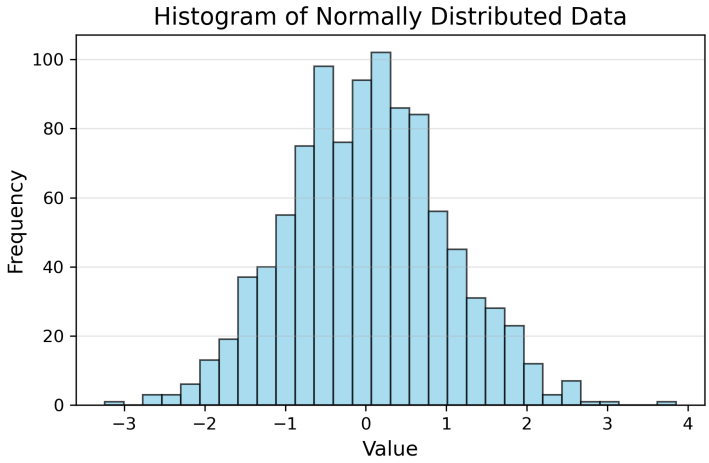

Figure 2: Line plot

```
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