Linear System
Reduced Echelon Form

Definition

A matrix is in **reduced echelon form** if

1. Any rows consisting entirely of zeros are grouped at the bottom of the matrix.
2. The first nonzero element of each other row is 1. This element is called a **leading 1**.
3. The leading 1 of each after the first is positioned to the right of the leading 1 of the previous row.
4. All other elements in a column that contains a leading 1 are zero.

In Reduced Echelon Form

A

$$\begin{bmatrix} 1 & 0 & 8 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$

B

$$\begin{bmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 9 \end{bmatrix}$$

C

$$\begin{bmatrix} 1 & 4 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

D

$$\begin{bmatrix} 1 & 2 & 3 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

E

$$\begin{bmatrix} 1 & 0 & 5 & 0 & 0 & 8 \\ 0 & 1 & 7 & 0 & 0 & 9 \\ 0 & 0 & 0 & 1 & 0 & 5 \\ 0 & 0 & 0 & 0 & 1 & 4 \end{bmatrix}$$

F

$$\begin{bmatrix} 1 & 2 & 0 & 3 & 0 & 4 \\ 0 & 0 & 1 & 2 & 0 & 7 \\ 0 & 0 & 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

ans =

1 0 8
0 1 2
0 0 0
0 0 0

Not in Reduced Echelon Form

G

$$\begin{bmatrix} 1 & 2 & 0 & 4 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 3 \end{bmatrix}$$

Row of zeros not at bottom of matrix

H

$$\begin{bmatrix} 1 & 2 & 0 & 3 & 0 \\ 0 & 0 & 3 & 4 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

First nonzero element in row 2 is not 1

I

$$\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 0 & 1 & 4 \\ 0 & 1 & 0 & 3 \end{bmatrix}$$

Leading 1 in row 3 not to the right of leading 1 in row 2

J

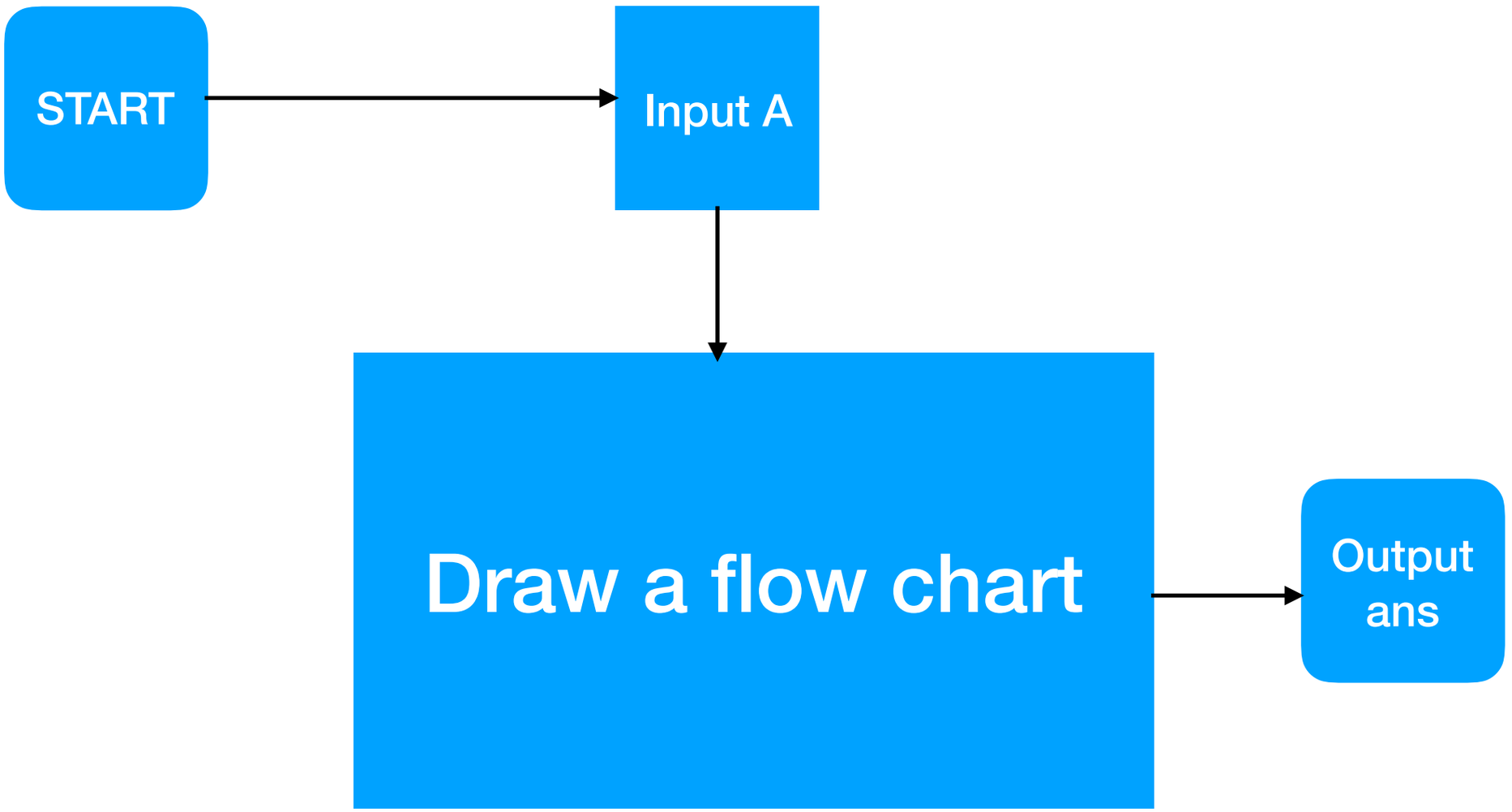
$$\begin{bmatrix} 1 & 7 & 0 & 8 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Nonzero element above leading 1 in Row 2

Main problem

- Check if a given matrix is in reduced echelon form or not

```
% Main problem 1
function ans = ck_ref(A)
```



Problem 1

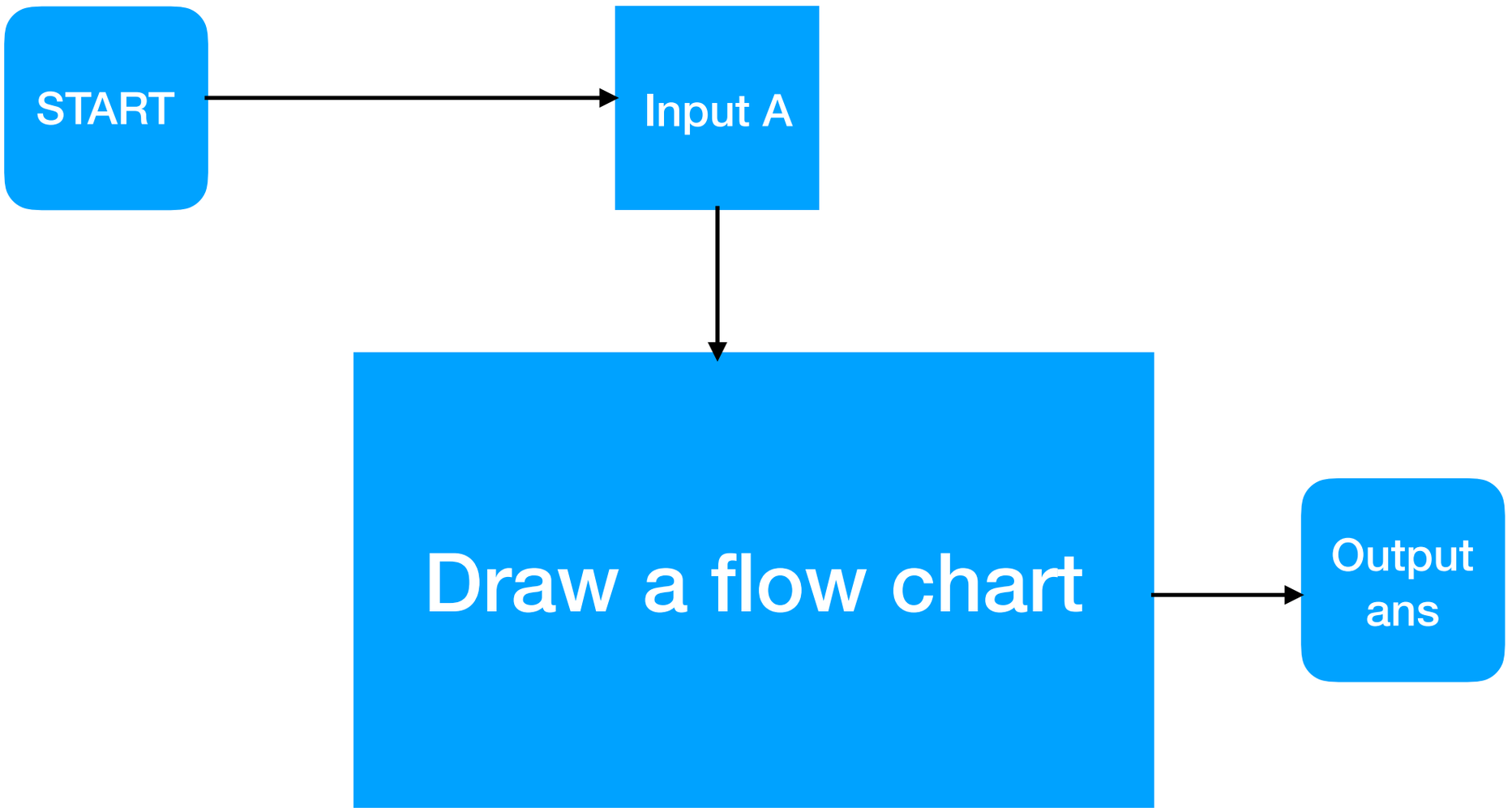
- Check the first condition. Any rows consisting entirely of zeros should be grouped at the bottom of the matrix.

$$\begin{bmatrix} 1 & 2 & 0 & 3 & 0 & 4 \\ 0 & 0 & 1 & 2 & 0 & 7 \\ 0 & 0 & 0 & 0 & 1 & 6 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 0 & 4 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 3 \end{bmatrix}$$

% problem 1
function ans = ck_cond_1(A)



Problem 2

- Check condition 2. The first nonzero element of each other row is a leading one.

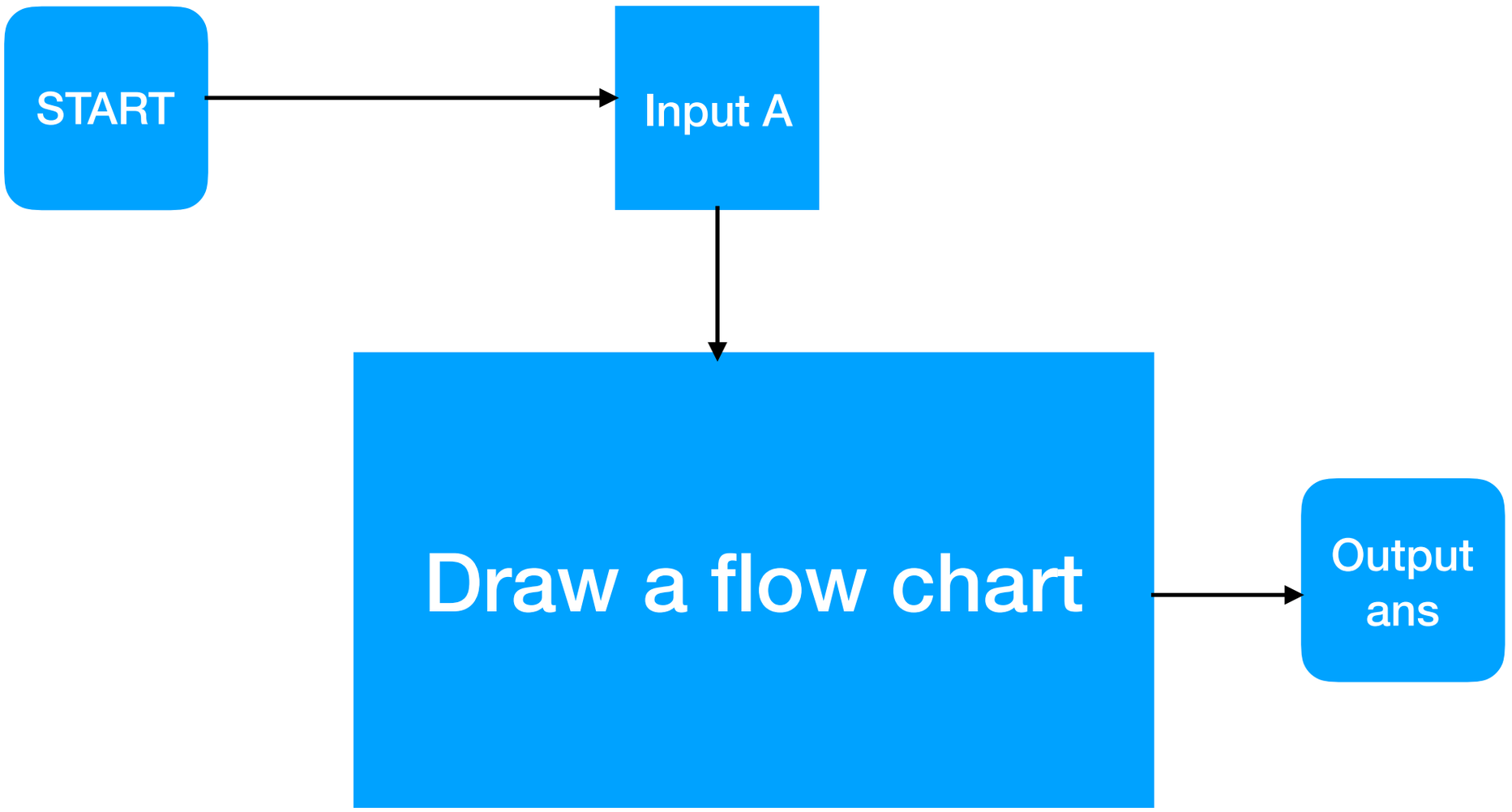
$$\begin{bmatrix} 1 & 0 & 8 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 9 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 0 & 3 & 0 \\ 0 & 0 & 3 & 4 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

First nonzero element in row 2 is not 1

% problem 2
function ans = ck_cond_2(A)



Problem 3

The leading 1 of each after the first should be positioned to the right of the leading 1 of the previous row.

$$\begin{bmatrix} 1 & 0 & 8 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$

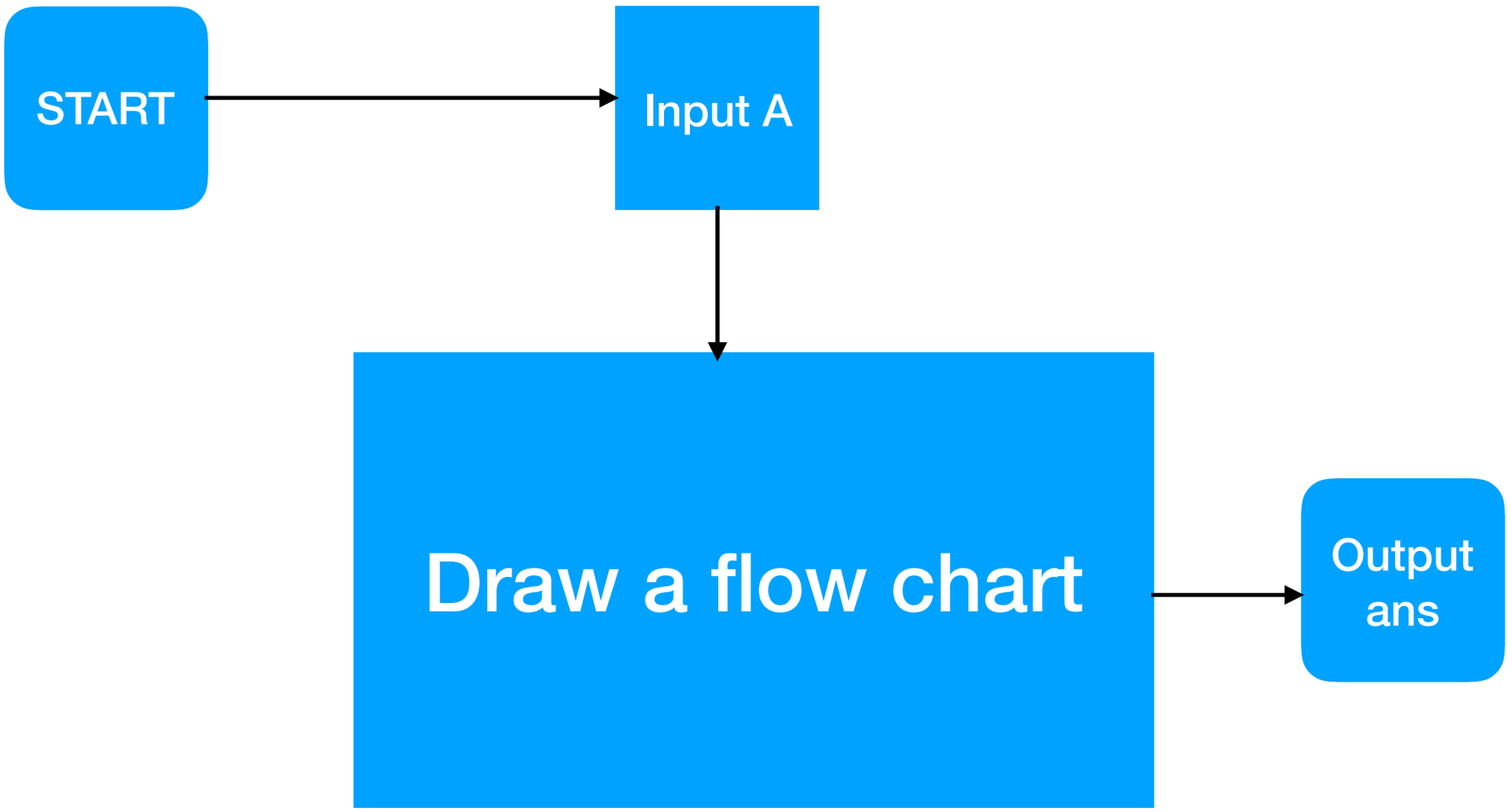
$$\begin{bmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 9 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 0 & 1 & 4 \\ 0 & 1 & 0 & 3 \end{bmatrix}$$

Leading 1 in row 3 not to the right of leading 1 in row 2

$$\begin{bmatrix} 1 & 0 & 5 & 0 & 0 & 8 \\ 0 & 1 & 7 & 0 & 0 & 9 \\ 0 & 0 & 0 & 1 & 0 & 5 \\ 0 & 0 & 0 & 0 & 1 & 4 \end{bmatrix}$$

% problem 3
function ans = ck_cond_3(A)



Problem 4

Check if all other elements in a column, which contains a leading 1, are zero.

$$\begin{bmatrix} 1 & 0 & 8 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{bmatrix}$$

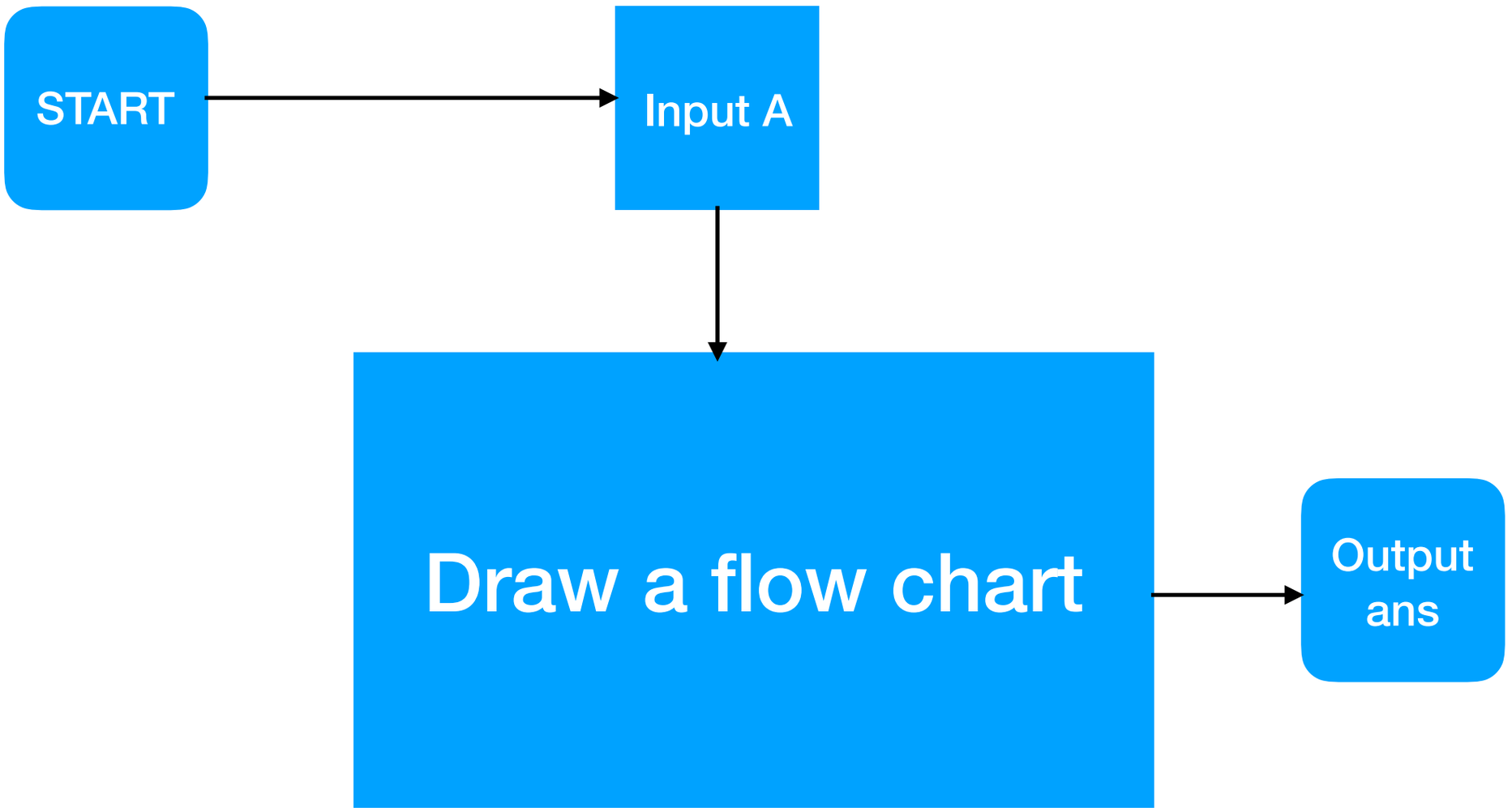
$$\begin{bmatrix} 1 & 0 & 0 & 7 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 9 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 7 & 0 & 8 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Nonzero element above leading 1 in Row 2

$$\begin{bmatrix} 1 & 0 & 5 & 0 & 0 & 8 \\ 0 & 1 & 7 & 0 & 0 & 9 \\ 0 & 0 & 0 & 1 & 0 & 5 \\ 0 & 0 & 0 & 0 & 1 & 4 \end{bmatrix}$$

% problem 4
function ans = ck_cond_4(A)



DATA ANALYSIS
Cifar-10

The CIFAR-10 dataset consists of 60000 32x32 colour images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

MatConvNet: CNNs for MATLAB

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MatConvNet is a MATLAB toolbox implementing *Convolutional Neural Networks* (CNNs) for computer vision applications. It is simple, efficient, and can run and learn state-of-the-art CNNs. Many pre-trained CNNs for image classification, segmentation, face recognition, and text detection are available.

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New: 1.0-beta22 released with a few bugfixes.

Obtaining MatConvNet

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- GIT repository
- Citation

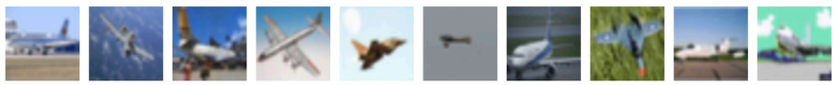
The CIFAR-10 dataset

The CIFAR-10 dataset consists of 60000 32x32 colour images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

The dataset is divided into five training batches and one test batch, each with 10000 images. The test batch contains exactly 1000 randomly-selected images from each class. The training batches contain the remaining images in random order, but some training batches may contain more images from one class than another. Between them, the training batches contain exactly 5000 images from each class.

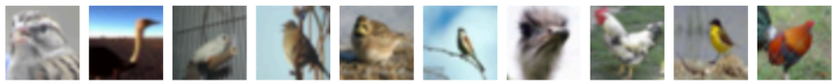
Here are the classes in the dataset, as well as 10 random images from each:

airplane

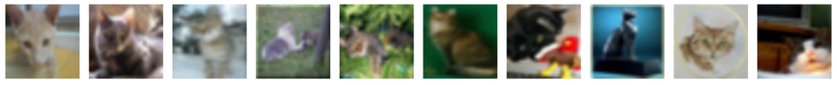


automobile

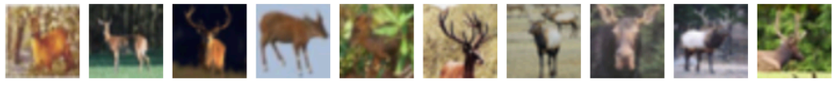
bird



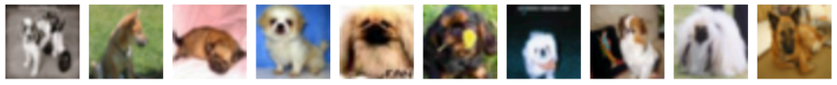
cat



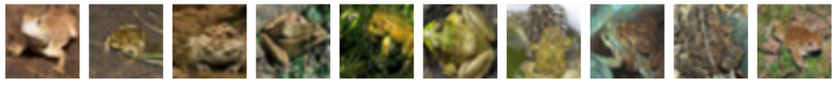
deer



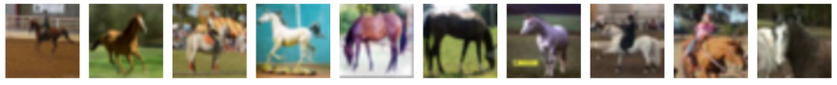
dog



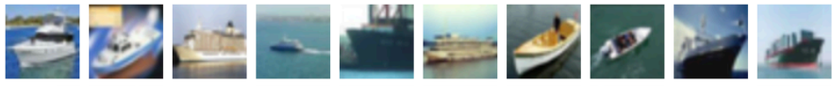
frog



horse



ship



truck

The classes are completely mutually exclusive. There is no overlap between automobiles and trucks. "Automobile" includes sedans, SUVs, things of that sort. "Truck" includes only big trucks. Neither includes pickup trucks.

airplane

automobile

bird

cat

deer

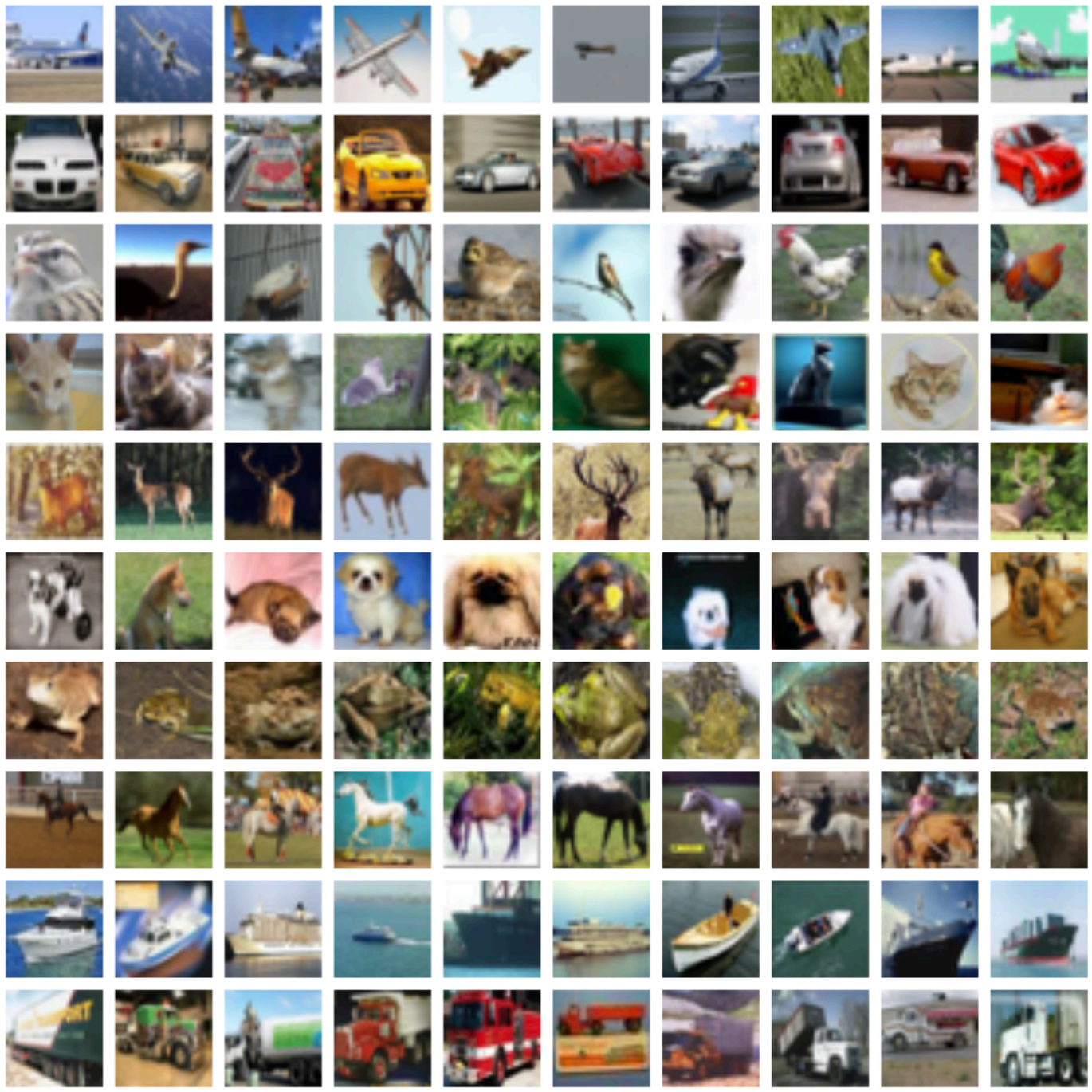
dog

frog

horse

ship

truck



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Current Folder

Name

- data
- cnn_cifar.m
- cnn_cifar_init.m
- cnn_cifar_init_nin.m

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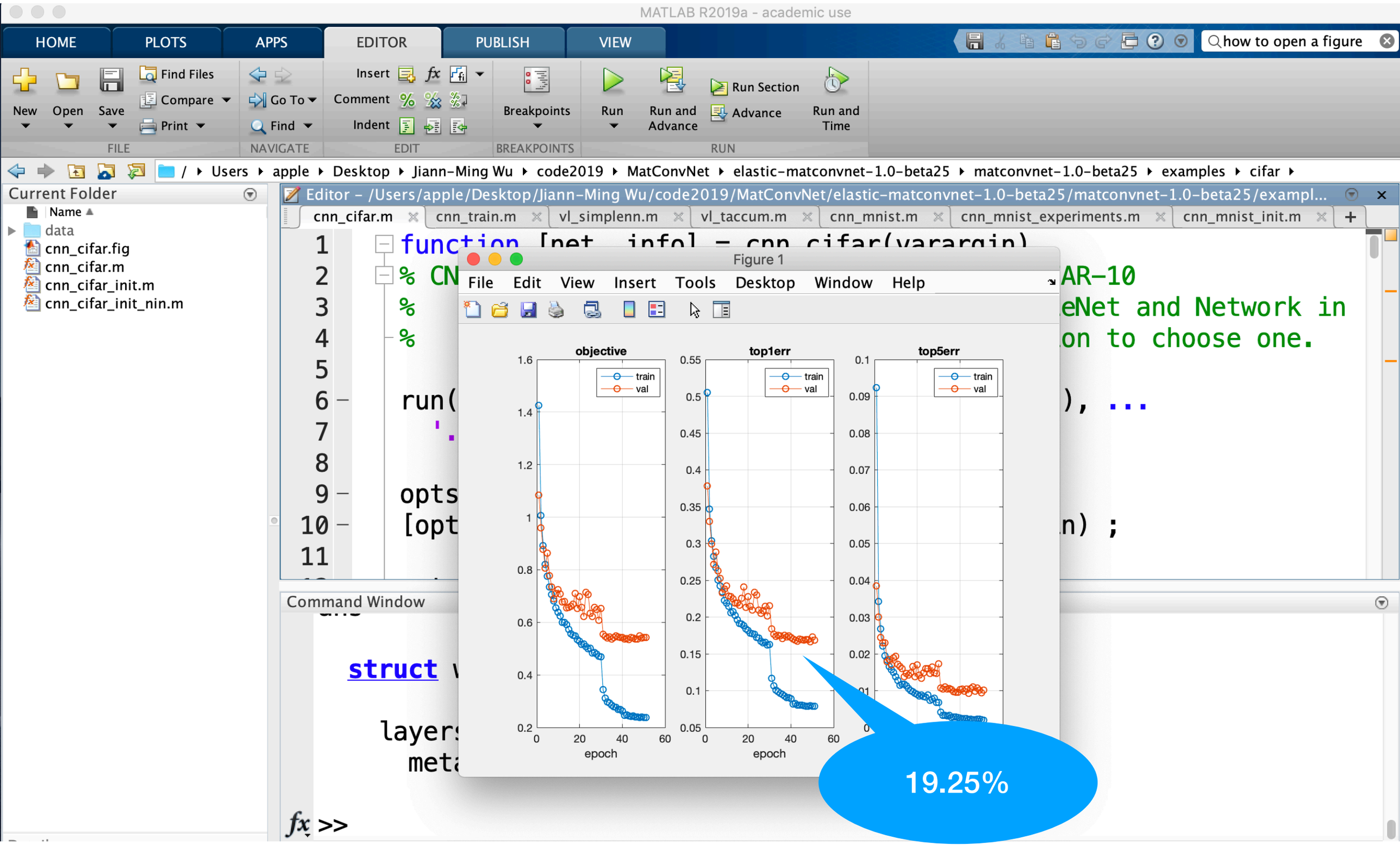
cnn_cifar.m | cnn_train.m | vl_simplenn.m | vl_taccum.m | cnn_mnist.m | cnn_mnist_experiments.m | cnn_mnist_init.m

```
1  function [net, info] = cnn_cifar(varargin)
2  % CNN_CIFAR   Demonstrates MatConvNet on CIFAR-10
3  %    The demo includes two standard model: LeNet and Network in
4  %    Network (NIN). Use the 'modelType' option to choose one.
5
6  run(fullfile(fileparts(mfilename('fullpath')), ...
7    '..' '..' 'matlab' 'vl_setupnn.m')) ;
```

Command Window

```
>> cnn_cifar
```

cnn_cifar



error rate for testing

You can find some baseline replicable results on this dataset on the project page for cuda-convnet. These results were obtained with a convolutional neural network. Briefly, they are 18% test error without data augmentation

DATA ANALYSIS
MNIST

The MNIST database of handwritten digits, available from this page, has a training set of 60,000 examples, and a test set of 10,000 examples. It is a subset of a larger set available from NIST. The digits have been size-normalized and centered in a fixed-size image.

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Current Folder

Name

- data
- cnn_mnist.fig
- cnn_mnist.m
- cnn_mnist_experiments.m
- cnn_mnist_init.m

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2  %CNN_MNIST  Demonstrates MatConvNet on MNIST
3
4  run(fullfile(fileparts(mfilename('fullpath')),...
5    '..', '..', 'matlab', 'vl_setupnn.m')) ;
```

Command Window

```
>> cnn_mnist
```

cnn_mnist