Anand Sekar HW 6

Exercise 8 Compute the tuning curves for cell_ids 541512399, 541512120, 541512548, 541513716, 541511455, 541513703, 541513685, 541511721. In what ways do these tuning curves differ? In what ways are they the same? What are interesting parameters of a cell's response to this stimulus?

Standard Imports

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import sys
from __future__ import print_function
```

Brain Observatory set up

In [2]:
```
from allensdk.core.brain_observatory_cache import BrainObservatoryCache
boc = BrainObservatoryCache(manifest_file='/Users/anand/OneDrive/Documents/School/UW/Fre
shman Year/Winter Quarter 2017/AMATH 342 Neural Computation/Homework/HW6/boc/manifest.js
on')
```

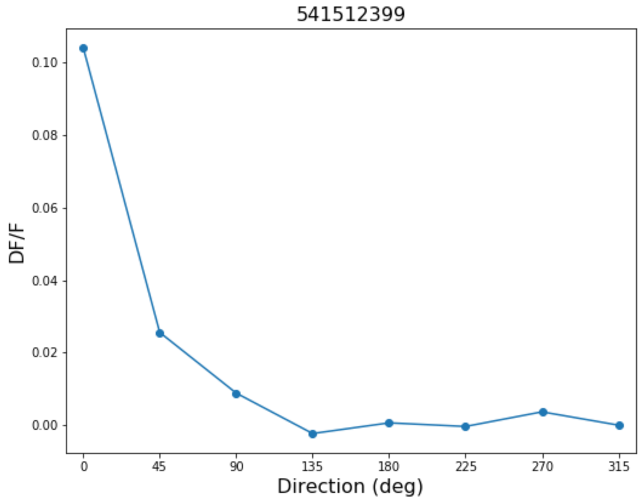
In [3]:
```
def get_dff_traces_and_stim_table(cell_specimen_id, stimulus):
    #print ("Downloading cell_specimens. This will take a moment the first time it is ru
n.")
    cell_specimens = pd.DataFrame(boc.get_cell_specimens())
    expt_id = cell_specimens[cell_specimens.cell_specimen_id==cell_specimen_id].experime
nt_container_id.values[0]
    session_id = boc.get_ophys_experiments(stimuli=[stimulus],experiment_container_ids=
[expt_id])[0]['id']
    #print ("Opening NWB file for ophys session. This will take several minutes if the f
ile isn't downloaded yet.")
    data_set = boc.get_ophys_experiment_data(session_id)
    #print ("All Done")
    timestamps, dff = data_set.get_dff_traces(cell_specimen_ids=[cell_specimen_id])
    dff_trace = dff[0,:]
    stim_table = data_set.get_stimulus_table(stimulus)
    return (timestamps, dff_trace, stim_table)
```

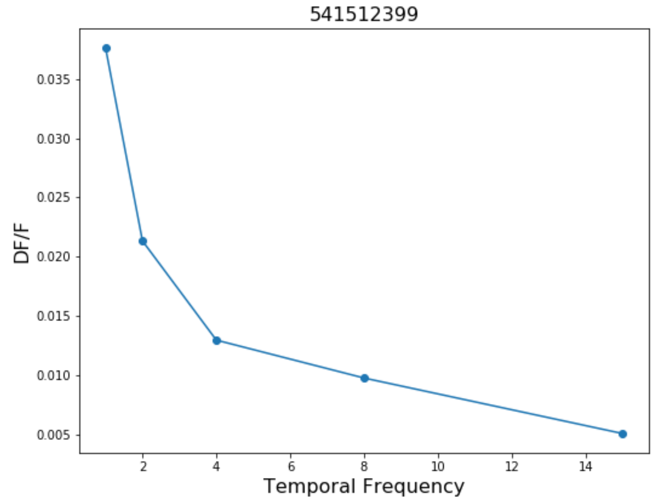
Plotting Tuning Curves

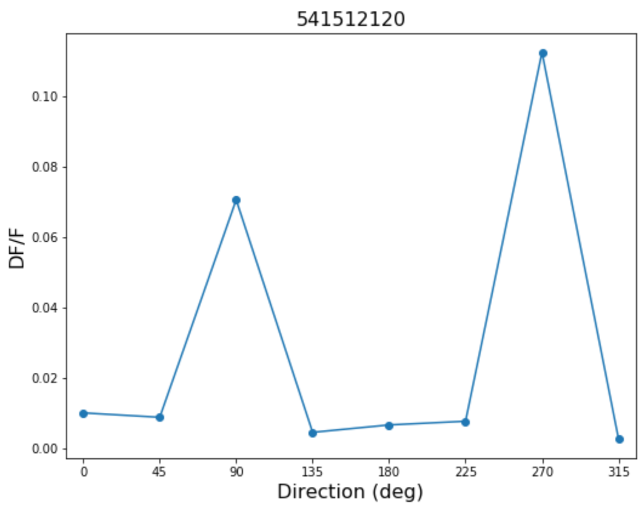
In [4]:
```
cell_ids = np.ravel(np.array([541512399, 541512120, 541512548, 541513716, 541511455, 541
513703, 541513685, 541511721]))

%matplotlib inline
# Import numpy and pyplot
import matplotlib.pyplot as plt
import numpy as np
# Import gridspec
import matplotlib.gridspec as gridspec
```

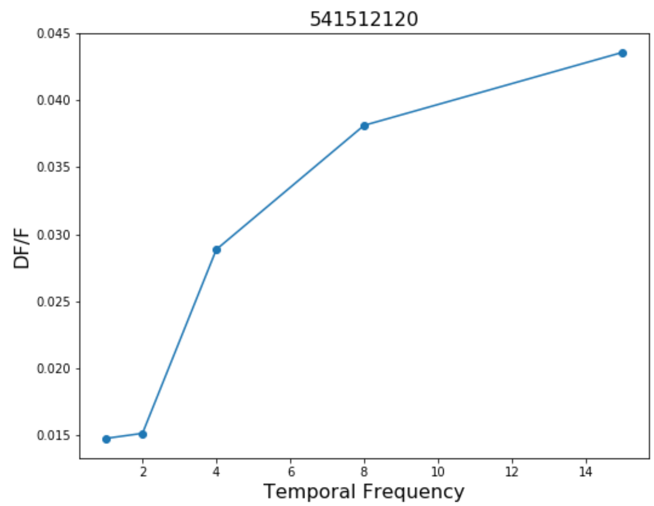
In [5]:

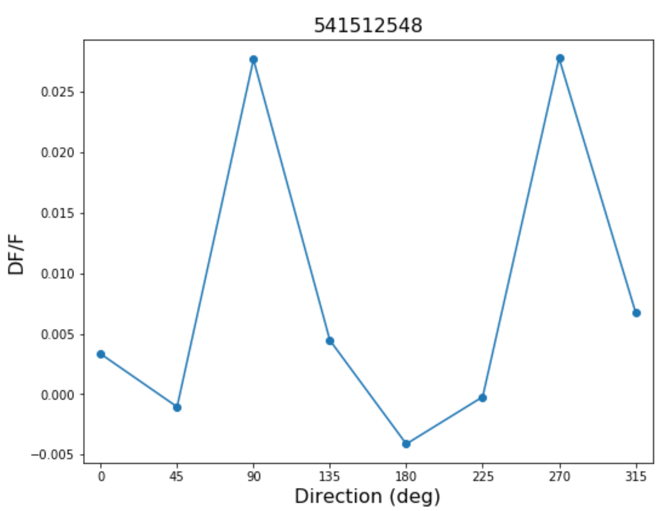
```
fig=plt.figure()
fig.set_size_inches(18.5, 74)
# Create gridspec object and define each subplot
gs = gridspec.GridSpec(8, 2, hspace = .5)
i_list = range(8)
axs_1 = [plt.subplot(gs[i, 0]) for i in i_list]
axs_2 = [plt.subplot(gs[i, 1]) for i in i_list]

for a, cell_id in enumerate(cell_ids):
    timestamps, dff_trace, stim_table = get_dff_traces_and_stim_table(cell_id, 'drifting
_gratings')

    cell_response= np.zeros((len(stim_table),3))

    for i in range(len(stim_table)):
        cell_response[i,0] = stim_table.orientation[i]
        cell_response[i,1] = stim_table.temporal_frequency[i]
        cell_response[i,2] = dff_trace[stim_table.start[i]:stim_table.end[i]].mean()

    #plotting DF/F vs Direction
    all_ori = np.unique(cell_response[:,0])
    orivals = all_ori[np.isfinite(all_ori)]

    tuning = np.empty((8))
    for i, ori in enumerate(orivals):
        trials = np.where(cell_response[:,0]==ori)[0]
        tuning[i] = cell_response[trials,2].mean()
    axs_1[a].plot(orivals, tuning, 'o-')
    axs_1[a].set_xlim(-10,325)
    axs_1[a].set_xticks(orivals)
    axs_1[a].set_xlabel("Direction (deg)", fontsize=16)
    axs_1[a].set_ylabel("DF/F", fontsize=16)
    axs_1[a].set_title(cell_id , fontsize=16)

    #plotting DF/F vs Temporal Frequency
    tfvals = np.unique(cell_response[:,1])
    tfvals = tfvals[np.isfinite(tfvals)]

    tuning_tf = np.empty((len(tfvals)))
    for i,tf in enumerate(tfvals):
        trials = np.where(cell_response[:,1]==tf)
        tuning_tf[i] = cell_response[trials,2].mean()

    axs_2[a].plot(tfvals, tuning_tf, 'o-')
    axs_2[a].set_xlabel("Temporal Frequency", fontsize=16)
    axs_2[a].set_ylabel("DF/F", fontsize=16)
    axs_2[a].set_title(cell_id , fontsize=16)
```

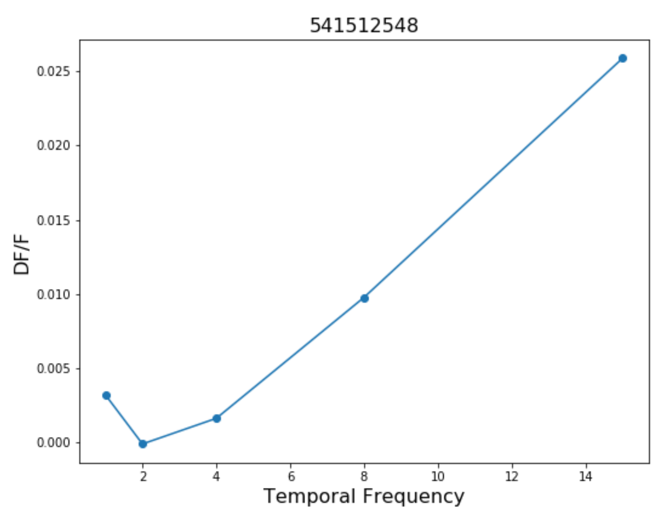

541512399
DF/F
Direction (deg)
0.10
0.08
0.06
0.04
0.02
0.00
0
45
90
135
180
225
270
315

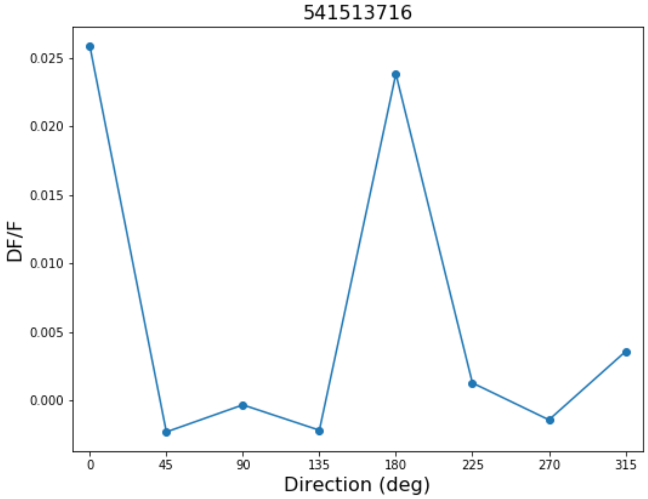

541512399
DF/F
Temporal Frequency
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2
4
6
8
10
12
14

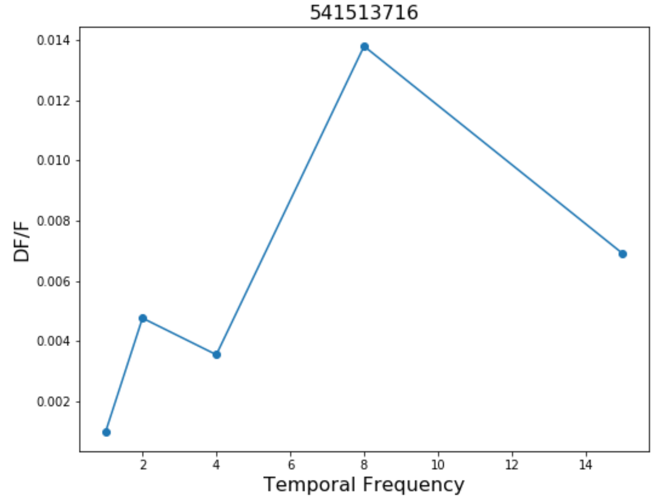

541512120
DF/F
Direction (deg)
0.10
0.08
0.06
0.04
0.02
0.00
0
45
90
135
180
225
270
315

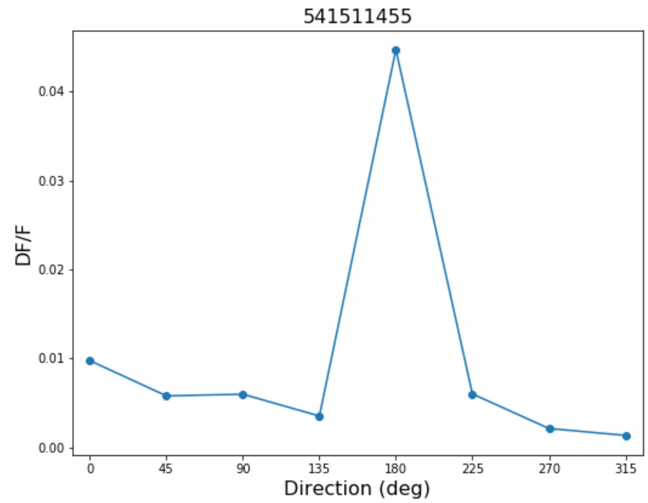

541512120
DF/F
Temporal Frequency
0.045
0.040
0.035
0.030
0.025
0.020
0.015
2
4
6
8
10
12
14

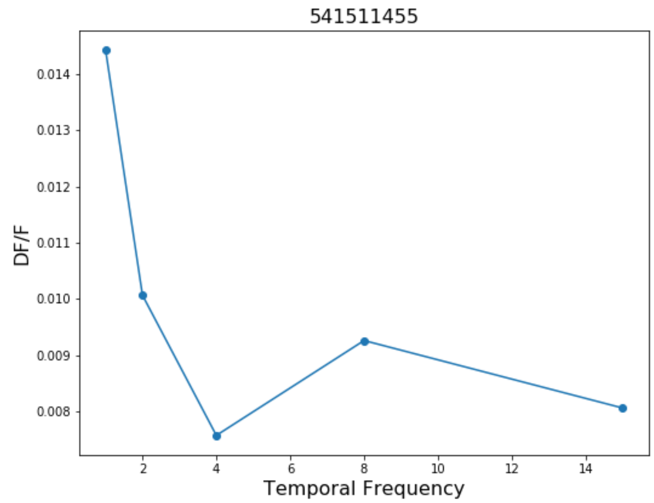

541512548
DF/F
Direction (deg)
0.025
0.020
0.015
0.010
0.005
0.000
−0.005
0
45
90
135
180
225
270
315

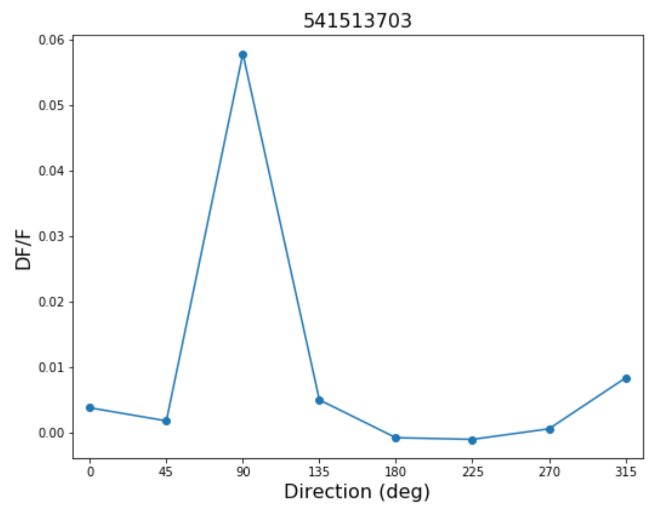

541512548
DF/F
Temporal Frequency
0.025
0.020
0.015
0.010
0.005
0.000
2
4
6
8
10
12
14

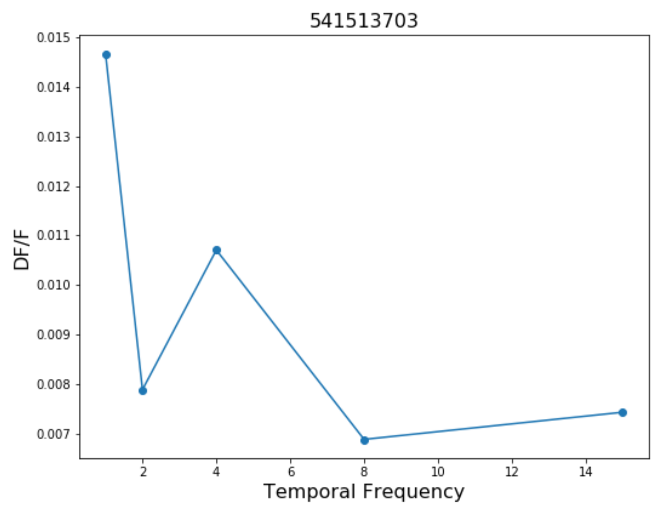

541513716
DF/F
0.025
0.020
0.015
0.010
0.005
0.000
0 45 90 135 180 225 270 315
Direction (deg)

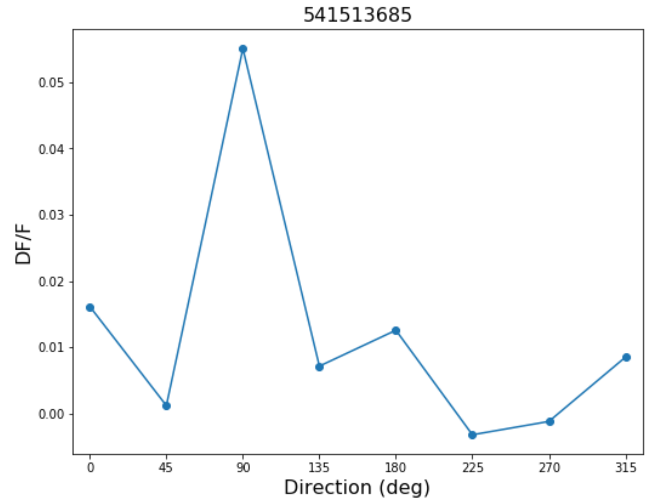

541513716
DF/F
0.014
0.012
0.010
0.008
0.006
0.004
0.002
2 4 6 8 10 12 14
Temporal Frequency

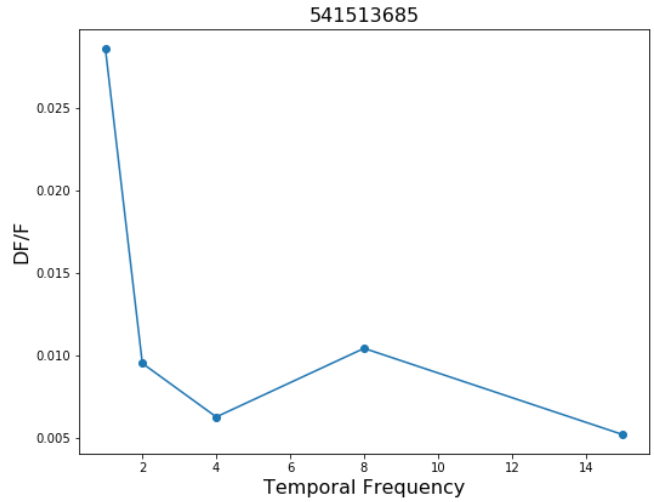

541511455
DF/F
0.04
0.03
0.02
0.01
0.00
0 45 90 135 180 225 270 315
Direction (deg)

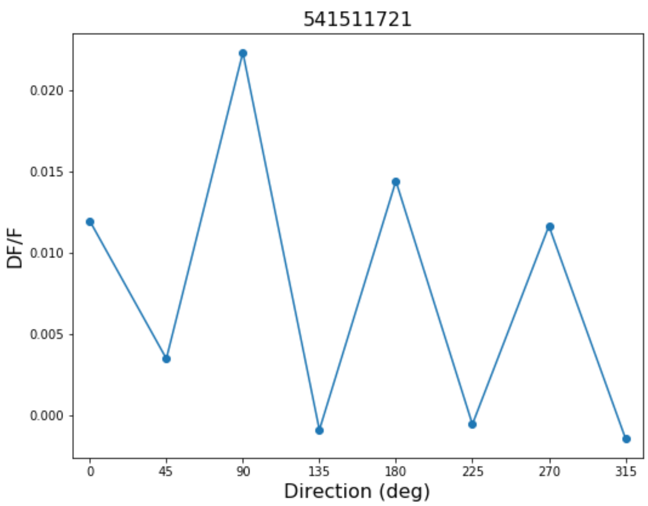

541511455
DF/F
0.014
0.013
0.012
0.011
0.010
0.009
0.008
2 4 6 8 10 12 14
Temporal Frequency

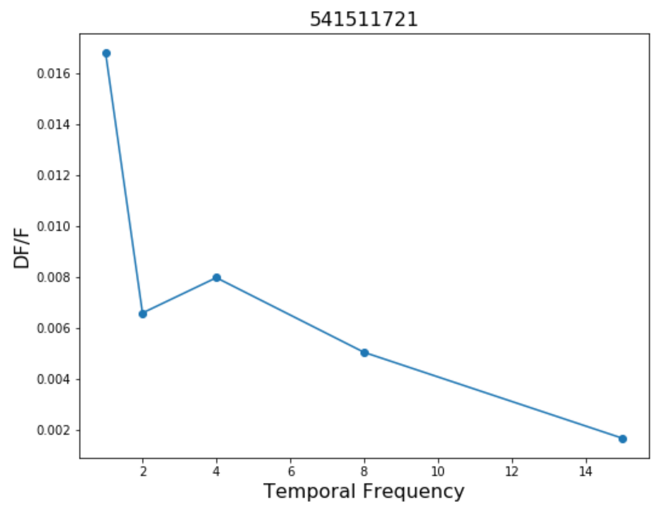

541513703
DF/F
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0 45 90 135 180 225 270 315
Direction (deg)


541513703
DF/F
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
2 4 6 8 10 12 14
Temporal Frequency









What are interesting parameters of a cell's response to this stimulus?

There are aspects of these graphs which are shared. Some parameters I have identified are:

- The nature of how a graph increases/ decreases as it approaches a maximum
- How bidirectional a response is (1 peak response vs. 2 peak responses)
- Which directions the cells respond to (90°, 180°, etc...)
- Preferred temporal frequencies (Lower, Higher)

In what way do these tuning curves differ? In what ways are they the same?

I believe these graphs are far more similar than they are dissimilar. To make my analysis clearer, I've written the numbers 1-8 on the left hand side to refer to the cells.

The most similar parameter the cells shared was that of preferred temporal frequencies. The temporal frequency graphs for cells 1, 5, 6, 7, and 8 all have a higher fluorescence response to the lowest temporal frequency, and they decrease in a similar nature (the steepness decreases from lower frequencies to higher frequencies). With all those cells, except 1, there seems to be a slight bump in the middle which indicates perhaps the cells not only respond to a low frequency, but also a little bit to a frequency somewhere in the middle. I'm not sure how safe of an assumption this is, because there are few data points. The nature of this response leads me to believe that there is something simiar to a low-pass filter for these cells. Cells 2 and 3 have a high-pass filter. The difference between the temporal frequency of graphs 2 and 3 is the way they reach the maximum: the rate of change of the slope of cell 2 is negative (inflection down) while the rate of change of slope of cell 3 is somewhat positive (more inflection up). Cell 4 is like a mid-pass filter, responding strongly to frequencies around 8 Hz.

Another similar parameter is that of bidirectionality - how many "preferences" a cell has with respect to direction. Cells 1, 5, 6, and 7 all strongly responded to one preference (0°, 180°, 90°, and 90° respectively). Note: In general, cells 6 and 7 are very similar, except 7 has a smaller local maximum at 180°. Cells 2 and 3 responded to 90° and 270° strongly - i.e. anything with vertical grating. These cells are bidirectional (responding to two different angles), but the directions are both "vertical" directions - so in a sense the cell does respond to a single defined aspect (verticality). Cell 8 is unique - it seems to have 3 or 4 preferred directions - at 0° (maybe), 90°, 180°, and 270°. These are all directions which can be defined as horizontal and vertical (up, down, left, right). If I were to perceive this as a neural network problem, similar to the last assignment, then I would consider cell 8 to be a complex cell (it seems hard to linearly discriminate between all those different axes/ directions). I find it interesting that all of these cells only respond to the North/ East/ West/ South directions, and not so much to anything in-between like 45°.