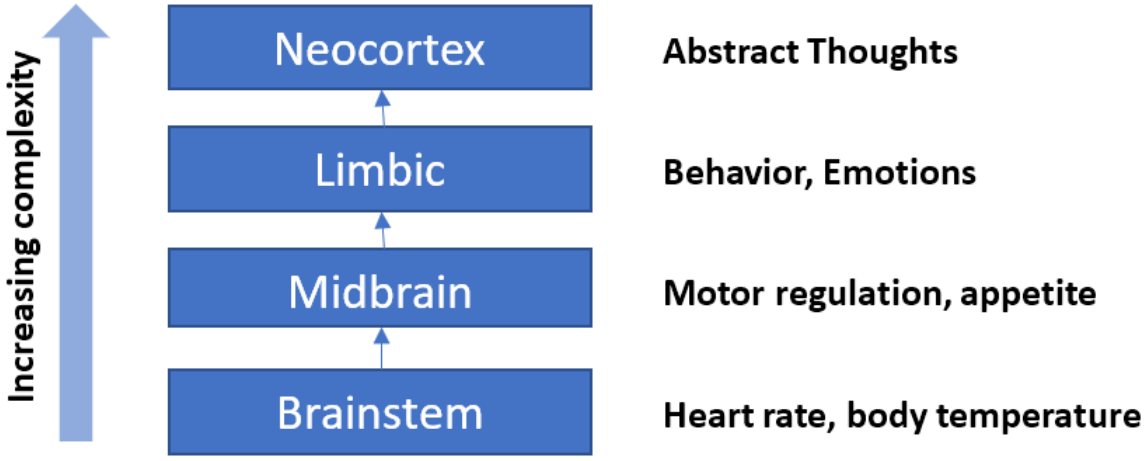
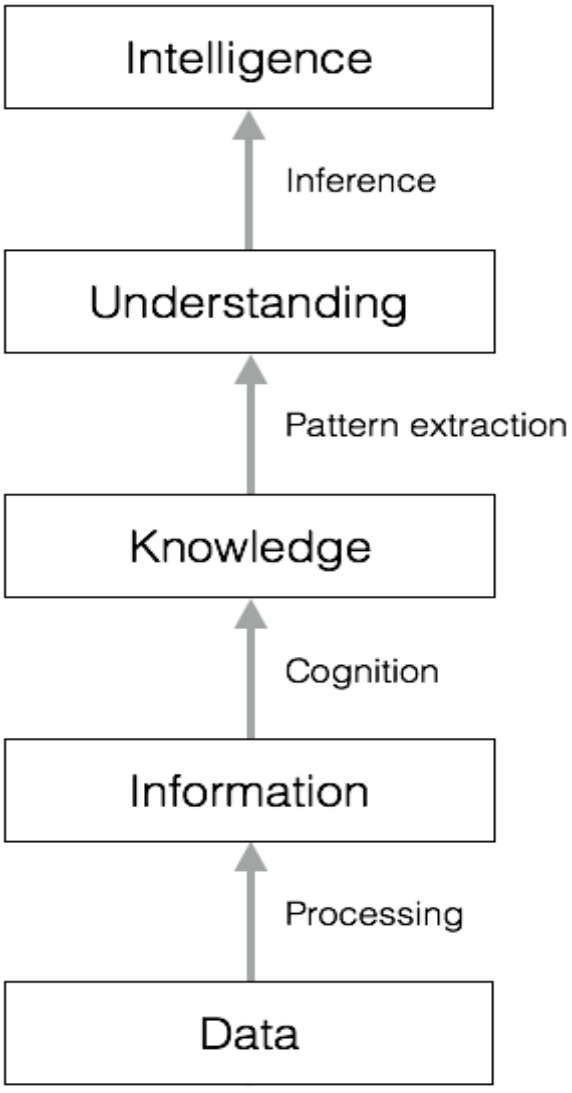
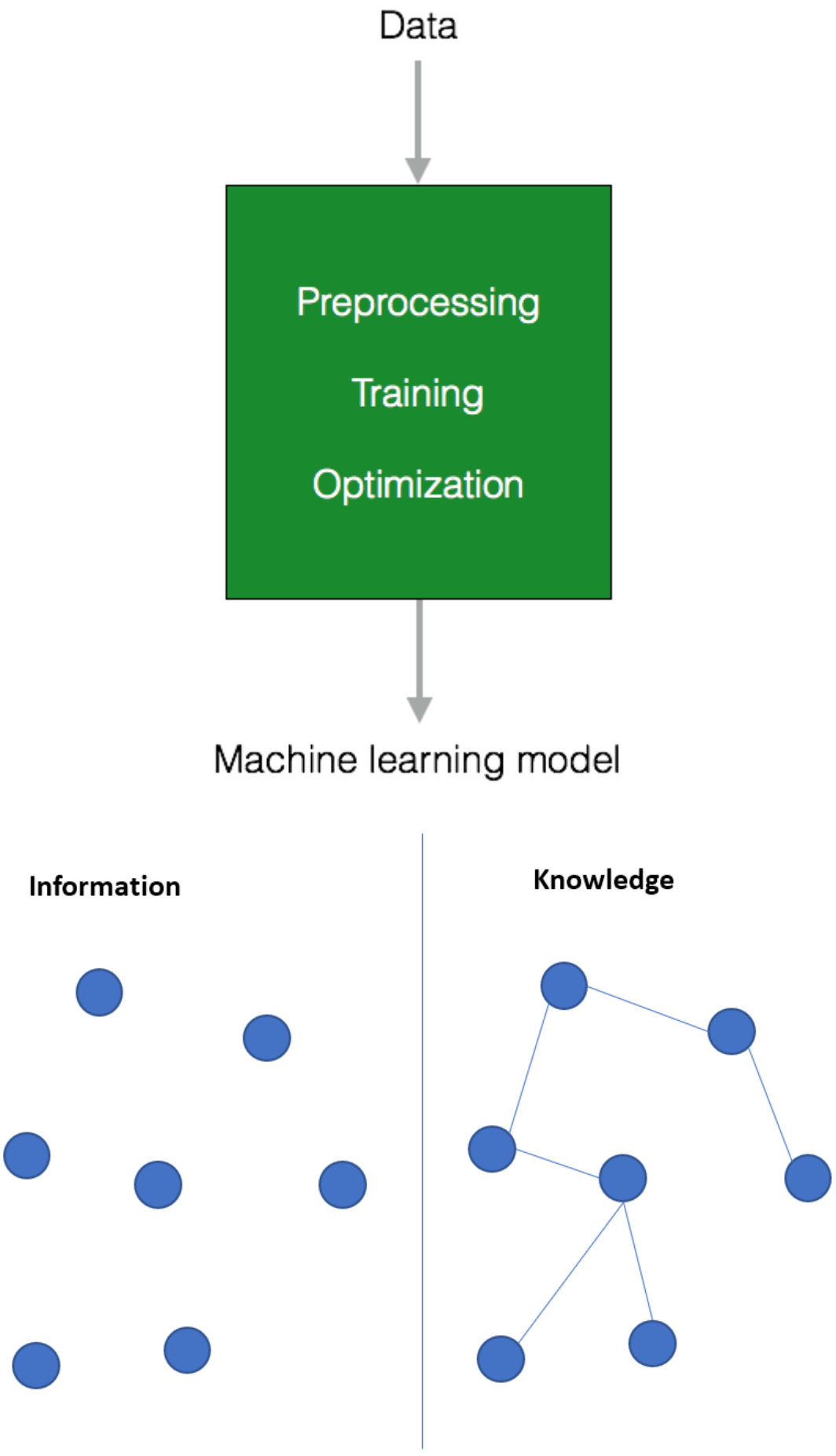
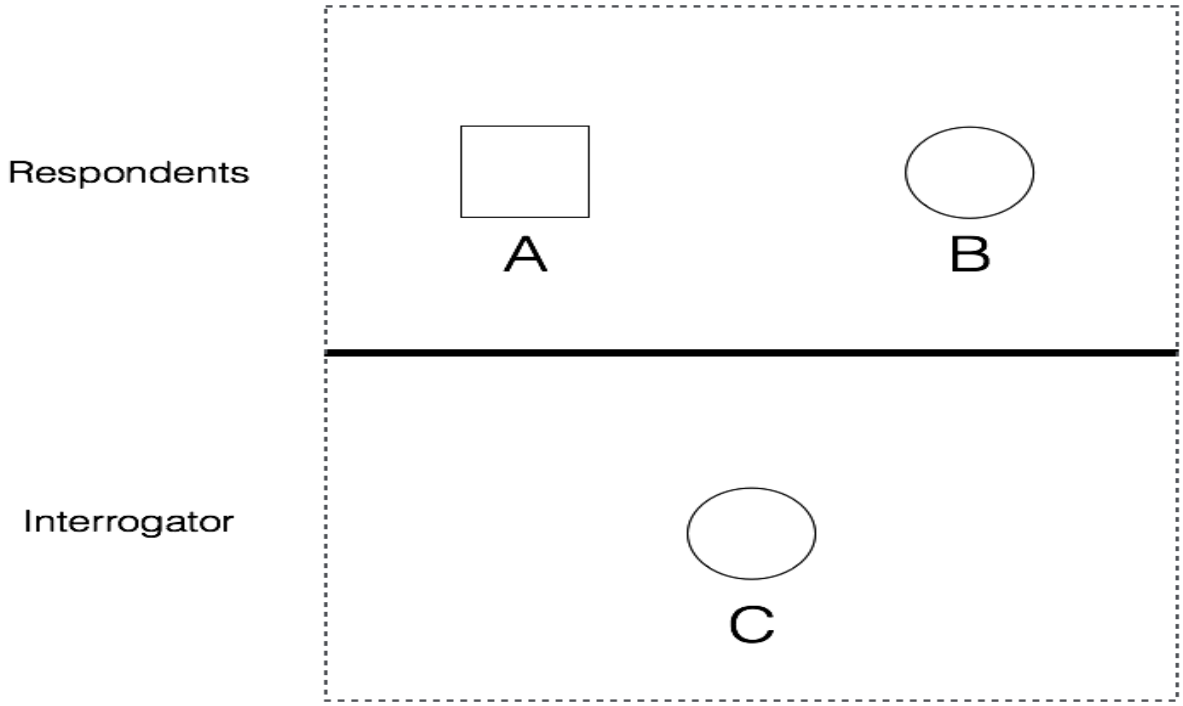
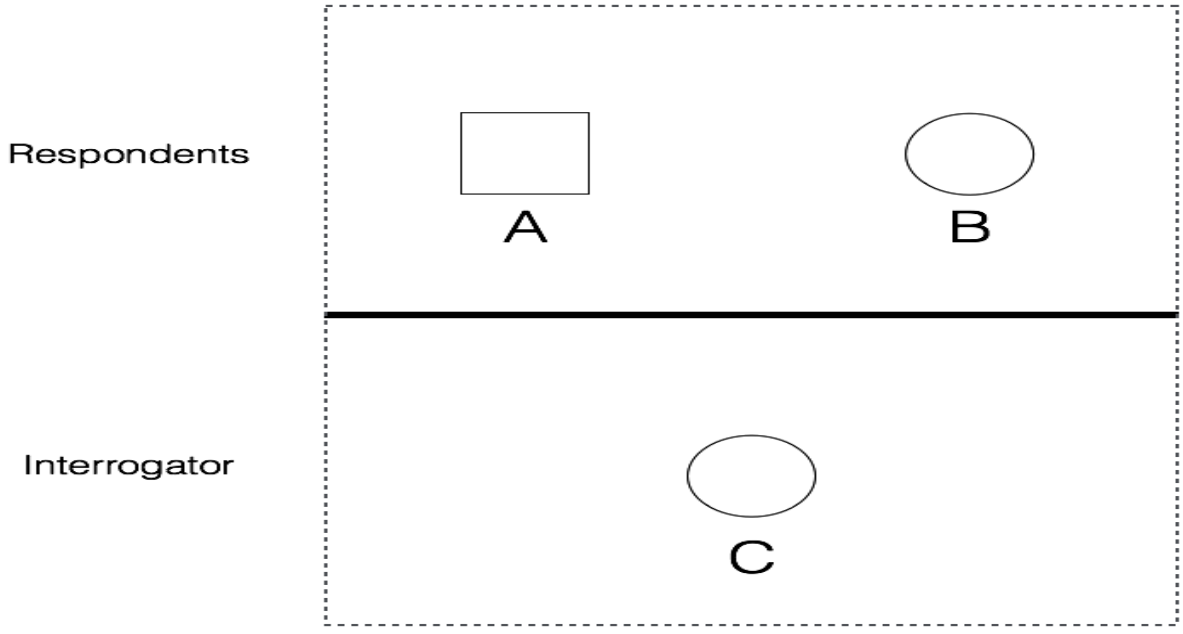
Chapter 01: Introduction to Artificial Intelligence

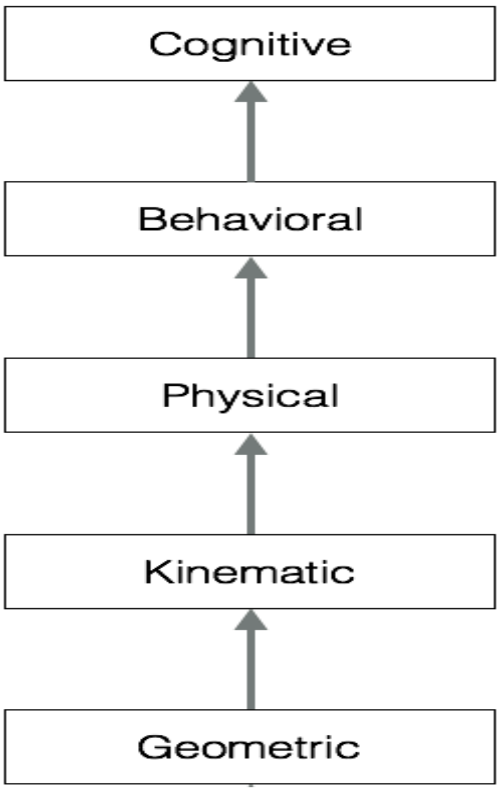


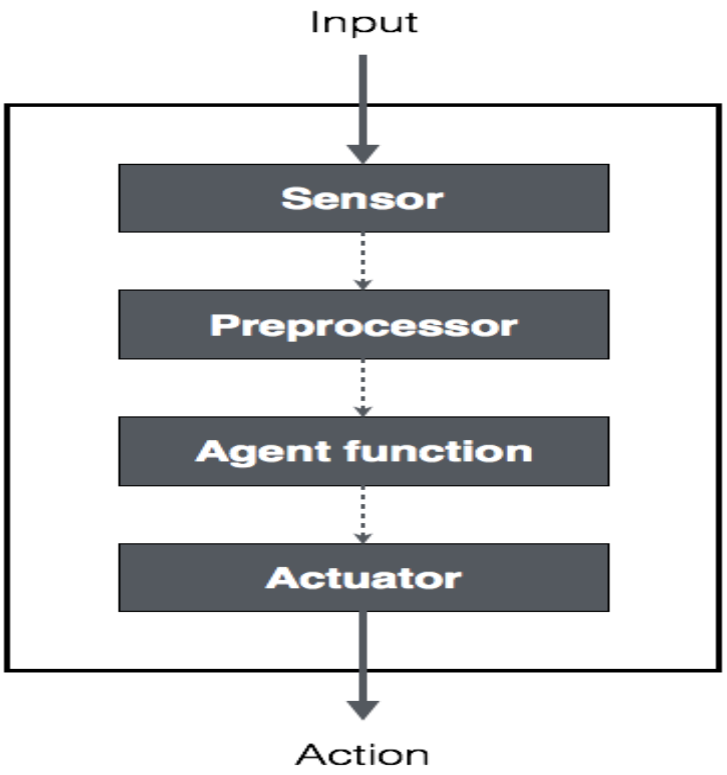


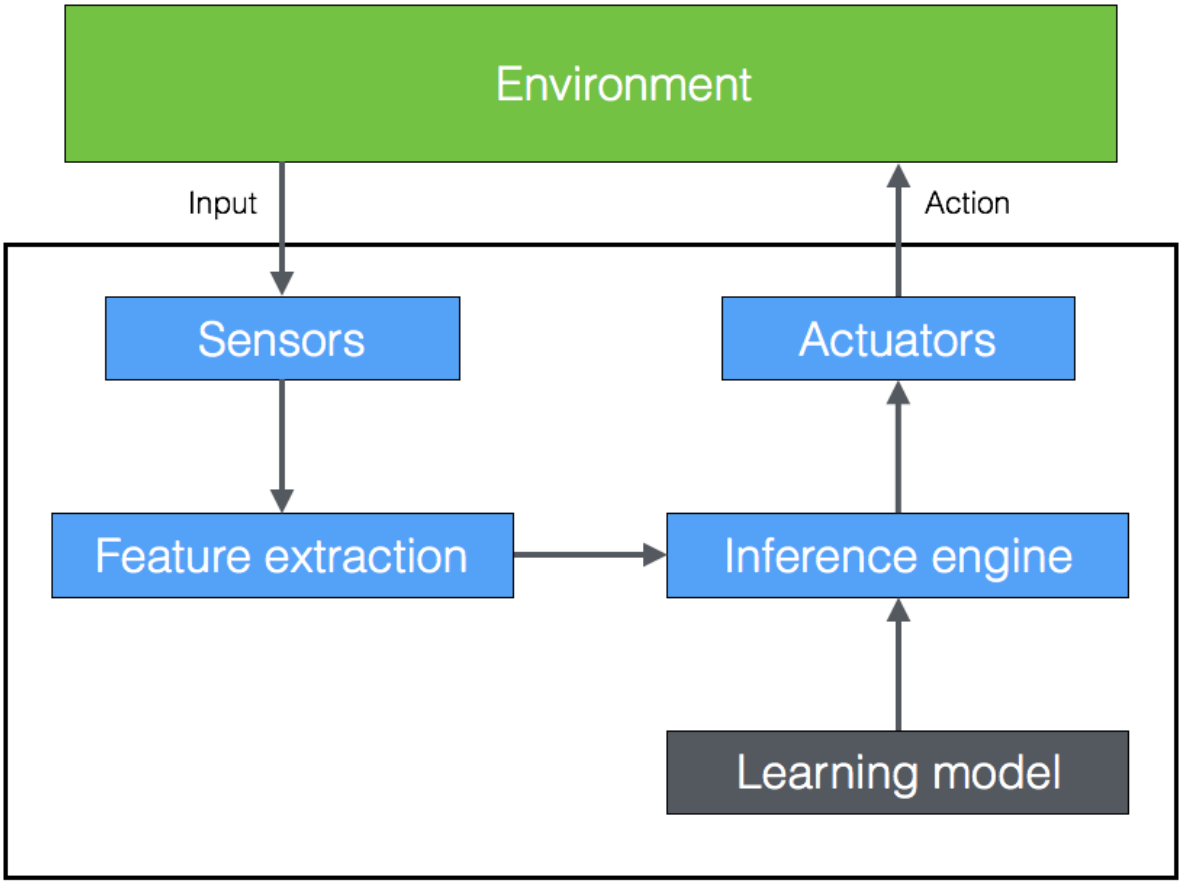

Data
Preprocessing
Training
Optimization
Machine learning model
Information
Knowledge


Respondents
A
B
Interrogator
C


Respondents
A
B
Interrogator
C


Cognitive
Behavioral
Physical
Kinematic
Geometric


Input
Sensor
Preprocessor
Agent function
Actuator
Action



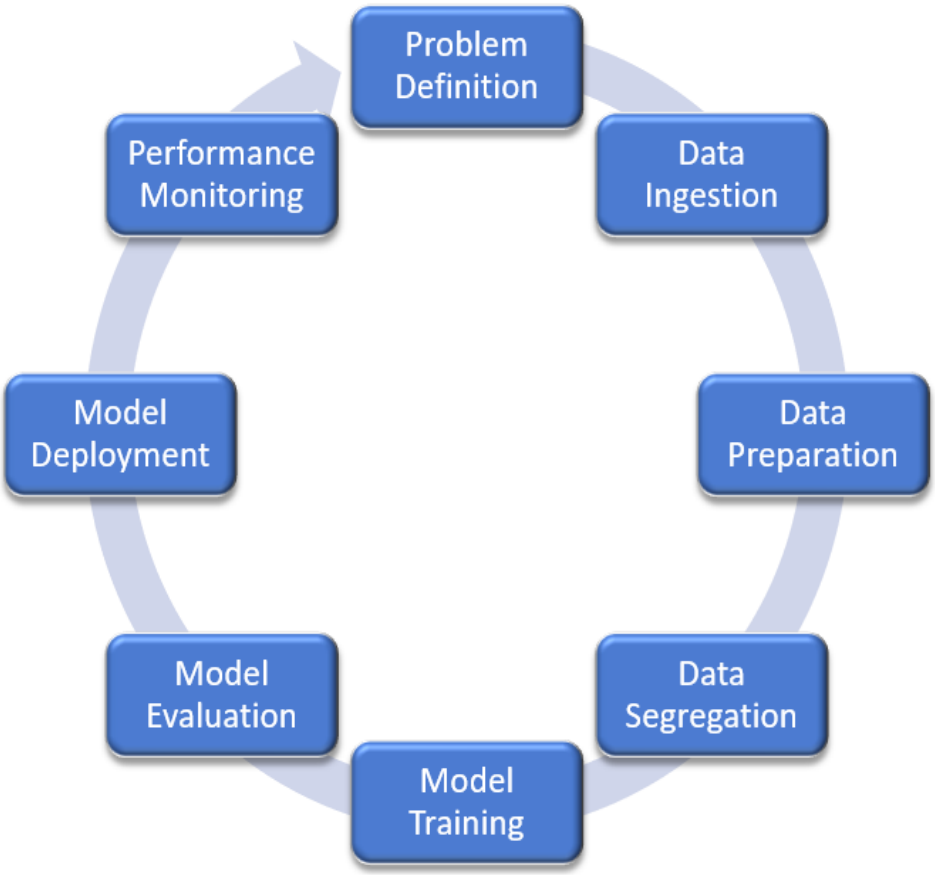
Intelligent agent

```
>>> print(house_prices.data)
[[  6.32000000e-03   1.80000000e+01   2.31000000e+00 ...,   1.53000000e+01
    3.96900000e+02   4.98000000e+00]
 [  2.73100000e-02   0.00000000e+00   7.07000000e+00 ...,   1.78000000e+01
    3.96900000e+02   9.14000000e+00]
 [  2.72900000e-02   0.00000000e+00   7.07000000e+00 ...,   1.78000000e+01
    3.92830000e+02   4.03000000e+00]
 ...,
 [  6.07600000e-02   0.00000000e+00   1.19300000e+01 ...,   2.10000000e+01
    3.96900000e+02   5.64000000e+00]
 [  1.09590000e-01   0.00000000e+00   1.19300000e+01 ...,   2.10000000e+01
    3.93450000e+02   6.48000000e+00]
 [  4.74100000e-02   0.00000000e+00   1.19300000e+01 ...,   2.10000000e+01
    3.96900000e+02   7.88000000e+00]]
```

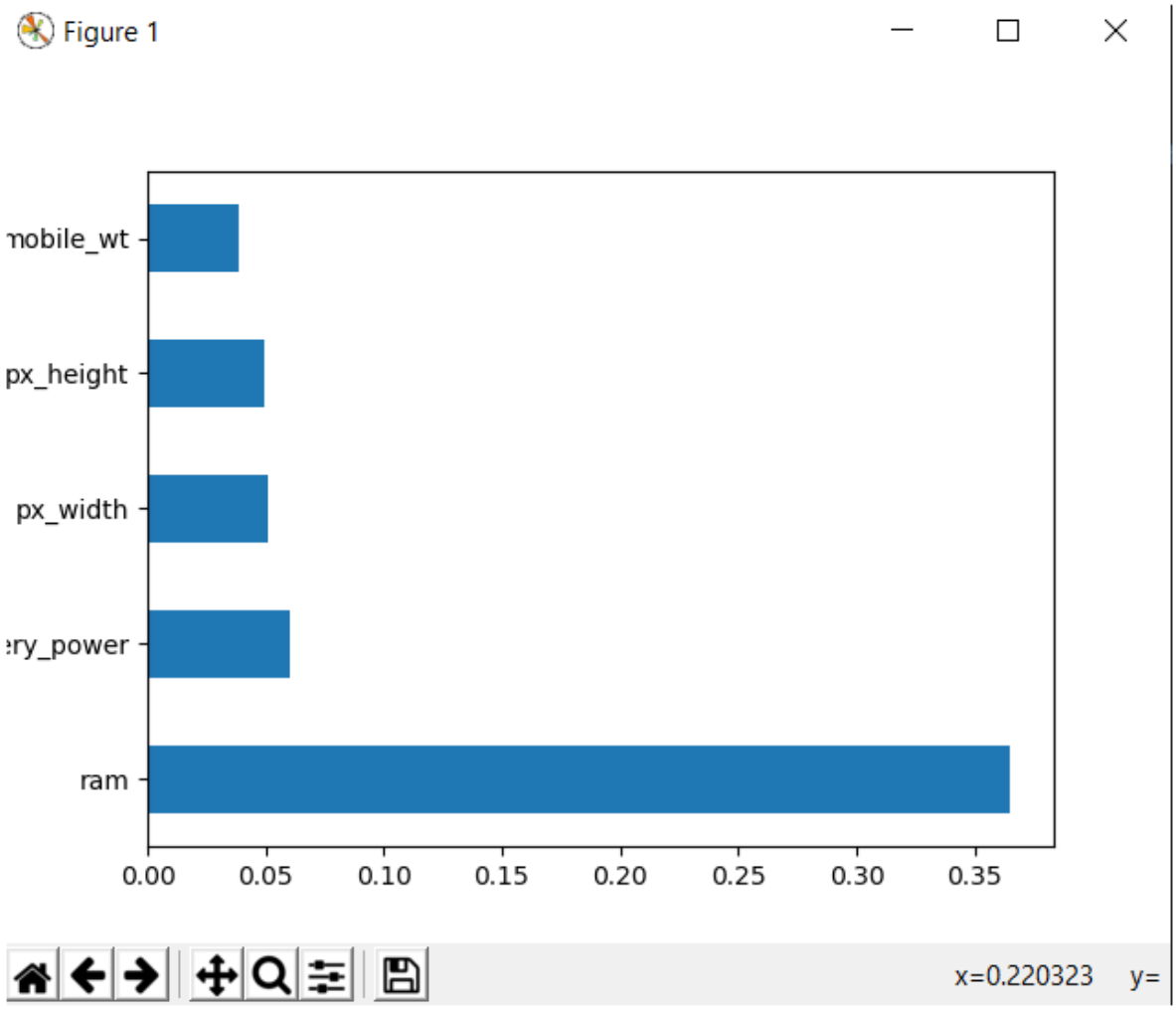
```
>>> print(house_prices.target)
[ 24.   21.6  34.7  33.4  36.2  28.7  22.9  27.1  16.5  18.9  15.   18.9
  21.7  20.4  18.2  19.9  23.1  17.5  20.2  18.2  13.6  19.6  15.2  14.5
  15.6  13.9  16.6  14.8  18.4  21.   12.7  14.5  13.2  13.1  13.5  18.9
  20.   21.   24.7  30.8  34.9  26.6  25.3  24.7  21.2  19.3  20.   16.6
  14.4  19.4  19.7  20.5  25.   23.4  18.9  35.4  24.7  31.6  23.3  19.6
  18.7  16.   22.2  25.   33.   23.5  19.4  22.   17.4  20.9  24.2  21.7
  22.8  23.4  24.1  21.4  20.   20.8  21.2  20.3  28.   23.9  24.8  22.9
  23.9  26.6  22.5  22.2  23.6  28.7  22.6  22.   22.9  25.   20.6  28.4
  21.4  38.7  43.8  33.2  27.5  26.5  18.6  19.3  20.1  19.5  19.5  20.4
  19.8  19.4  21.7  22.8  18.8  18.7  18.5  18.3  21.2  19.2  20.4  19.3
  22.   20.3  20.5  17.3  18.8  21.4  15.7  16.2  18.   14.3  19.2  19.6
  23.   18.4  15.6  18.1  17.4  17.1  13.3  17.8  14.   14.4  13.4  15.6
  11.8  13.8  15.6  14.6  17.8  15.4  21.5  19.6  15.3  19.4  17.   15.6
  13.1  41.3  24.3  23.3  27.   50.   50.   50.   22.7  25.   50.   23.8
  23.8  22.3  17.4  19.1  23.1  23.6  22.6  29.4  23.2  24.6  29.9  37.2
  39.8  36.2  37.9  32.5  26.4  29.6  50.   32.   29.8  34.9  37.   30.5
  36.4  31.1  29.1  50.   33.3  30.3  34.6  34.9  32.9  24.1  42.3  48.5
  50.   22.6  24.4  22.5  24.4  20.   21.7  19.3  22.4  28.1  23.7  25.
  23.3  28.7  21.5  23.   26.7  21.7  27.5  30.1  44.8  50.   37.6  31.6
  46.7  31.5  24.3  31.7  41.7  48.3  29.   24.   25.1  31.5  23.7  23.3
```

```
>>> print(digits.images[4])
[[  0.   0.   0.   1.  11.   0.   0.   0.]
 [  0.   0.   0.   7.   8.   0.   0.   0.]
 [  0.   0.   1.  13.   6.   2.   2.   0.]
 [  0.   0.   7.  15.   0.   9.   8.   0.]
 [  0.   5.  16.  10.   0.  16.   6.   0.]
 [  0.   4.  15.  16.  13.  16.   1.   0.]
 [  0.   0.   0.   3.  15.  10.   0.   0.]
 [  0.   0.   0.   2.  16.   4.   0.   0.]]
...
```

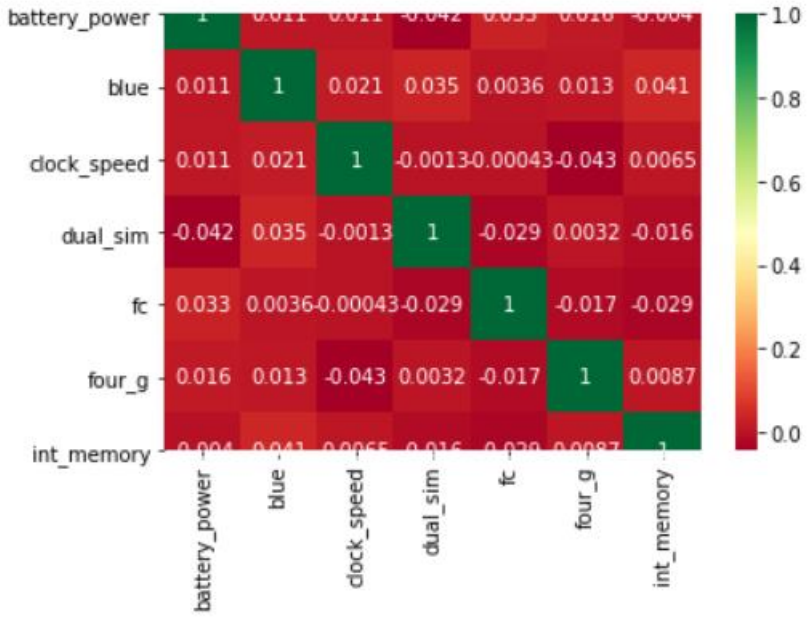
Chapter 03: Machine Learning Pipelines

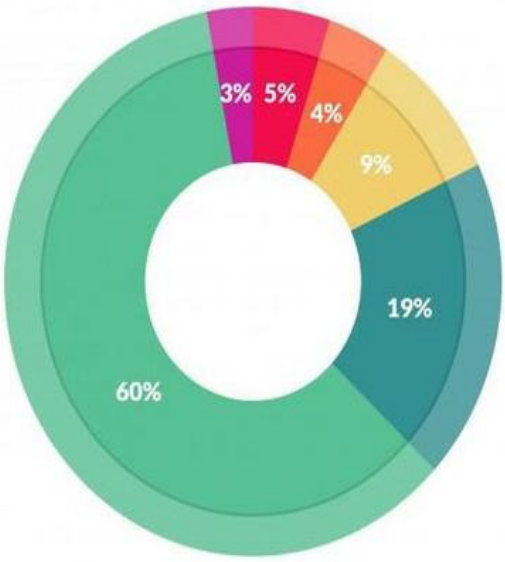


Chapter 04: Feature Selection and Feature Engineering



specs	score
ram	931267.519053
px_height	17363.569536
battery_power	14129.866576
px_width	9810.586750
mobile_wt	95.972863





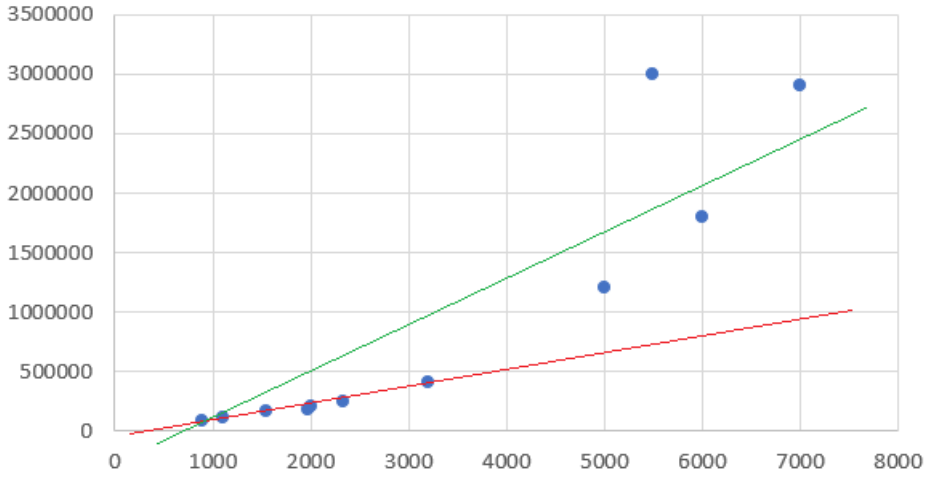
What data scientists spend the most time doing

- *Building training sets: 3%*
- *Cleaning and organizing data: 60%*
- *Collecting data sets; 19%*
- *Mining data for patterns: 9%*
- *Refining algorithms: 4%*
- *Other: 5%*

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	\
0	842	0	2.2	0	1	0	7	
1	1021	1	0.5	1	0	1	53	
2	563	1	0.5	1	2	1	41	
3	615	1	2.5	0	0	0	10	
4	1821	1	1.2	0	13	1	44	
5	1859	0	0.5	1	3	0	22	
6	1821	0	1.7	0	4	1	10	
7	1954	0	0.5	1	0	0	24	
8	1445	1	0.5	0	0	0	53	
9	509	1	0.6	1	2	1	9	
10	769	1	2.9	1	0	0	9	
11	1520	1	2.2	0	5	1	33	
12	1815	0	2.8	0	2	0	33	
13	803	1	2.1	0	7	0	17	
14	1866	0	0.5	0	13	1	52	
15	775	0	1.0	0	3	0	46	
16	838	0	0.5	0	1	1	13	
17	595	0	0.9	1	7	1	23	

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory
0	842	0	2.2	0	1	0	7
1	1021	1	0.5	1	0	1	53
2	563	1	0.5	1	2	1	41
3	615	1	2.5	0	0	0	10
4	1821	1	1.2	0	13	1	44
5	1859	0	0.5	1	3	0	22
6	1821	0	1.7	0	4	1	10
7	1954	0	0.5	1	0	0	24
8	1445	1	0.5	0	0	0	53
9	509	1	0.6	1	2	1	9
10	769	1	2.9	1	0	0	9
11	1520	1	2.2	0	5	1	33
12	1815	0	2.8	0	2	0	33
13	803	1	2.1	0	7	0	17
14	1866	0	0.5	0	13	1	52
15	775	0	1.0	0	3	0	46
16	838	0	0.5	0	1	1	13
17	595	0	0.9	1	7	1	23

	index	color
0	0	green
1	1	yellow
2	2	red
3	3	red
4	4	purple
5	5	red
6	6	red
7	7	purple
8	8	red
9	9	red
10	10	yellow
11	11	red
12	12	black
13	13	white



	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory
0	842	0	2.2	0	1	0	7
1	1021	1	0.5	1	0	1	53
2	563	1	0.5	1	2	1	41
3	615	1	2.5	0	0	0	10
4	1821	1	1.2	0	13	1	44
5	1859	0	0.5	1	3	0	22
6	1821	0	1.7	0	4	1	10
7	1954	0	0.5	1	0	0	24
8	1445	1	0.5	0	0	0	53
9	509	1	0.6	1	2	1	9
10	769	1	2.9	1	0	0	9
11	1520	1	2.2	0	5	1	33
12	1815	0	2.8	0	2	0	33
13	803	1	2.1	0	7	0	17
14	1866	0	0.5	0	13	1	52
15	775	0	1.0	0	3	0	46
16	838	0	0.5	0	1	1	13
17	595	0	0.9	1	7	1	23

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory
1	1021	1	0.5	1	0	1	53
8	1445	1	0.5	0	0	0	53
11	1520	1	2.2	0	5	1	33
18	1131	1	0.5	1	11	0	49
25	961	1	1.4	1	0	1	57
27	956	0	0.5	0	1	1	41
28	1453	0	1.6	1	12	1	52
30	1579	1	0.5	1	0	0	5
31	1568	1	0.5	0	16	0	33
32	1319	1	0.9	0	3	1	41
33	1310	1	2.2	1	0	1	51
40	1347	0	2.9	0	5	0	44
42	1253	1	0.5	1	5	1	5
44	1195	1	2.8	0	1	1	20
45	1514	0	2.9	0	0	0	27
47	1054	1	1.8	1	3	1	40
50	1547	1	3.0	1	2	1	14
53	1457	0	1.9	1	1	1	16

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory
1	1021.00	1	0.5	1	0	1	53
8	1445.00	1	0.5	0	0	0	53
11	1520.00	1	2.2	0	5	1	33
18	1131.00	1	0.5	1	11	0	49
25	961.00	1	1.4	1	0	1	57
27	956.00	0	0.5	0	1	1	41
28	1453.00	0	1.6	1	12	1	52
30	1579.00	1	0.5	1	0	0	5
31	1568.00	1	0.5	0	16	0	33
32	1319.00	1	0.9	0	3	1	41
33	1310.00	1	2.2	1	0	1	51
40	1347.00	0	2.9	0	5	0	44
42	1253.00	1	0.5	1	5	1	5
44	1195.00	1	2.8	0	1	1	20
45	1514.00	0	2.9	0	0	0	27
47	1054.00	1	1.8	1	3	1	40
50	1547.00	1	3.0	1	2	1	14
53	1457.00	0	1.9	1	1	1	16

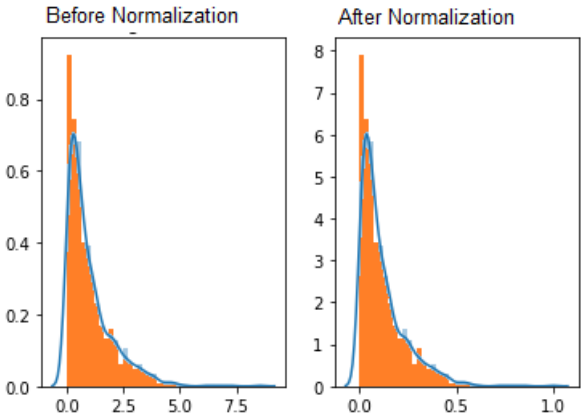
	index	black	green	purple	red	white	yellow
0	0	0	1	0	0	0	0
1	1	0	0	0	0	0	1
2	2	0	0	0	0	0	0
3	3	0	0	0	1	0	0
4	4	0	0	1	0	0	0
5	5	0	0	0	1	0	0
6	6	0	0	0	1	0	0
7	7	0	0	1	0	0	0
8	8	0	0	0	0	0	0
9	9	0	0	0	1	0	0
10	10	0	0	0	0	0	1
11	11	0	0	0	0	0	0
12	12	1	0	0	0	0	0
13	13	0	0	0	0	1	0

	value	log+1	log
0	3	1.386294	3.737670
1	67	4.219508	4.663439
2	-17	NaN	3.091042
3	44	3.806662	4.418841
4	37	3.637586	4.330733
5	3	1.386294	3.737670
6	31	3.465736	4.248495
7	-38	NaN	0.000000

	value	normalized
0	7	0.450000
1	25	0.600000
2	-47	0.000000
3	73	1.000000
4	8	0.458333
5	22	0.575000
6	53	0.833333
7	-25	0.183333

	value	standardized
0	7	-0.193539
1	25	0.270954
2	-47	-1.587017
3	73	1.509601
4	8	-0.167733
5	22	0.193539
6	53	0.993498
7	-25	-1.019303

Chapter 05: Classification and Regression Using Supervised Learning




```
Label mapping:
black --> 0
green --> 1
red --> 2
white --> 3
yellow --> 4

Labels = ['green', 'red', 'black']
Encoded values = [1, 2, 0]

Encoded values = [3, 0, 4, 1]
Decoded labels = ['white', 'black', 'yellow', 'green']
```

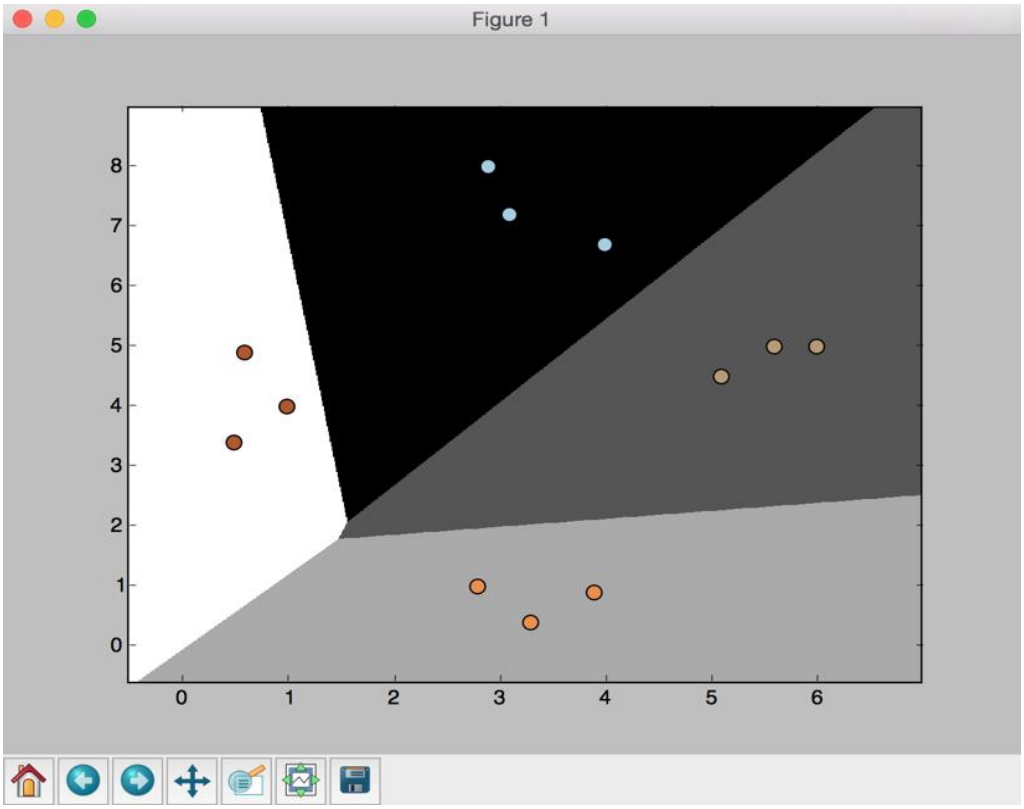


Figure 1
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6

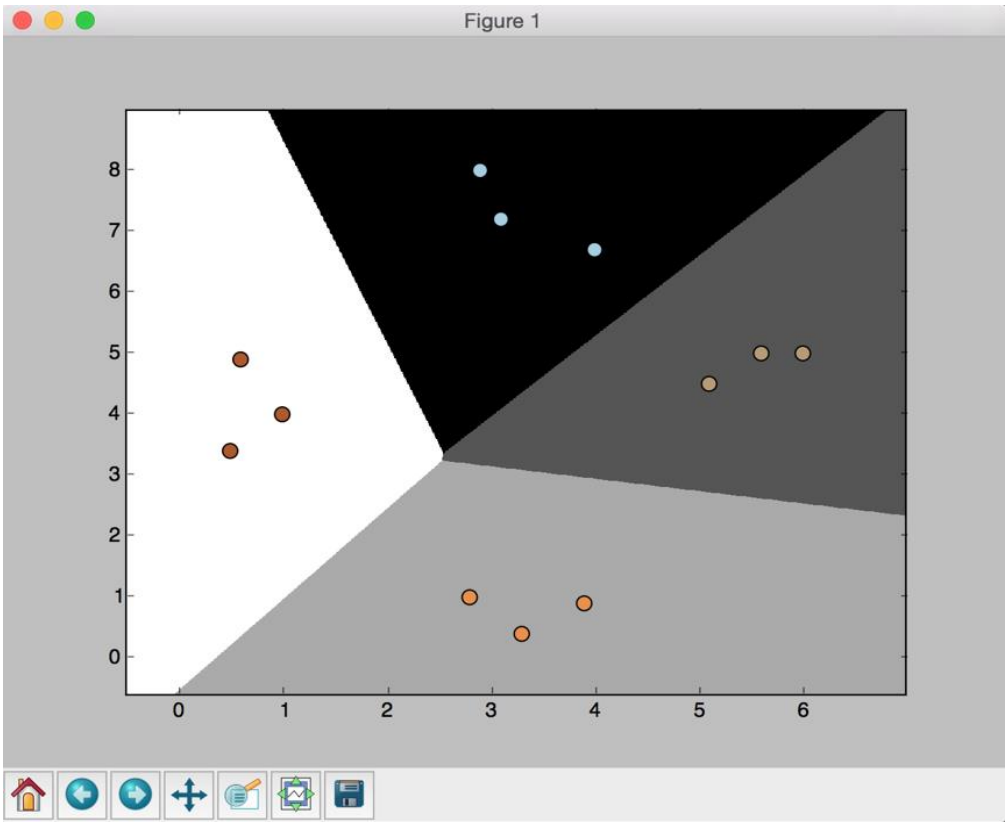


Figure 1
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6

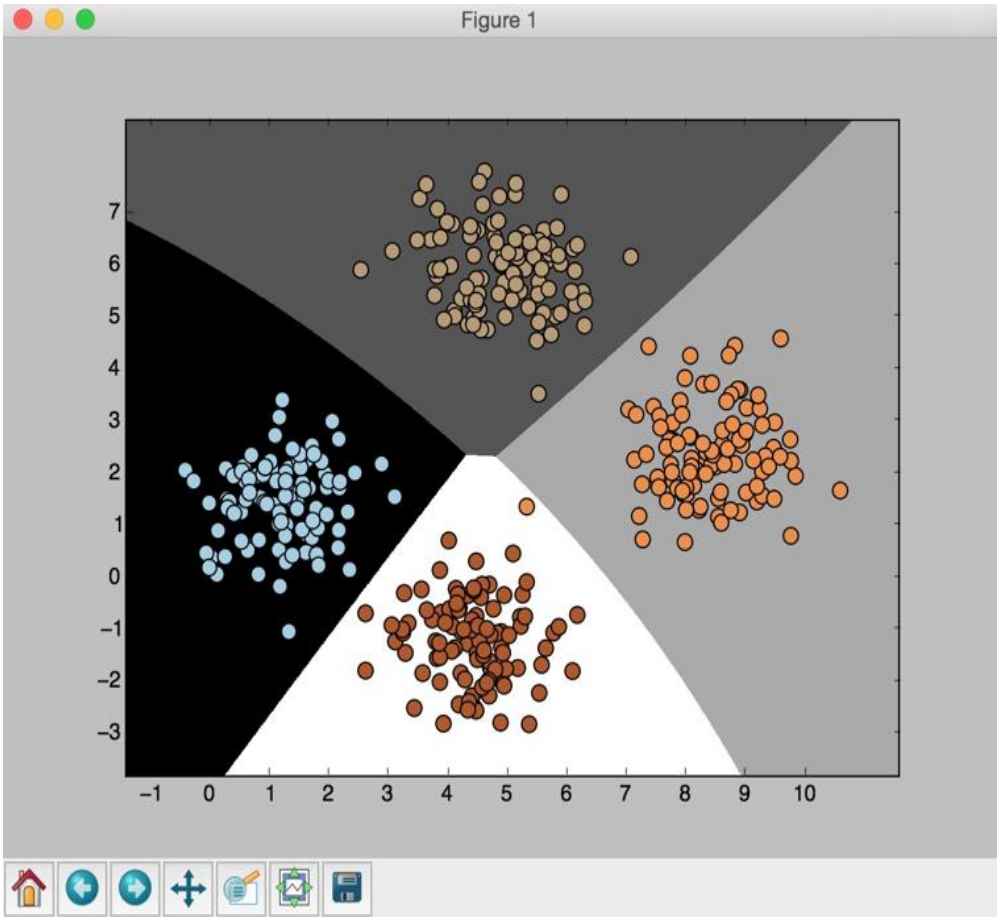


Figure 1
7
6
5
4
3
2
1
0
−1
−2
−3
−1 0 1 2 3 4 5 6 7 8 9 10

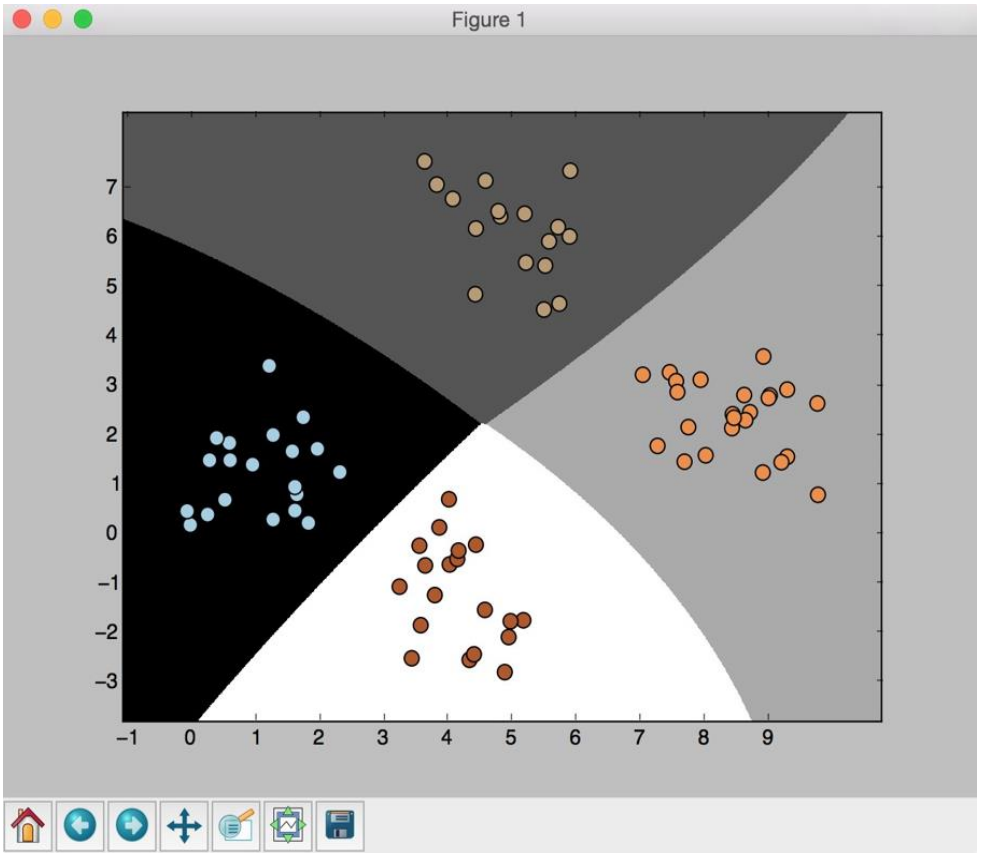
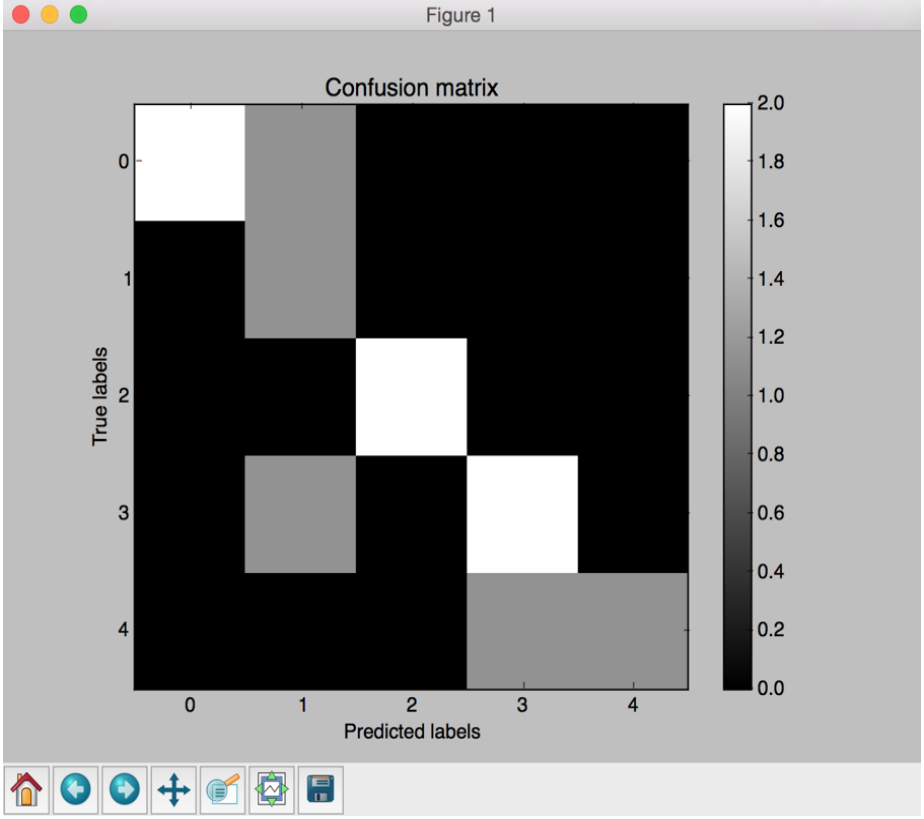
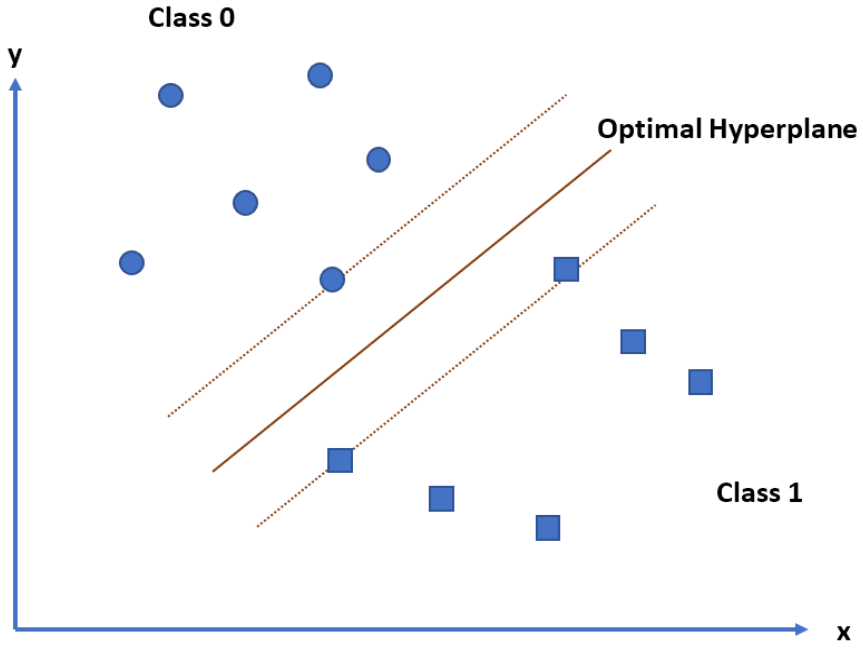


Figure 1
7
6
5
4
3
2
1
0
−1
−2
−3
−1 0 1 2 3 4 5 6 7 8 9



	precision	recall	f1-score	support
Class-0	1.00	0.67	0.80	3
Class-1	0.33	1.00	0.50	1
Class-2	1.00	1.00	1.00	2
Class-3	0.67	0.67	0.67	3
Class-4	1.00	0.50	0.67	2
avg / total	0.85	0.73	0.75	11


Class 0
y
Optimal Hyperplane
Class 1
x

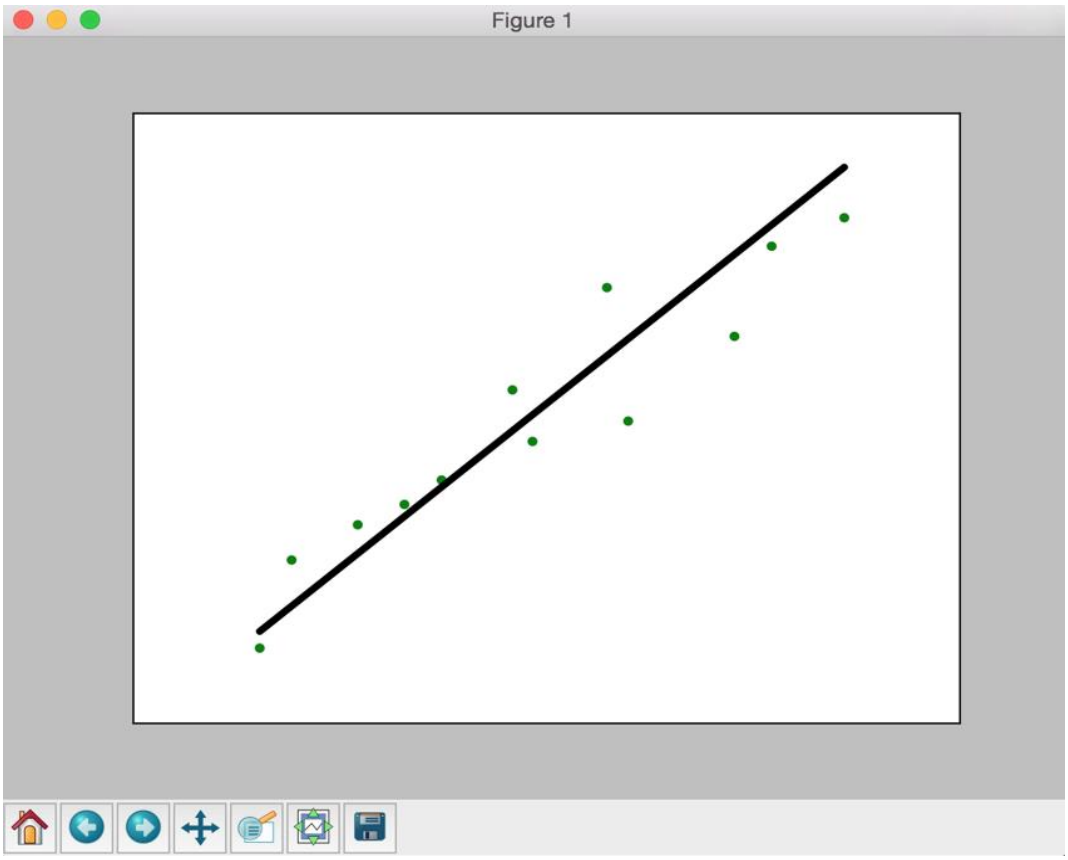
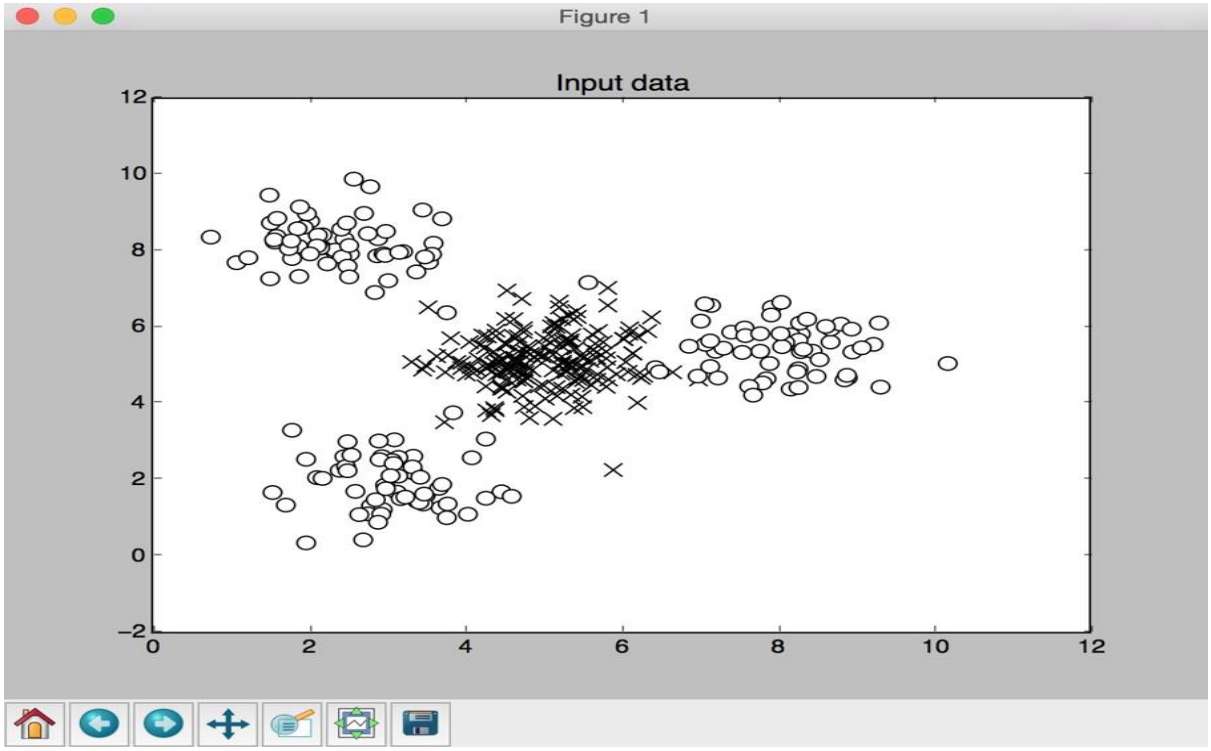
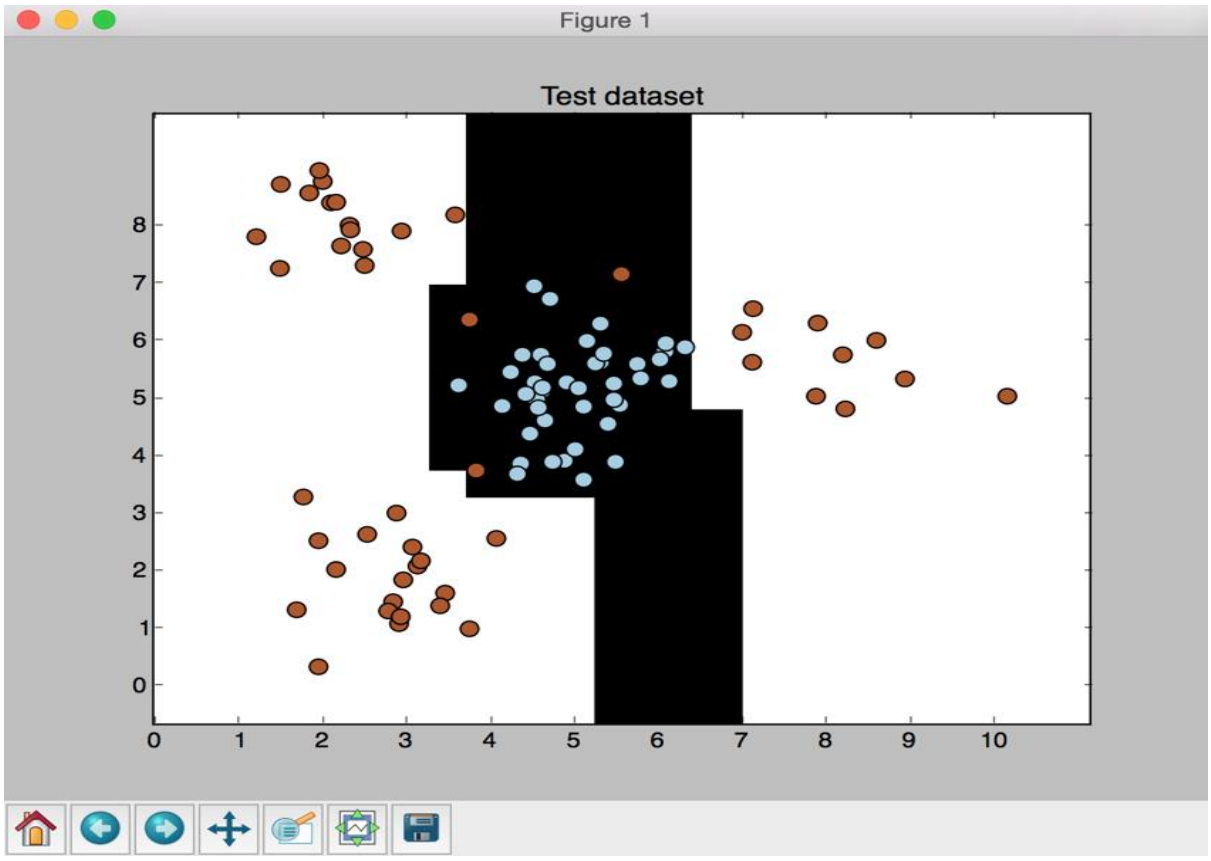


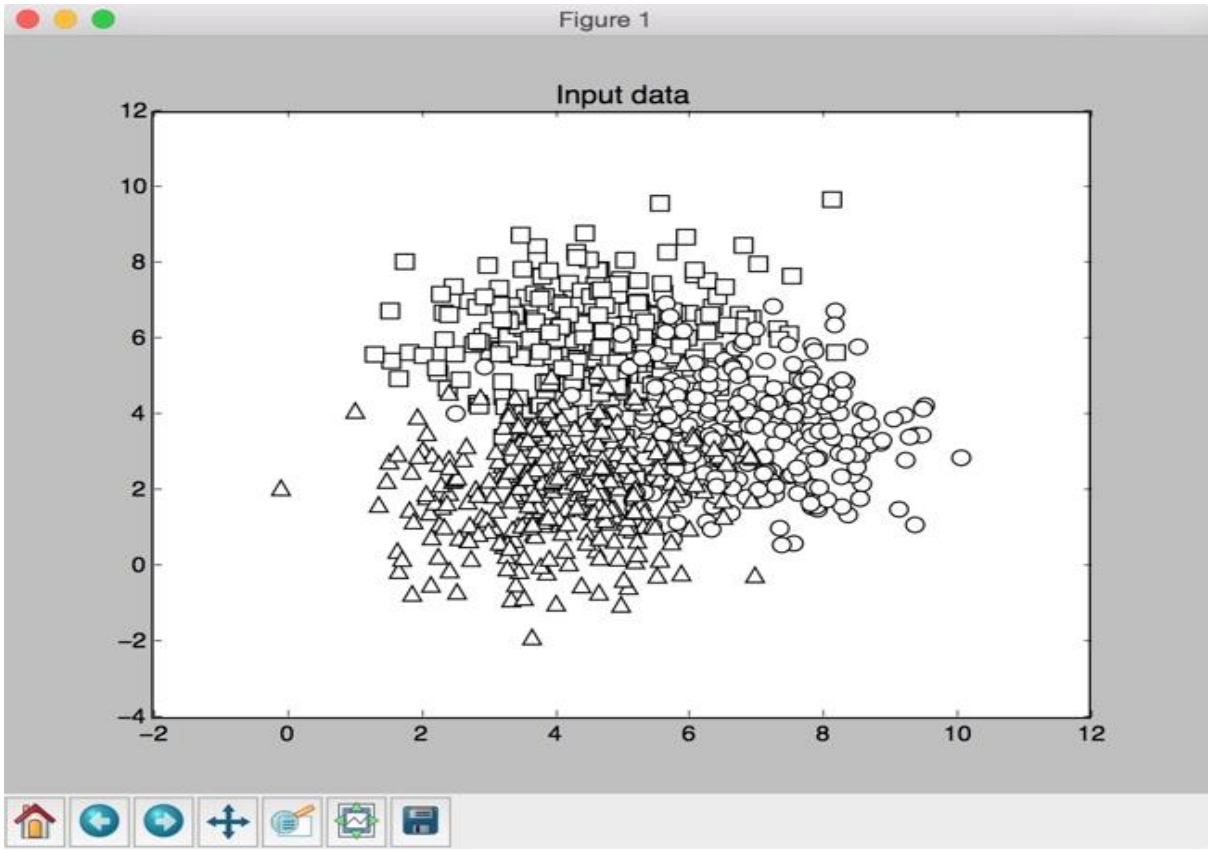
Figure 1

Chapter 06: Predictive Analytics with Ensemble Learning





```
########################################

Classifier performance on training dataset

             precision    recall  f1-score   support

    Class-0       0.99      1.00      1.00       137
    Class-1       1.00      0.99      1.00       133

avg / total       1.00      1.00      1.00       270

########################################

########################################

Classifier performance on test dataset

             precision    recall  f1-score   support

    Class-0       0.93      1.00      0.97        43
    Class-1       1.00      0.94      0.97        47

avg / total       0.97      0.97      0.97        90

########################################
```



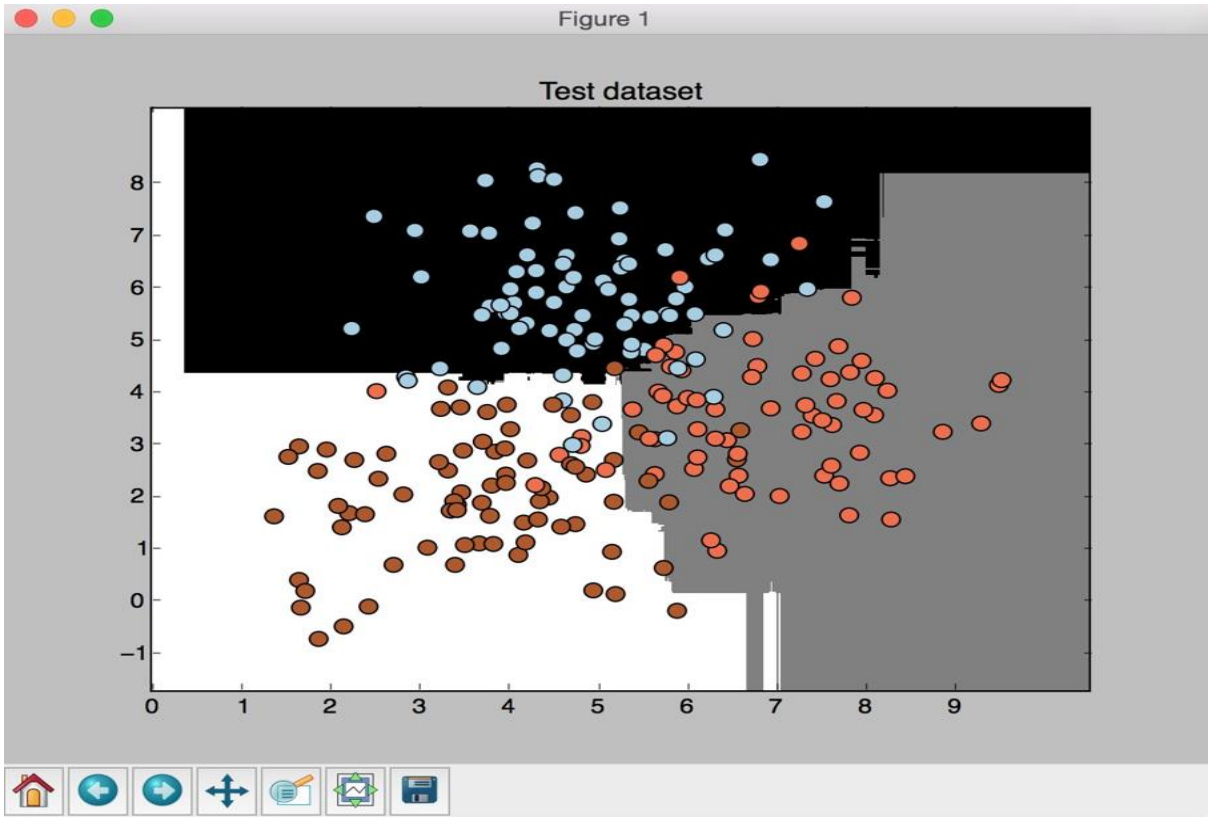


Figure 1
Test dataset
8
7
6
5
4
3
2
1
0
−1
0
1
2
3
4
5
6
7
8
9

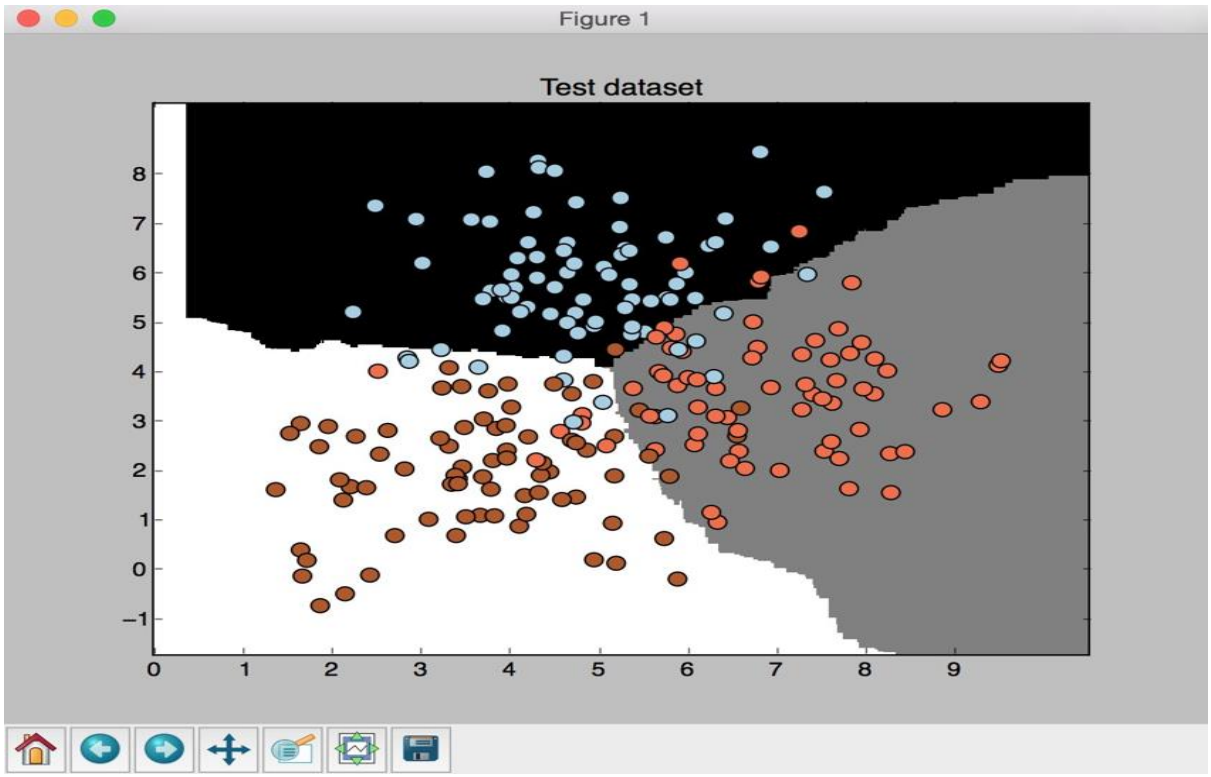
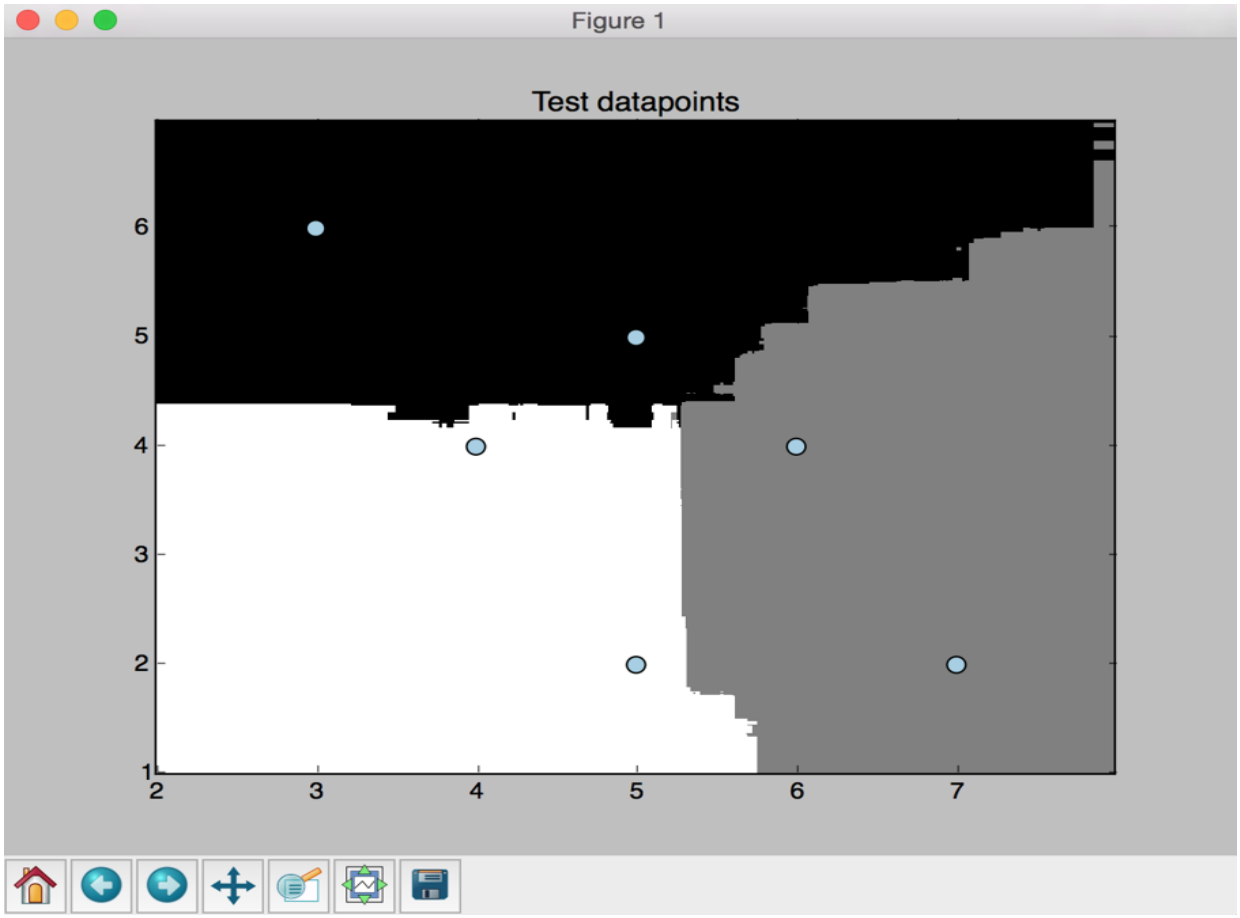
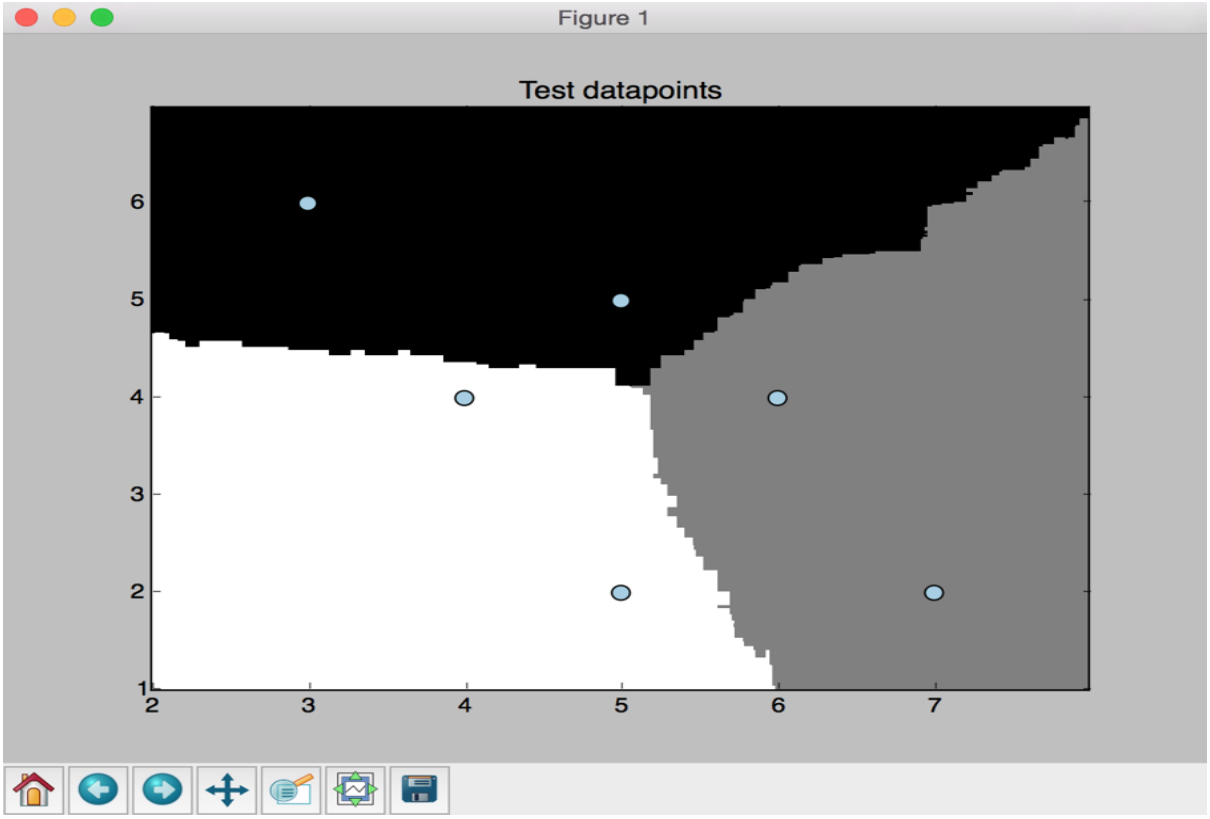


Figure 1
Test dataset
8
7
6
5
4
3
2
1
0
−1
0
1
2
3
4
5
6
7
8
9




```
Datapoint: [5 5]
Probabilities: [ 0.81427532  0.08639273  0.09933195]
Predicted class: Class-0

Datapoint: [3 6]
Probabilities: [ 0.93574458  0.02465345  0.03960197]
Predicted class: Class-0

Datapoint: [6 4]
Probabilities: [ 0.12232404  0.7451078   0.13256816]
Predicted class: Class-1

Datapoint: [7 2]
Probabilities: [ 0.05415465  0.70660226  0.23924309]
Predicted class: Class-1

Datapoint: [4 4]
Probabilities: [ 0.20594744  0.15523491  0.63881765]
Predicted class: Class-2

Datapoint: [5 2]
Probabilities: [ 0.05403583  0.0931115   0.85285267]
Predicted class: Class-2
```




```
Datapoint: [5 5]
Probabilities: [ 0.48904419  0.28020114  0.23075467]
Predicted class: Class-0

Datapoint: [3 6]
Probabilities: [ 0.66707383  0.12424406  0.20868211]
Predicted class: Class-0

Datapoint: [6 4]
Probabilities: [ 0.25788769  0.49535144  0.24676087]
Predicted class: Class-1

Datapoint: [7 2]
Probabilities: [ 0.10794013  0.6246677   0.26739217]
Predicted class: Class-1

Datapoint: [4 4]
Probabilities: [ 0.33383778  0.21495182  0.45121039]
Predicted class: Class-2

Datapoint: [5 2]
Probabilities: [ 0.18671115  0.28760896  0.52567989]
Predicted class: Class-2
```

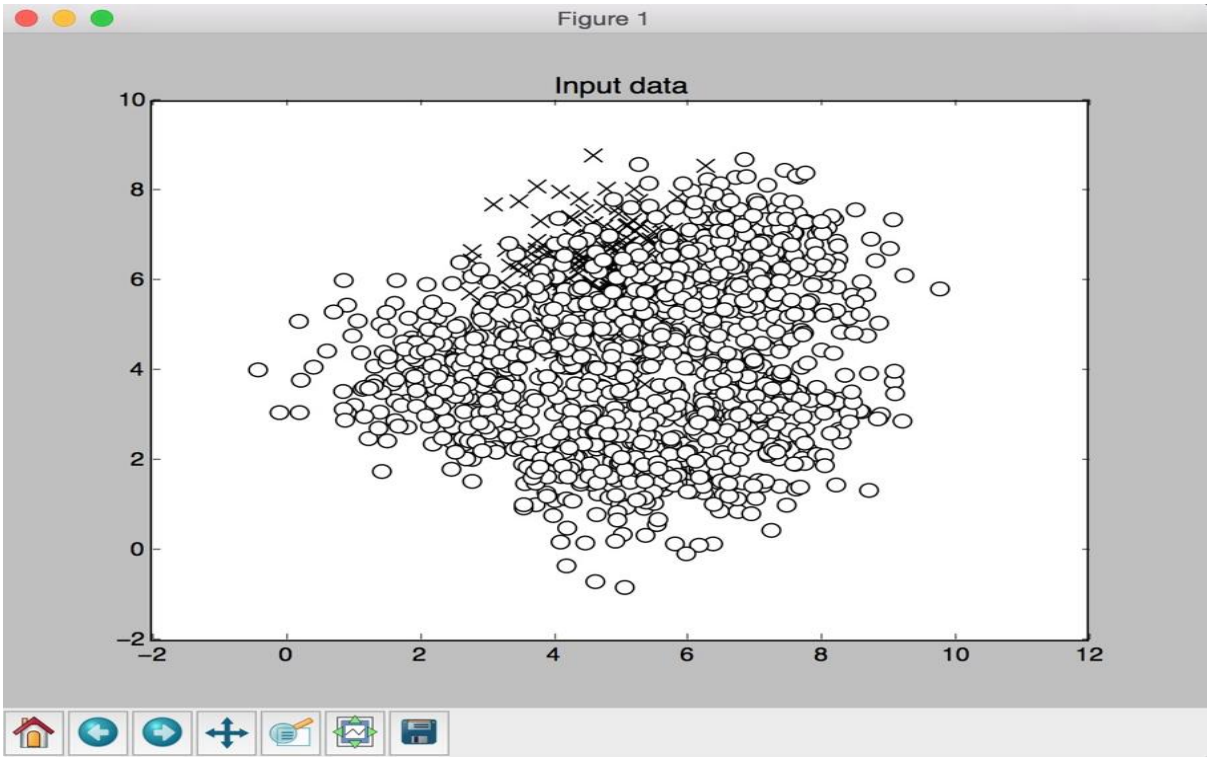


Figure 1
Input data
10
8
6
4
2
0
−2
−2
0
2
4
6
8
10
12

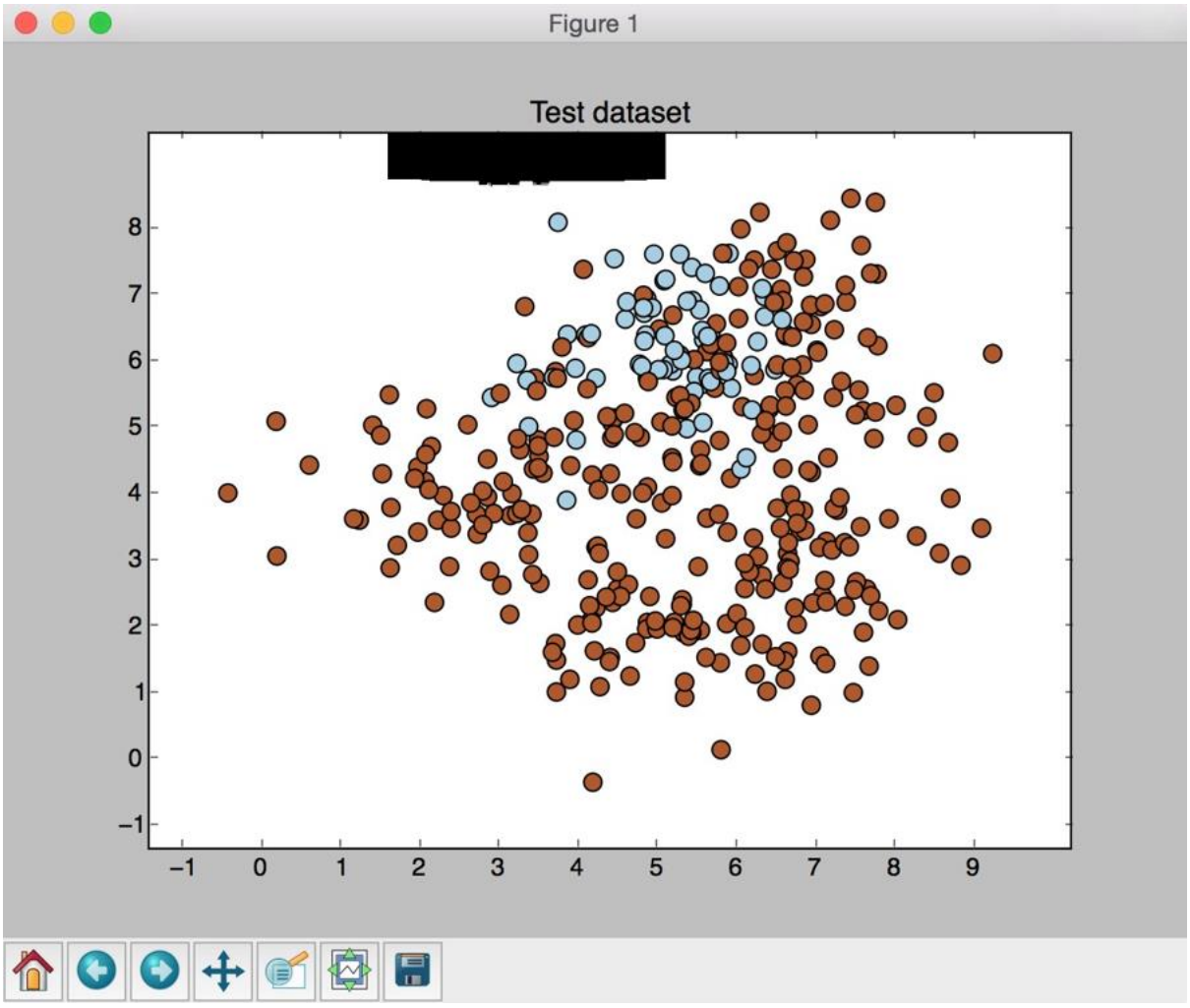
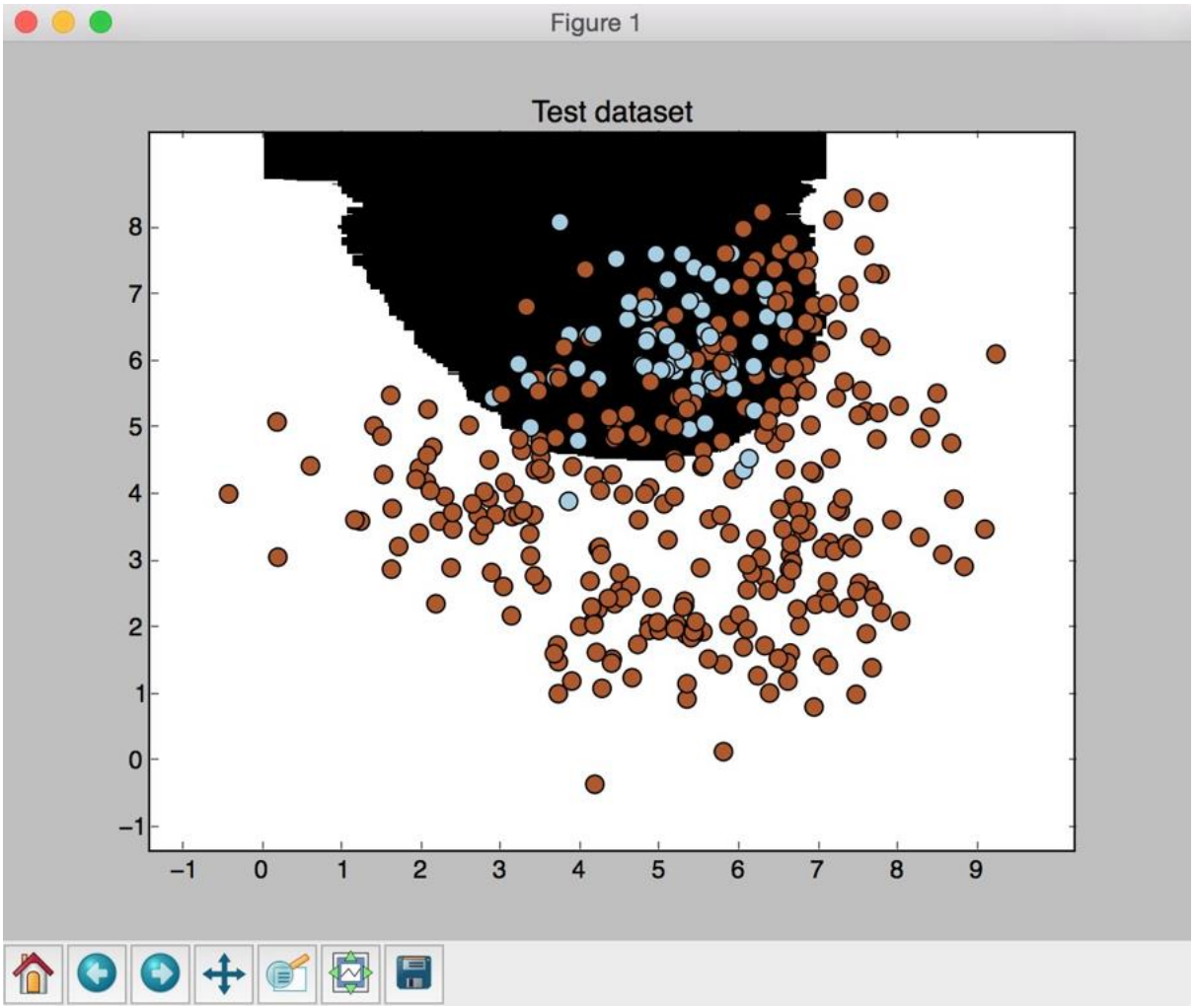


Figure 1
Test dataset
8
7
6
5
4
3
2
1
0
−1
−1
0
1
2
3
4
5
6
7
8
9

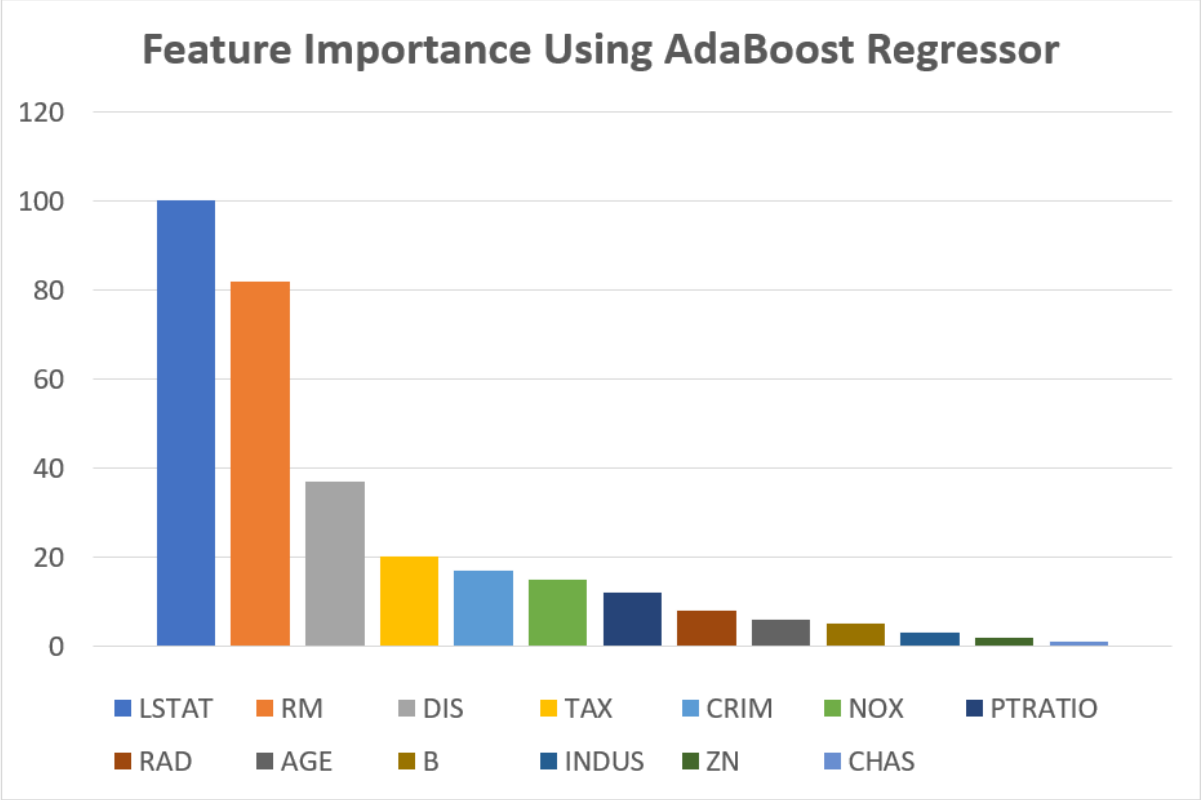
```
########################################

Classifier performance on test dataset

             precision    recall  f1-score   support

    Class-0       0.00      0.00      0.00        69
    Class-1       0.82      1.00      0.90       306

avg / total       0.67      0.82      0.73       375

########################################
```



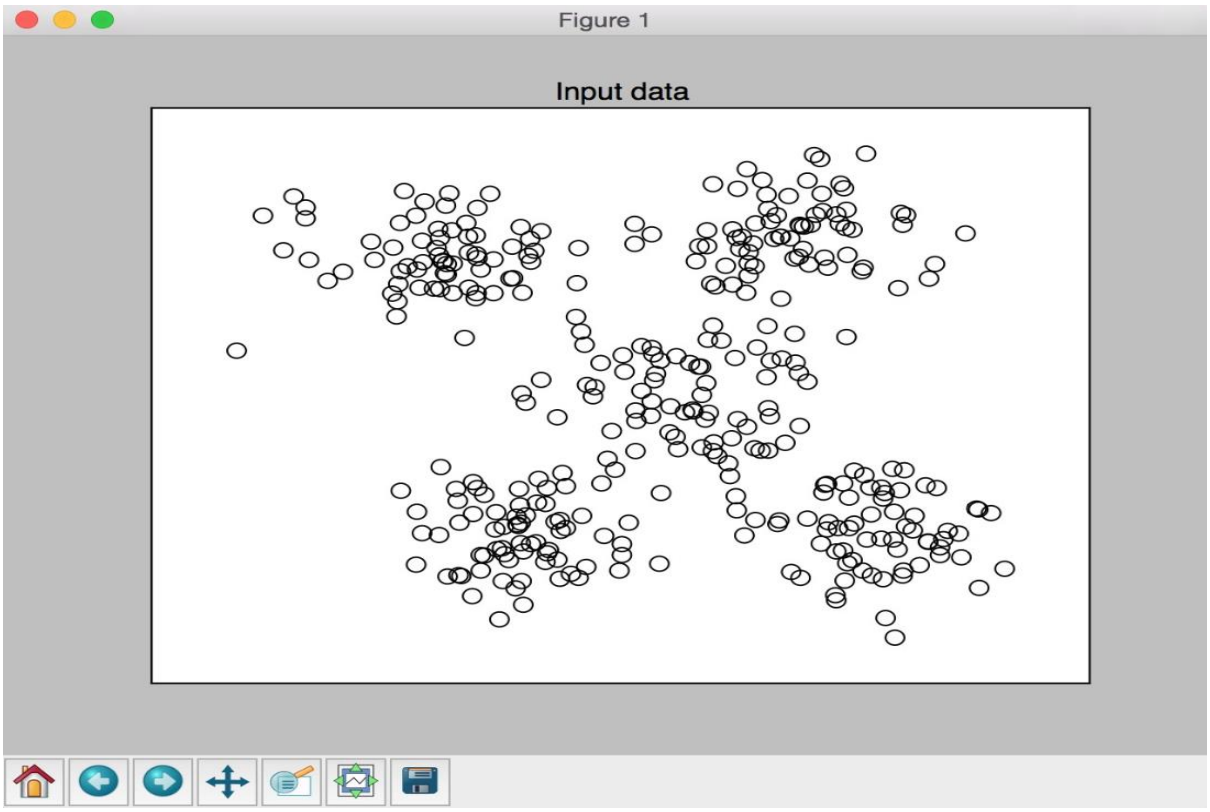
```
##########################################

Classifier performance on test dataset

             precision    recall  f1-score   support

    Class-0       0.45      0.94      0.61        69
    Class-1       0.98      0.74      0.84       306

avg / total       0.88      0.78      0.80       375

##########################################
```

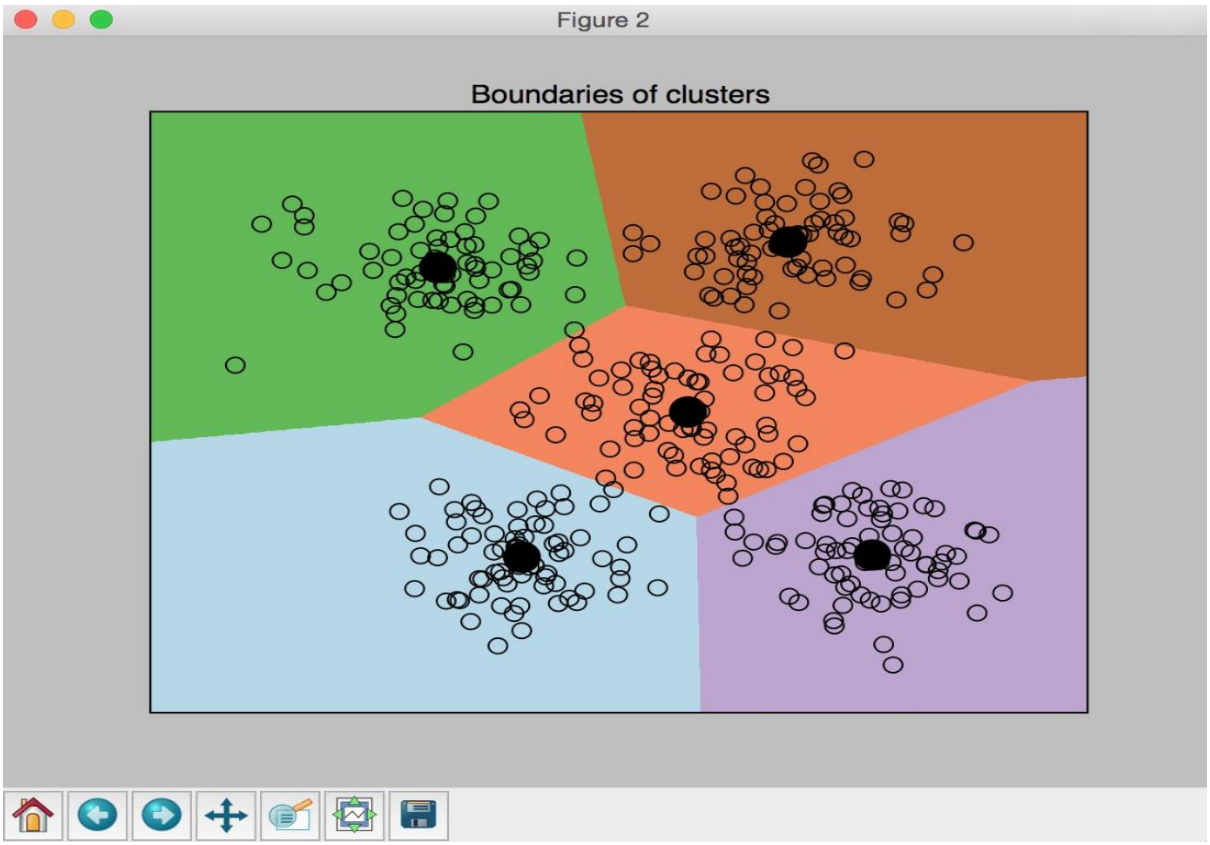
```
##### Searching optimal parameters for precision_weighted

Grid scores for the parameter grid:
{'n_estimators': 100, 'max_depth': 2} --> 0.847
{'n_estimators': 100, 'max_depth': 4} --> 0.841
{'n_estimators': 100, 'max_depth': 7} --> 0.844
{'n_estimators': 100, 'max_depth': 12} --> 0.836
{'n_estimators': 100, 'max_depth': 16} --> 0.818
{'n_estimators': 25, 'max_depth': 4} --> 0.846
{'n_estimators': 50, 'max_depth': 4} --> 0.84
{'n_estimators': 100, 'max_depth': 4} --> 0.841
{'n_estimators': 250, 'max_depth': 4} --> 0.845

Best parameters: {'n_estimators': 100, 'max_depth': 2}

Performance report:

             precision    recall  f1-score   support

        0.0       0.94      0.81      0.87        79
        1.0       0.81      0.86      0.83        70
        2.0       0.83      0.91      0.87        76

avg / total       0.86      0.86      0.86       225
```

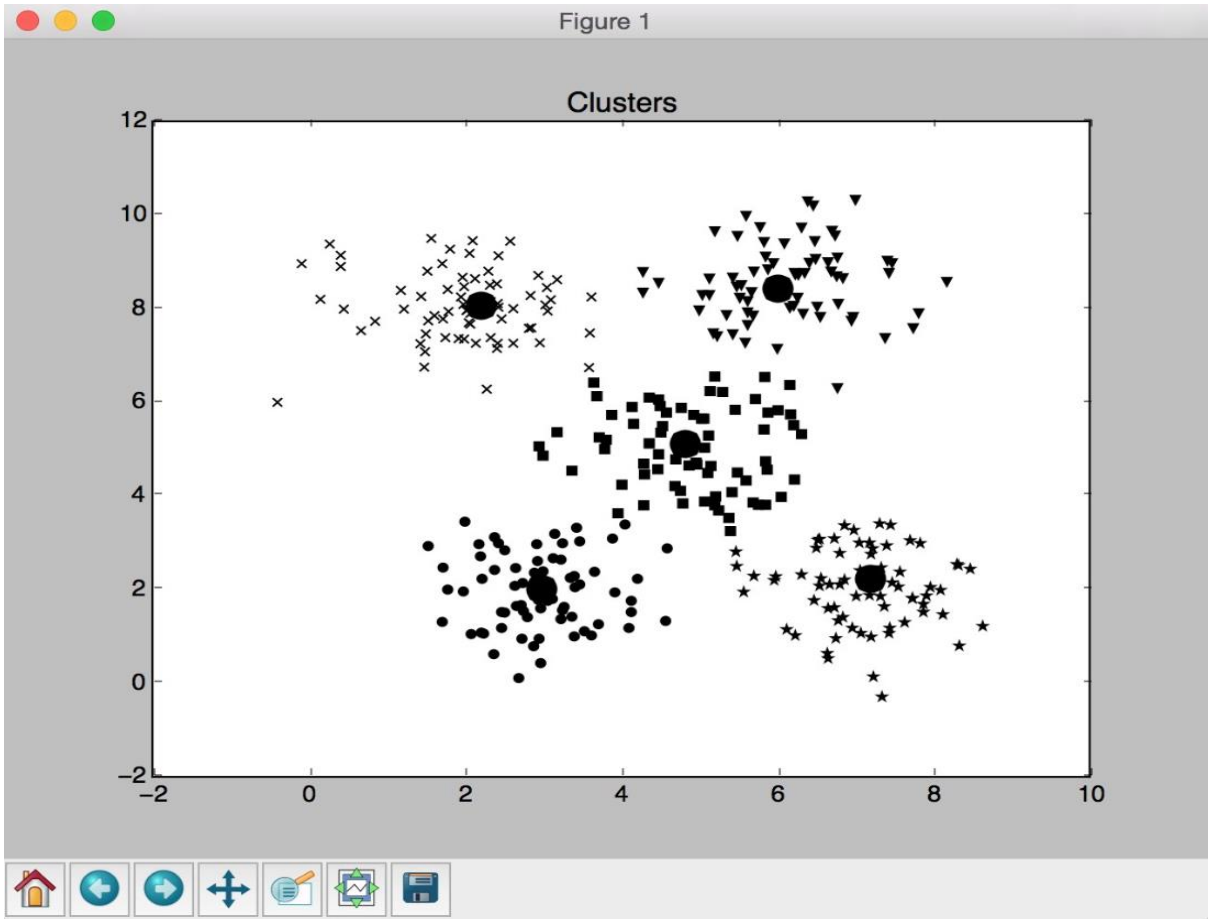
```
##### Searching optimal parameters for recall_weighted

Grid scores for the parameter grid:
{'n_estimators': 100, 'max_depth': 2} --> 0.84
{'n_estimators': 100, 'max_depth': 4} --> 0.837
{'n_estimators': 100, 'max_depth': 7} --> 0.841
{'n_estimators': 100, 'max_depth': 12} --> 0.834
{'n_estimators': 100, 'max_depth': 16} --> 0.816
{'n_estimators': 25, 'max_depth': 4} --> 0.843
{'n_estimators': 50, 'max_depth': 4} --> 0.836
{'n_estimators': 100, 'max_depth': 4} --> 0.837
{'n_estimators': 250, 'max_depth': 4} --> 0.841

Best parameters: {'n_estimators': 25, 'max_depth': 4}

Performance report:

             precision    recall  f1-score   support

        0.0       0.93      0.84      0.88        79
        1.0       0.85      0.86      0.85        70
        2.0       0.84      0.92      0.88        76

avg / total       0.87      0.87      0.87       225
```


Feature Importance Using AdaBoost Regressor
120
100
80
60
40
20
0
LSTAT
RM
DIS
TAX
CRIM
NOX
PTRATIO
RAD
AGE
B
INDUS
ZN
CHAS

Chapter 07: Detecting Patterns with Unsupervised Learning








```
Centers of clusters:
 [[ 2.95568966  1.95775862]
 [ 7.17563636  2.18145455]
 [ 2.17603774  8.03283019]
 [ 5.97960784  8.39078431]
 [ 4.81044444  5.07111111]]

Number of clusters in input data = 5
```

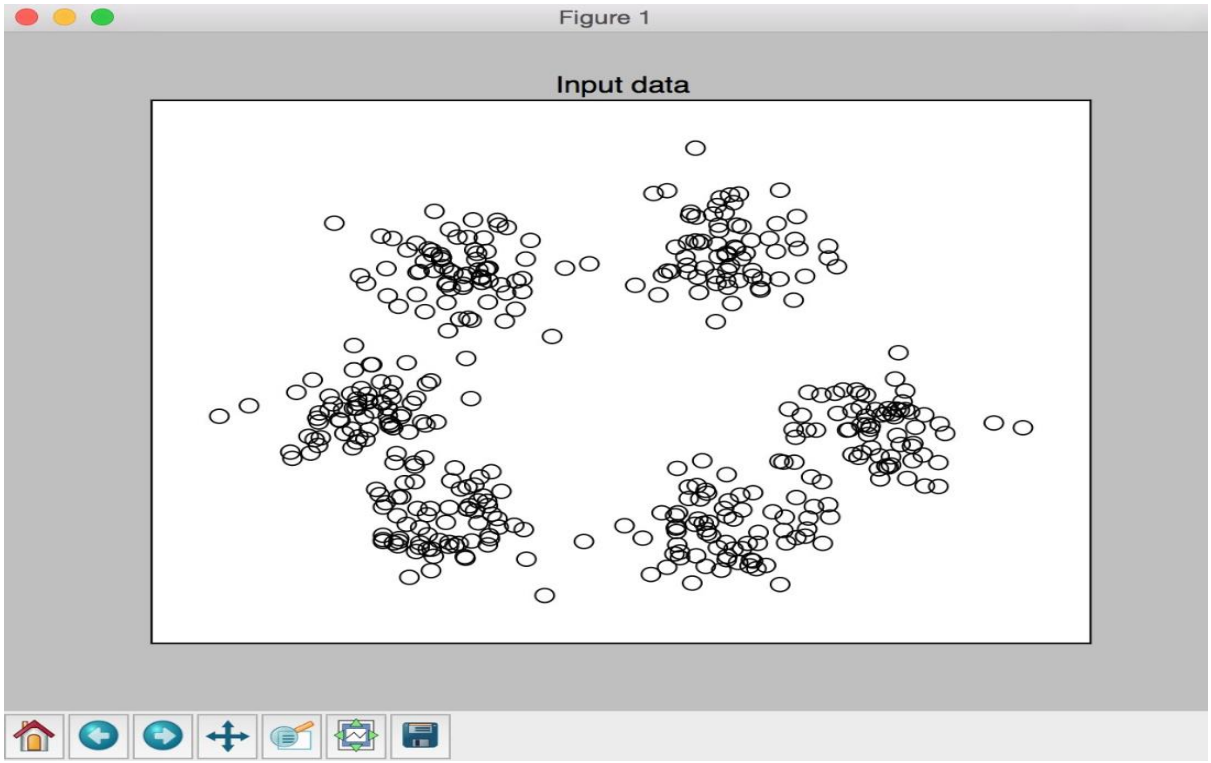


Figure 1
Input data

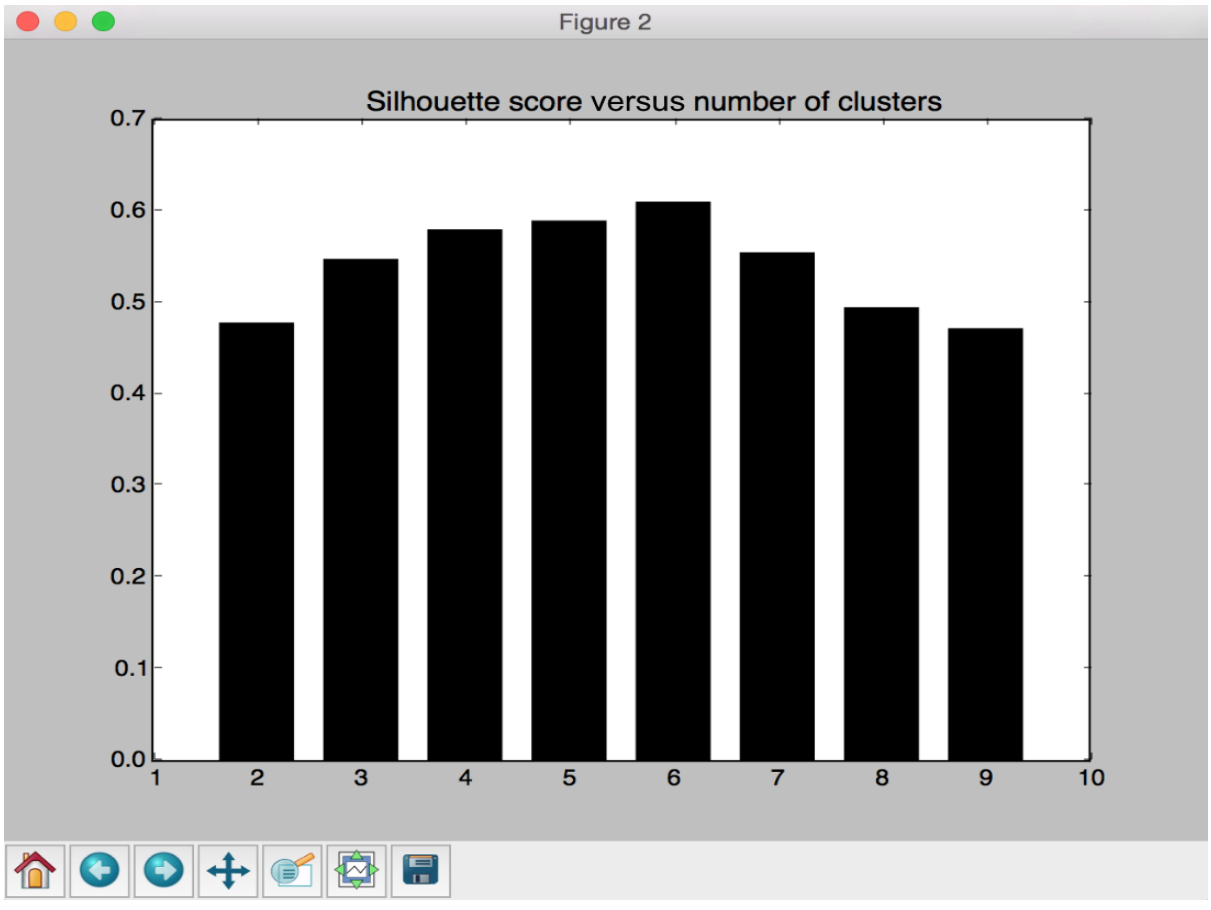
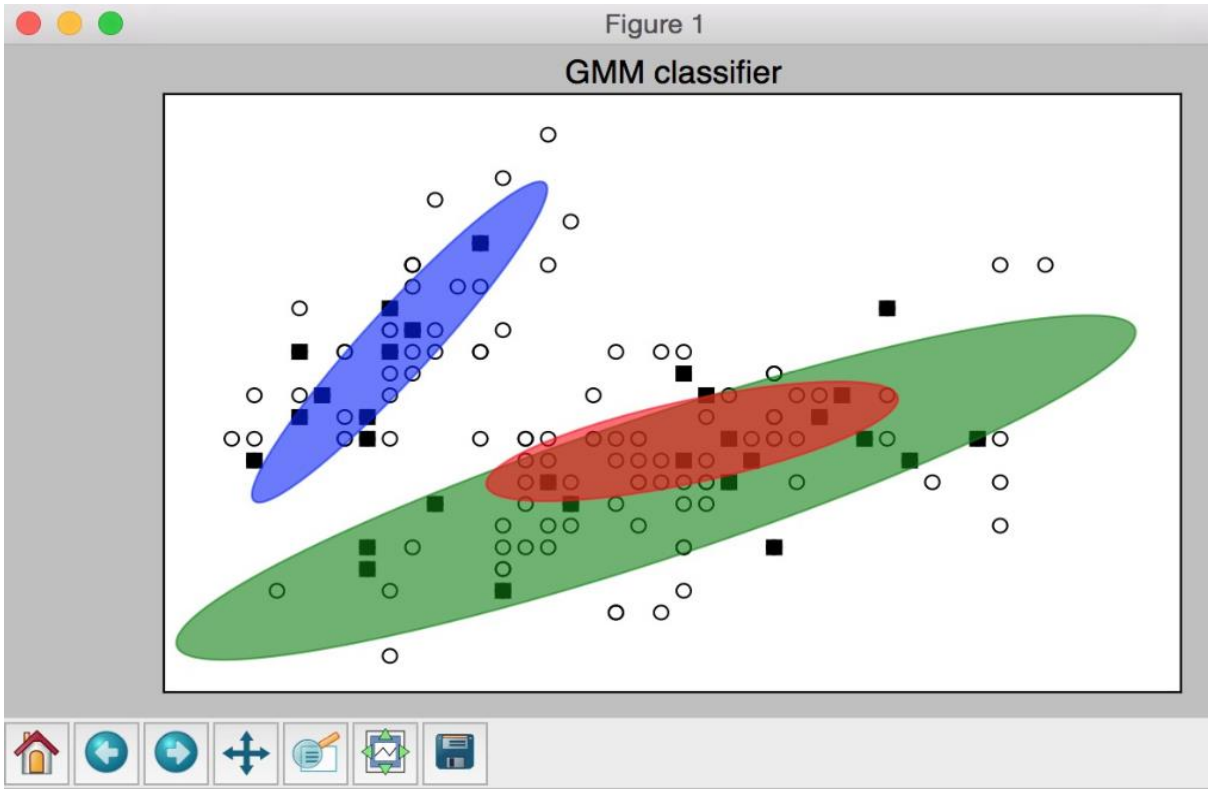
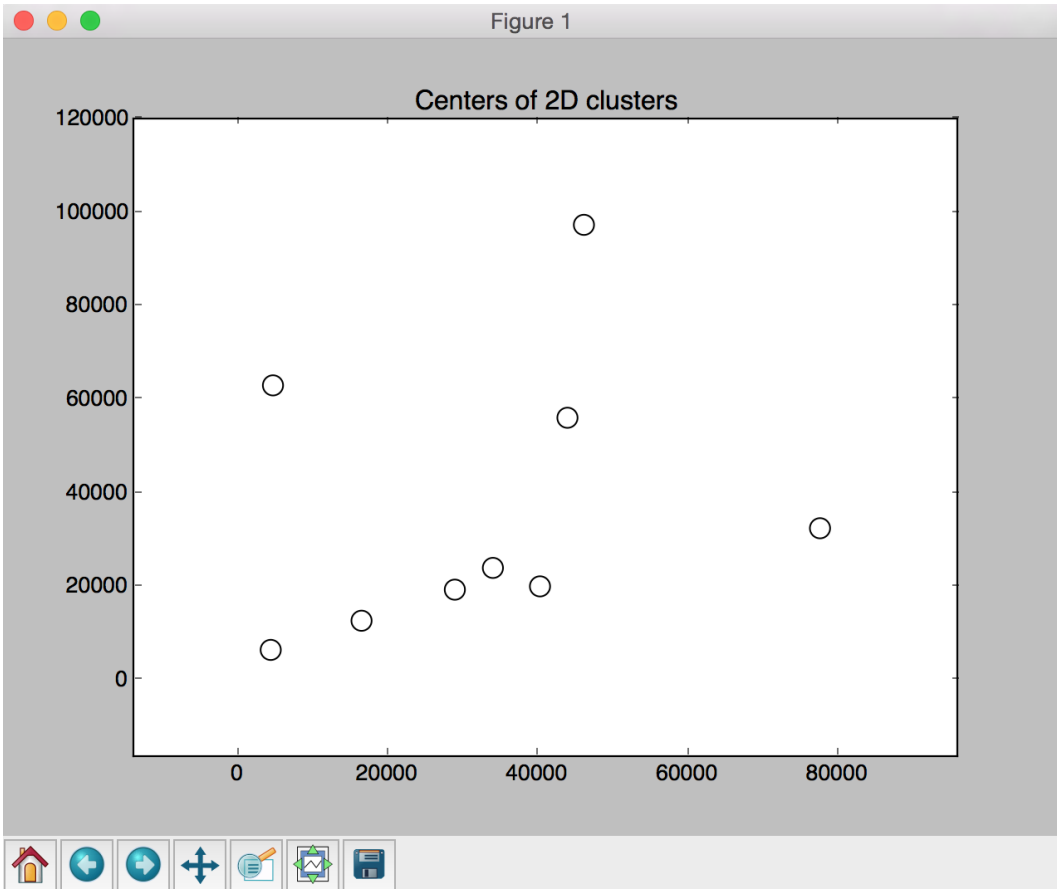


Figure 2
Silhouette score versus number of clusters
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
2
3
4
5
6
7
8
9
10

```
Number of clusters = 2
Silhouette score = 0.477626248705

Number of clusters = 3
Silhouette score = 0.547174241173

Number of clusters = 4
Silhouette score = 0.579480188969

Number of clusters = 5
Silhouette score = 0.589003263565

Number of clusters = 6
Silhouette score = 0.609690411895

Number of clusters = 7
Silhouette score = 0.554310234032

Number of clusters = 8
Silhouette score = 0.494433661954

Number of clusters = 9
Silhouette score = 0.471414689437

Optimal number of clusters = 6
```

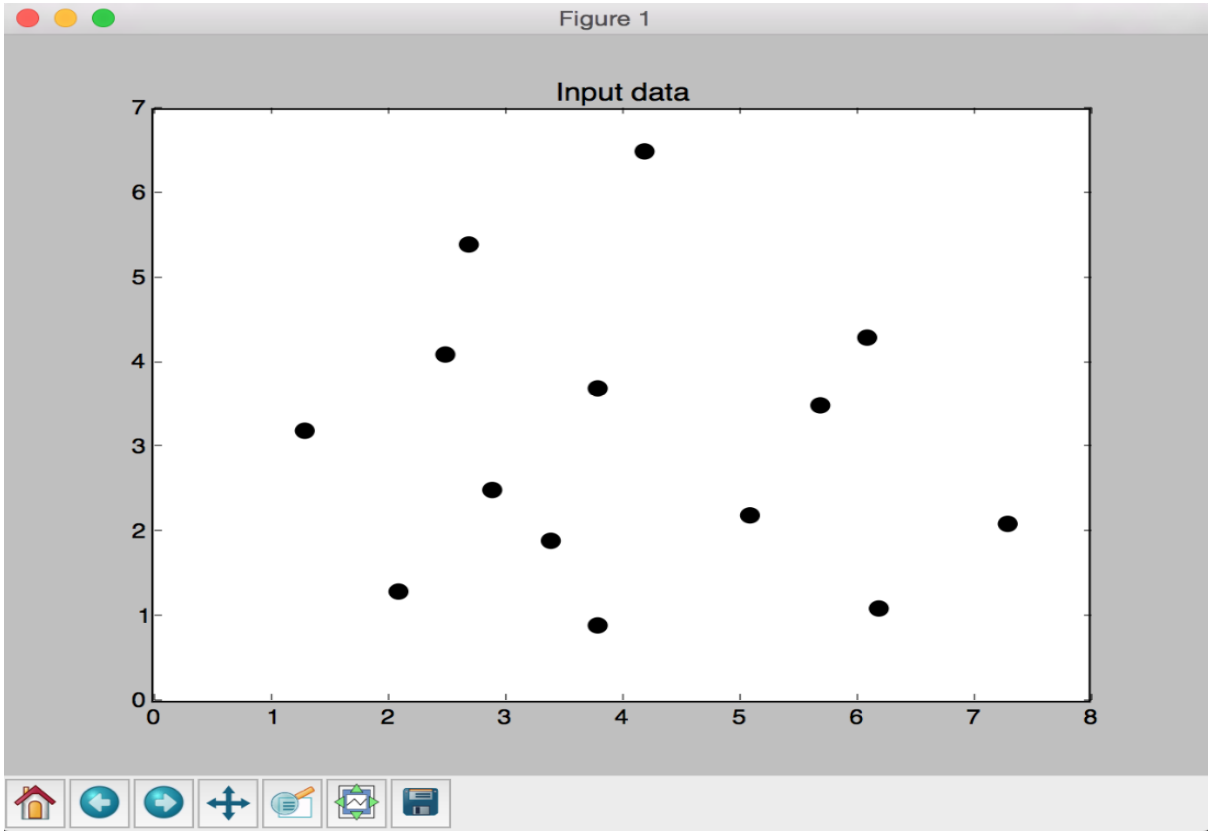


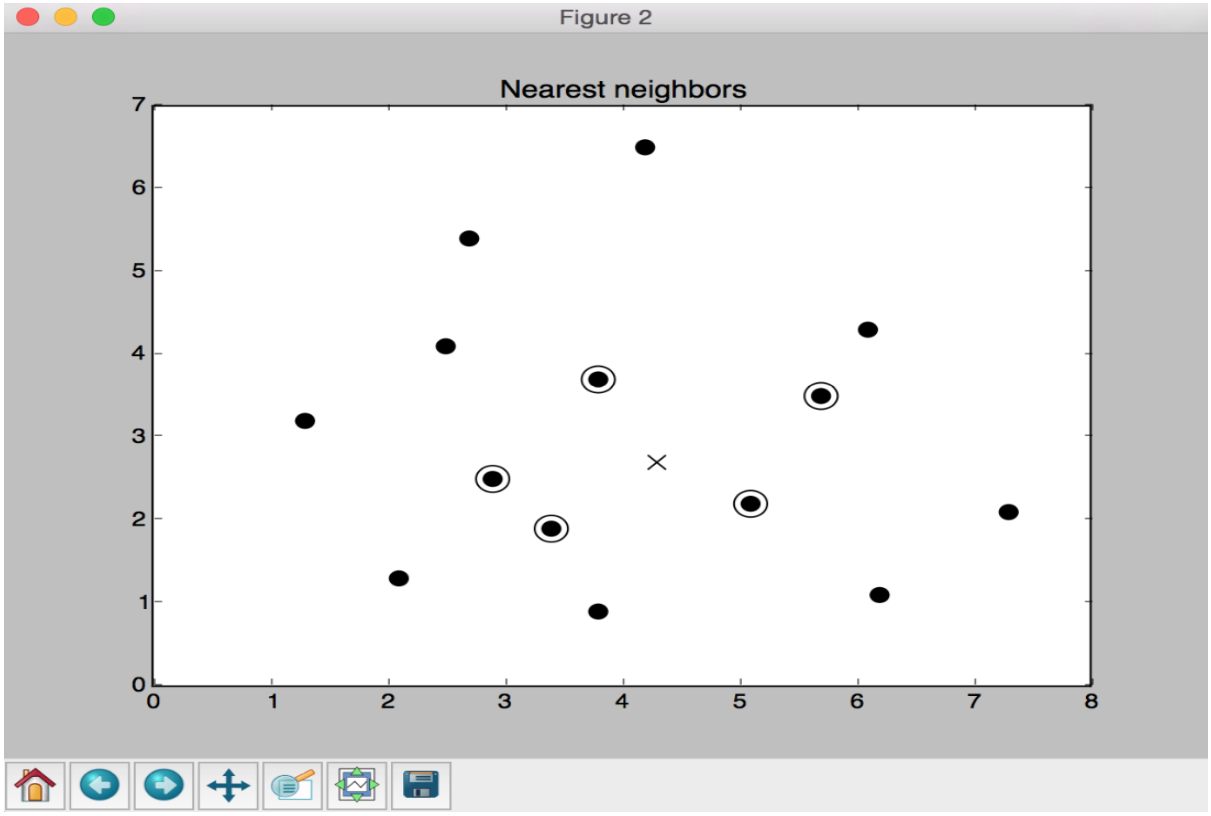

```
Clustering of stocks based on difference in opening and closing quotes:

Cluster 1 ==> Kraft Foods
Cluster 2 ==> CVS, Walgreen
Cluster 3 ==> Amazon, Yahoo
Cluster 4 ==> Cablevision
Cluster 5 ==> Pfizer, Sanofi-Aventis, GlaxoSmithKline, Novartis
Cluster 6 ==> HP, General Electrics, 3M, Microsoft, Cisco, IBM, Texas instruments, Dell
Cluster 7 ==> Coca Cola, Kimberly-Clark, Pepsi, Procter Gamble, Kellogg, Colgate-Palmolive
Cluster 8 ==> Comcast, Wells Fargo, Xerox, Home Depot, Wal-Mart, Marriott, Navistar, DuPont de Nemours, A
merican express, Ryder, JPMorgan Chase, AIG, Time Warner, Bank of America, Goldman Sachs
Cluster 9 ==> Canon, Unilever, Mitsubishi, Apple, Mc Donalds, Boeing, Toyota, Caterpillar, Ford, Honda, S
AP, Sony
Cluster 10 ==> Valero Energy, Exxon, ConocoPhillips, Chevron, Total
Cluster 11 ==> Raytheon, General Dynamics, Lookheed Martin, Northrop Grumman
```



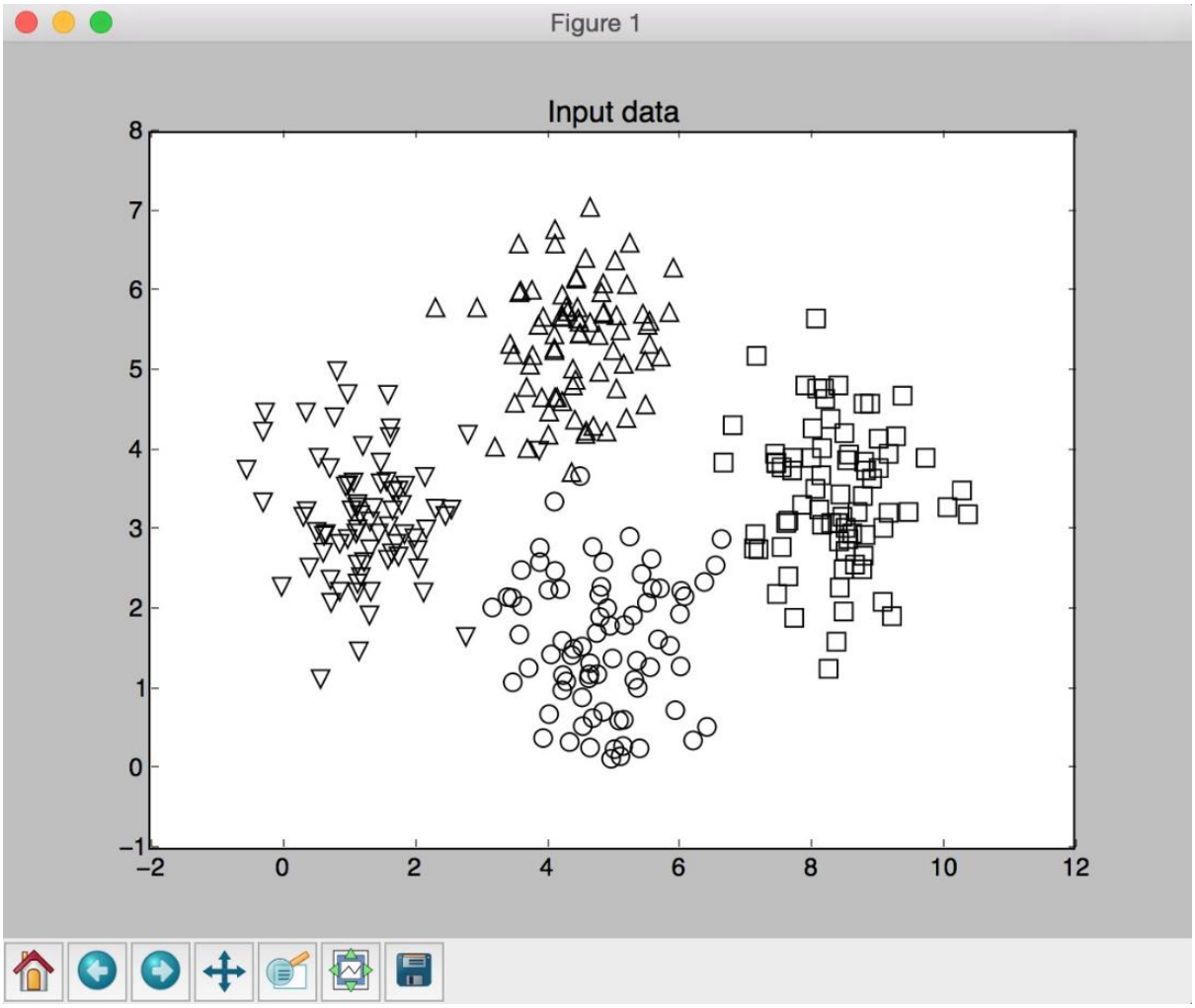

```
Number of clusters in input data = 9

Centers of clusters:
Tsh      Tan      Hal      Tur      Tub      Swe
9823     4637     6539     2607     2228     1239
38589    44199    56158    5030     24674    4125
7852     4939     63081    134      40066    1332
35314    16745    12775    66900    1298     5613
22617    77873    32543    1005     21035    837
104972   29186    19415    16016    5060     9372
38741    40539    20120    35059    255      50710
28333    34263    24065    5575     4229     18076
14987    46397    97393    1127     37315    3235
```

Chapter 08: Building Recommender Systems





```
K Nearest Neighbors:
1 ==> [ 5.1  2.2]
2 ==> [ 3.8  3.7]
3 ==> [ 3.4  1.9]
4 ==> [ 2.9  2.5]
5 ==> [ 5.7  3.5]
```



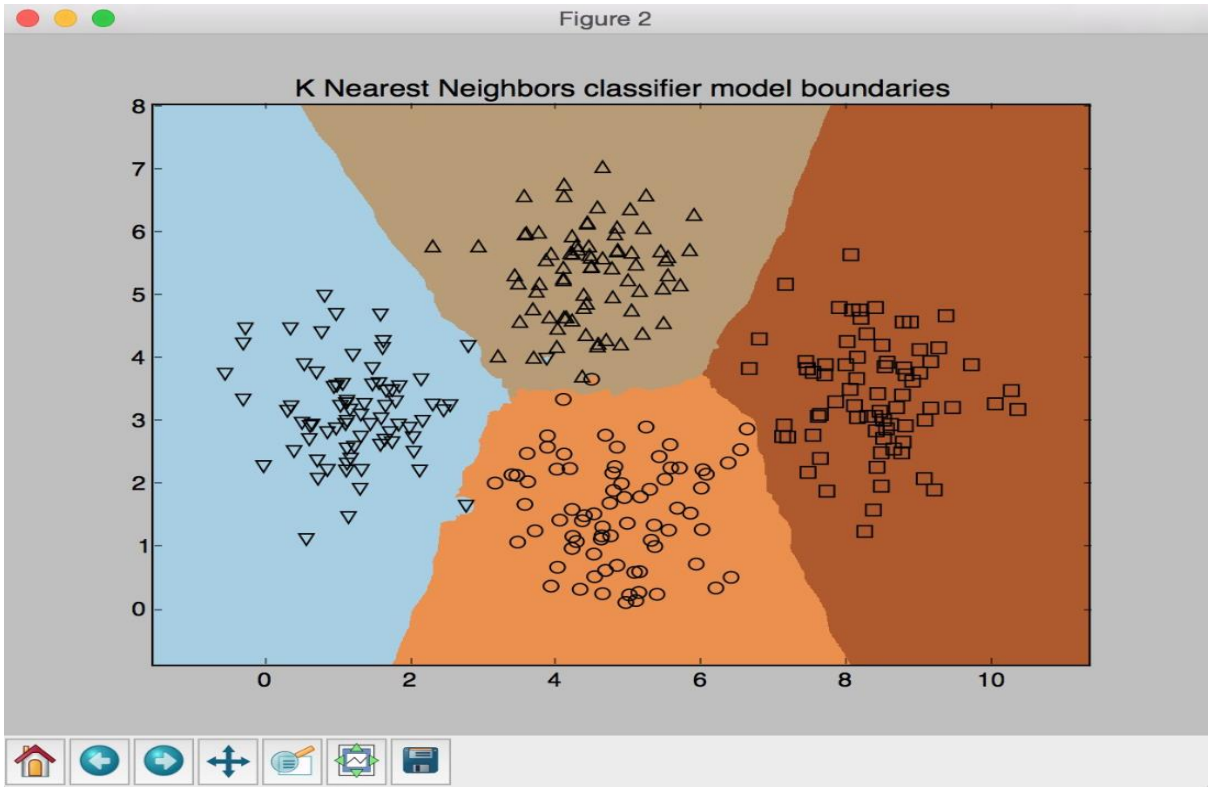


Figure 2
K Nearest Neighbors classifier model boundaries
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10

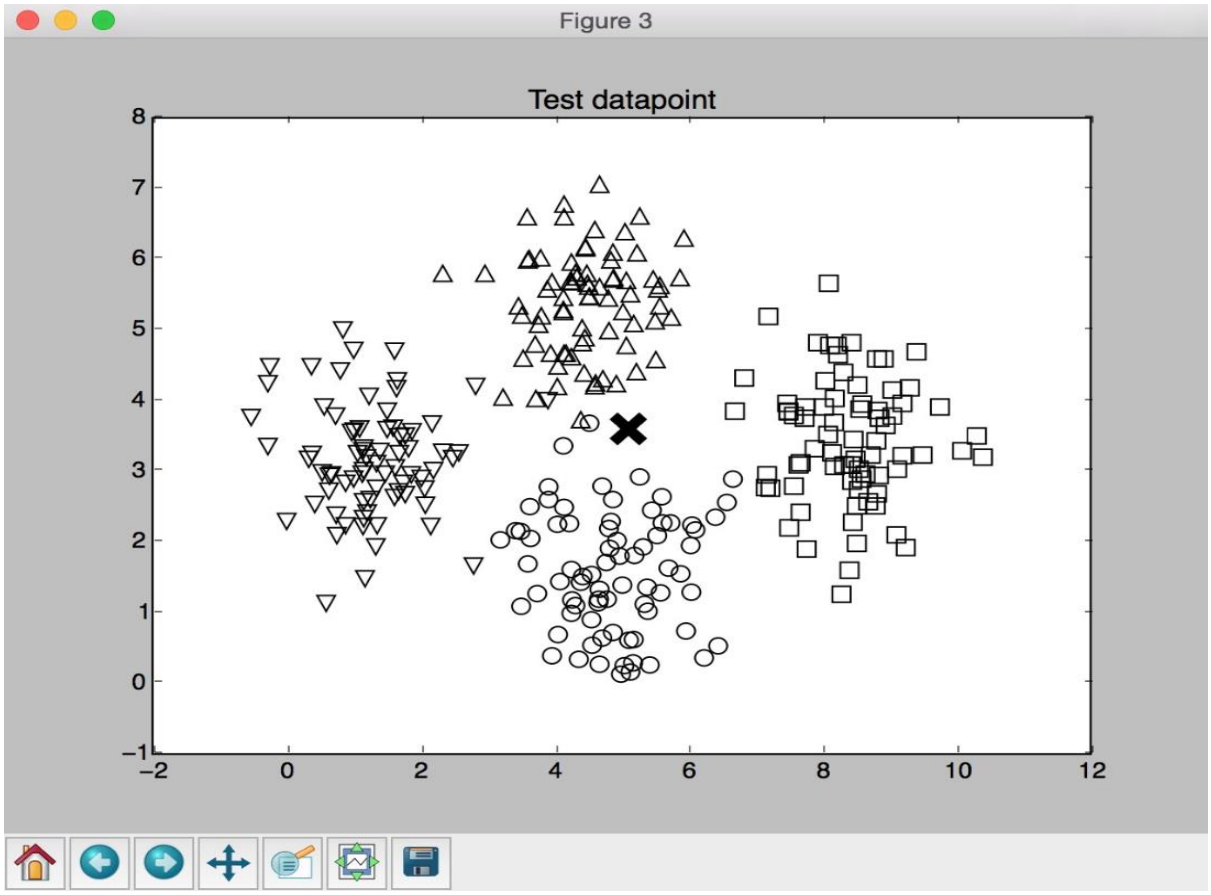
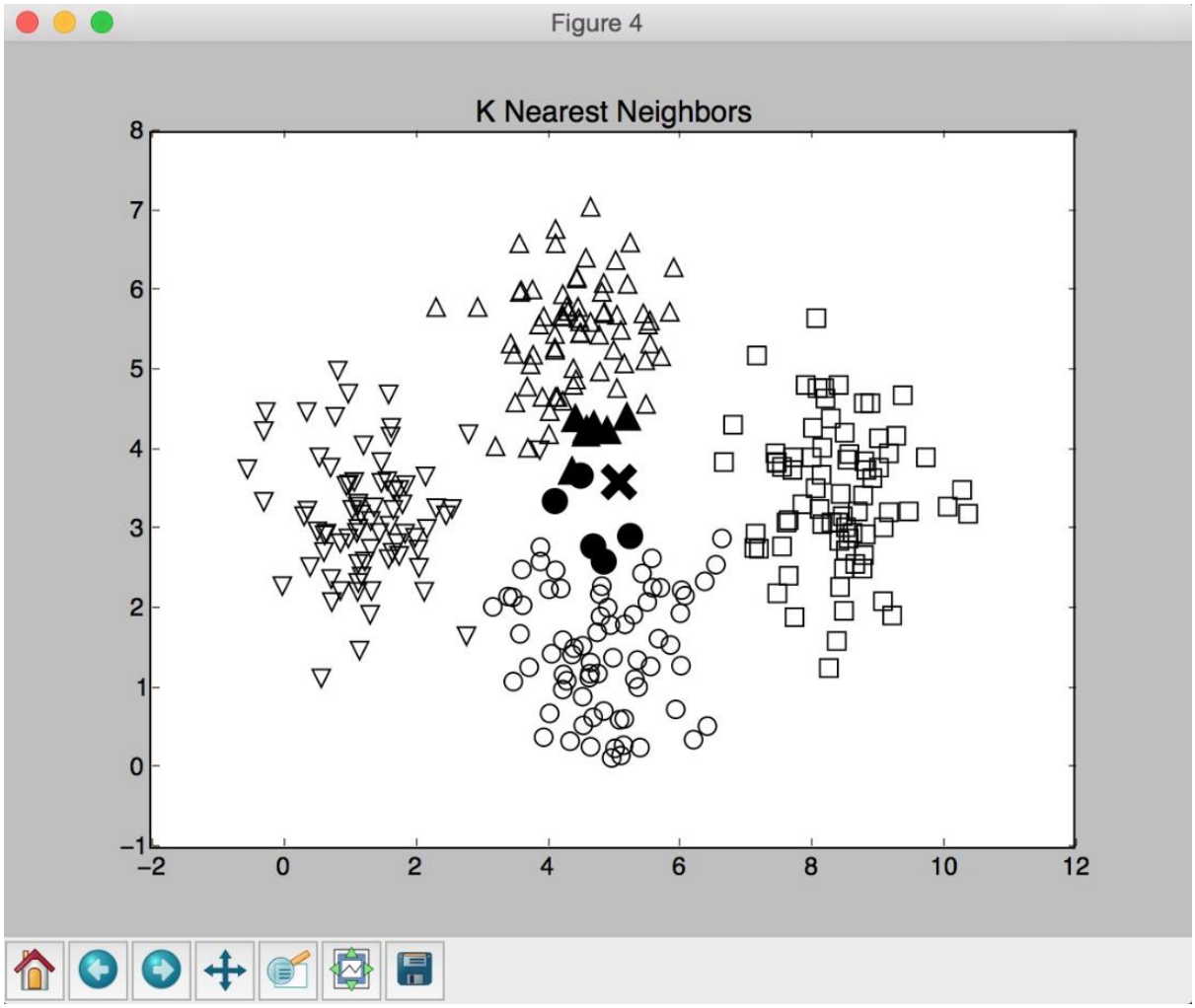


Figure 3
Test datapoint
8
7
6
5
4
3
2
1
0
−1
−2
0
2
4
6
8
10
12



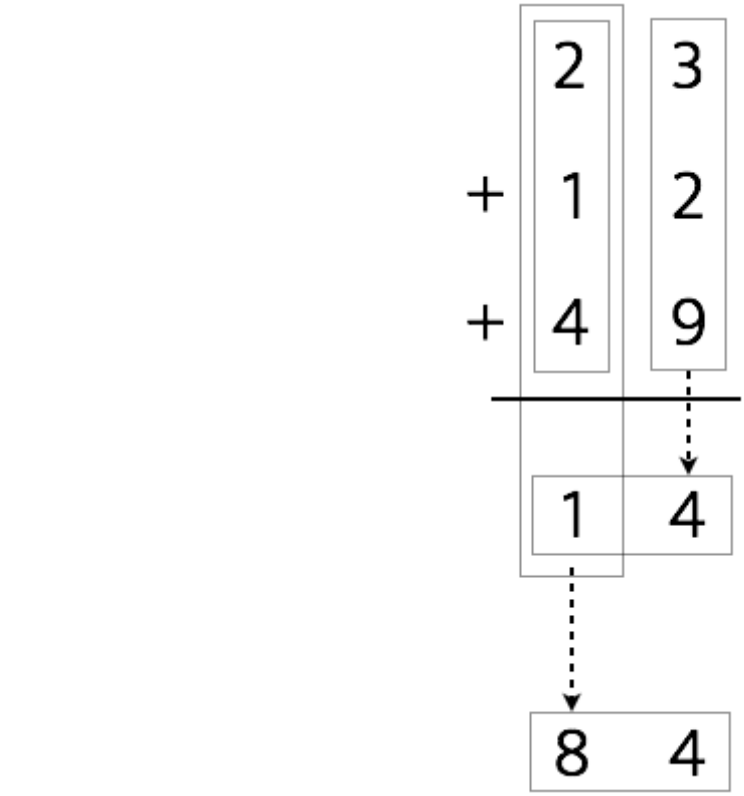

```
Users similar to Bill Duffy:

User                     Similarity score
-----------------------------------------
David Smith                 0.99
Samuel Miller               0.88
Adam Cohen                  0.86
```

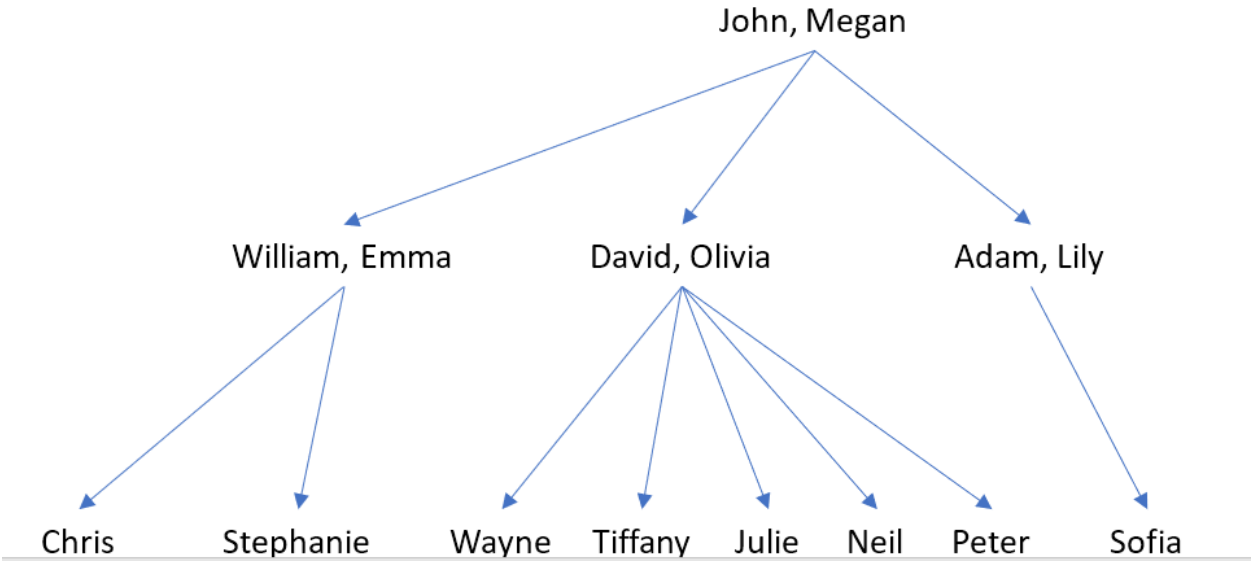
```
Users similar to Clarissa Jackson:

User                     Similarity score
-----------------------------------------
Chris Duncan              1.0
Bill Duffy                0.83
Samuel Miller             0.73
```

```
Movie recommendations for Chris Duncan:
1. Vertigo
2. Goodfellas
3. Scarface
4. Roman Holiday

Movie recommendations for Julie Hammel:
1. The Apartment
2. Vertigo
3. Raging Bull
```

```
Movie recommendations for Julie Hammel:
1. The Apartment
2. Vertigo
3. Raging Bull
```

Chapter 09: Logic Programming



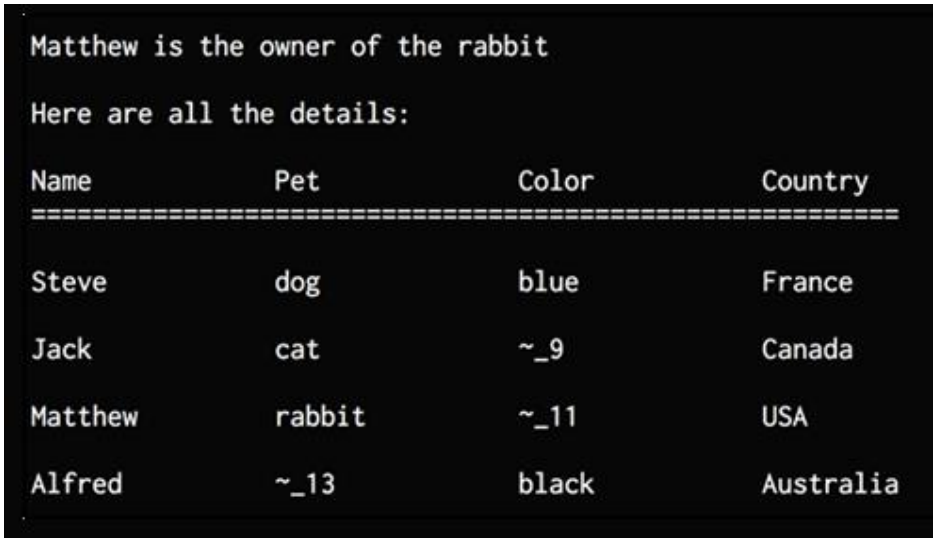


```
List of John's children:
David
William
Adam

William's mother:
Megan

List of Adam's parents:
John
Megan

List of Wayne's grandparents:
John
Megan
```

```
List of Megan's grandchildren:
Chris
Sophia
Peter
Stephanie
Julie
Tiffany
Neil
Wayne

List of David's siblings:
William
Adam

List of Tiffany's uncles:
William
Adam

List of all spouses:
Husband: Adam <==> Wife: Lily
Husband: David <==> Wife: Olivia
Husband: John <==> Wife: Megan
Husband: William <==> Wife: Emma
```


```
Is Nevada adjacent to Louisiana?:
No

List of states adjacent to Oregon:
Washington
California
Nevada
Idaho

List of coastal states adjacent to Mississippi:
Alabama
Louisiana

List of 7 states that border a coastal state:
Georgia
Pennsylvania
Massachusetts
Wisconsin
Maine
Oregon
Ohio

List of states that are adjacent to Arkansas and Kentucky:
Missouri
Tennessee
```

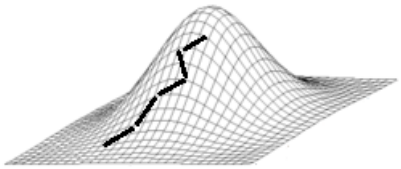
	Pet	Car Color	Country
Steve	dog	blue	France
Jack	cat	green	Canada
Matthew	rabbit	yellow	USA
Alfred	parrot	black	Australia



Chapter 10: Heuristic Search Techniques

			2	6		7		1
6	8			7			9	
1	9				4	5		
8	2		1				4	
		4	6		2	9		
	5				3		2	8
		9	3				7	4
	4			5			3	6
7		3		1	8			

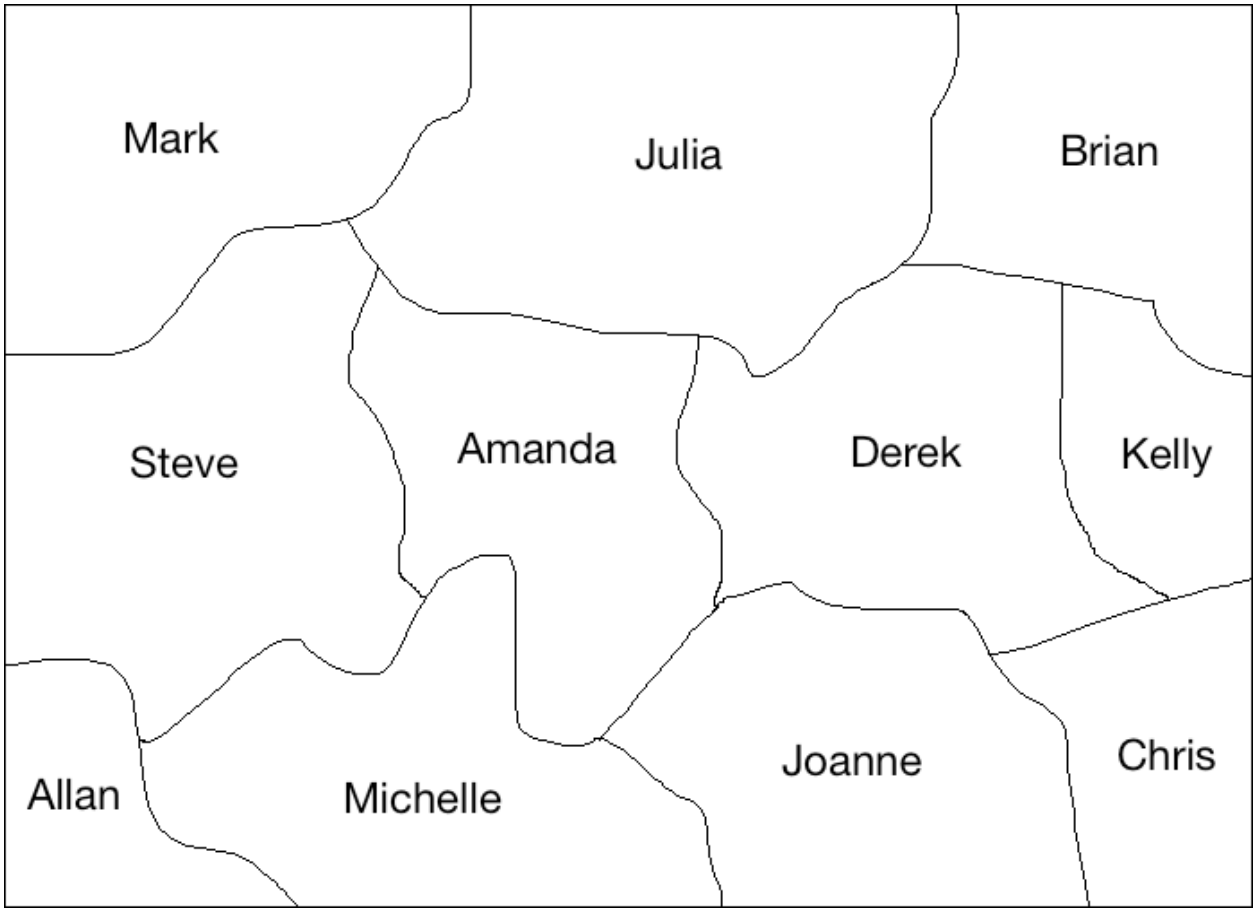
6	8	
1	9	



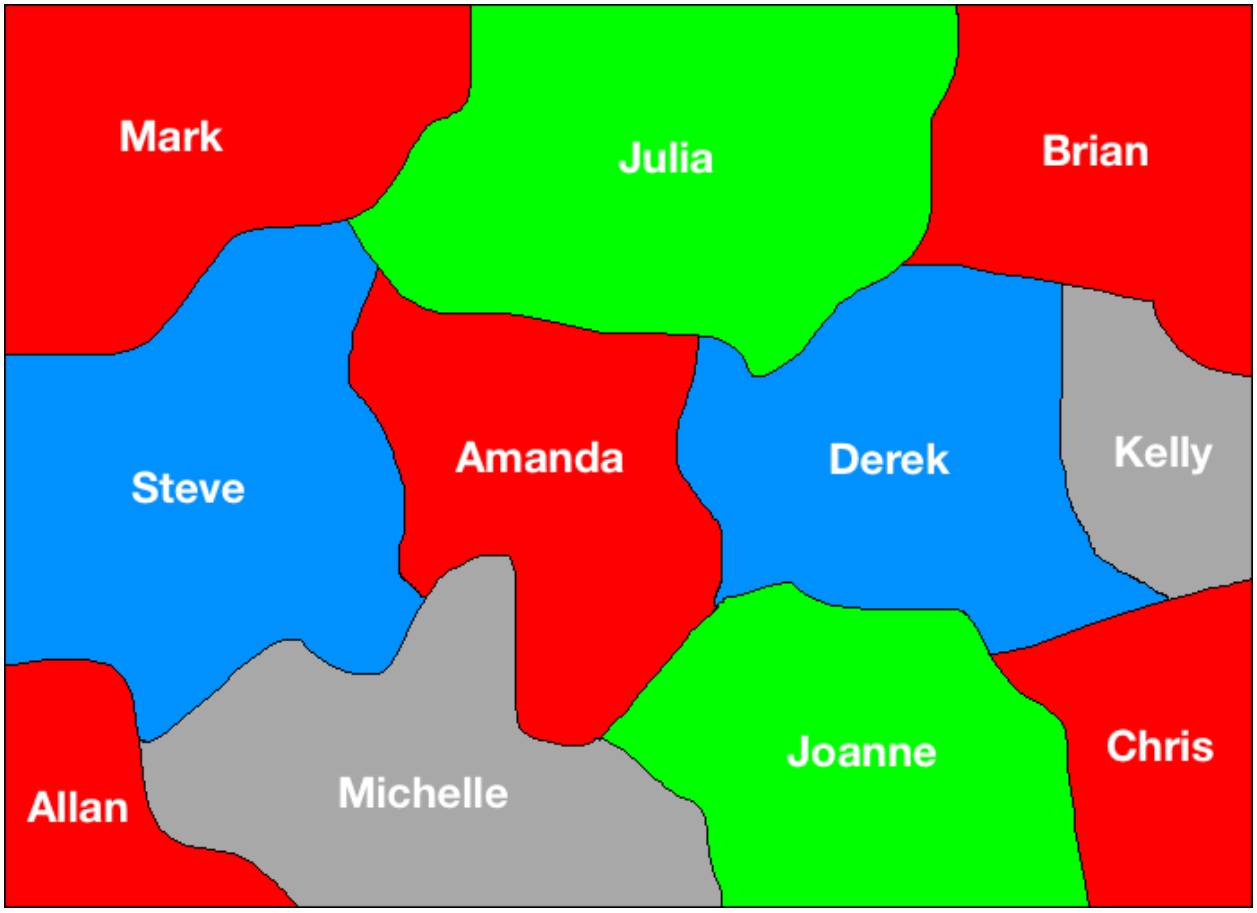
```
Path to the solution:
(None, '')
('A', 'A')
('r', 'Ar')
('t', 'Art')
('i', 'Arti')
('f', 'Artif')
('i', 'Artifi')
('c', 'Artific')
('i', 'Artifici')
('a', 'Artificia')
('l', 'Artificial')
(' ', 'Artificial ')
('I', 'Artificial I')
('n', 'Artificial In')
('t', 'Artificial Int')
('e', 'Artificial Inte')
('l', 'Artificial Intel')
('l', 'Artificial Intell')
('i', 'Artificial Intelli')
('g', 'Artificial Intellig')
('e', 'Artificial Intellige')
('n', 'Artificial Intelligen')
('c', 'Artificial Intelligenc')
('e', 'Artificial Intelligence')
```

```
Path to the solution:
(None, 'Artificial Inte')
('l', 'Artificial Intel')
('l', 'Artificial Intell')
('i', 'Artificial Intelli')
('g', 'Artificial Intellig')
('e', 'Artificial Intellige')
('n', 'Artificial Intelligen')
('c', 'Artificial Intelligenc')
('e', 'Artificial Intelligence')
(' ', 'Artificial Intelligence ')
('w', 'Artificial Intelligence w')
('i', 'Artificial Intelligence wi')
('t', 'Artificial Intelligence wit')
('h', 'Artificial Intelligence with')
(' ', 'Artificial Intelligence with ')
('P', 'Artificial Intelligence with P')
('y', 'Artificial Intelligence with Py')
('t', 'Artificial Intelligence with Pyt')
('h', 'Artificial Intelligence with Pyth')
('o', 'Artificial Intelligence with Pytho')
('n', 'Artificial Intelligence with Python')
```

```
Solutions:

Normal: {'Patricia': 2, 'John': 1, 'Anna': 3, 'Tom': 4}

Most constrained variable: {'Patricia': 2, 'John': 3, 'Anna': 1, 'Tom': 2}

Highest degree variable: {'Patricia': 2, 'John': 1, 'Anna': 3, 'Tom': 4}

Least constraining value: {'Patricia': 2, 'John': 1, 'Anna': 3, 'Tom': 4}

Most constrained variable and least constraining value: {'Patricia': 2, 'John': 3, 'Anna': 1, 'Tom': 2}

Highest degree and least constraining value: {'Patricia': 2, 'John': 1, 'Anna': 3, 'Tom': 4}

Minimum conflicts: {'Patricia': 4, 'John': 1, 'Anna': 3, 'Tom': 4}
```

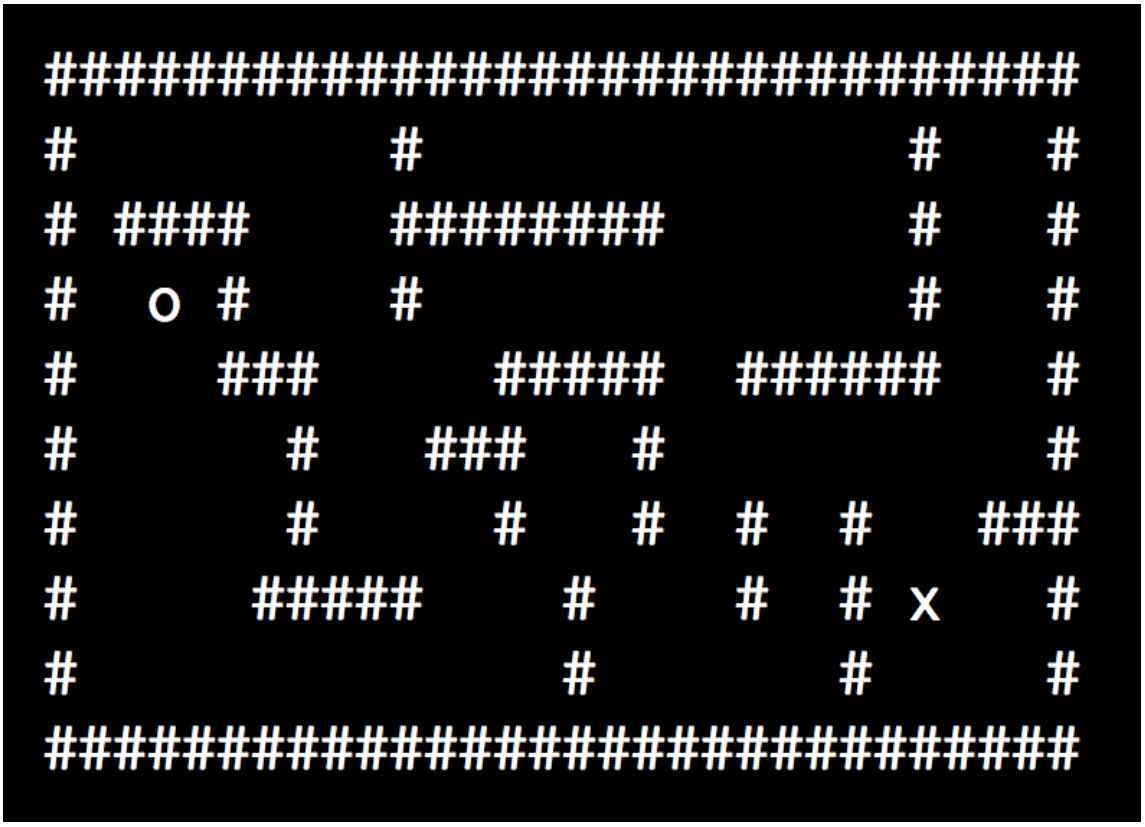

Mark
Julia
Brian
Steve
Amanda
Derek
Kelly
Allan
Michelle
Joanne
Chris

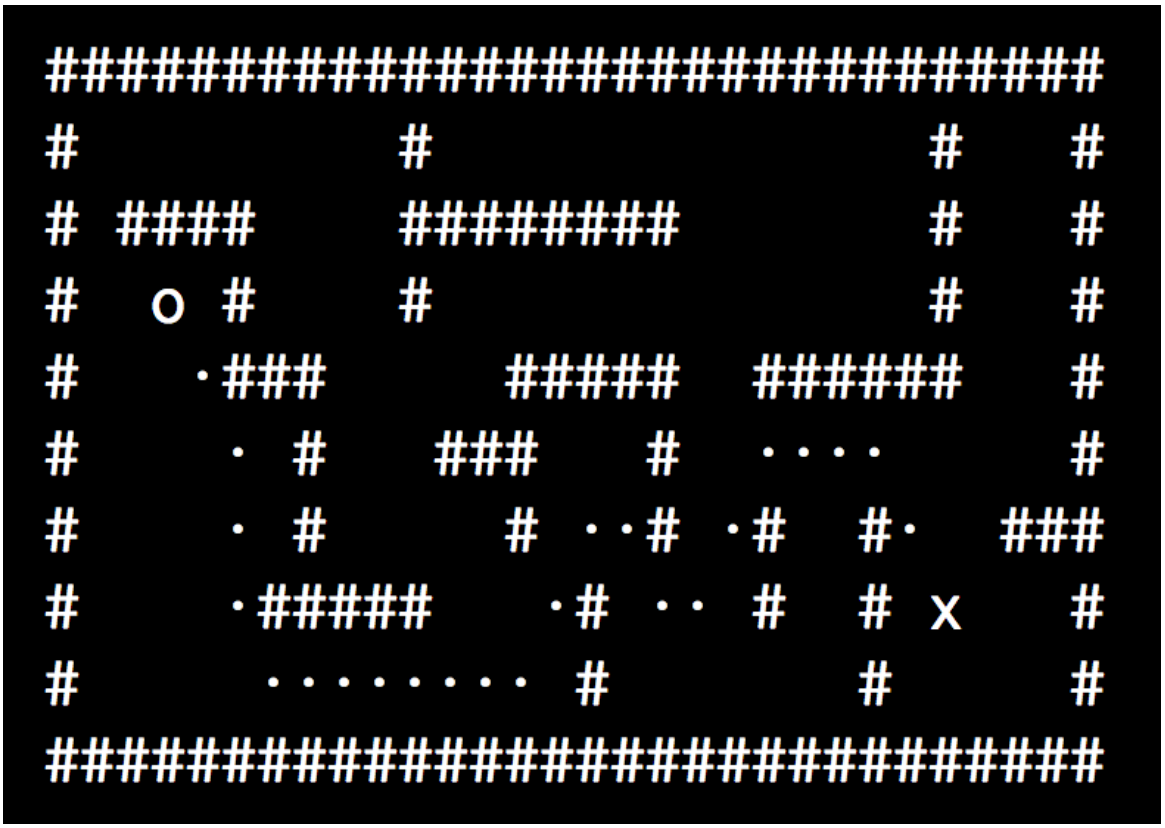
```
Color mapping:

Derek ==> blue
Michelle ==> gray
Allan ==> red
Steve ==> blue
Julia ==> green
Amanda ==> red
Joanne ==> green
Mark ==> red
Kelly ==> gray
Brian ==> red
```


Mark
Julia
Brian
Steve
Amanda
Derek
Kelly
Allan
Michelle
Joanne
Chris

```
Initial configuration
1-e-2
6-3-4
7-5-8

After moving 2 into the empty space
1-2-e
6-3-4
7-5-8

After moving 4 into the empty space
1-2-4
6-3-e
7-5-8

After moving 3 into the empty space
1-2-4
6-e-3
7-5-8

After moving 6 into the empty space
1-2-4
e-6-3
7-5-8
```

```
After moving 2 into the empty space
e-2-3
1-4-6
7-5-8

After moving 1 into the empty space
1-2-3
e-4-6
7-5-8

After moving 4 into the empty space
1-2-3
4-e-6
7-5-8

After moving 5 into the empty space
1-2-3
4-5-6
7-e-8

After moving 8 into the empty space. Goal achieved!
1-2-3
4-5-6
7-8-e
```


o
x


o
x

```
Starting the evolution process

Evaluated 500 individuals

===== Generation 0
Evaluated 297 individuals
Min = 58.0 , Max = 75.0
Average = 70.43 , Standard deviation = 2.91

===== Generation 1
Evaluated 303 individuals
Min = 63.0 , Max = 75.0
Average = 72.44 , Standard deviation = 2.16

===== Generation 2
Evaluated 310 individuals
Min = 65.0 , Max = 75.0
Average = 73.31 , Standard deviation = 1.6

===== Generation 3
Evaluated 273 individuals
Min = 67.0 , Max = 75.0
Average = 73.76 , Standard deviation = 1.41
```

```
===== Generation 57
Evaluated 306 individuals
Min = 68.0 , Max = 75.0
Average = 74.02 , Standard deviation = 1.27

===== Generation 58
Evaluated 276 individuals
Min = 69.0 , Max = 75.0
Average = 74.15 , Standard deviation = 1.18

===== Generation 59
Evaluated 288 individuals
Min = 69.0 , Max = 75.0
Average = 74.12 , Standard deviation = 1.24

==== End of evolution

Best individual:
 [1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1
, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0
, 1, 0, 0, 0, 1]

Number of ones: 45
```

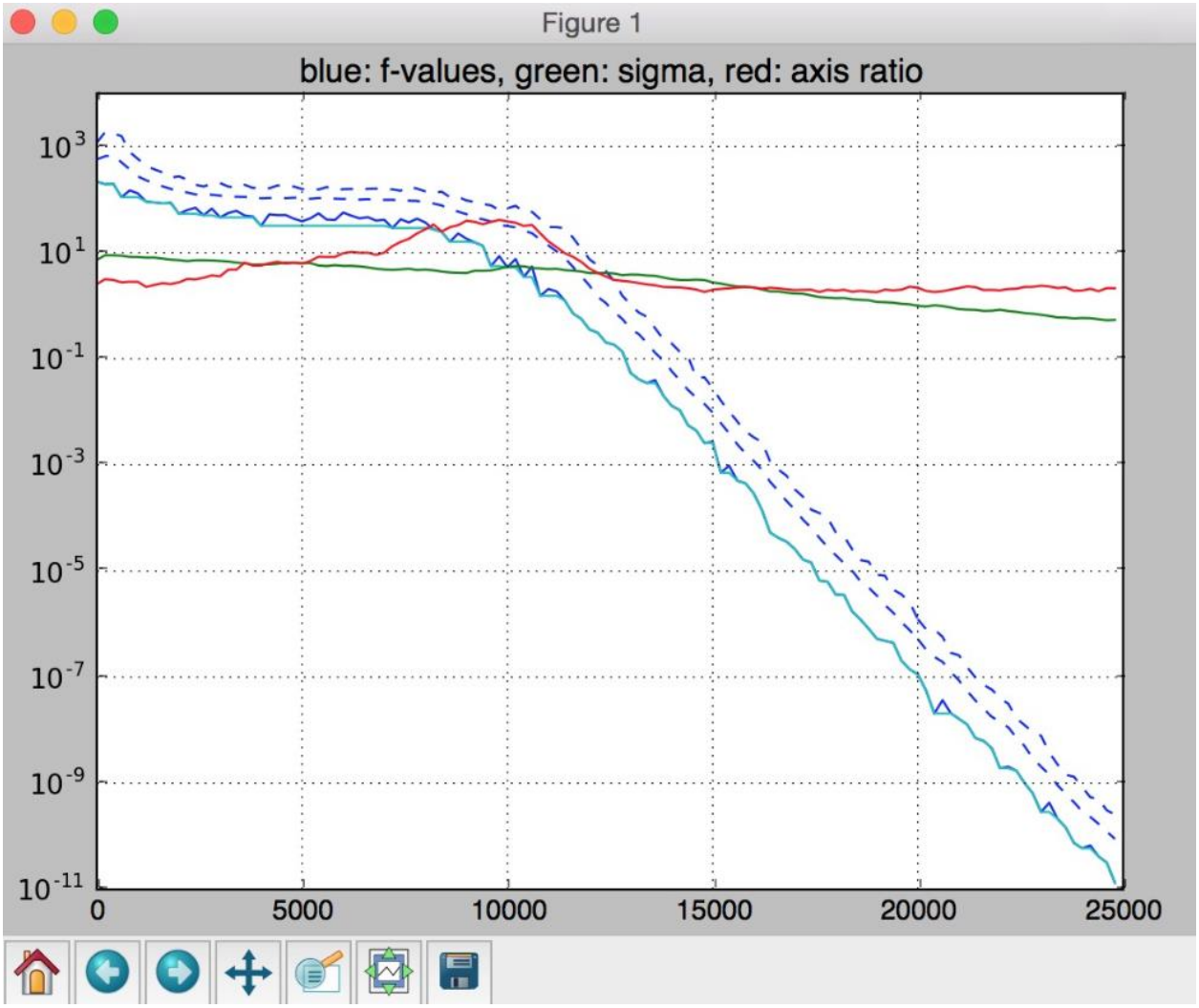


Figure 1
blue: f-values, green: sigma, red: axis ratio
10^3
10^1
10^-1
10^-3
10^-5
10^-7
10^-9
10^-11
0
5000
10000
15000
20000
25000

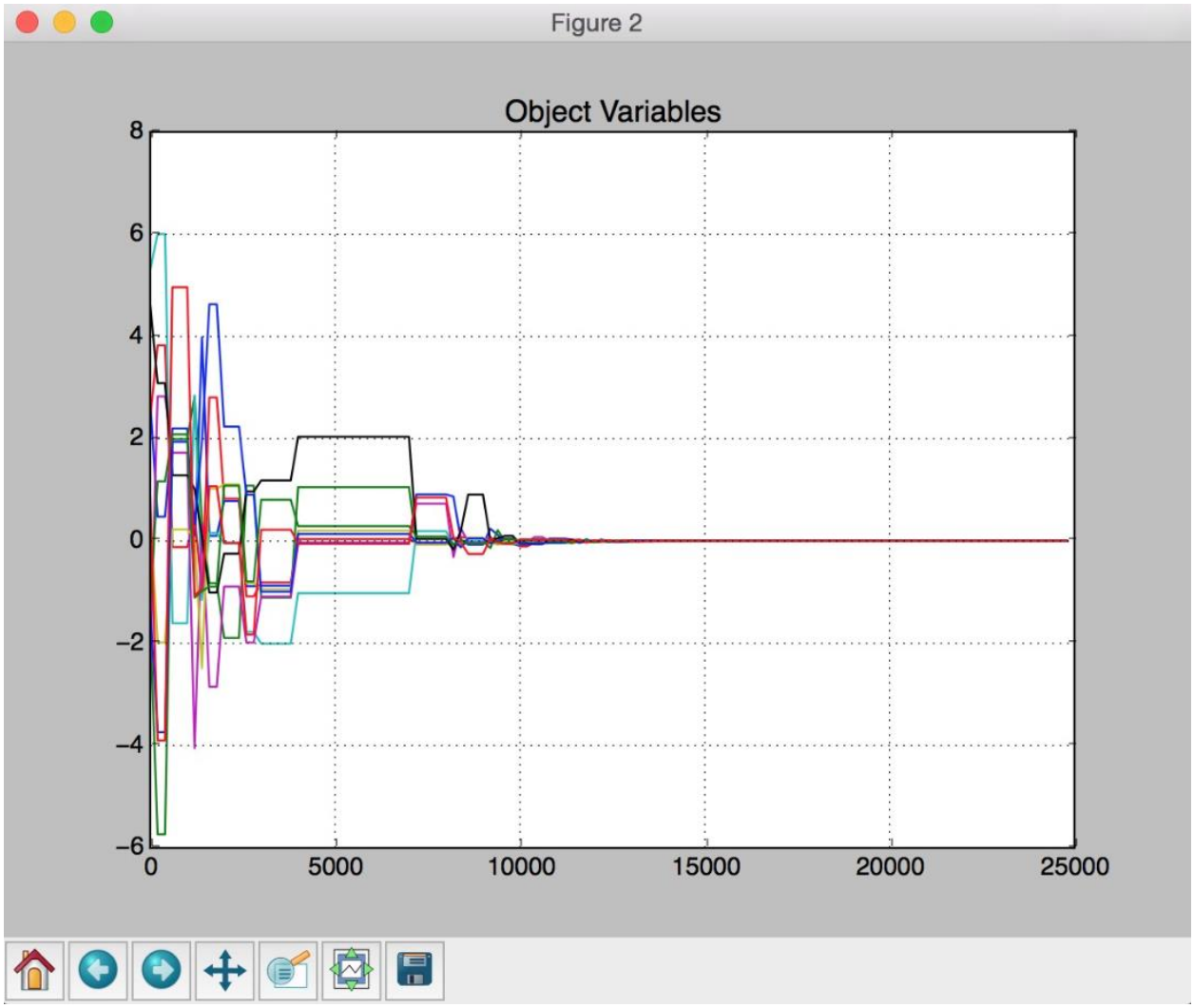


Figure 2
Object Variables
8
6
4
2
0
−2
−4
−6
0
5000
10000
15000
20000
25000

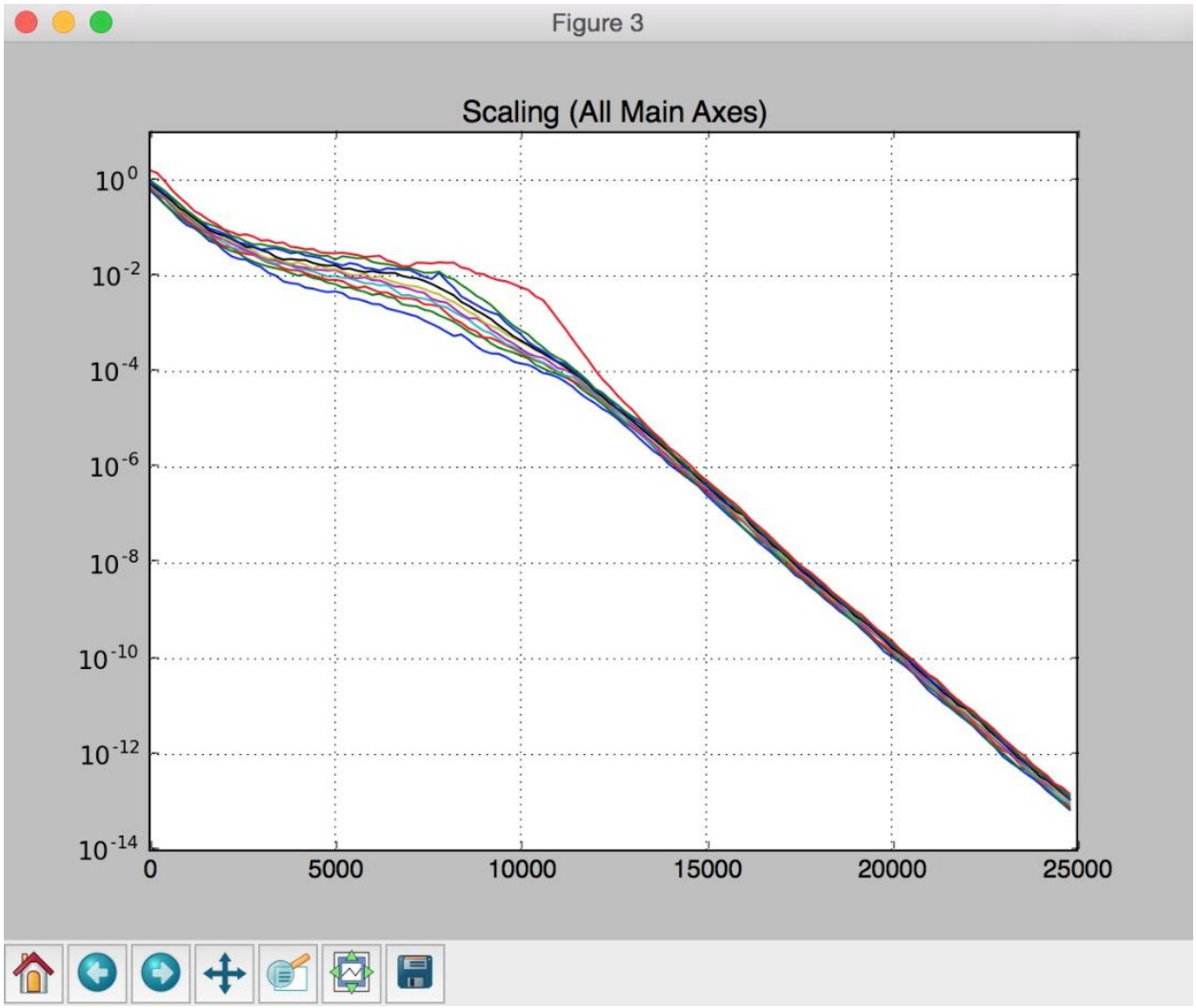


Figure 3
Scaling (All Main Axes)
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-12}
10^{-14}
0
5000
10000
15000
20000
25000

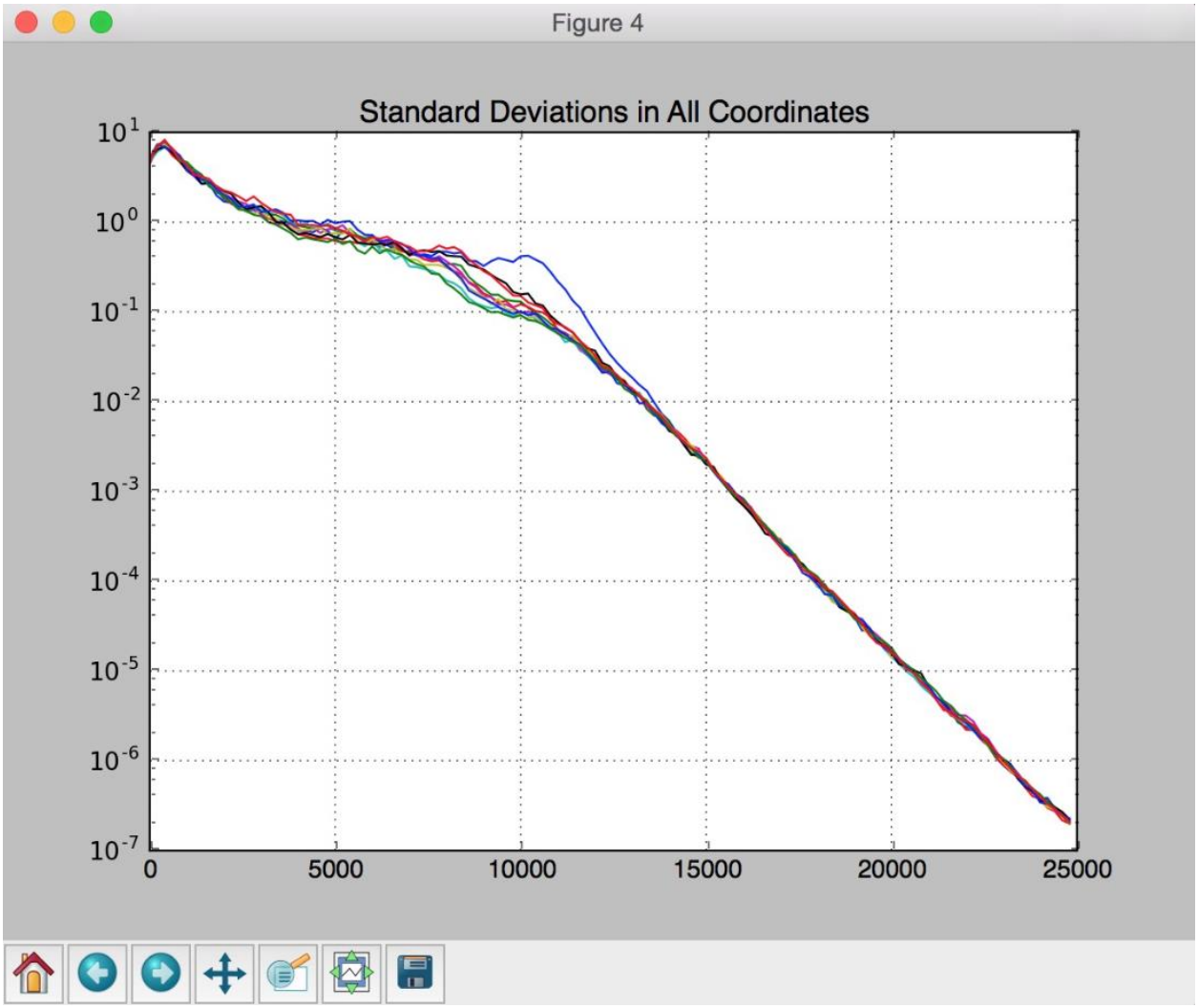


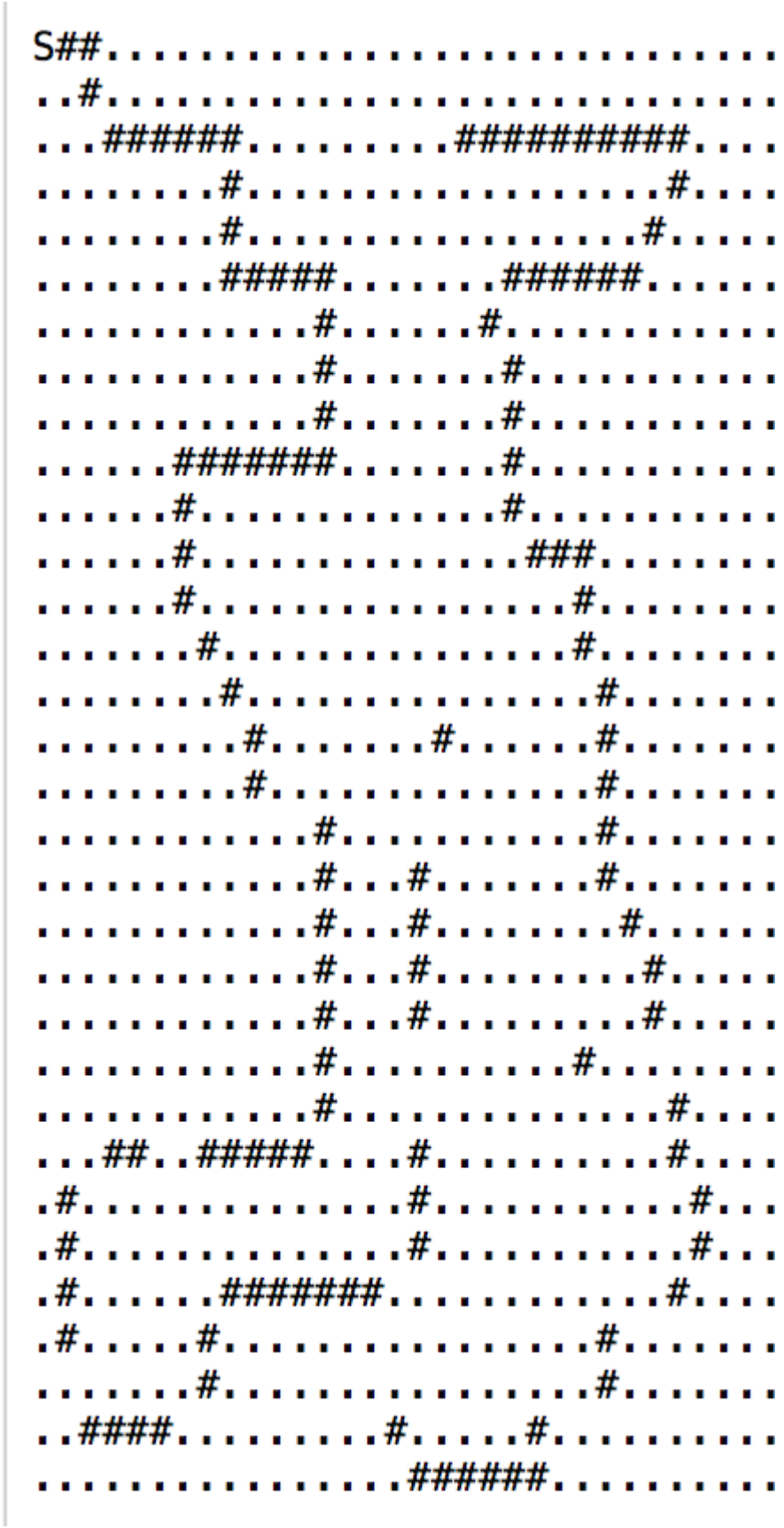
Figure 4
Standard Deviations in All Coordinates
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
5000
10000
15000
20000
25000

gen	evals	std	min	avg	max
0	200	188.36	217.082	576.281	1199.71
1	200	250.543	196.583	659.389	1869.02
2	200	273.081	199.455	683.641	1770.65
3	200	215.326	111.298	503.933	1579.3
4	200	133.046	149.47	373.124	790.899
5	200	75.4405	131.117	274.092	585.433
6	200	61.2622	91.7121	232.624	426.666
7	200	49.8303	88.8185	201.117	373.543
8	200	39.9533	85.0531	178.645	326.209
9	200	31.3781	87.4824	159.211	261.132
10	200	31.3488	54.0743	144.561	274.877
11	200	30.8796	63.6032	136.791	240.739
12	200	24.1975	70.4913	125.691	190.684
13	200	21.2274	50.6409	122.293	177.483
14	200	25.4931	67.9873	124.132	199.296
15	200	26.9804	46.3411	119.295	205.331
16	200	24.8993	56.0033	115.614	176.702
17	200	21.9789	61.4999	113.417	170.156
18	200	21.2823	50.2455	112.419	190.677
19	200	22.5016	48.153	111.543	166.2
20	200	21.1602	32.1864	106.044	171.899
21	200	23.3864	52.8601	107.301	163.617
22	200	23.1008	51.1226	109.628	185.777
23	200	22.0836	51.3058	106.402	179.673

100	200	2.38865e-07	1.12678e-07	5.18814e-07	1.23527e-06
101	200	1.49444e-07	5.56979e-08	3.3199e-07	7.98774e-07
102	200	1.11635e-07	2.07109e-08	2.41361e-07	7.96738e-07
103	200	9.50257e-08	3.69117e-08	1.94641e-07	5.75896e-07
104	200	5.63849e-08	2.09827e-08	1.26148e-07	2.887e-07
105	200	4.42488e-08	1.64212e-08	8.6972e-08	2.58639e-07
106	200	2.34933e-08	1.28302e-08	5.47789e-08	1.54658e-07
107	200	1.74434e-08	7.13185e-09	3.64705e-08	9.88235e-08
108	200	1.17157e-08	6.32208e-09	2.54673e-08	7.13075e-08
109	200	8.73027e-09	4.60369e-09	1.79681e-08	5.88066e-08
110	200	6.39874e-09	1.92573e-09	1.43229e-08	4.00087e-08
111	200	5.31196e-09	2.05551e-09	1.13736e-08	3.16793e-08
112	200	3.15607e-09	1.72427e-09	7.28548e-09	1.67727e-08
113	200	2.3789e-09	1.01164e-09	5.01177e-09	1.24541e-08
114	200	1.38424e-09	6.43112e-10	2.94696e-09	9.25819e-09
115	200	1.04172e-09	2.87571e-10	2.06068e-09	7.90436e-09
116	200	6.08685e-10	4.32905e-10	1.4704e-09	3.80221e-09
117	200	4.51515e-10	2.1538e-10	9.23627e-10	2.2759e-09
118	200	2.77204e-10	1.46869e-10	6.3507e-10	1.44637e-09
119	200	2.06475e-10	7.54881e-11	4.41427e-10	1.33167e-09
120	200	1.3138e-10	5.97282e-11	2.98116e-10	8.60453e-10
121	200	9.52385e-11	6.753e-11	2.32358e-10	5.45441e-10
122	200	7.55001e-11	4.1851e-11	1.72688e-10	5.05054e-10
123	200	5.52125e-11	3.2216e-11	1.23505e-10	3.10081e-10
124	200	4.38068e-11	1.32871e-11	8.94929e-11	2.57202e-10

		fitness				size			
gen	nevals	avg	max	min	std	avg	max	min	std
0	450	18.6918	47.1923	7.39087	6.27543	3.73556	7	2	1.62449
1	251	15.4572	41.3823	4.46965	4.54993	3.80222	12	1	1.81316
2	236	13.2545	37.7223	4.46965	4.06145	3.96889	12	1	1.98861
3	251	12.2299	60.828	4.46965	4.70055	4.19556	12	1	1.9971
4	235	11.001	47.1923	4.46965	4.48841	4.84222	13	1	2.17245
5	229	9.44483	31.478	4.46965	3.8796	5.56	19	1	2.43168
6	225	8.35975	22.0546	3.02133	3.40547	6.38889	15	1	2.40875
7	237	7.99309	31.1356	1.81133	4.08463	7.14667	16	1	2.57782
8	224	7.42611	359.418	1.17558	17.0167	8.33333	19	1	3.11127
9	237	5.70308	24.1921	1.17558	3.71991	9.64444	23	1	3.31365
10	254	5.27991	30.4315	1.13301	4.13556	10.5089	25	1	3.51898

36	209	1.10464	22.0546	0.0474957	2.71898	26.4867	46	1	5.23289
37	258	1.61958	86.0936	0.0382386	6.1839	27.2111	45	3	4.75557
38	257	2.03651	70.4768	0.0342642	5.15243	26.5311	49	1	6.22327
39	235	1.95531	185.328	0.0472693	9.32516	26.9711	48	1	6.00345
40	234	1.51403	28.5529	0.0472693	3.24513	26.6867	52	1	5.39811
41	230	1.4753	70.4768	0.0472693	5.4607	27.1	46	3	4.7433
42	233	12.3648	4880.09	0.0396503	229.754	26.88	53	1	5.18192
43	251	1.807	86.0936	0.0396503	5.85281	26.4889	50	1	5.43741
44	236	9.30096	3481.25	0.0277886	163.888	26.9622	55	1	6.27169
45	231	1.73196	86.7372	0.0342642	6.8119	27.4711	51	2	5.27807
46	227	1.86086	185.328	0.0342642	10.1143	28.0644	56	1	6.10812
47	216	12.5214	4923.66	0.0342642	231.837	29.1022	54	1	6.45898
48	232	14.3469	5830.89	0.0322462	274.536	29.8244	58	3	6.24093
49	242	2.56984	272.833	0.0322462	18.2752	29.9267	51	1	6.31446
50	227	2.80136	356.613	0.0322462	21.0416	29.7978	56	4	6.50275
51	243	1.75099	86.0936	0.0322462	5.70833	29.8089	56	1	6.62379
52	253	10.9184	3435.84	0.0227048	163.602	29.9911	55	1	6.66833
53	243	1.80265	48.0418	0.0227048	4.73856	29.88	55	1	7.33084
54	234	1.74487	86.0936	0.0227048	6.0249	30.6067	55	1	6.85782
55	220	1.58888	31.094	0.0132398	3.82809	30.5644	54	1	6.96669
56	234	1.46711	103.287	0.00766444	6.81157	30.6689	55	3	6.6806
57	250	17.0896	6544.17	0.00424267	308.689	31.1267	60	4	7.25837
58	231	1.66757	141.584	0.00144401	7.35306	32	52	1	7.23295
59	229	2.22325	265.224	0.00144401	13.388	33.5489	64	1	8.38351
60	248	2.60303	521.804	0.00144401	24.7018	35.2533	58	1	7.61506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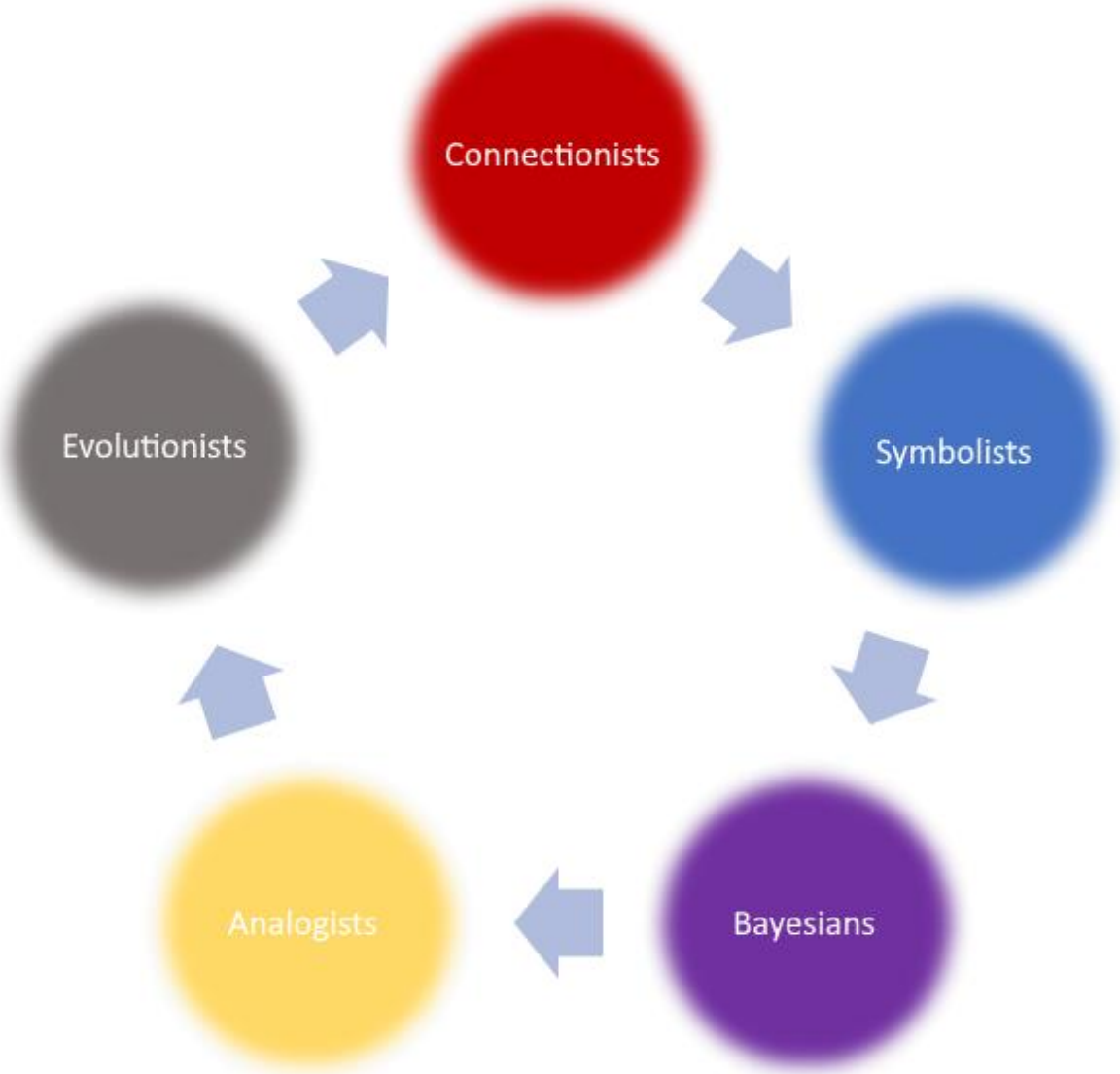
gen	nevals	avg	std	min	max
0	400	1.4875	4.37491	0	62
1	231	4.285	7.56993	0	73
2	235	10.8925	14.8493	0	73
3	231	21.72	22.1239	0	73
4	238	29.9775	27.7861	0	76
5	224	37.6275	31.8698	0	76
6	231	42.845	33.0541	0	80
7	223	43.55	33.9369	0	83
8	234	44.0675	34.5201	0	83
9	231	49.2975	34.3065	0	83
10	249	47.075	36.4106	0	93
11	222	52.7925	36.2826	0	97
12	248	51.0725	37.2598	0	97
13	234	54.01	37.4614	0	97
14	229	59.615	37.7894	0	97
15	228	63.3	39.8205	0	97
16	220	64.605	40.3962	0	97
17	236	62.545	40.5607	0	97
18	233	67.99	38.9033	0	97
19	236	66.4025	39.6574	0	97
20	221	69.785	38.7117	0	97
21	244	65.705	39.0957	0	97
22	230	70.32	37.1206	0	97
23	241	67.3825	39.4028	0	97

26	214	71.505	36.964	0	97
27	246	72.72	37.1637	0	97
28	238	73.5975	36.5385	0	97
29	239	76.405	35.5696	0	97
30	246	78.6025	33.4281	0	97
31	240	74.83	36.5157	0	97
32	216	80.2625	32.6659	0	97
33	220	80.6425	33.0933	0	97
34	247	78.245	34.6022	0	97
35	241	81.22	32.1885	0	97
36	234	83.6375	29.0002	0	97
37	228	82.485	31.7354	0	97
38	219	83.4625	30.0592	0	97
39	212	88.64	24.2702	0	97
40	231	86.7275	27.0879	0	97
41	229	89.1825	23.8773	0	97
42	216	87.96	25.1649	0	97
43	218	86.85	27.1116	0	97
44	236	88.78	23.7278	0	97
45	225	89.115	23.4212	0	97
46	232	88.5425	24.187	0	97
47	245	87.7775	25.3909	0	97
48	231	87.78	26.3786	0	97
49	238	88.8525	24.5115	0	97
50	233	87.82	25.4164	1	97


Connectionists
Symbolists
Bayesians
Analogists
Evolutionists

```
d:2, a:0, m:1
d:3, a:0, m:1
d:4, a:0, m:1
d:5, a:0, m:1
d:6, a:0, m:1
d:7, a:0, m:1
d:8, a:0, m:1
d:9, a:0, m:1
d:10, a:100, m:4
1 10 4
25 coins left in the pile

Move #1: player 1 plays 4 :
21 coins left in the pile

Player 2 what do you play ? 1

Move #2: player 2 plays 1 :
20 coins left in the pile

Move #3: player 1 plays 4 :
16 coins left in the pile
```

```
Move #5: player 1 plays 2 :
11 coins left in the pile

Player 2 what do you play ? 4

Move #6: player 2 plays 4 :
7 coins left in the pile

Move #7: player 1 plays 1 :
6 coins left in the pile

Player 2 what do you play ? 2

Move #8: player 2 plays 2 :
4 coins left in the pile

Move #9: player 1 plays 3 :
1 coins left in the pile

Player 2 what do you play ? 1

Move #10: player 2 plays 1 :
0 coins left in the pile
```

```
. . .
. . .
. . .

Player 1 what do you play ? 5

Move #1: player 1 plays 5 :

. . .
. O .
. . .

Move #2: player 2 plays 1 :

X . .
. O .
. . .

Player 1 what do you play ? 9

Move #3: player 1 plays 9 :

X . .
. O .
. . O
```

```
X O X
. O .
. X O

Player 1 what do you play ? 4

Move #7: player 1 plays 4 :

X O X
O O .
. X O

Move #8: player 2 plays 6 :

X O X
O O X
. X O

Player 1 what do you play ? 7

Move #9: player 1 plays 7 :

X O X
O O X
O X O
```

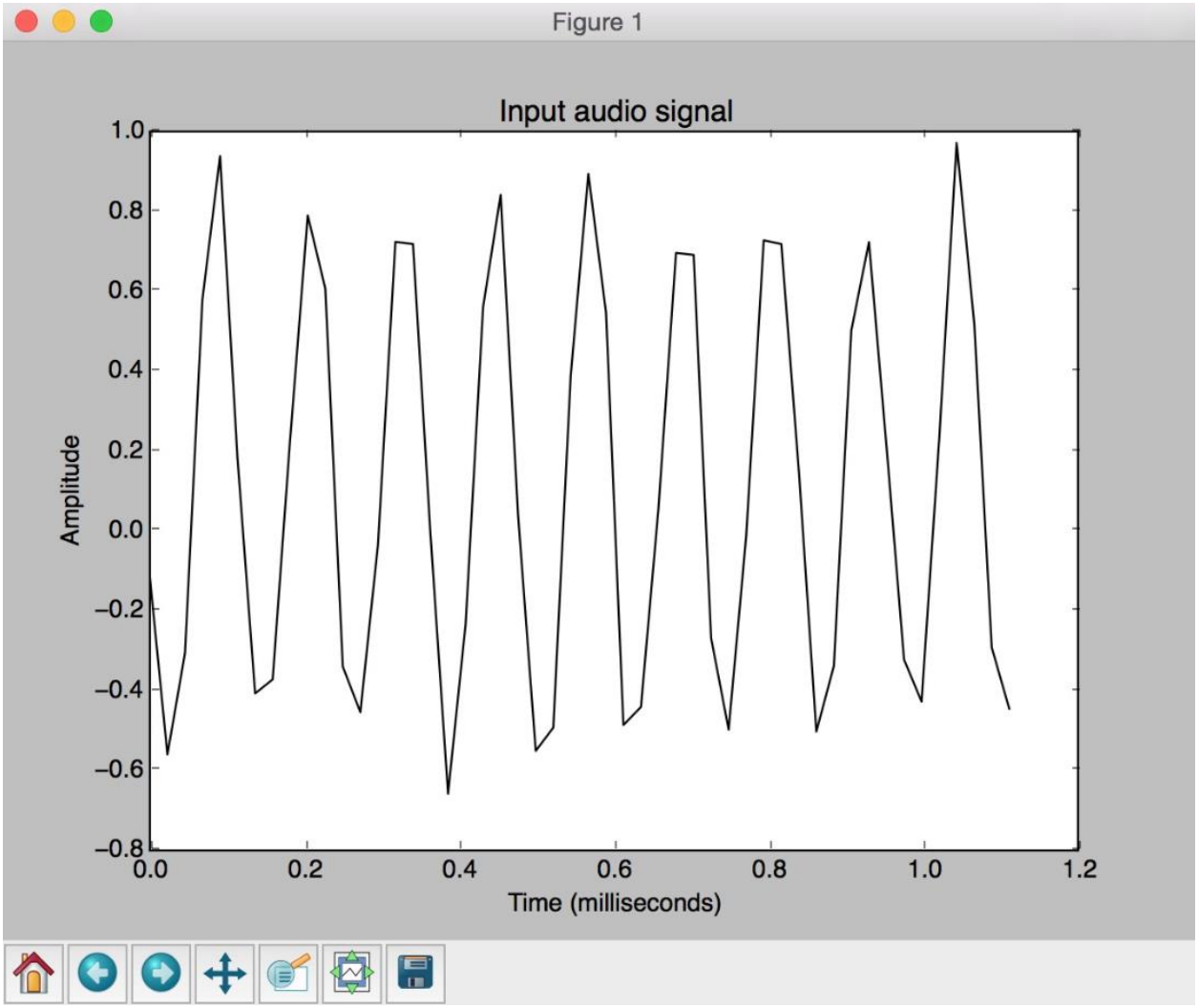
```
0 1 2 3 4 5 6
-------------
. . . . . . .
. . . . . . .
. . . . . . .
. . . . . . .
. . . . . . .
. . . . . . .

Move #1: player 1 plays 0 :

0 1 2 3 4 5 6
-------------
. . . . . . .
. . . . . . .
. . . . . . .
. . . . . . .
. . . . . . .
O . . . . . .

Move #2: player 2 plays 0 :

0 1 2 3 4 5 6
-------------
. . . . . . .
```

```
O O O X O O .

Move #35: player 1 plays 6 :

0 1 2 3 4 5 6
-------------
X X O O X . .
O O X X O . .
X X O O X X .
O O X X O O .
X X O X X X .
O O O X O O O

Move #36: player 2 plays 6 :

0 1 2 3 4 5 6
-------------
X X O O X . .
O O X X O . .
X X O O X X .
O O X X O O .
X X O X X X X
O O O X O O O

Player 2 wins.
```

```
1 1 1 1
. . . .
. . . .
2 2 2 2

Move #1: player 1 plays A1 B1 :
. 1 1 1
1 . . .
. . . .
2 2 2 2

Move #2: player 2 plays D1 C1 :
. 1 1 1
1 . . .
2 . . .
. 2 2 2

Move #3: player 1 plays A2 B2 :
. . 1 1
1 1 . .
2 . . .
. 2 2 2

Move #4: player 2 plays D2 C2 :
. . 1 1
```

```
Move #4: player 2 plays D2 C2 :
. . 1 1
1 1 . .
2 2 . .
. . 2 2

Move #5: player 1 plays B1 C2 :
. . 1 1
. 1 . .
2 1 . .
. . 2 2

Move #6: player 2 plays C1 B1 :
. . 1 1
2 1 . .
. 1 . .
. . 2 2

Move #7: player 1 plays C2 D2 :
. . 1 1
2 1 . .
. . . .
. 1 2 2

Player 1 wins after 8 turns
```

Chapter 14: Building a Speech Recognizer




```
Signal shape: (132300,)
Datatype: int16
Signal duration: 3.0 seconds
```

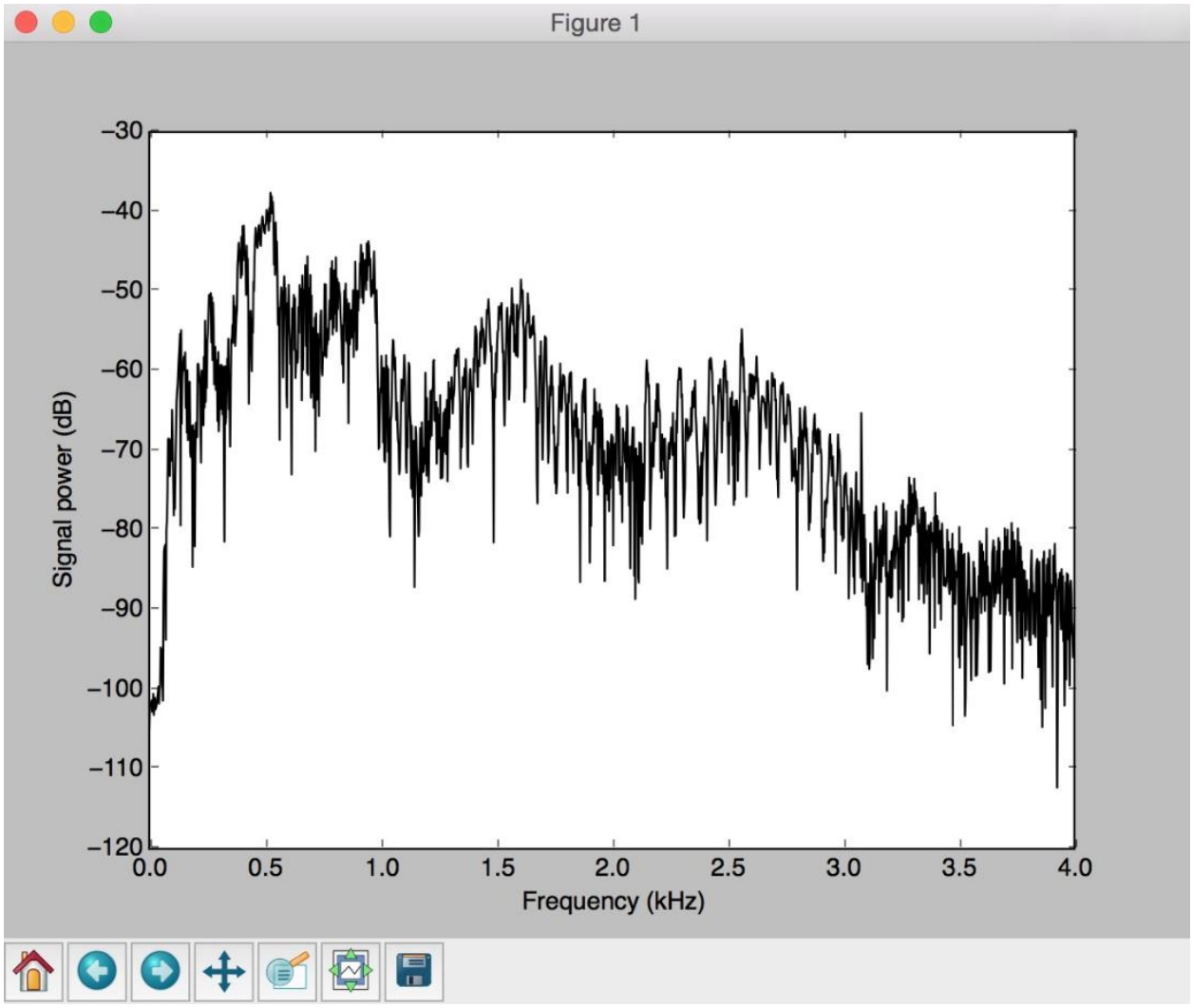


Figure 1
−30
−40
−50
−60
−70
−80
−90
−100
−110
−120
Signal power (dB)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Frequency (kHz)

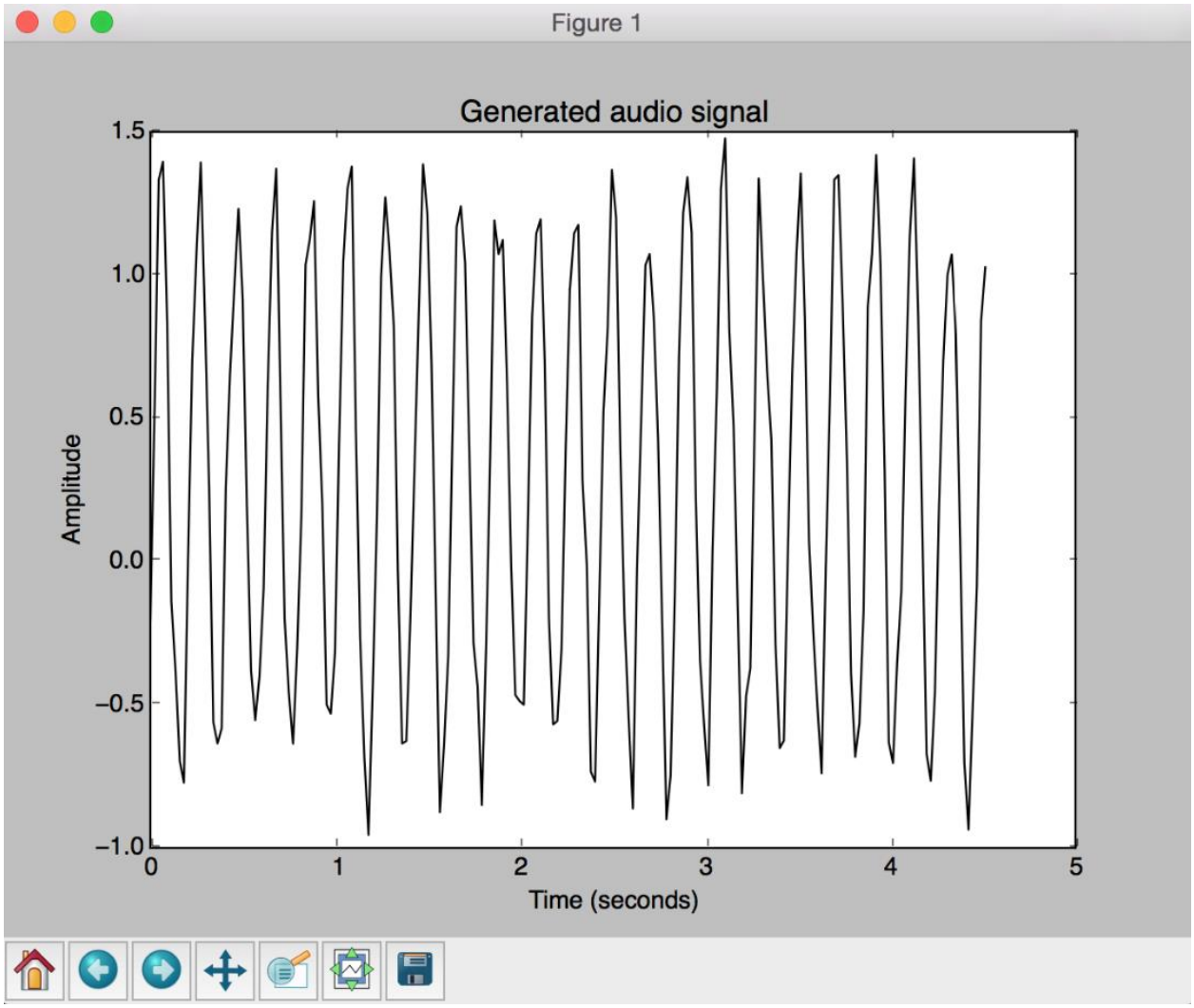


Figure 1
Generated audio signal
Amplitude
Time (seconds)
1.5
1.0
0.5
0.0
−0.5
−1.0
0
1
2
3
4
5

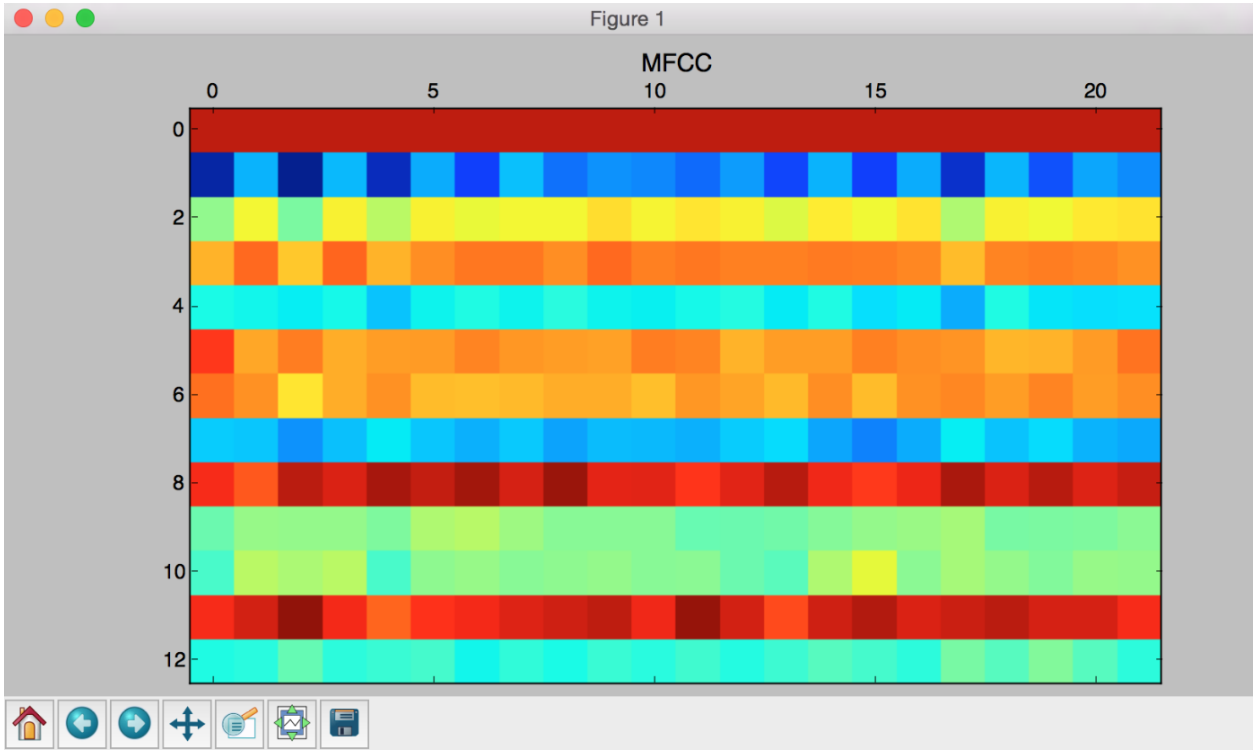


Figure 1
MFCC
0
5
10
15
20
0
2
4
6
8
10
12

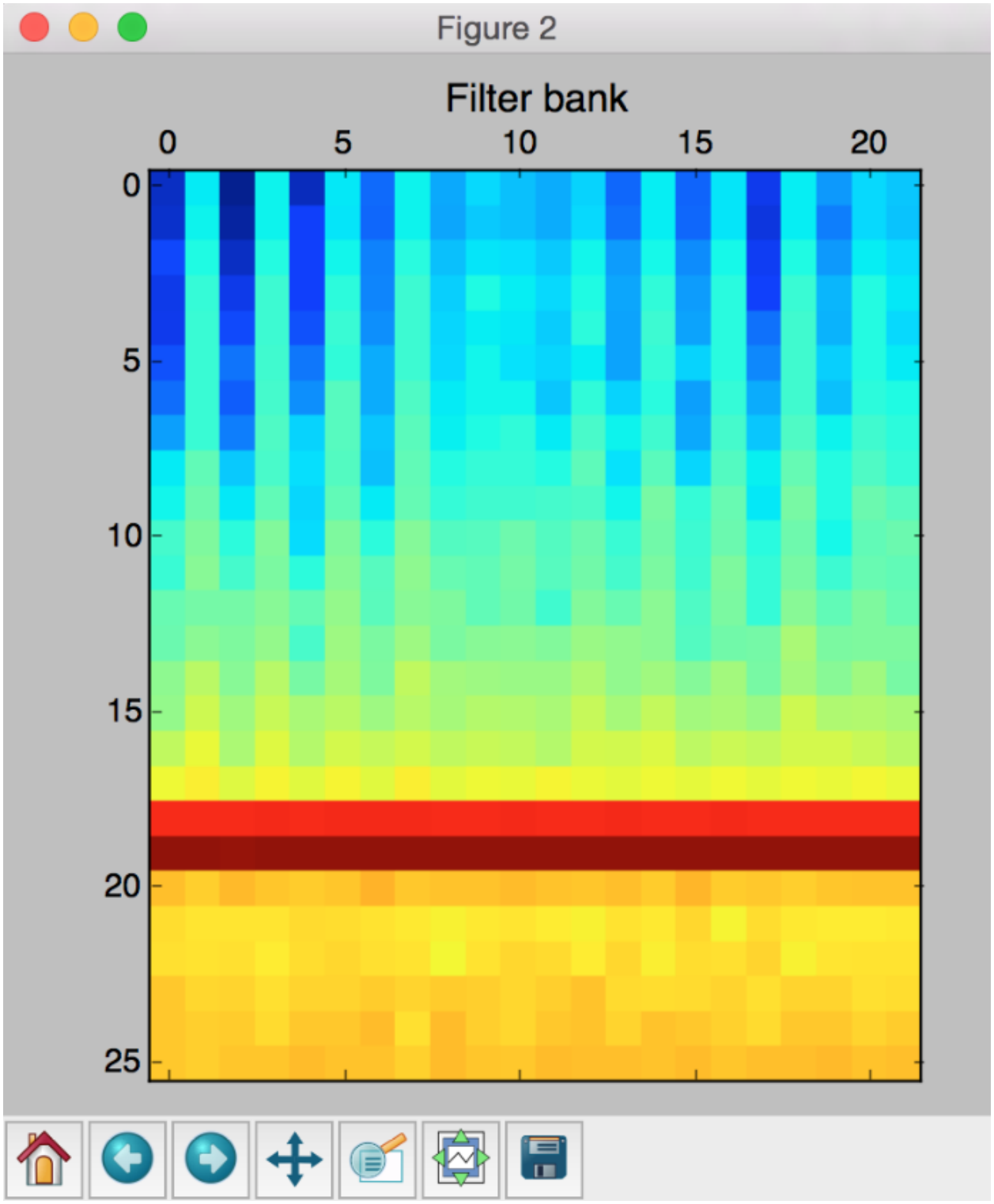


Figure 2
Filter bank
0
5
10
15
20
0
5
10
15
20
25

```
MFCC:
Number of windows = 22
Length of each feature = 13

Filter bank:
Number of windows = 22
Length of each feature = 26
```

```
Original:  apple
Predicted: apple

Original:  banana
Predicted: banana

Original:  kiwi
Predicted: kiwi

Original:  lime
Predicted: lime

Original:  orange
Predicted: orange

Original:  peach
Predicted: peach

Original:  pineapple
Predicted: pineapple
```

Chapter 15: Natural Language Processing

```
Sentence tokenizer:
['Do you know how tokenization works?', "It's actually quite interesting!", "Let's analyze a couple of se
ntences and figure it out."]

Word tokenizer:
['Do', 'you', 'know', 'how', 'tokenization', 'works', '?', 'It', "'s", 'actually', 'quite', 'interesting'
, '!', 'Let', "'s", 'analyze', 'a', 'couple', 'of', 'sentences', 'and', 'figure', 'it', 'out', '.']

Word punct tokenizer:
['Do', 'you', 'know', 'how', 'tokenization', 'works', '?', 'It', "'", 's', 'actually', 'quite', 'interest
ing', '!', 'Let', "'", 's', 'analyze', 'a', 'couple', 'of', 'sentences', 'and', 'figure', 'it', 'out', '.
']
```

INPUT WORD	PORTER	LANCASTER	SNOWBALL
writing	write	writ	write
calves	calv	calv	calv
be	be	be	be
branded	brand	brand	brand
horse	hors	hors	hors
randomize	random	random	random
possibly	possibl	poss	possibl
provision	provis	provid	provis
hospital	hospit	hospit	hospit
kept	kept	kept	kept
scratchy	scratchi	scratchy	scratchi
code	code	cod	code

INPUT WORD	NOUN LEMMATIZER	VERB LEMMATIZER
writing	writing	write
calves	calf	calve
be	be	be
branded	branded	brand
horse	horse	horse
randomize	randomize	randomize
possibly	possibly	possibly
provision	provision	provision
hospital	hospital	hospital
kept	kept	keep
scratchy	scratchy	scratchy
code	code	code

```
Number of text chunks = 18

Chunk 1 ==> The Fulton County Grand Jury said Friday an invest
Chunk 2 ==> '' . ( 2 ) Fulton legislators `` work with city of
Chunk 3 ==> . Construction bonds Meanwhile , it was learned th
Chunk 4 ==> , anonymous midnight phone calls and veiled threat
Chunk 5 ==> Harris , Bexar , Tarrant and El Paso would be $451
Chunk 6 ==> set it for public hearing on Feb. 22 . The proposa
Chunk 7 ==> College . He has served as a border patrolman and
Chunk 8 ==> of his staff were doing on the address involved co
Chunk 9 ==> plan alone would boost the base to $5,000 a year a
Chunk 10 ==> nursing homes In the area of `` community health s
Chunk 11 ==> of its Angola policy prove harsh , there has been
Chunk 12 ==> system which will prevent Laos from being used as
Chunk 13 ==> reform in recipient nations . In Laos , the admini
Chunk 14 ==> . He is not interested in being named a full-time
Chunk 15 ==> said , `` to obtain the views of the general publi
Chunk 16 ==> '' . Mr. Reama , far from really being retired , i
Chunk 17 ==> making enforcement of minor offenses more effectiv
Chunk 18 ==> to tell the people where he stands on the tax issu
```

Document term matrix:

Word	Chunk-1	Chunk-2	Chunk-3	Chunk-4	Chunk-5	Chunk-6	Chunk-7
and	23	9	9	11	9	17	10
are	2	2	1	1	2	2	1
be	6	8	7	7	6	2	1
by	3	4	4	5	14	3	6
county	6	2	7	3	1	2	2
for	7	13	4	10	7	6	4
in	15	11	15	11	13	14	17
is	2	7	3	4	5	5	2
it	8	6	8	9	3	1	2
of	31	20	20	30	29	35	26
on	4	3	5	10	6	5	2
one	1	3	1	2	2	1	1
said	12	5	7	7	4	3	7
state	3	7	2	6	3	4	1
that	13	8	9	2	7	1	7
the	71	51	43	51	43	52	49
to	11	26	20	26	21	15	11
two	2	1	1	1	1	2	2
was	5	6	7	7	4	7	3
which	7	4	5	4	3	1	1
with	2	2	3	1	2	2	3

```
Dimensions of training data: (2844, 40321)

Input: You need to be careful with cars when you are driving on slippery roads
Predicted category: Autos

Input: A lot of devices can be operated wirelessly
Predicted category: Electronics

Input: Players need to be careful when they are close to goal posts
Predicted category: Hockey

Input: Political debates help us understand the perspectives of both sides
Predicted category: Politics
```

```
Number of end letters: 1
Accuracy = 74.7%
Alexander ==> male
Danielle ==> female
David ==> male
Cheryl ==> male

Number of end letters: 2
Accuracy = 78.79%
Alexander ==> male
Danielle ==> female
David ==> male
Cheryl ==> female

Number of end letters: 3
Accuracy = 77.22%
Alexander ==> male
Danielle ==> female
David ==> male
Cheryl ==> female
```

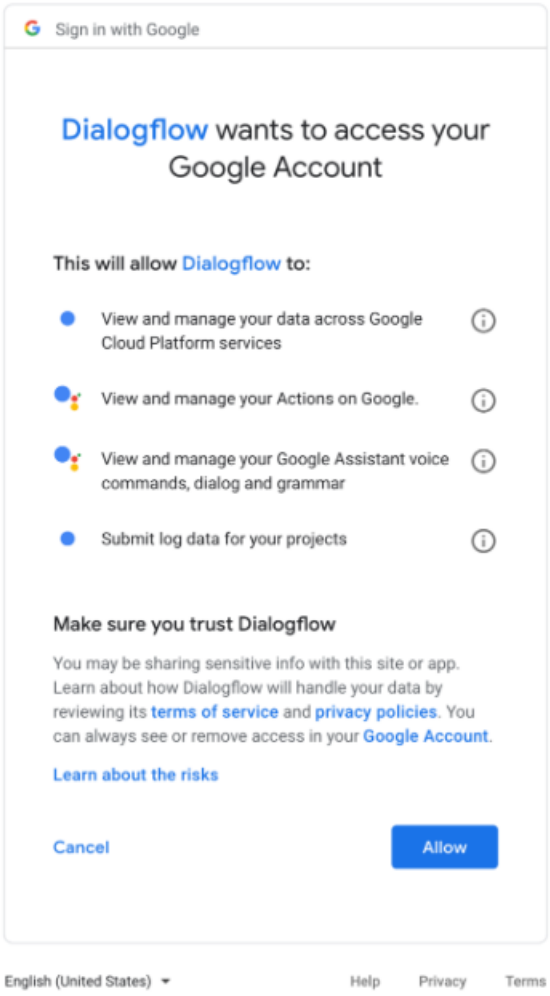
```
Number of end letters: 4
Accuracy = 69.98%
Alexander ==> male
Danielle ==> female
David ==> male
Cheryl ==> female

Number of end letters: 5
Accuracy = 64.63%
Alexander ==> male
Danielle ==> female
David ==> male
Cheryl ==> female
```

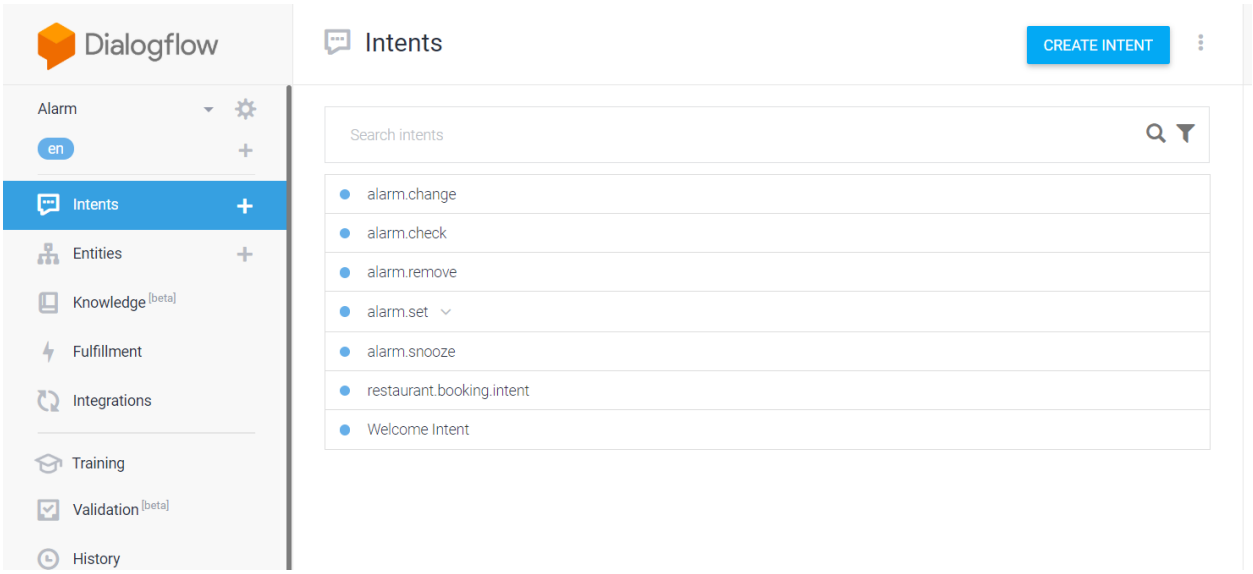
```
Number of training datapoints: 1600
Number of test datapoints: 400

Accuracy of the classifier: 0.735

Top 15 most informative words:
1. outstanding
2. insulting
3. vulnerable
4. ludicrous
5. uninvolving
6. astounding
7. avoids
8. fascination
9. symbol
10. seagal
11. affecting
12. anna
13. darker
14. animators
15. idiotic
```

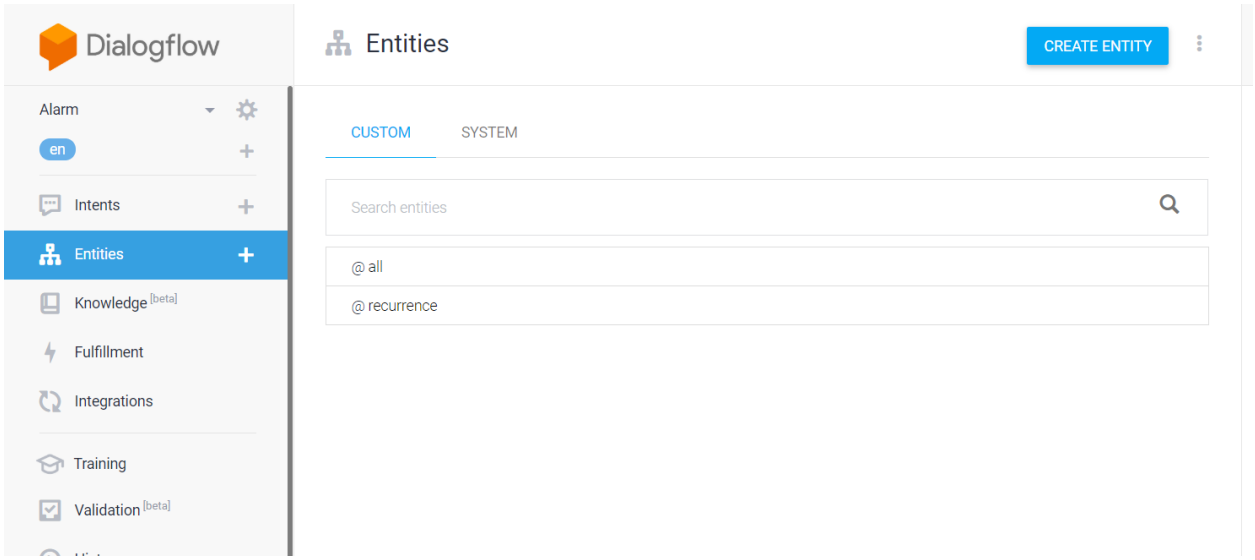
```
Movie review predictions:

Review: The costumes in this movie were great
Predicted sentiment: Positive
Probability: 0.59

Review: I think the story was terrible and the characters were very weak
Predicted sentiment: Negative
Probability: 0.8

Review: People say that the director of the movie is amazing
Predicted sentiment: Positive
Probability: 0.6

Review: This is such an idiotic movie. I will not recommend it to anyone.
Predicted sentiment: Negative
Probability: 0.87
```

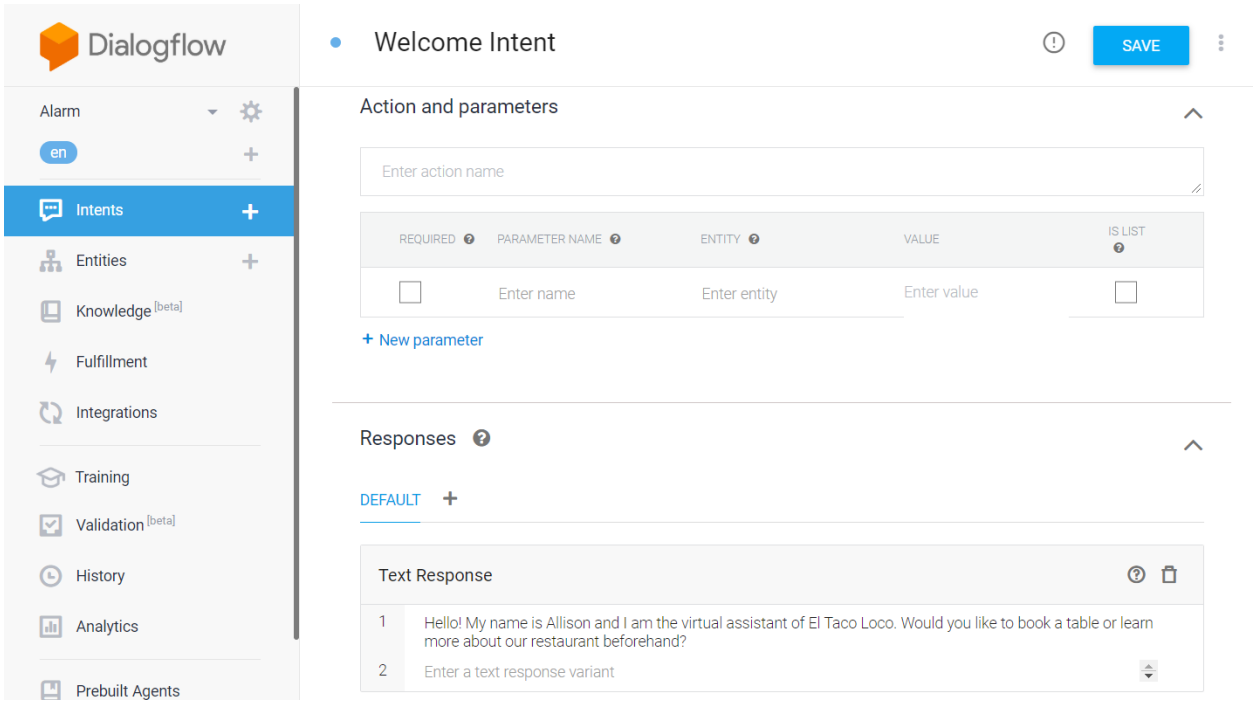
```
Top 5 contributing words to each topic:

Topic 0
mathemat ==> 2.7%
structur ==> 2.6%
set ==> 2.6%
formul ==> 2.6%
tradit ==> 1.6%

Topic 1
empir ==> 4.7%
expand ==> 3.3%
time ==> 2.0%
peopl ==> 2.0%
histor ==> 2.0%
```

Chapter 16: Chatbots






Dialogflow
Entities
CREATE ENTITY
Alarm
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
Validation [beta]
CUSTOM
SYSTEM
Search entities
@ all
@ recurrence


Dialogflow
Welcome Intent
SAVE
Alarm
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
Validation [beta]
History
Analytics
Prebuilt Agents
Action and parameters
Enter action name
REQUIRED
PARAMETER NAME
ENTITY
VALUE
IS LIST
Enter name
Enter entity
Enter value
+ New parameter
Responses
DEFAULT
Text Response
1
Hello! My name is Allison and I am the virtual assistant of El Taco Loco. Would you like to book a table or learn more about our restaurant beforehand?
2
Enter a text response variant

Web Demo

Test the agent on its own page. Share the link to the page or embed the ` widget in other websites to get more conversations going. More in documentation.

https://bot.dialogflow.com/1130d514-0fa1-4069-9027-57066748b

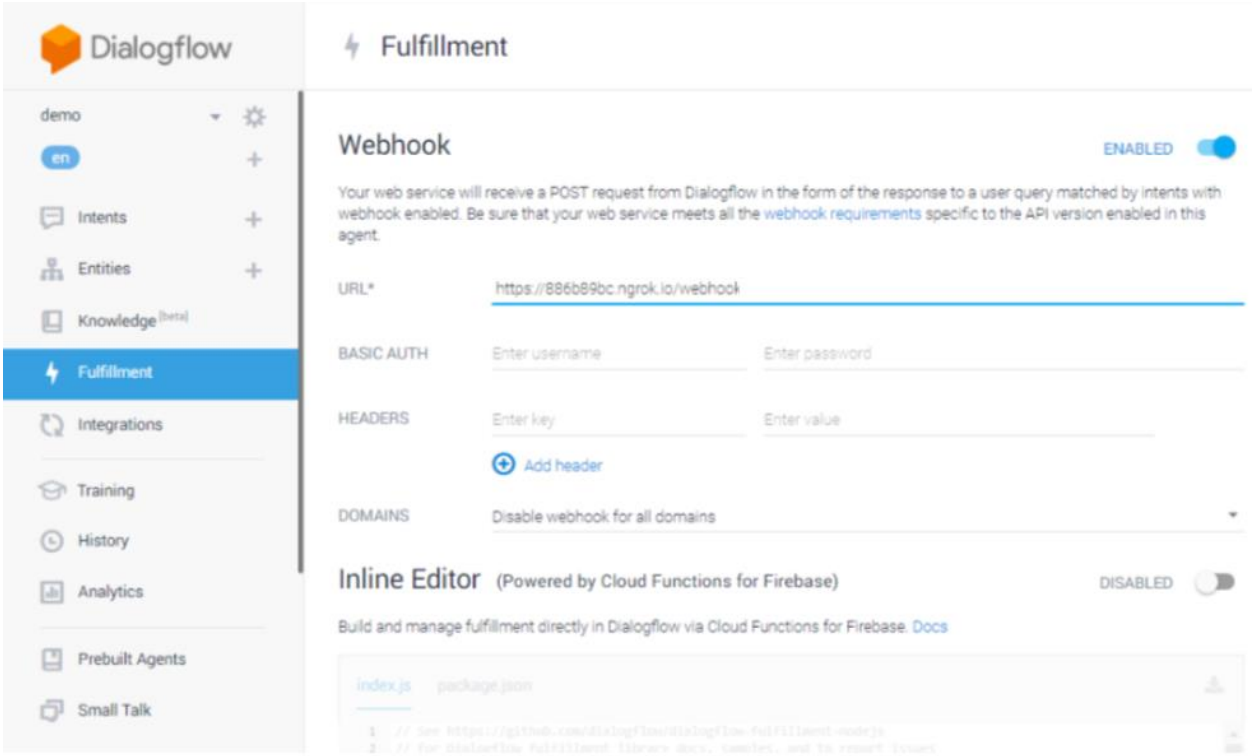
Seems that your agent info is not filled yet. Set icon and description for better end-user experience.

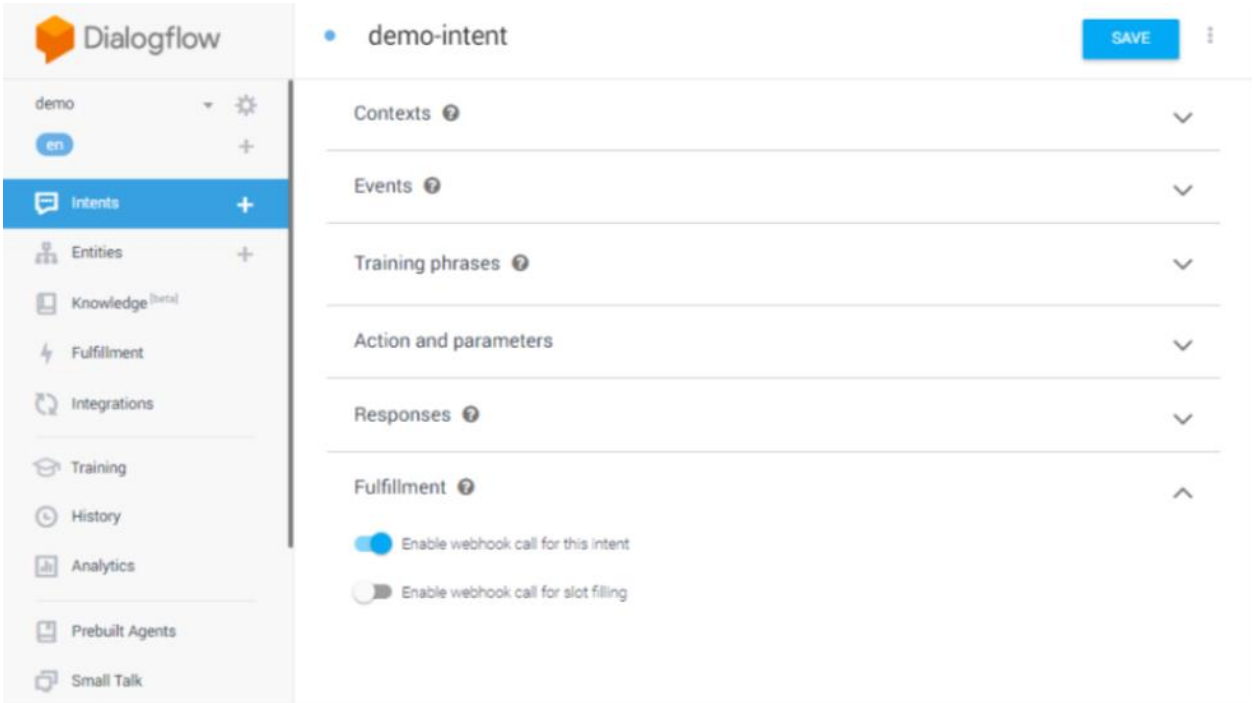
Add this agent to your website by copying the code below:

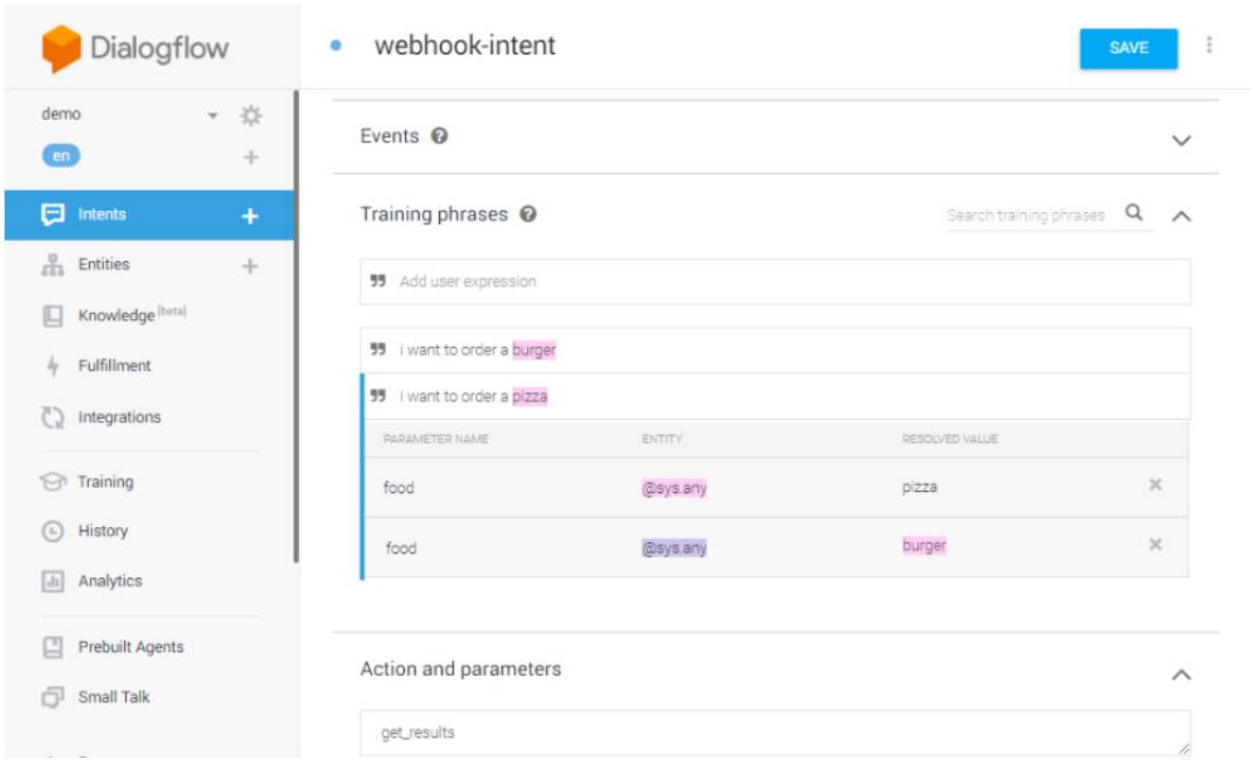
```
<iframe
    allow="microphone;"
    width="350"
    height="430"
    src="https://console.dialogflow.com/api-client/demo/embedded/30d514-0fa1-4069-9027-57066748bb3
6">
</iframe>
```

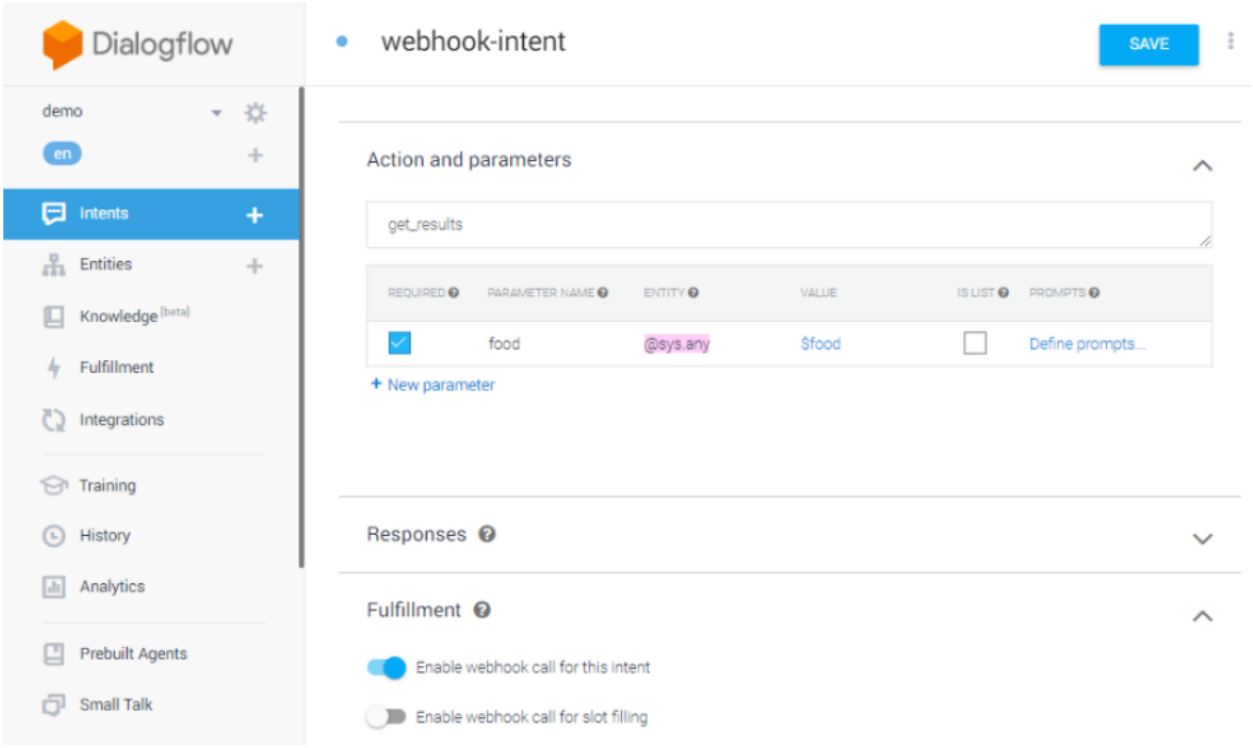
CLOSE

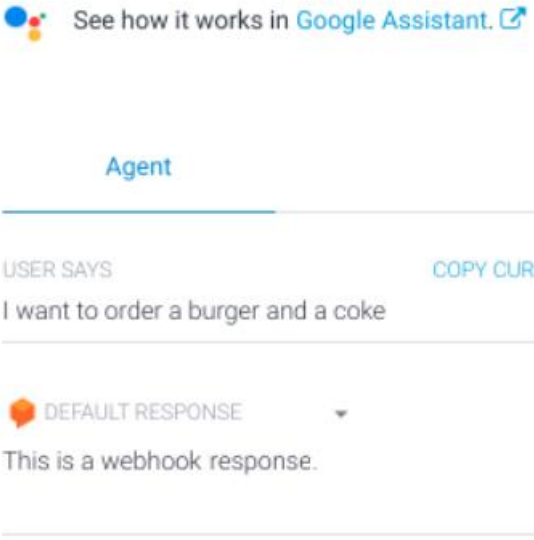
```
ngrok by @inconshreveable                                       (Ctrl+C to quit)

Session Status                online
Account
Version                       2.2.8
Region                        United States (us)
Web Interface                 http://127.0.0.1:4040
Forwarding                    http://886b69bc.ngrok.io -> localhost:5000
Forwarding                    https://886b69bc.ngrok.io -> localhost:5000

Connections                   ttl     opn     rt1     rt5     p50     p90
                              0       0       0.00    0.00    0.00    0.00
```


Dialogflow
Fulfillment
demo
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
History
Analytics
Prebuilt Agents
Small Talk
Webhook
ENABLED
Your web service will receive a POST request from Dialogflow in the form of the response to a user query matched by intents with webhook enabled. Be sure that your web service meets all the webhook requirements specific to the API version enabled in this agent.
URL*
https://886b89bc.ngrok.io/webhook
BASIC AUTH
Enter username
Enter password
HEADERS
Enter key
Enter value
Add header
DOMAINS
Disable webhook for all domains
Inline Editor (Powered by Cloud Functions for Firebase)
DISABLED
Build and manage fulfillment directly in Dialogflow via Cloud Functions for Firebase. Docs
index.js
package.json

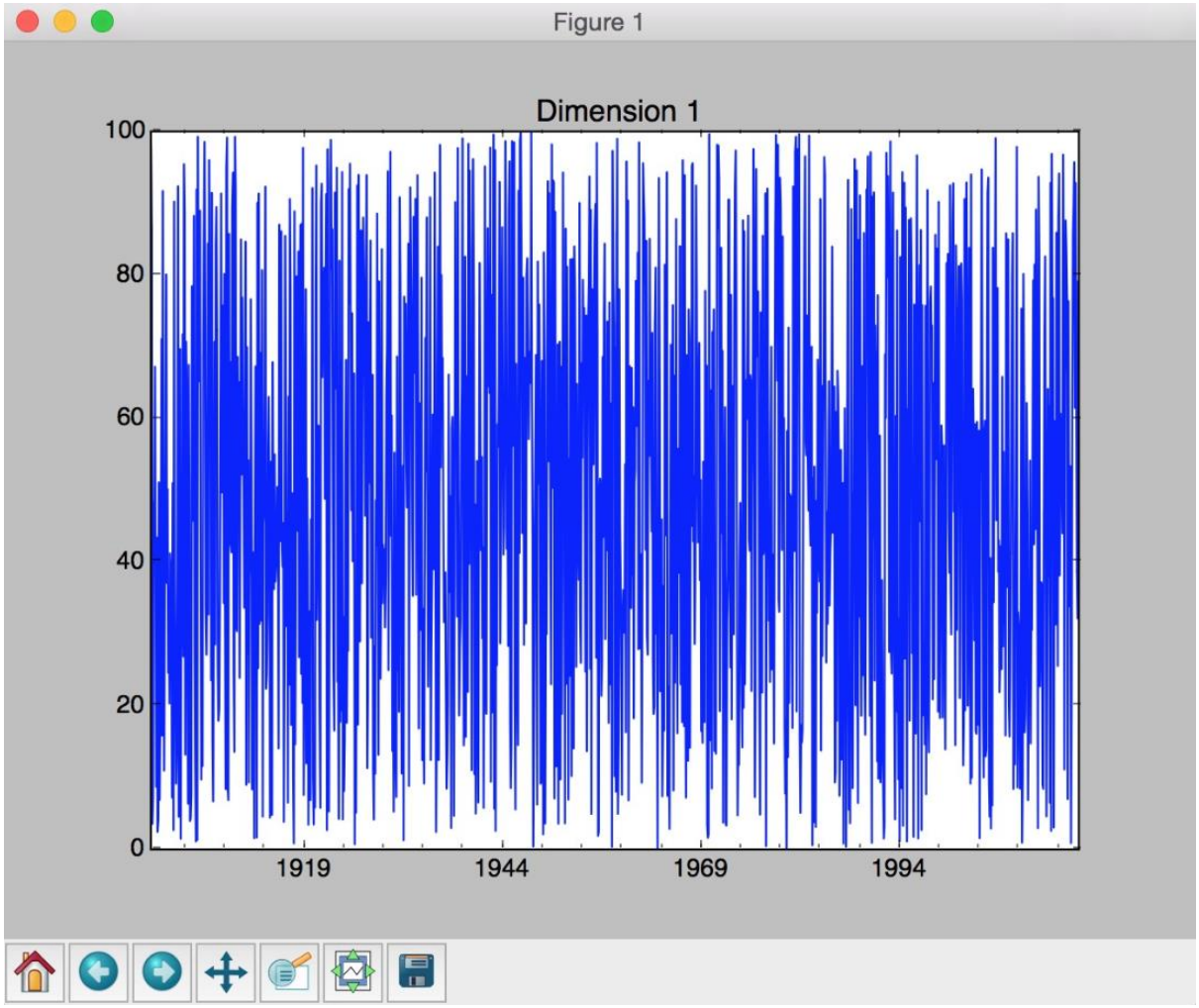

Dialogflow
demo-intent
SAVE
demo
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
History
Analytics
Prebuilt Agents
Small Talk
Contexts
Events
Training phrases
Action and parameters
Responses
Fulfillment
Enable webhook call for this intent
Enable webhook call for slot filling


Dialogflow
webhook-intent
SAVE
demo
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
History
Analytics
Prebuilt Agents
Small Talk
Events
Training phrases
Search training phrases
Add user expression
I want to order a burger
I want to order a pizza
PARAMETER NAME
ENTITY
RESOLVED VALUE
food
@sys.any
pizza
food
@sys.any
burger
Action and parameters
get_results


Dialogflow
webhook-intent
SAVE
demo
en
Intents
Entities
Knowledge [beta]
Fulfillment
Integrations
Training
History
Analytics
Prebuilt Agents
Small Talk
Action and parameters
get_results
REQUIRED
PARAMETER NAME
ENTITY
VALUE
IS LIST
PROMPTS
food
@sys.any
$food
Define prompts...
+ New parameter
Responses
Fulfillment
Enable webhook call for this intent
Enable webhook call for slot filling


See how it works in Google Assistant.
Agent
USER SAYS
COPY CURL
I want to order a burger and a coke
DEFAULT RESPONSE
This is a webhook response.

Chapter 17: Sequential Data and Time Series Analysis



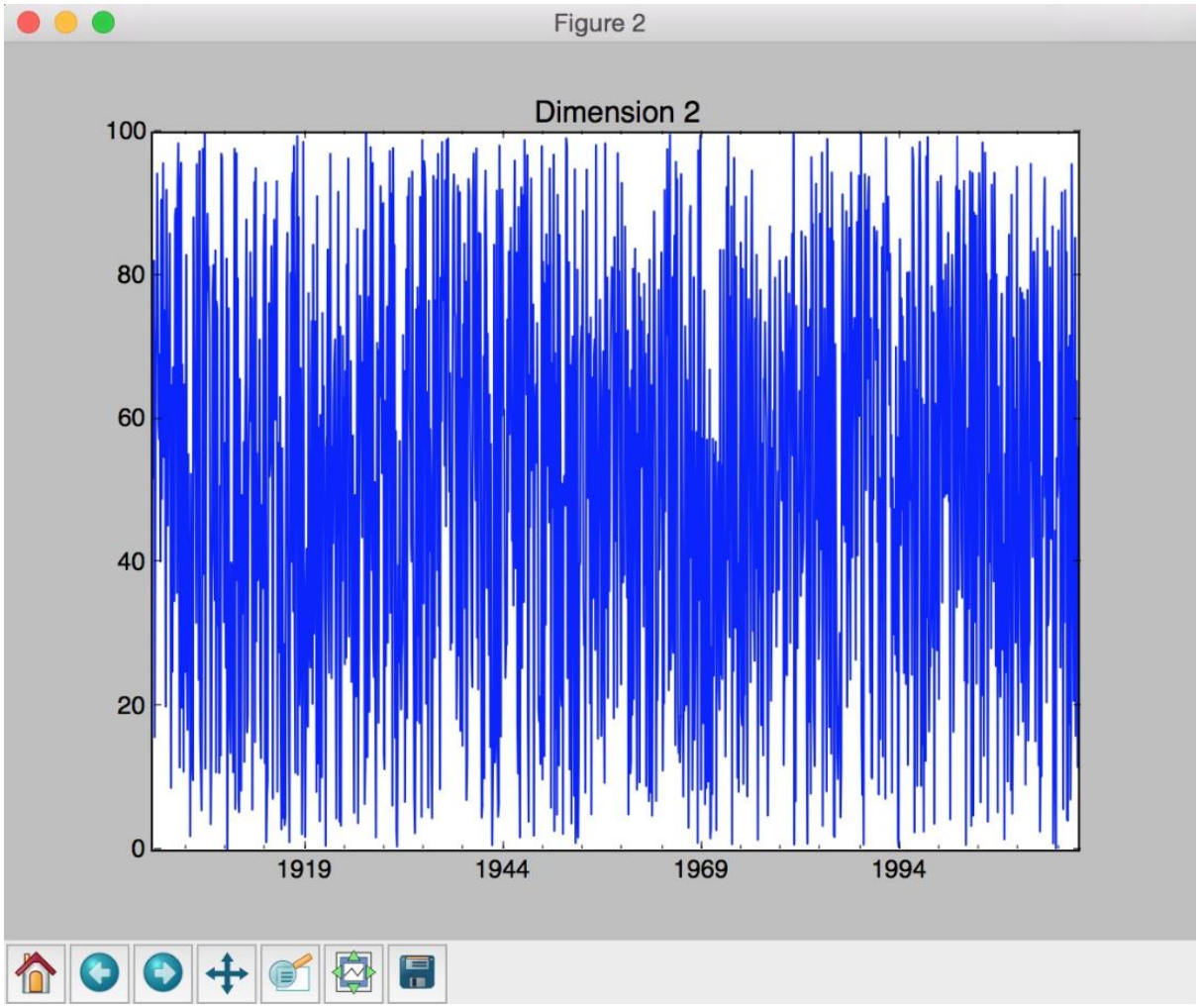


Figure 2
Dimension 2
100
80
60
40
20
0
1919
1944
1969
1994

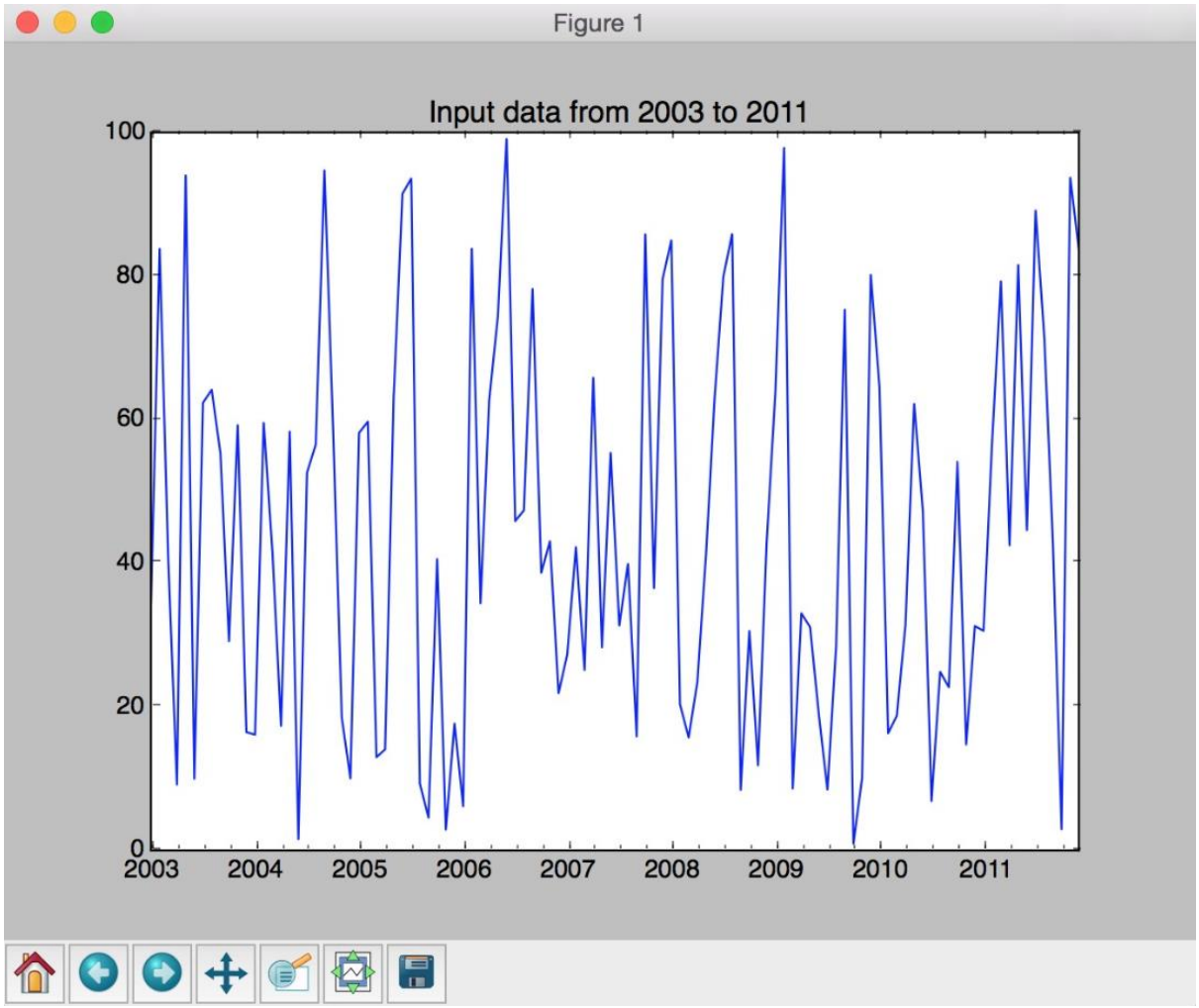


Figure 1
Input data from 2003 to 2011
100
80
60
40
20
0
2003
2004
2005
2006
2007
2008
2009
2010
2011

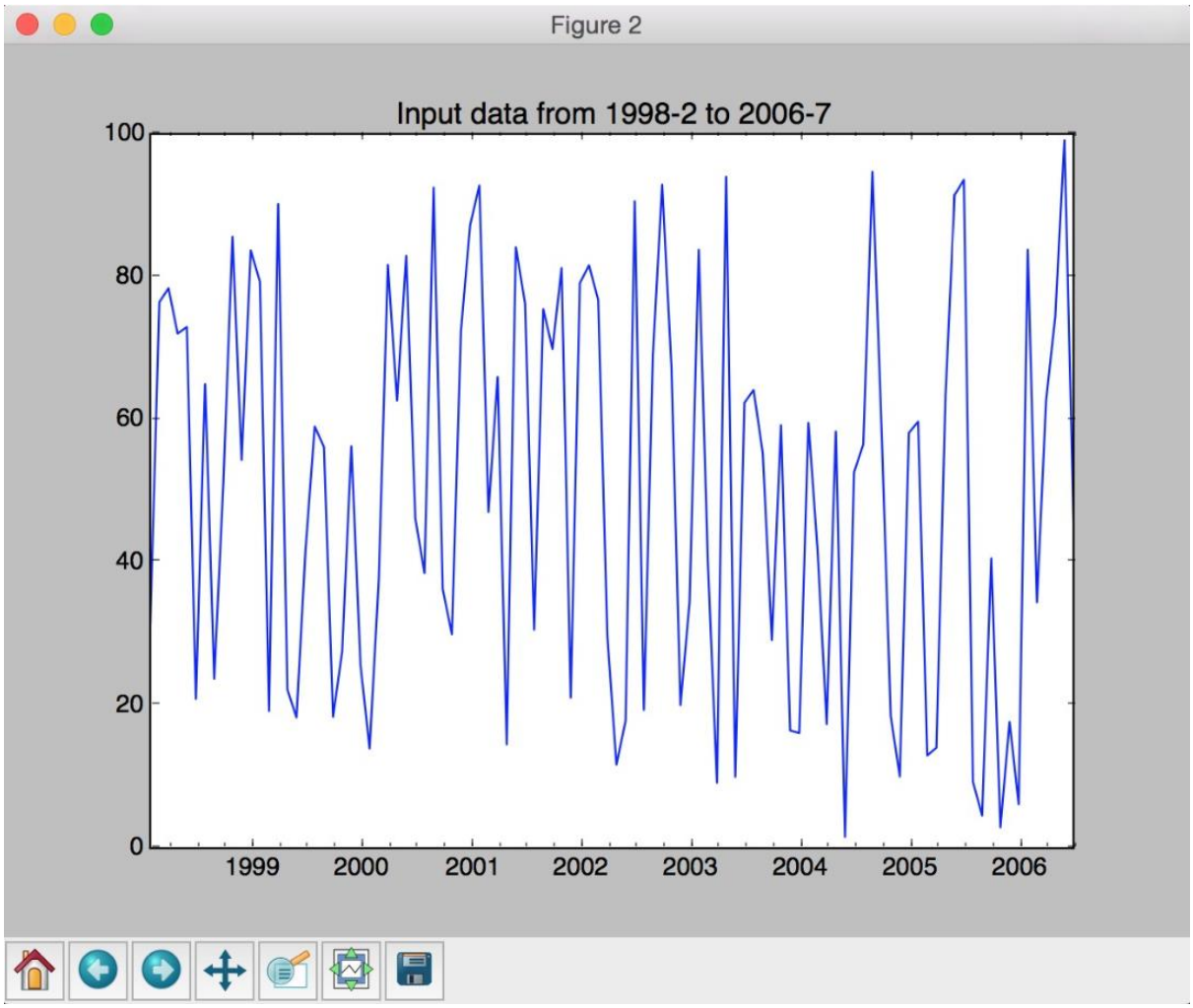


Figure 2
Input data from 1998-2 to 2006-7
100
80
60
40
20
0
1999
2000
2001
2002
2003
2004
2005
2006

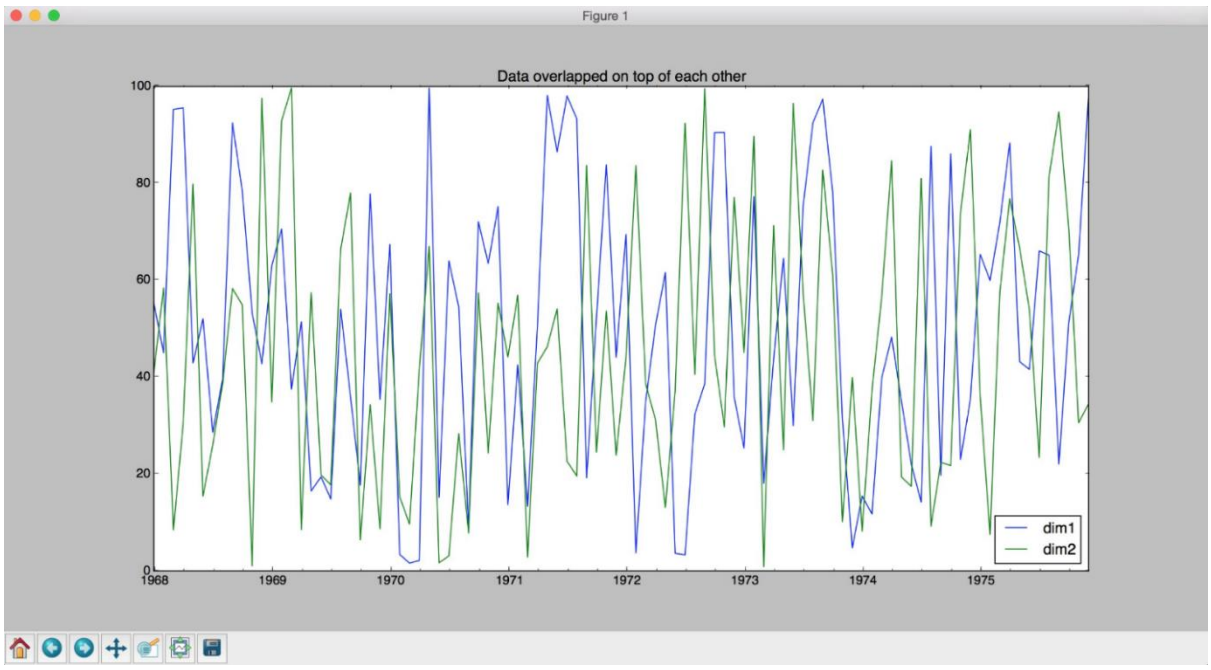


Figure 1
Data overlapped on top of each other
100
80
60
40
20
0
1968
1969
1970
1971
1972
1973
1974
1975
dim1
dim2

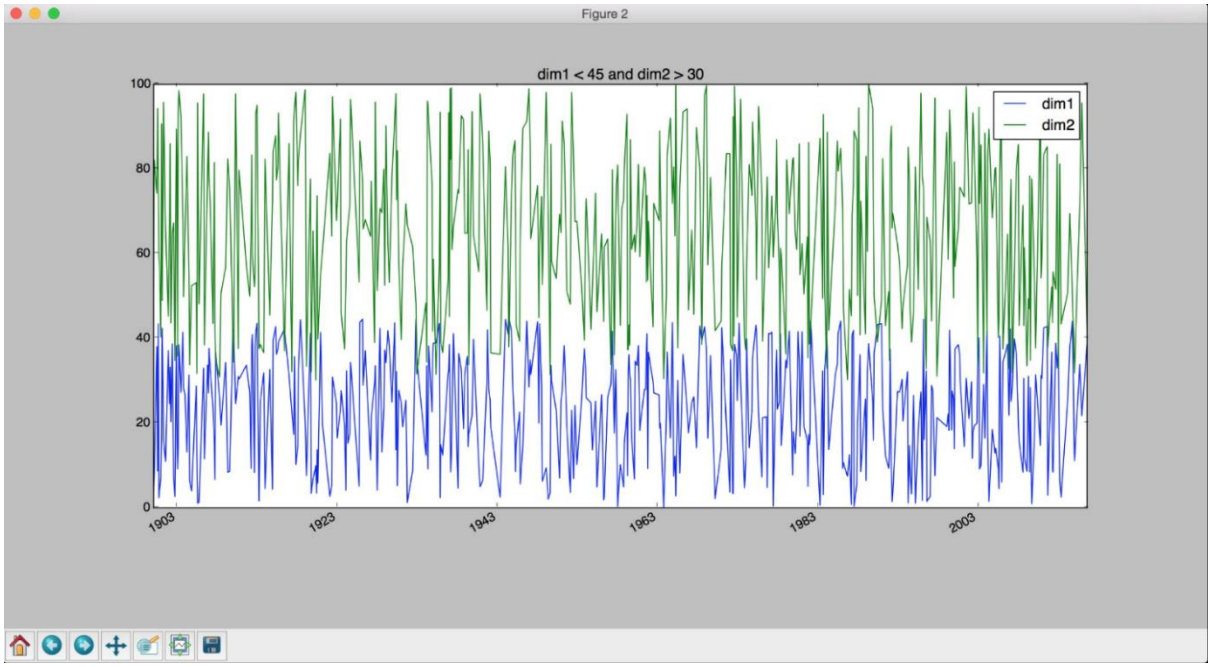


Figure 2
dim1 < 45 and dim2 > 30
dim1
dim2
100
80
60
40
20
0
1903
1923
1943
1963
1983
2003

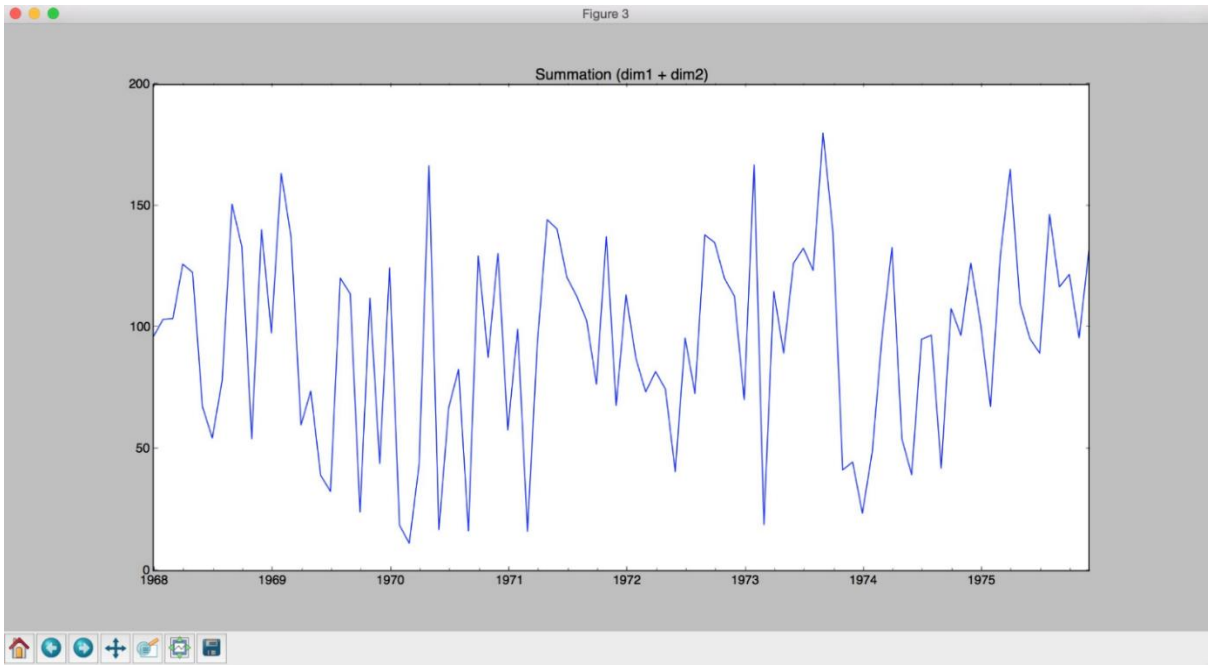


Figure 3
Summation (dim1 + dim2)
200
150
100
50
0
1968
1969
1970
1971
1972
1973
1974
1975

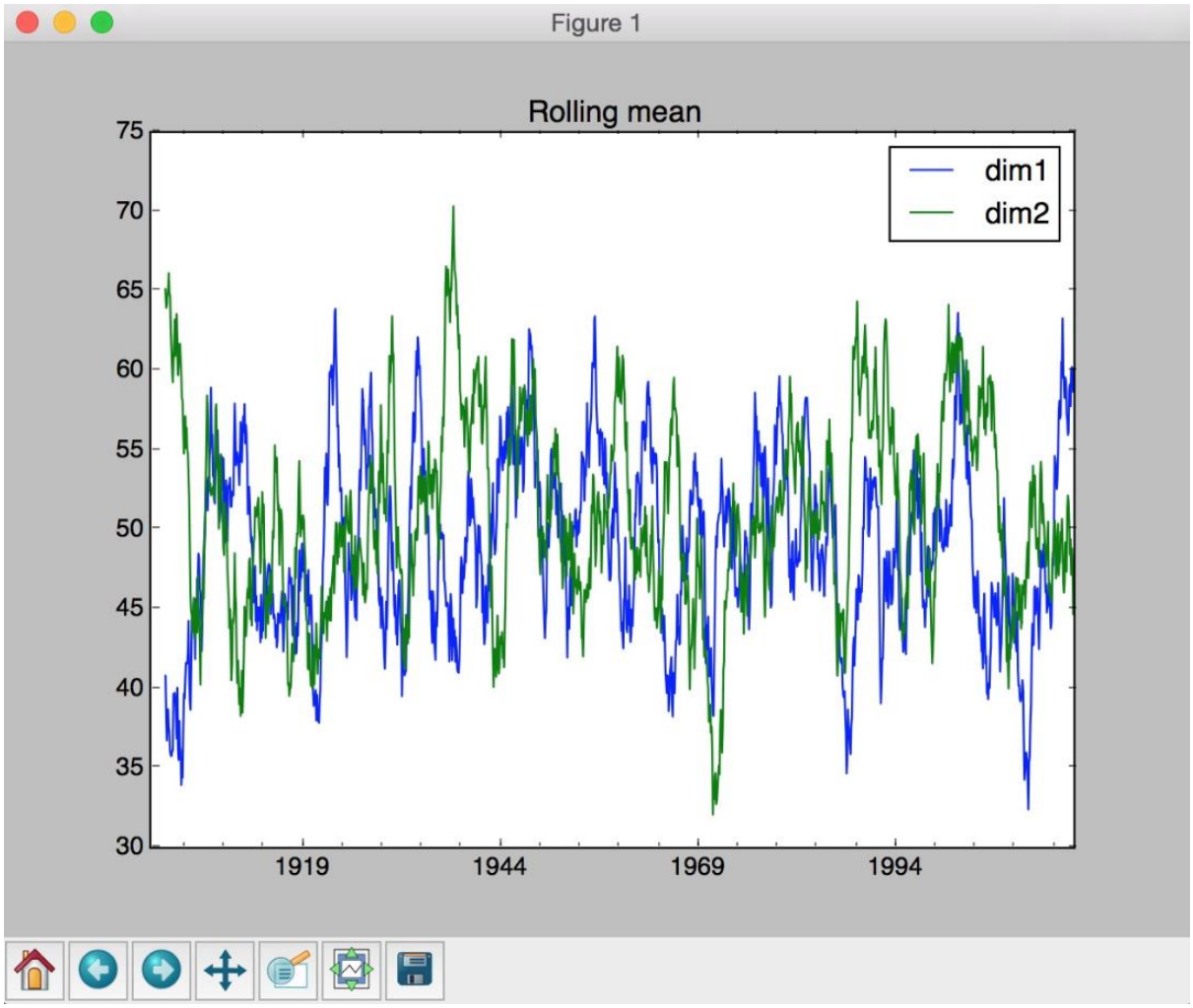
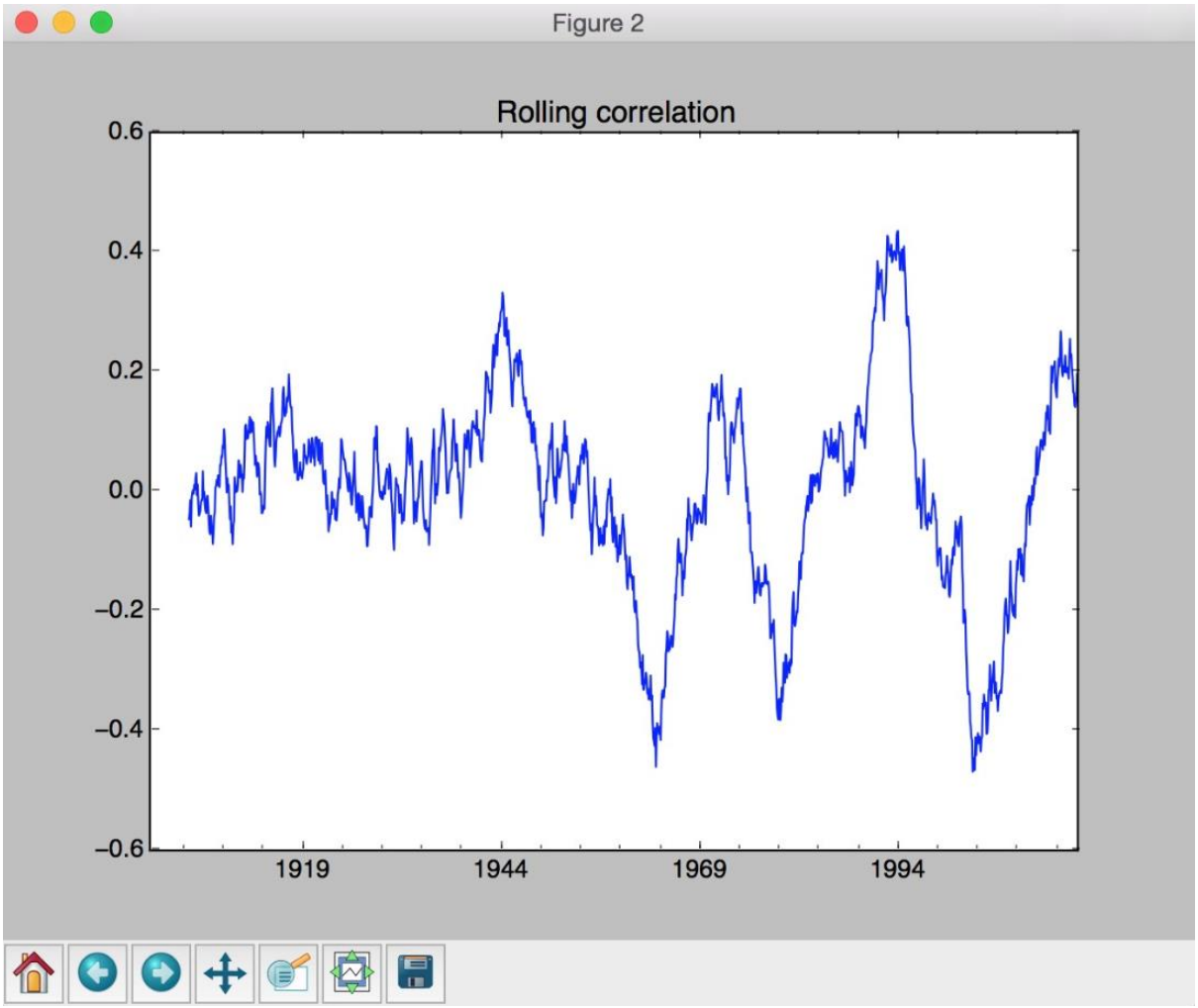


Figure 1
Rolling mean
dim1
dim2
75
70
65
60
55
50
45
40
35
30
1919
1944
1969
1994




```
Maximum values for each dimension:
dim1    99.98
dim2    99.97
dtype: float64

Minimum values for each dimension:
dim1    0.18
dim2    0.16
dtype: float64

Overall mean:
dim1    49.030541
dim2    50.983291
dtype: float64
```

```
Row-wise mean:
1900-01-31    85.595
1900-02-28    75.310
1900-03-31    27.700
1900-04-30    44.675
1900-05-31    31.295
1900-06-30    44.160
1900-07-31    67.415
1900-08-31    56.160
1900-09-30    51.495
1900-10-31    61.260
1900-11-30    30.925
1900-12-31    30.785
Freq: M, dtype: float64

Correlation coefficients:
          dim1     dim2
dim1  1.00000  0.00627
dim2  0.00627  1.00000
```

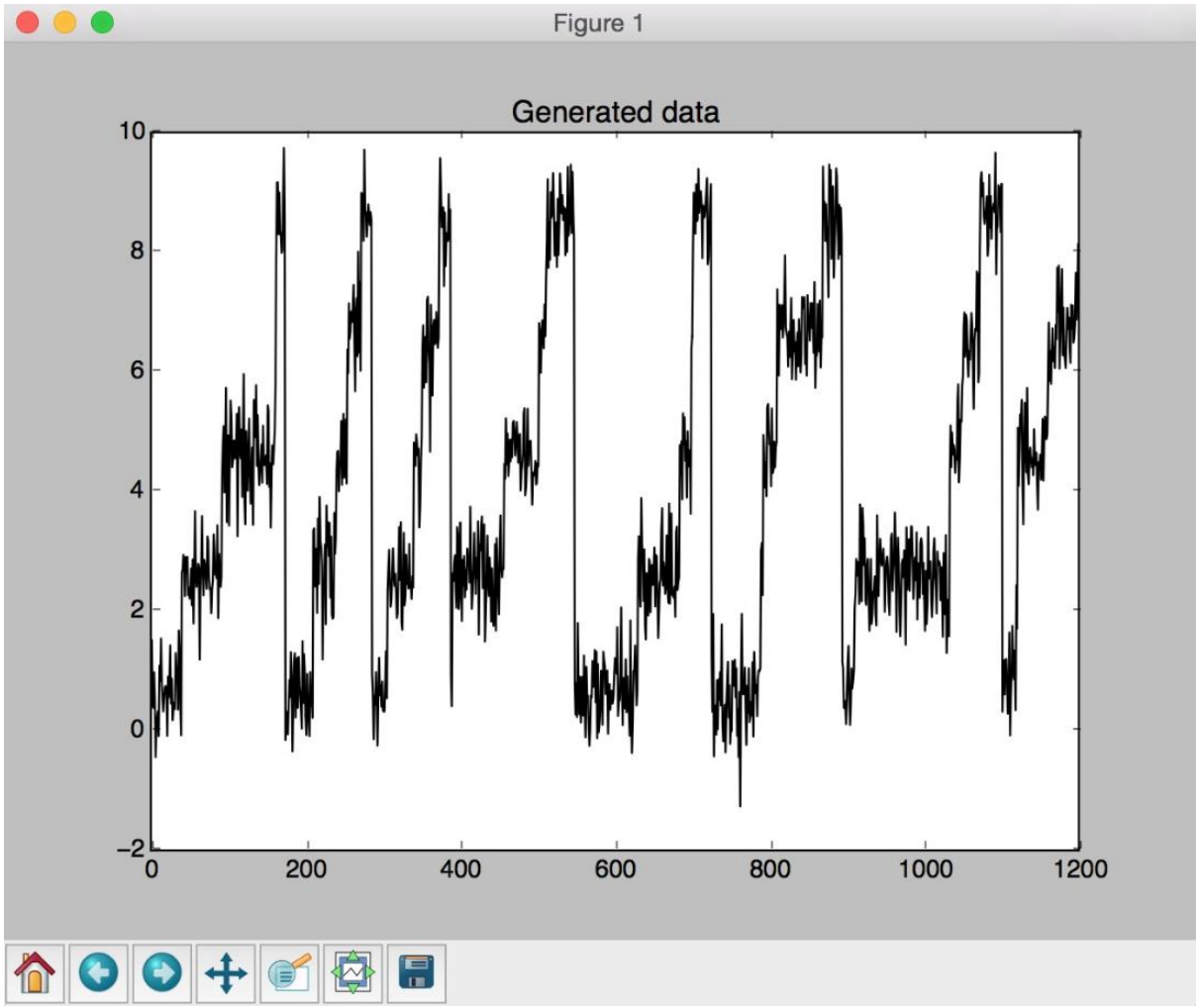


Figure 1
Generated data
10
8
6
4
2
0
−2
0
200
400
600
800
1000
1200

```
Training the Hidden Markov Model...

Means and variances:

Hidden state 1
Mean = 4.6
Variance = 0.25

Hidden state 2
Mean = 6.59
Variance = 0.25

Hidden state 3
Mean = 0.6
Variance = 0.25

Hidden state 4
Mean = 8.6
Variance = 0.26

Hidden state 5
Mean = 2.6
Variance = 0.26
```

```
Training the CRF model...

Accuracy score = 77.93%

Original  = rojections
Predicted = rojectiong

Original  = uff
Predicted = ufr

Original  = kiing
Predicted = kiing

Original  = ecompress
Predicted = ecomertig

Original  = uzz
Predicted = vex

Original  = poiling
Predicted = aciting
```

```
Original  = abulously
Predicted = abuloualy

Original  = ormalization
Predicted = ormalisation

Original  = ake
Predicted = aka

Original  = afeteria
Predicted = ateteria

Original  = obble
Predicted = obble

Original  = hadow
Predicted = habow

Original  = ndustrialized
Predicted = ndusqrialyled

Original  = ympathetically
Predicted = ympnshetically
```

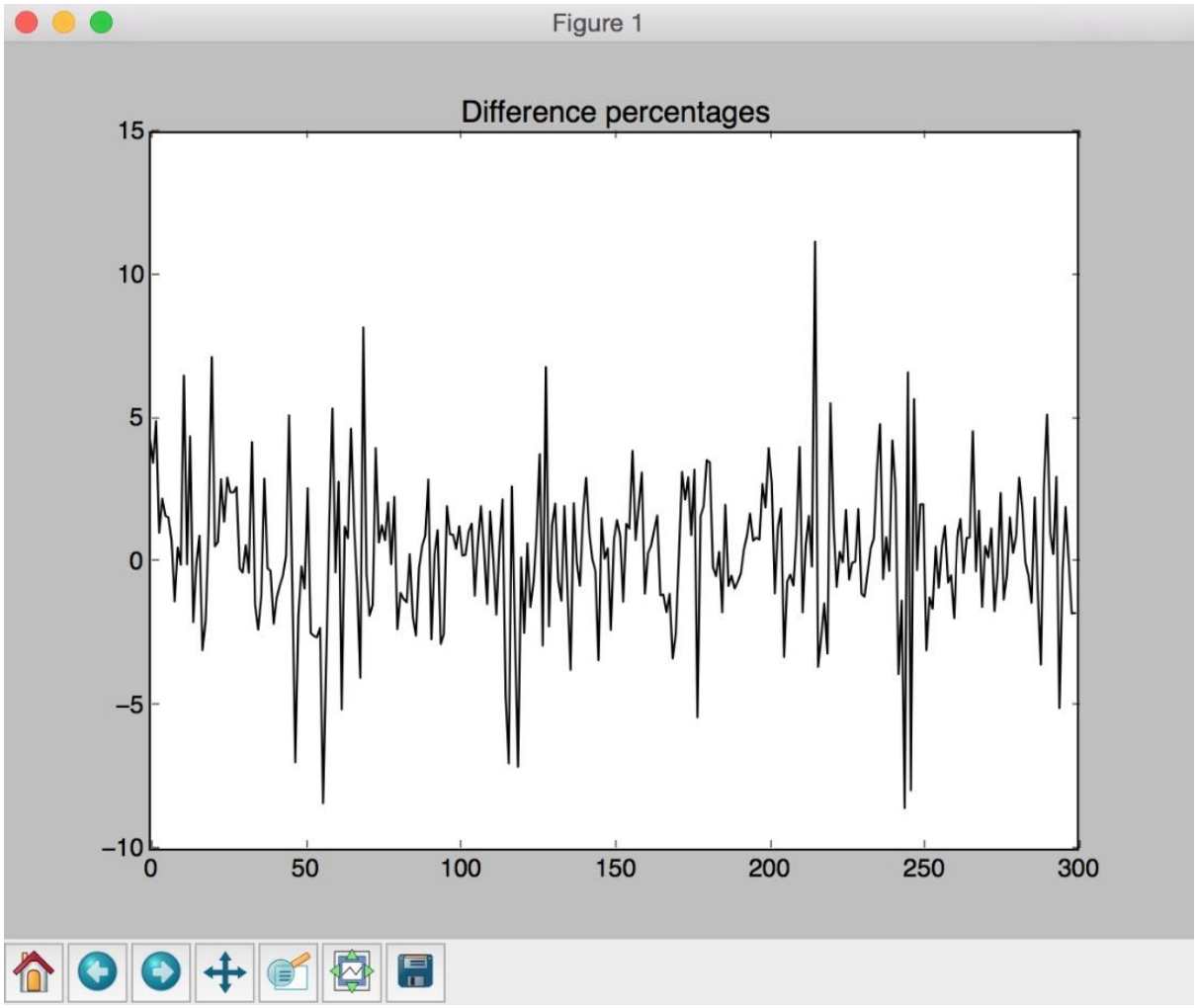


Figure 1
Difference percentages
15
10
5
0
−5
−10
0
50
100
150
200
250
300

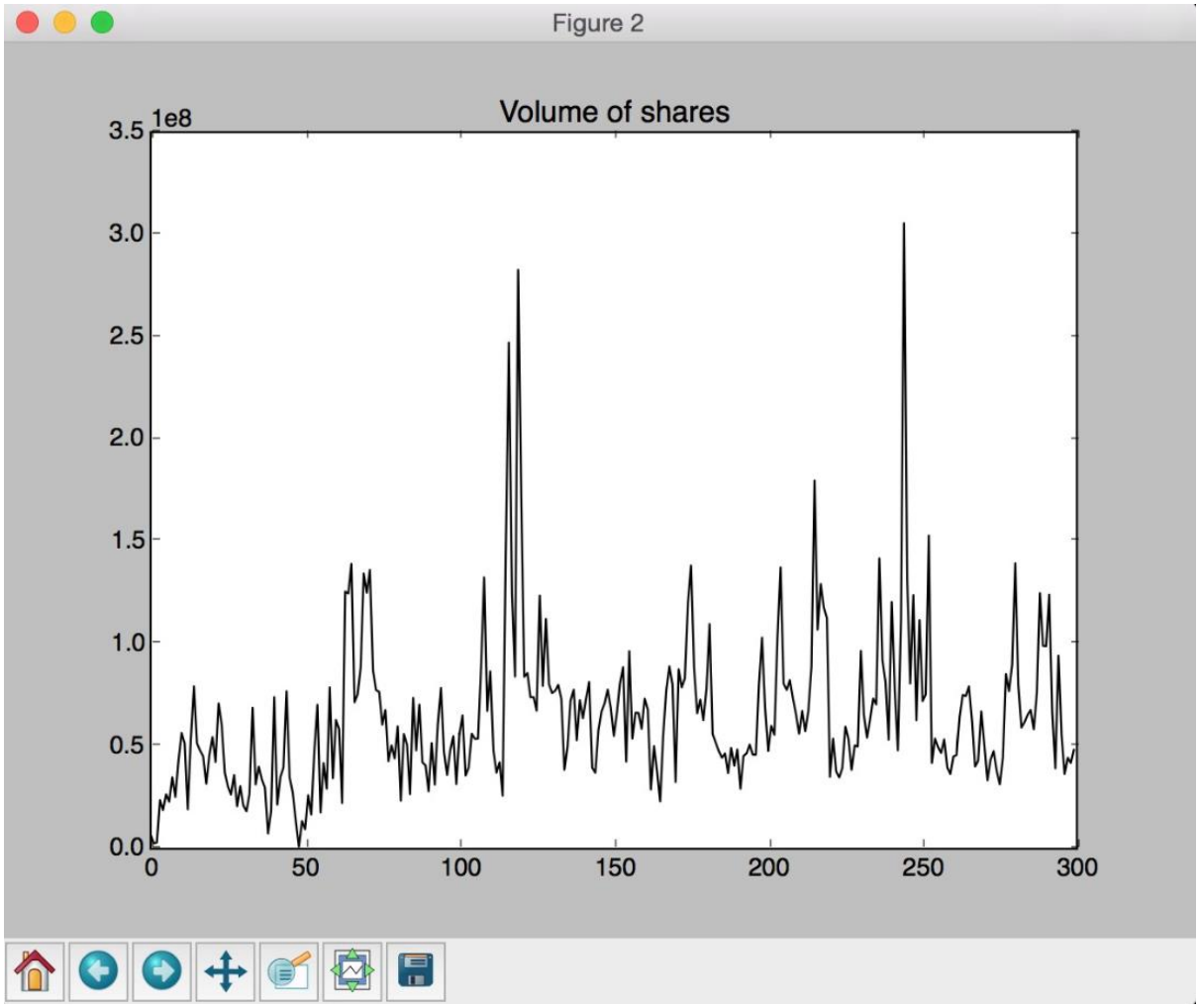
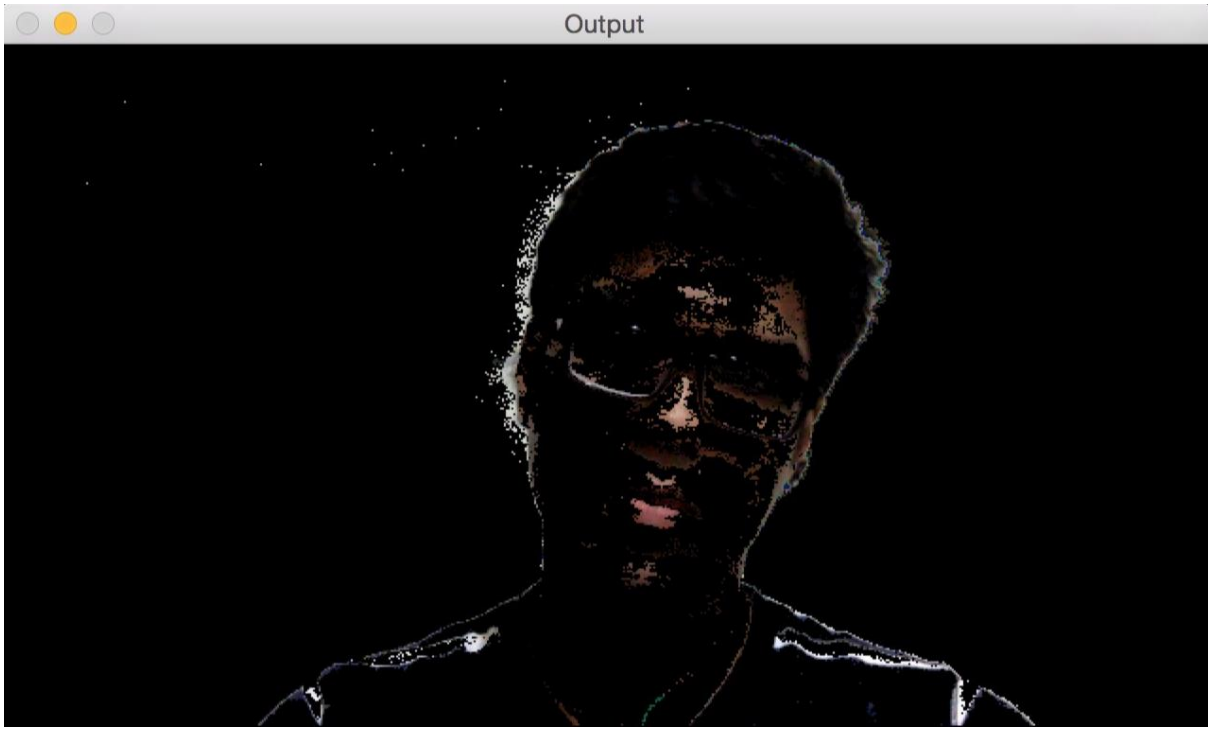
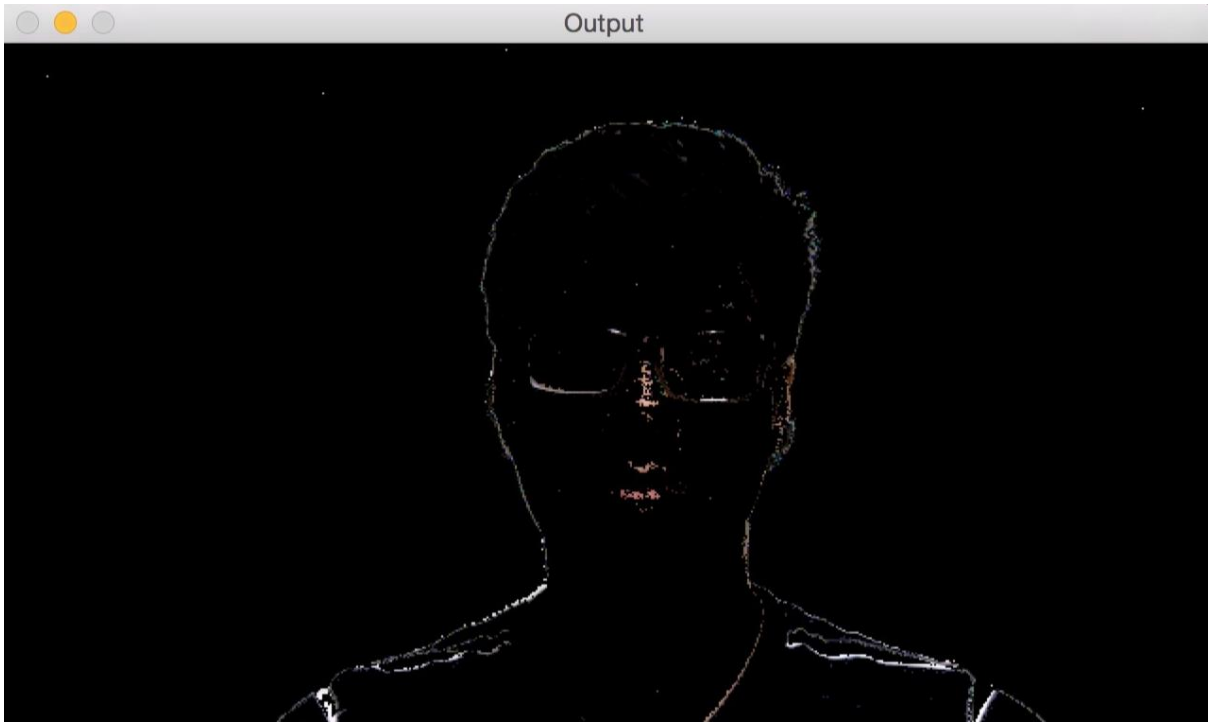


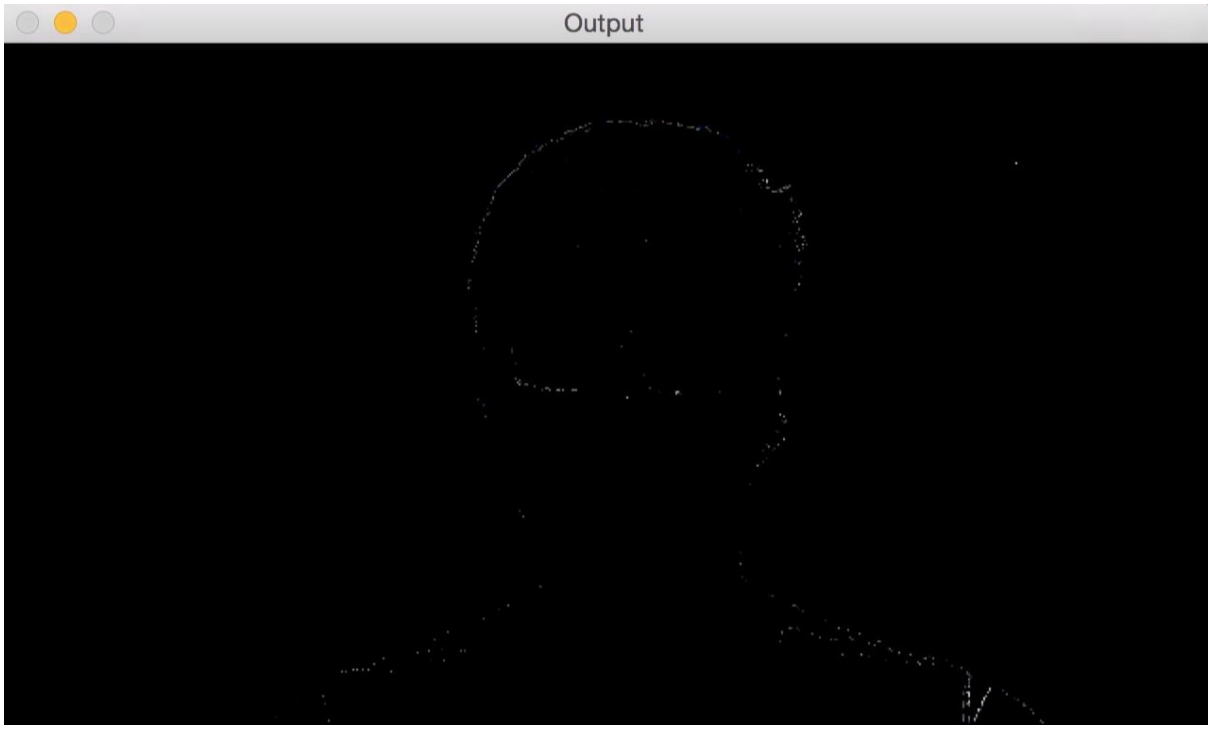
Figure 2
Volume of shares
1e8
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300

Chapter 18: Image Recognition


Output


Output

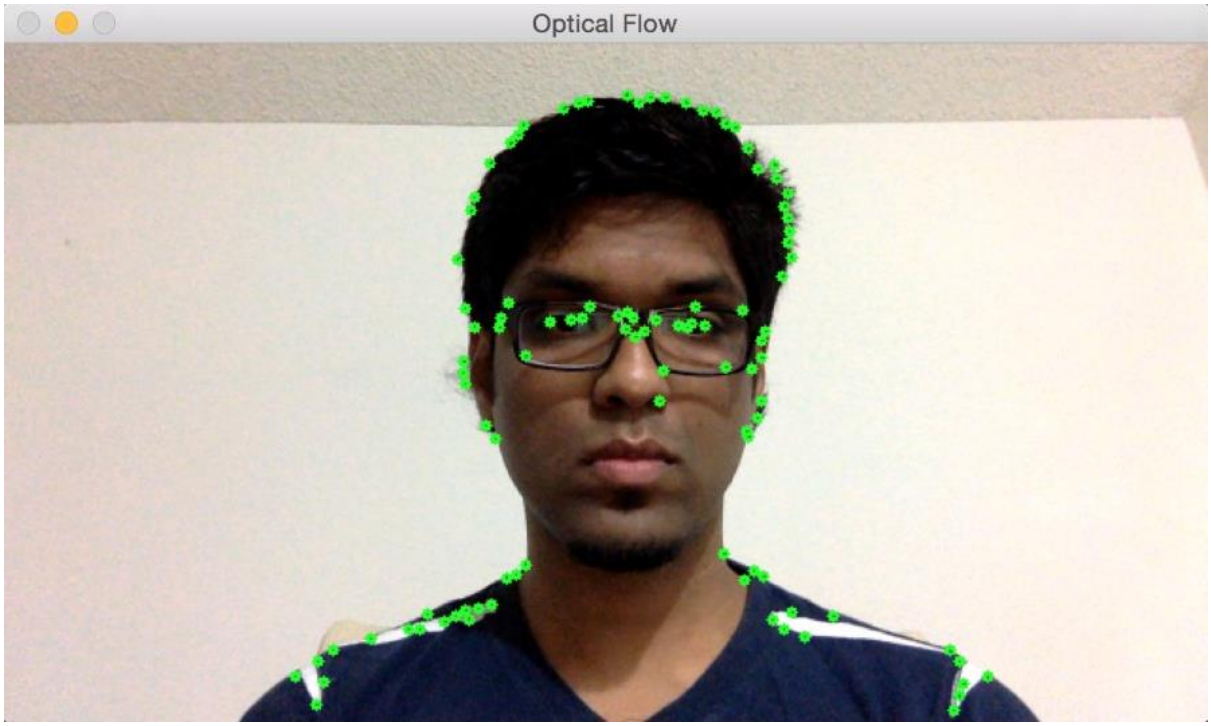

Output

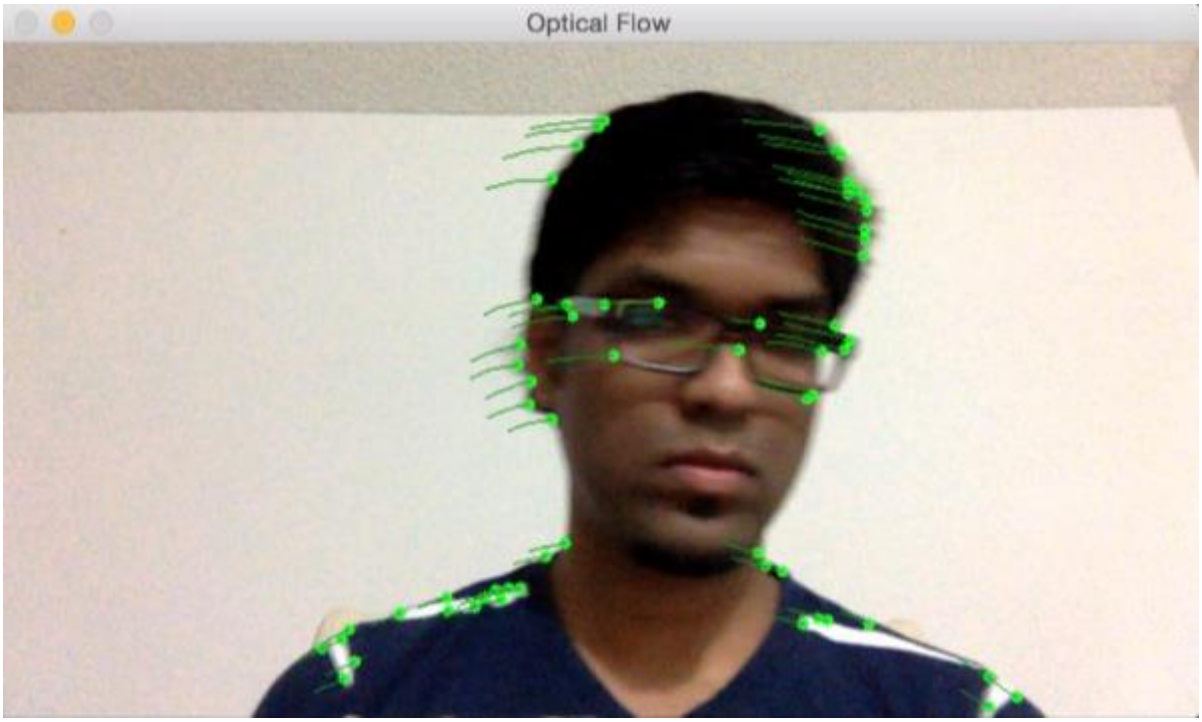

Output

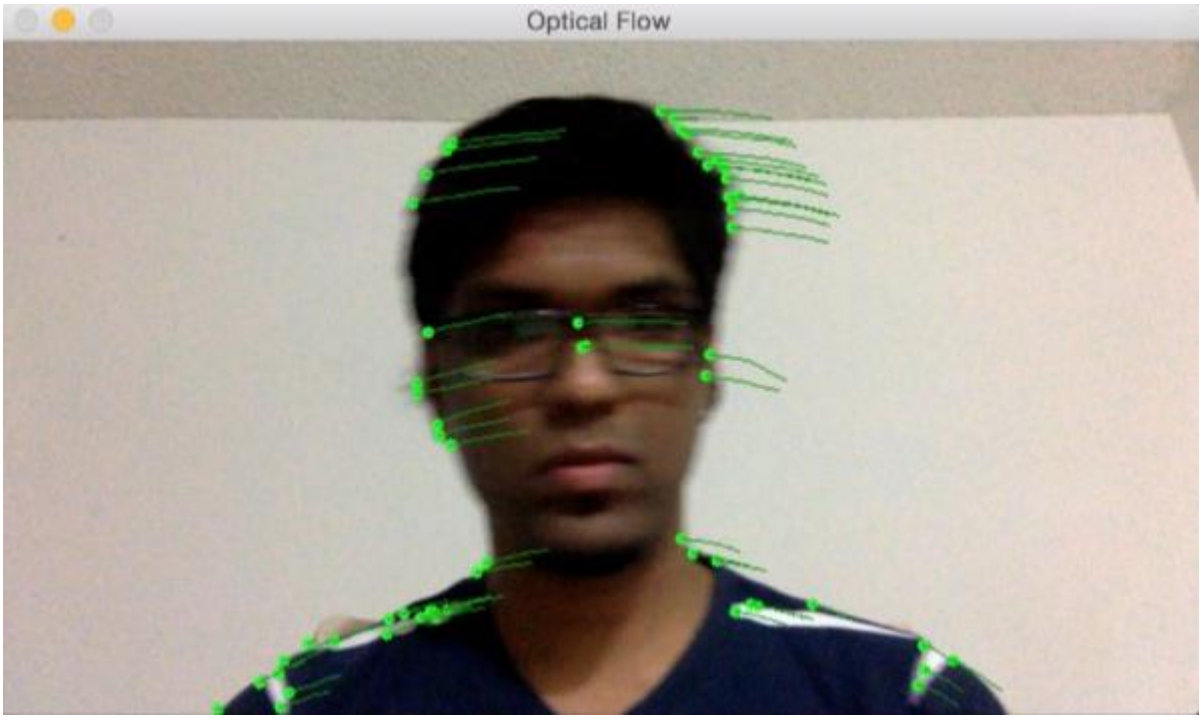

Object Tracker

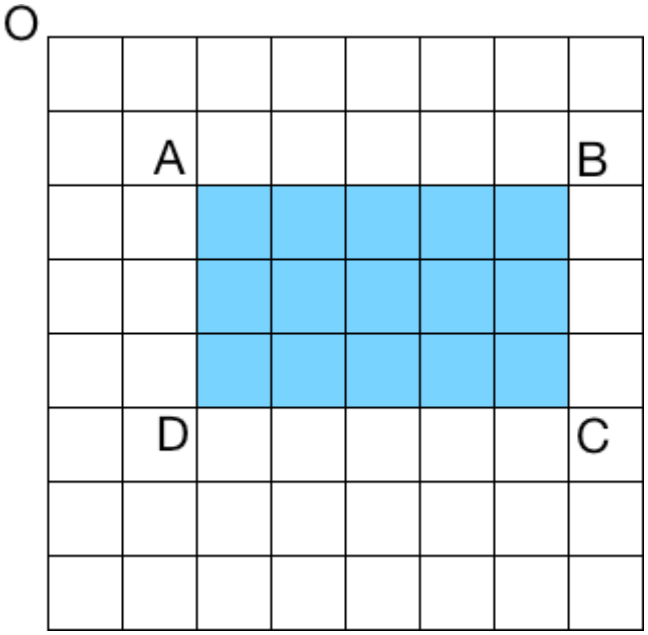

Object Tracker

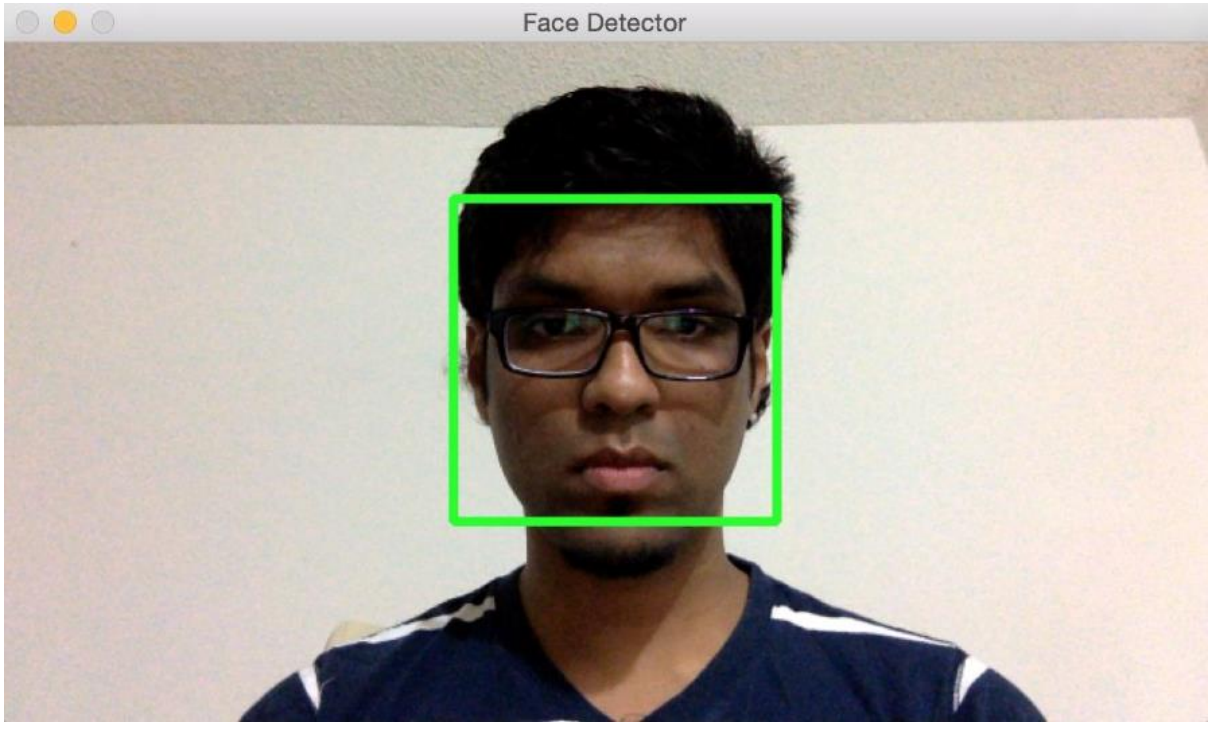

Object Tracker

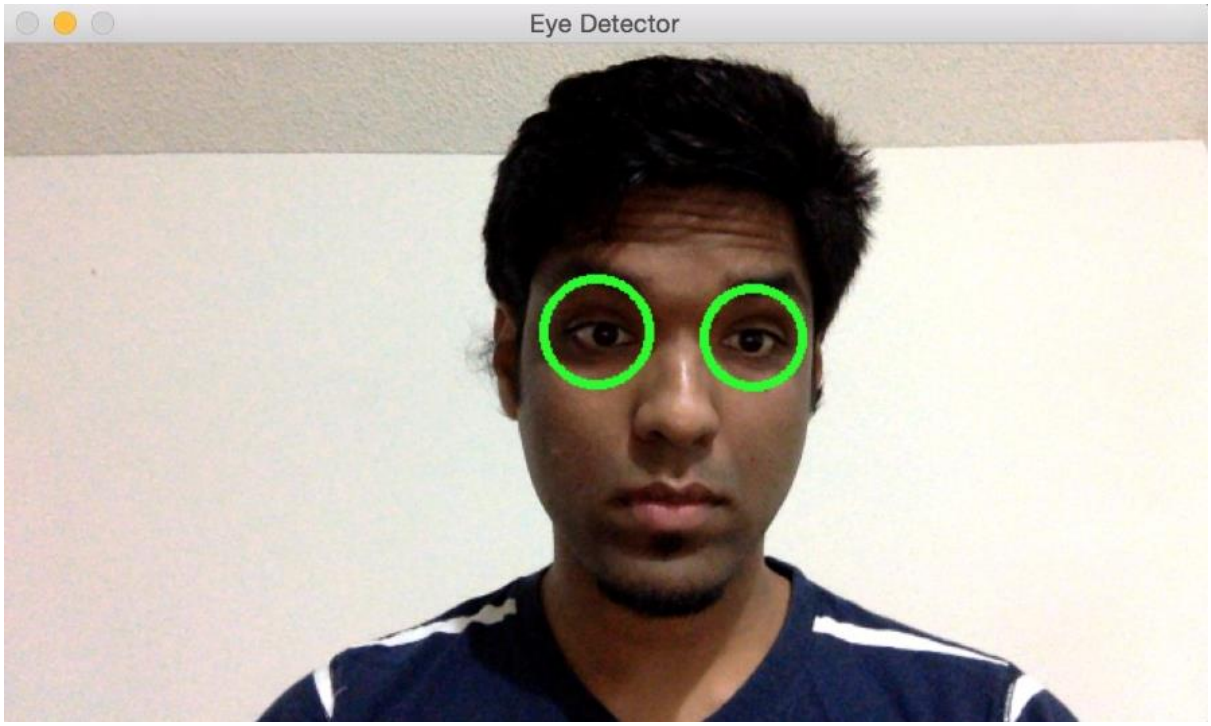

Optical Flow


Optical Flow

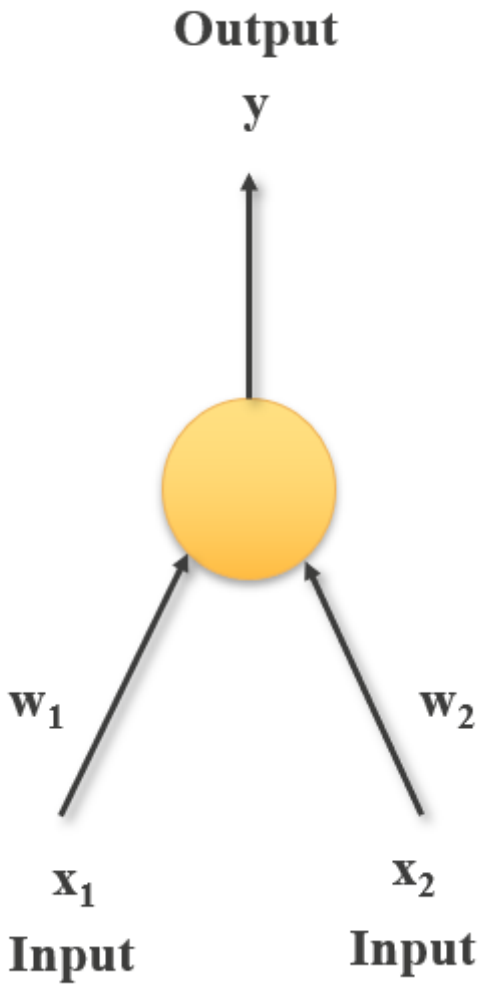

Optical Flow


O
A
B
D
C


Face Detector


Eye Detector

Chapter 19: Neural Networks



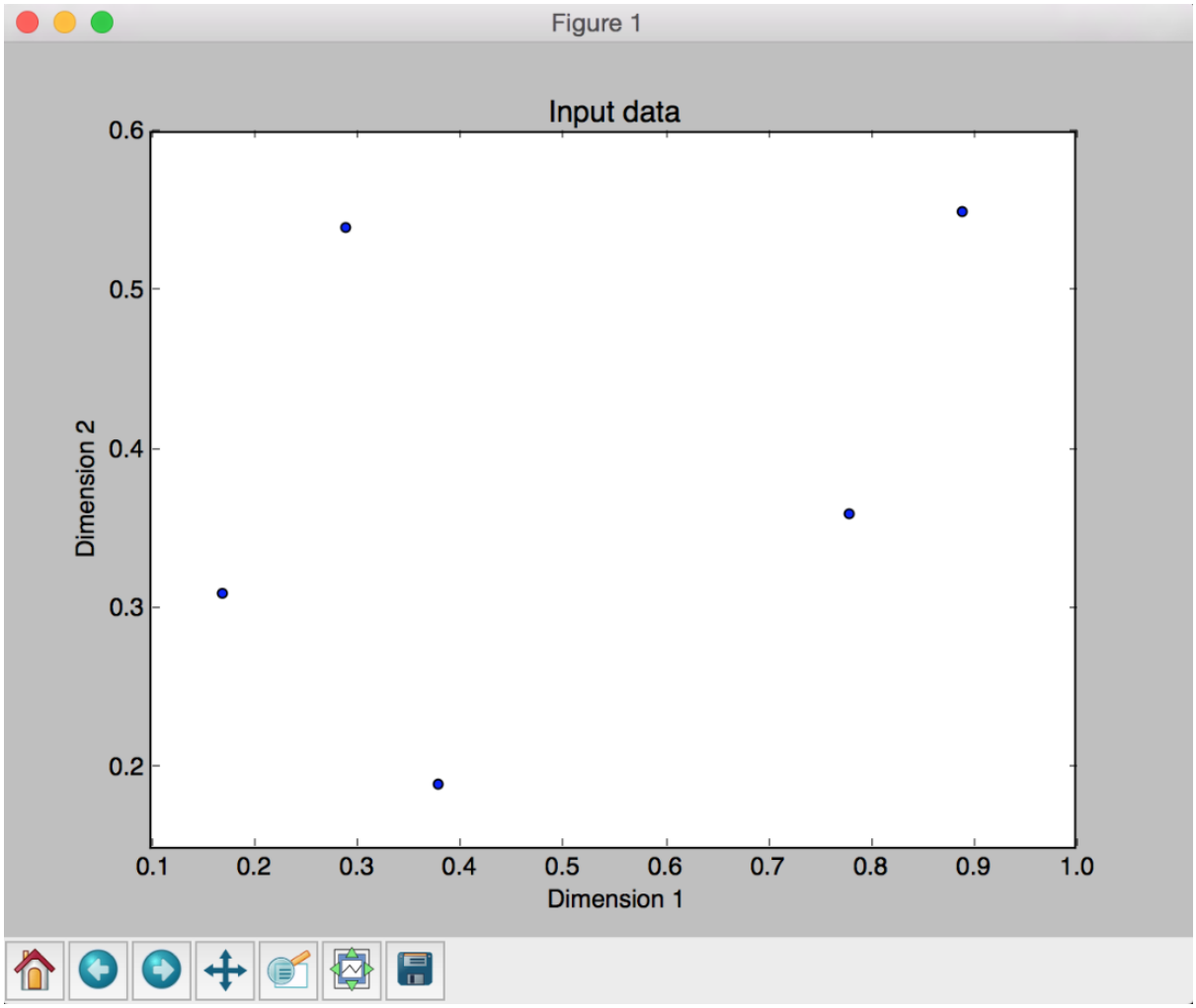


Figure 1
Input data
Dimension 2
Dimension 1
0.6
0.5
0.4
0.3
0.2
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

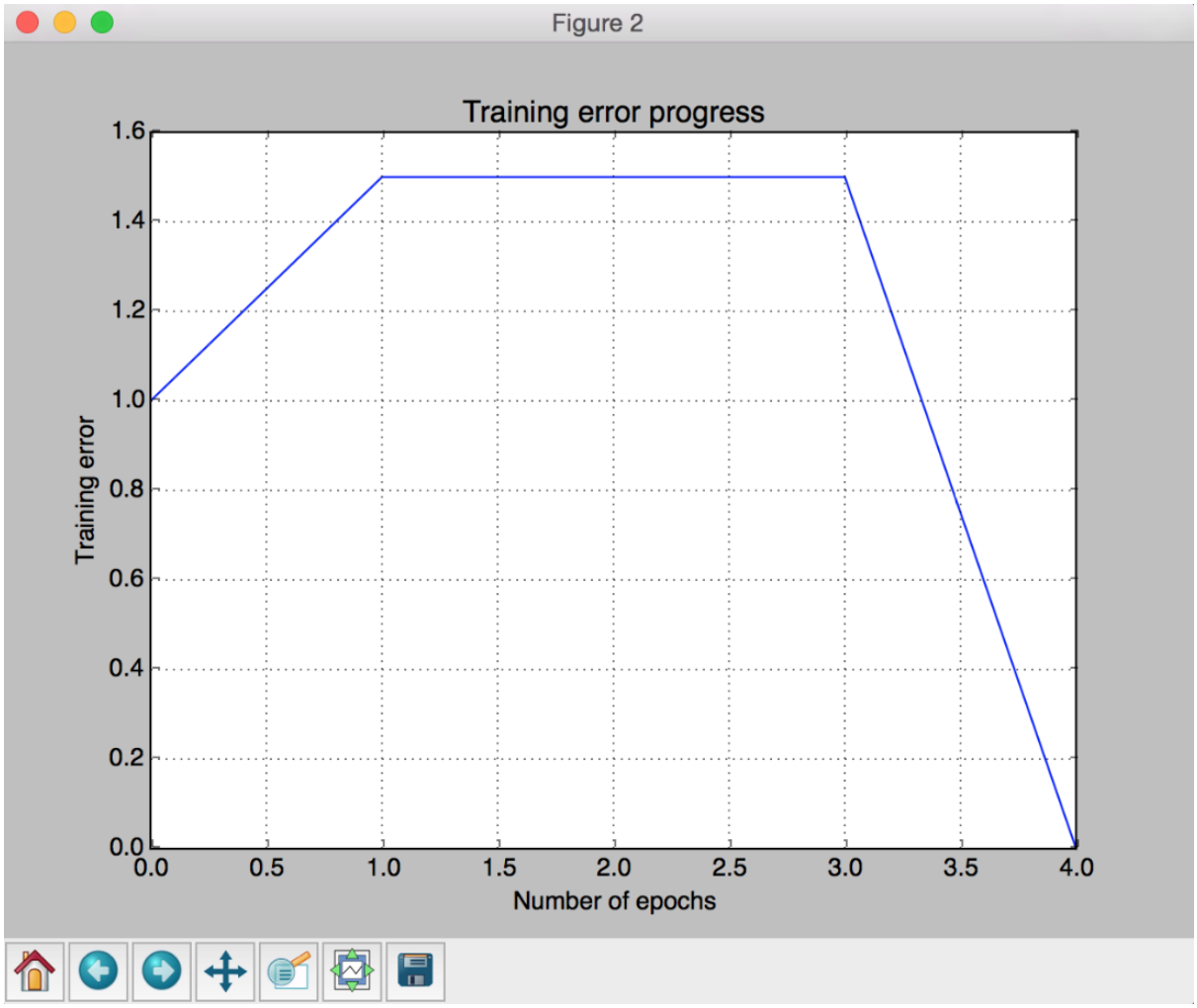


Figure 2
Training error progress
Training error
Number of epochs
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

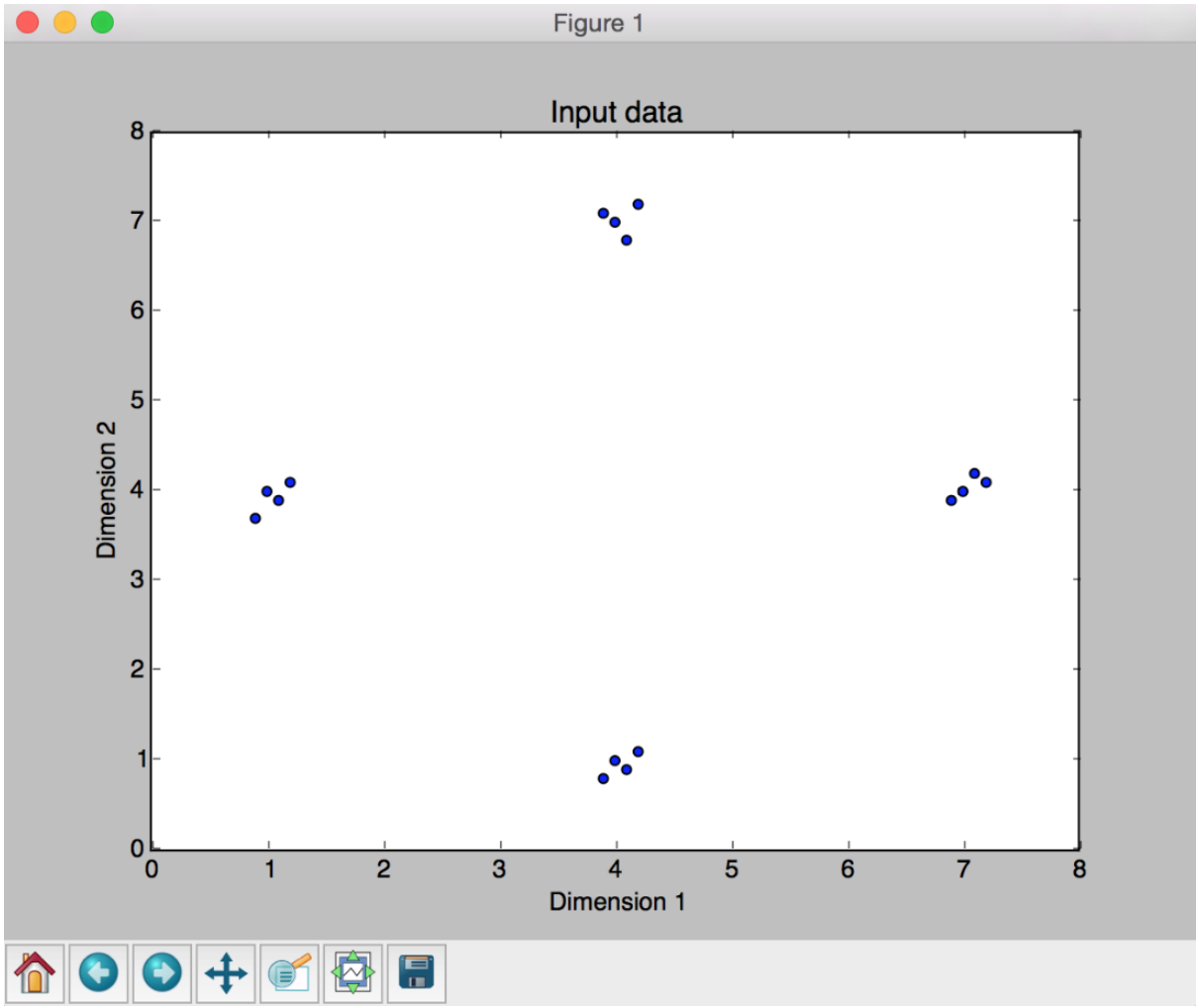
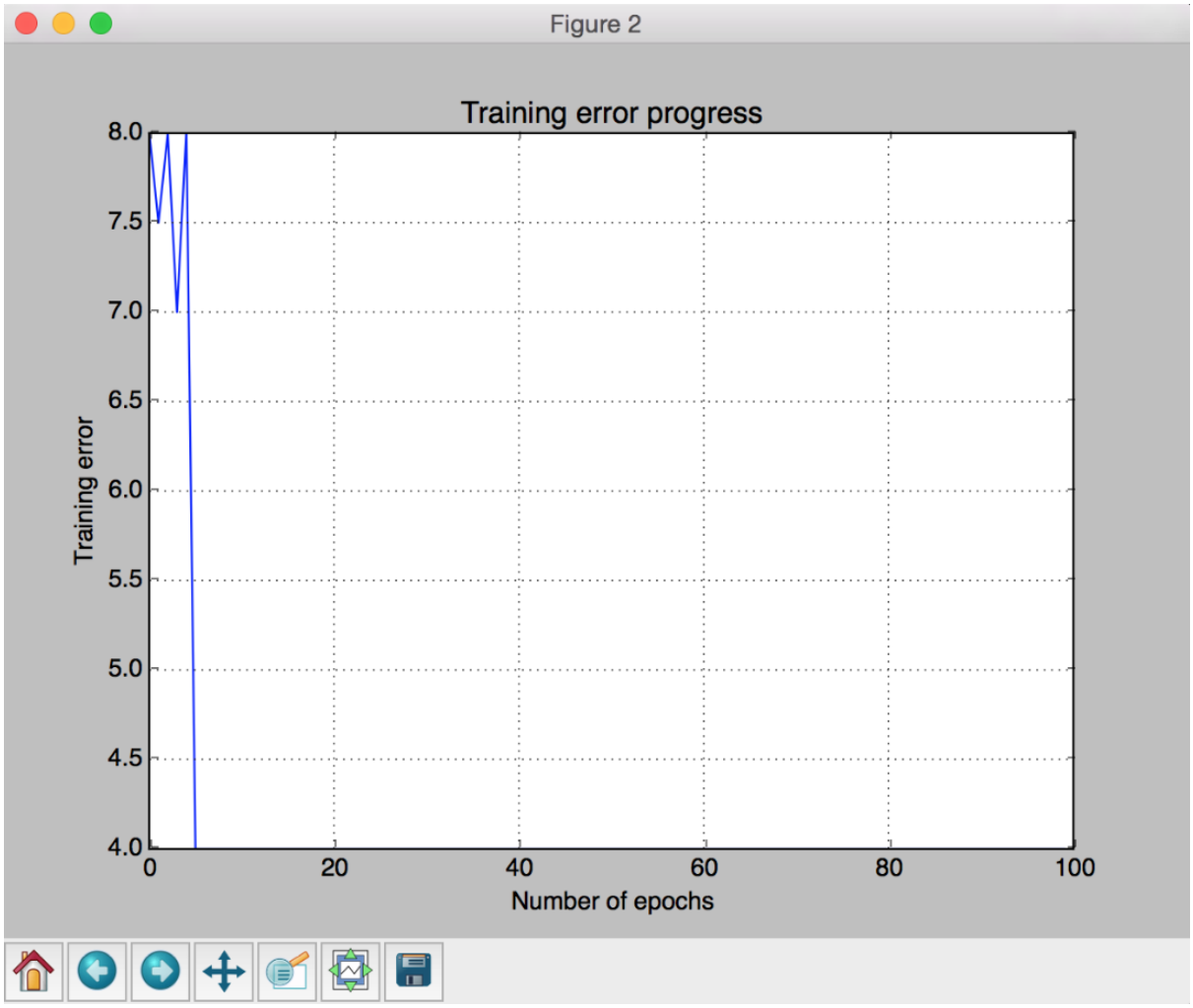


Figure 1
Input data
Dimension 2
Dimension 1
0
1
2
3
4
5
6
7
8




```
Epoch: 20; Error: 4.0;
Epoch: 40; Error: 4.0;
Epoch: 60; Error: 4.0;
Epoch: 80; Error: 4.0;
Epoch: 100; Error: 4.0;
The maximum number of train epochs is reached

Test results:
[0.4, 4.3] --> [ 0.  0.]
[4.4, 0.6] --> [ 1.  0.]
[4.7, 8.1] --> [ 1.  1.]
```

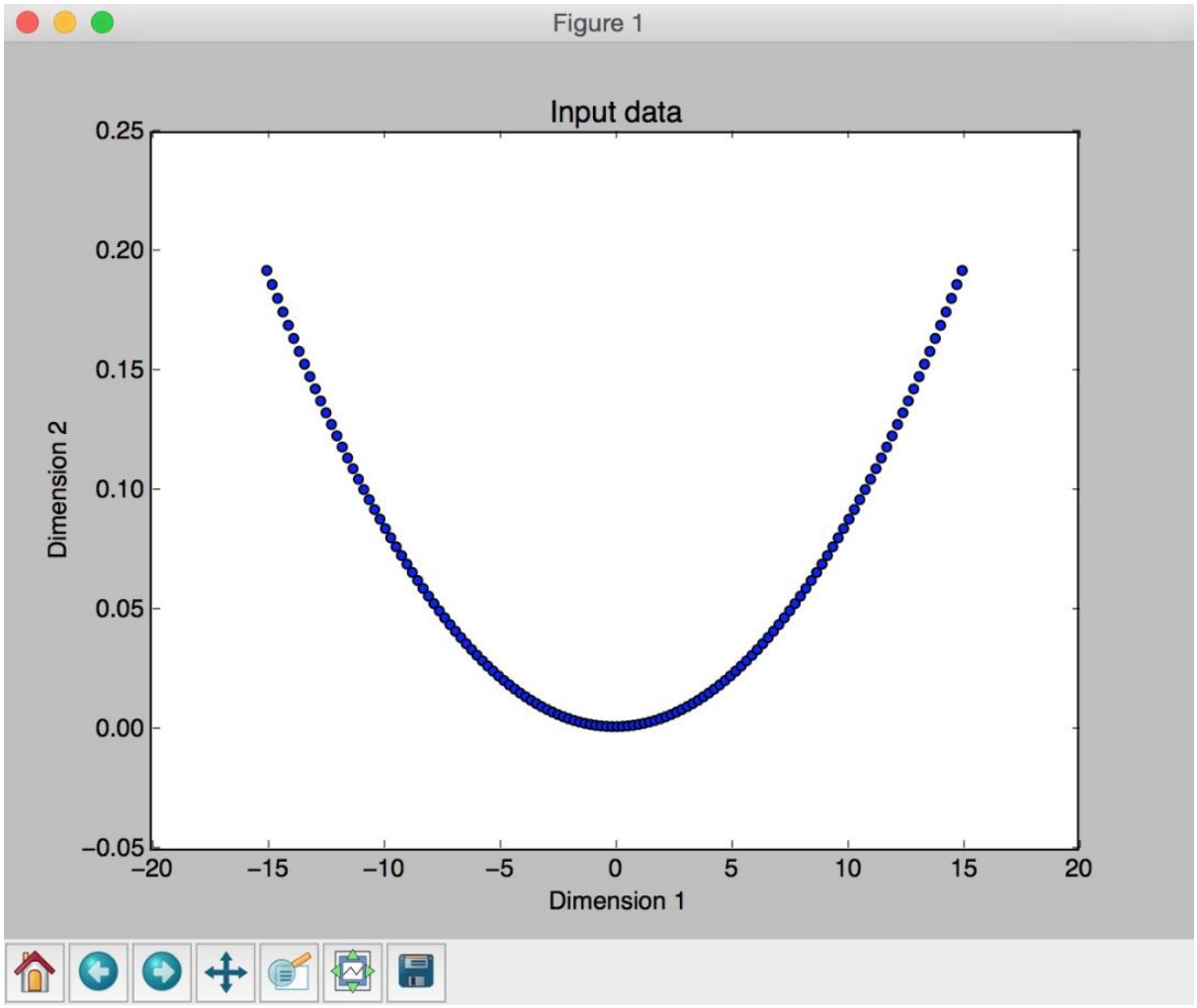


Figure 1
Input data
Dimension 2
Dimension 1
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
−20
−15
−10
−5
0
5
10
15
20

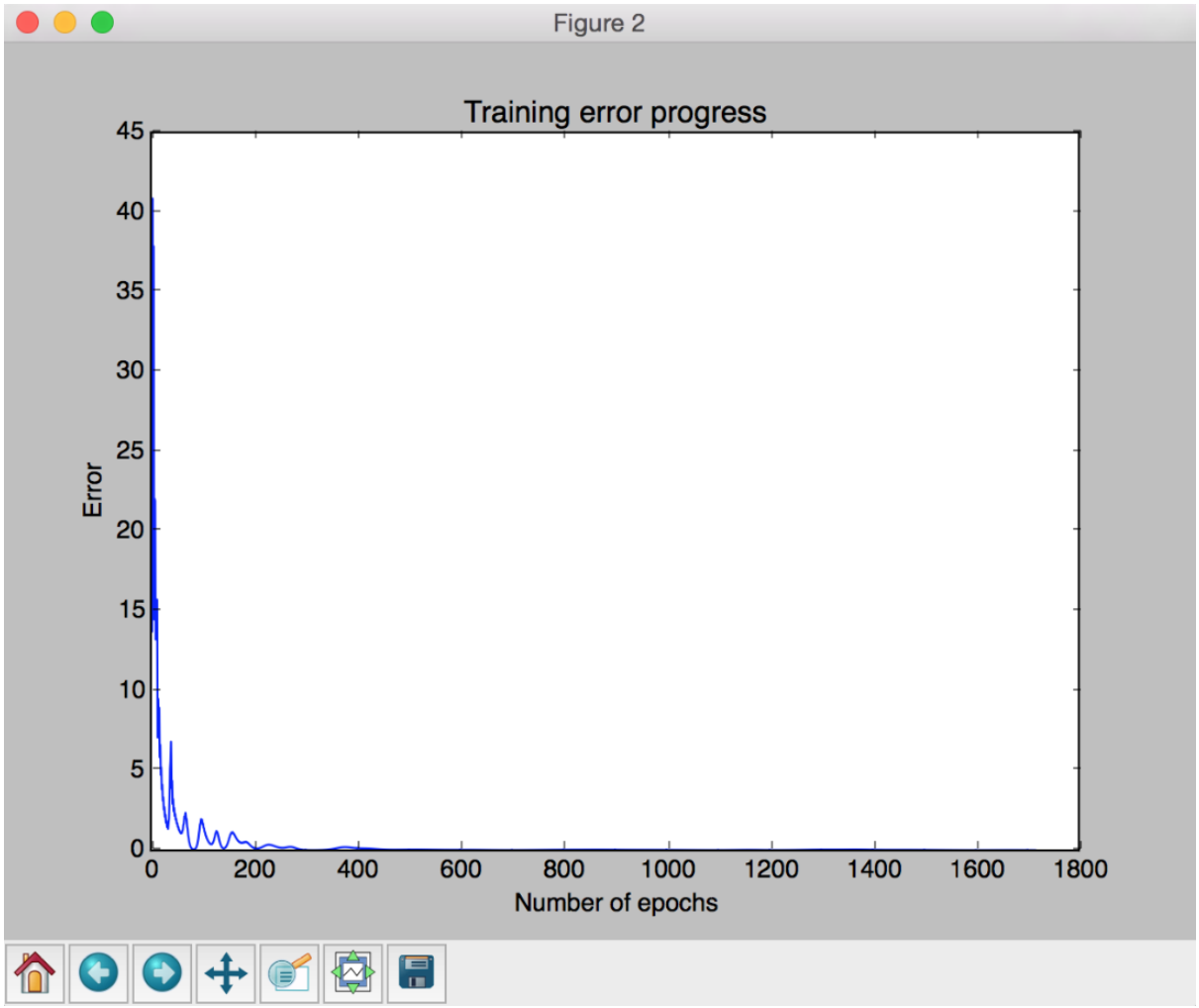


Figure 2
Training error progress
Error
Number of epochs
0
5
10
15
20
25
30
35
40
45
0
200
400
600
800
1000
1200
1400
1600
1800

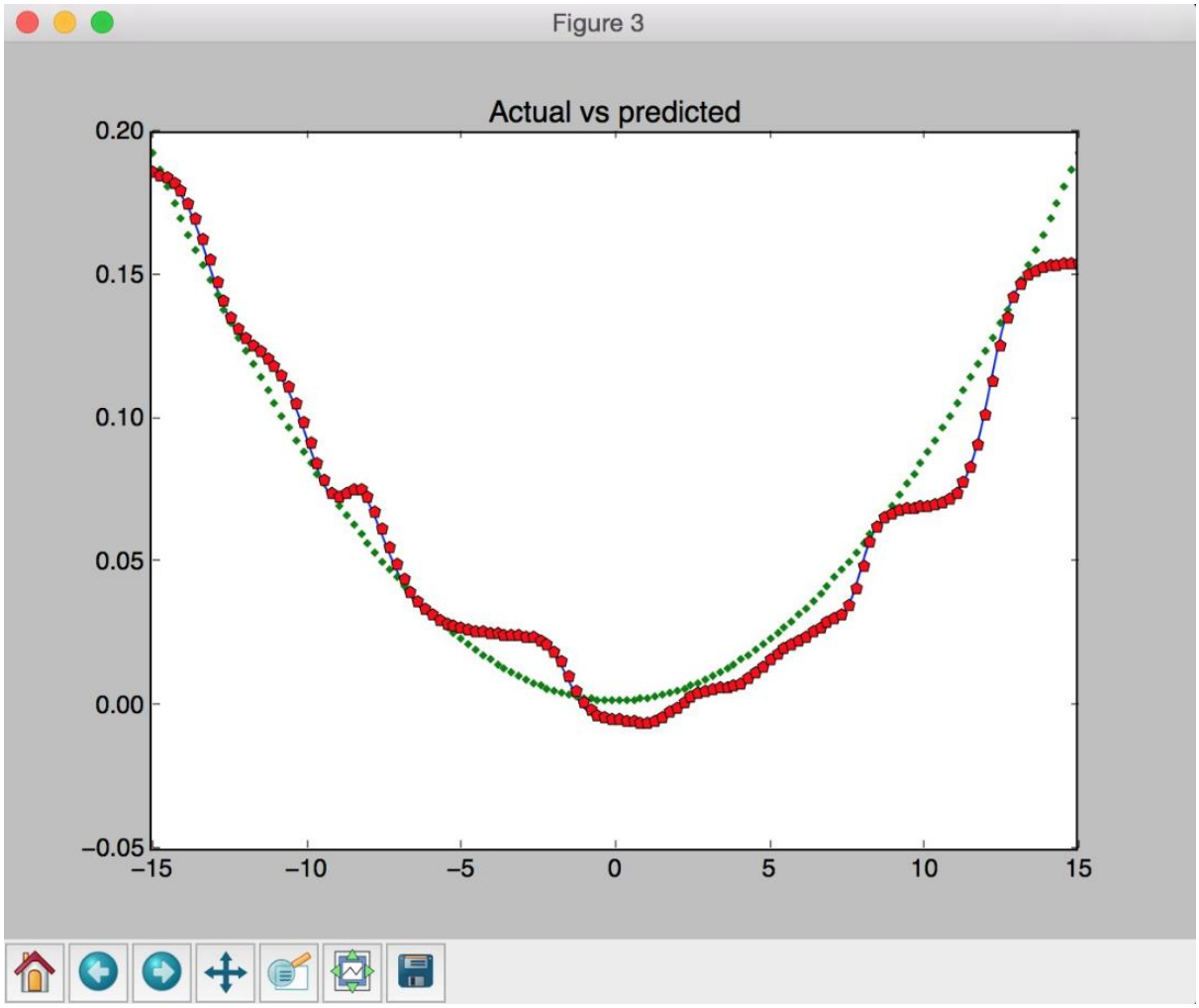
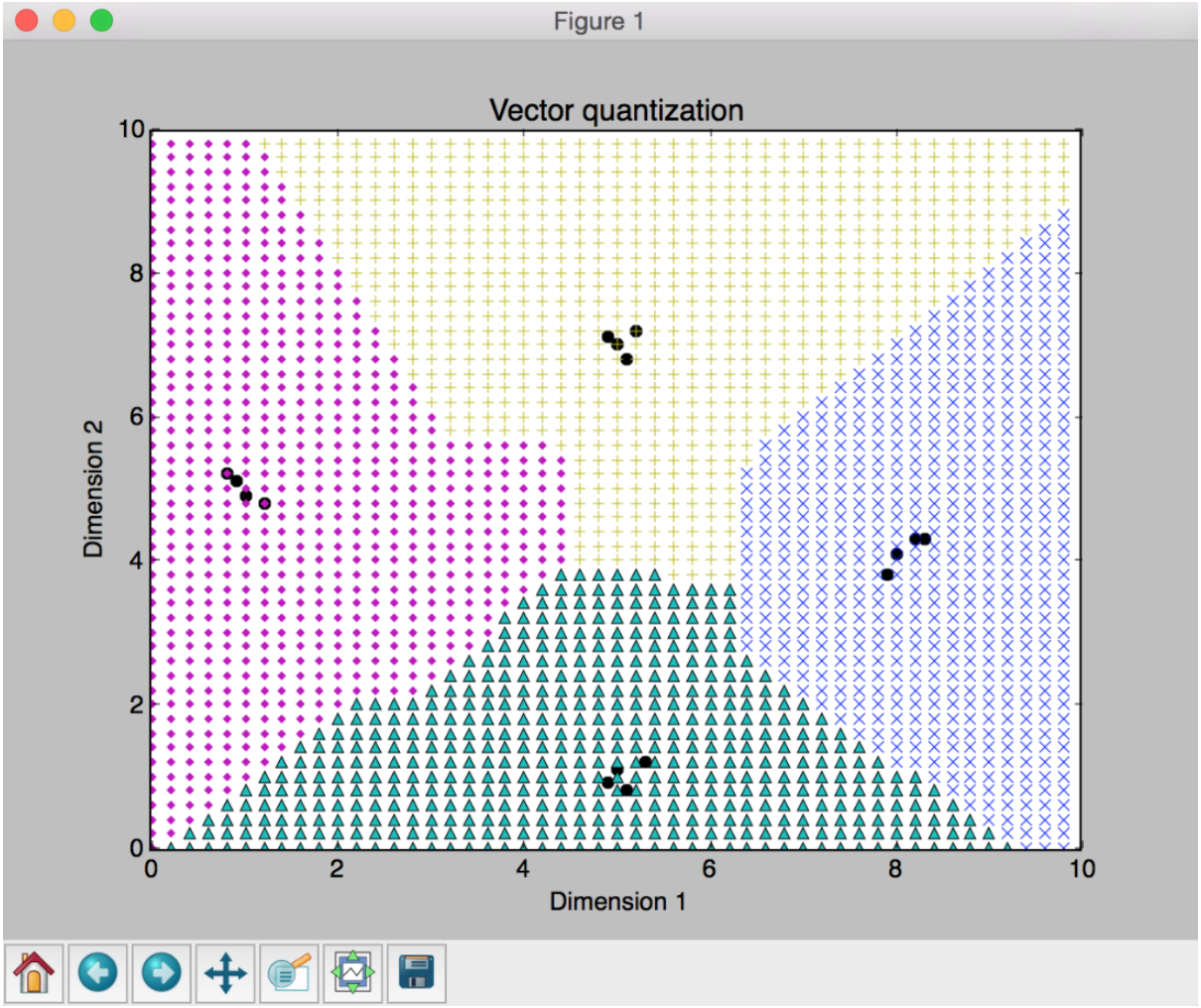


Figure 3
Actual vs predicted
0.20
0.15
0.10
0.05
0.00
−0.05
−15
−10
−5
0
5
10
15

```
Epoch: 100; Error: 1.9247718251621995;
Epoch: 200; Error: 0.157232947980795 26;
Epoch: 300; Error: 0.021680213116912858;
Epoch: 400; Error: 0.1381761995539017;
Epoch: 500; Error: 0.043925533819487 37;
Epoch: 600; Error: 0.029754015970149 79;
Epoch: 700; Error: 0.014228560930227126;
Epoch: 800; Error: 0.03460207842970052;
Epoch: 900; Error: 0.035934053149433196;
Epoch: 1000; Error: 0.025833284445815966;
Epoch: 1100; Error: 0.013672412879982398;
Epoch: 1200; Error: 0.01776586425692384;
Epoch: 1300; Error: 0.043102426103849 76;
Epoch: 1400; Error: 0.037996812960966 11;
Epoch: 1500; Error: 0.024670300415208 45;
Epoch: 1600; Error: 0.010094873168855236;
Epoch: 1700; Error: 0.012108660430210 68;
The goal of learning is reached
```




```
Epoch: 100; Error: 0.0;
Epoch: 200; Error: 0.0;
Epoch: 300; Error: 0.0;
Epoch: 400; Error: 0.0;
Epoch: 500; Error: 0.0;
The maximum number of train epochs is reached
```

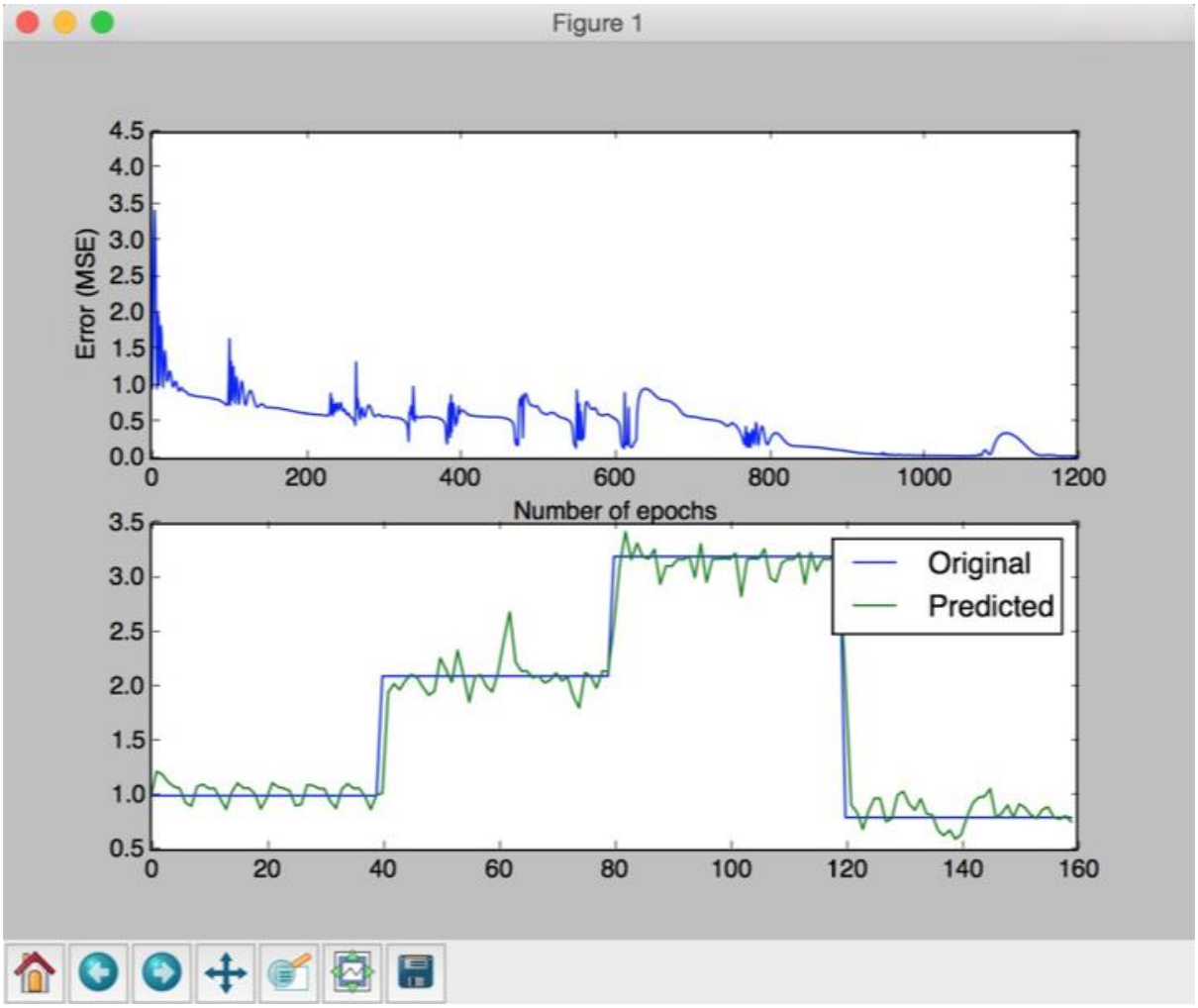
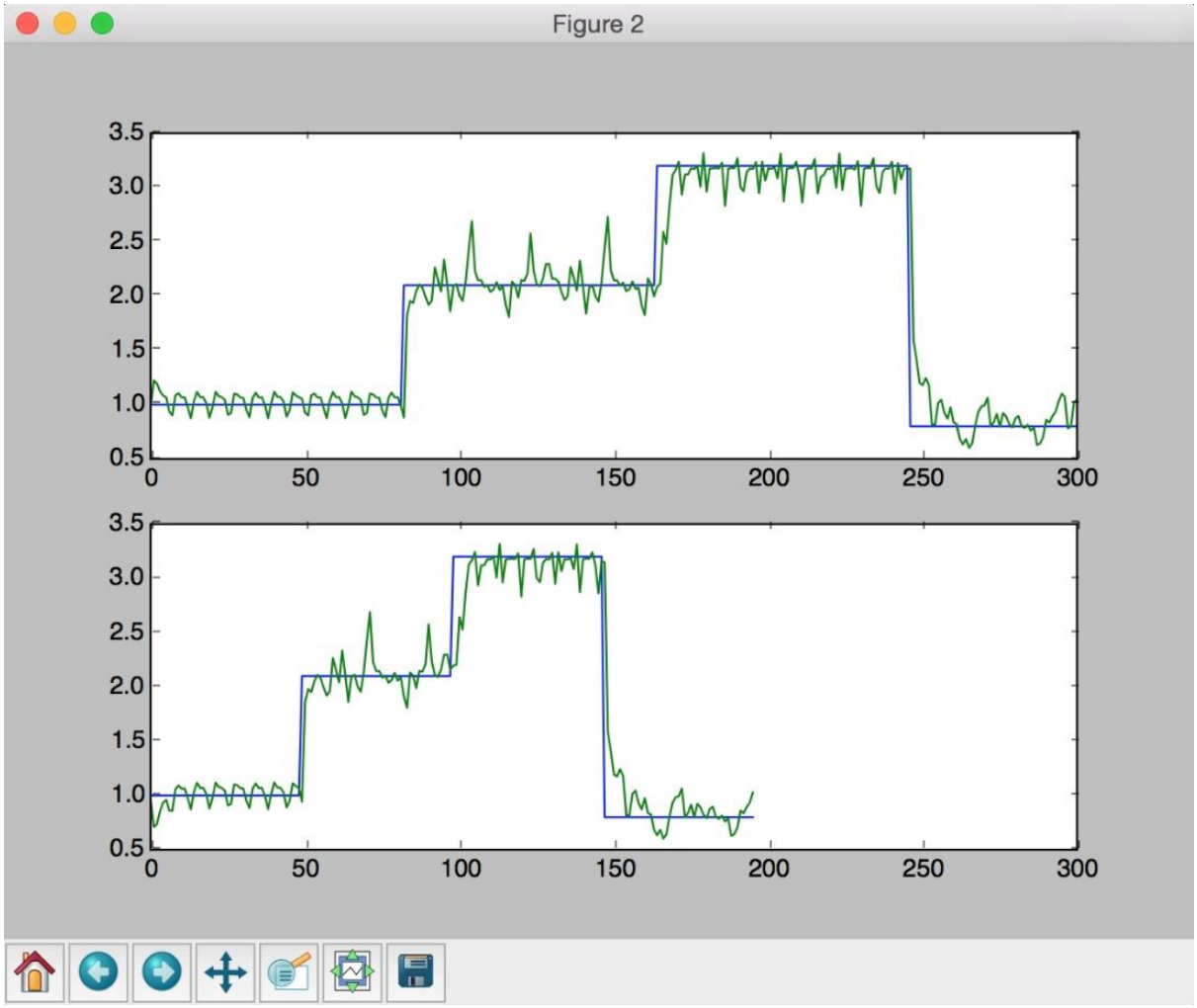
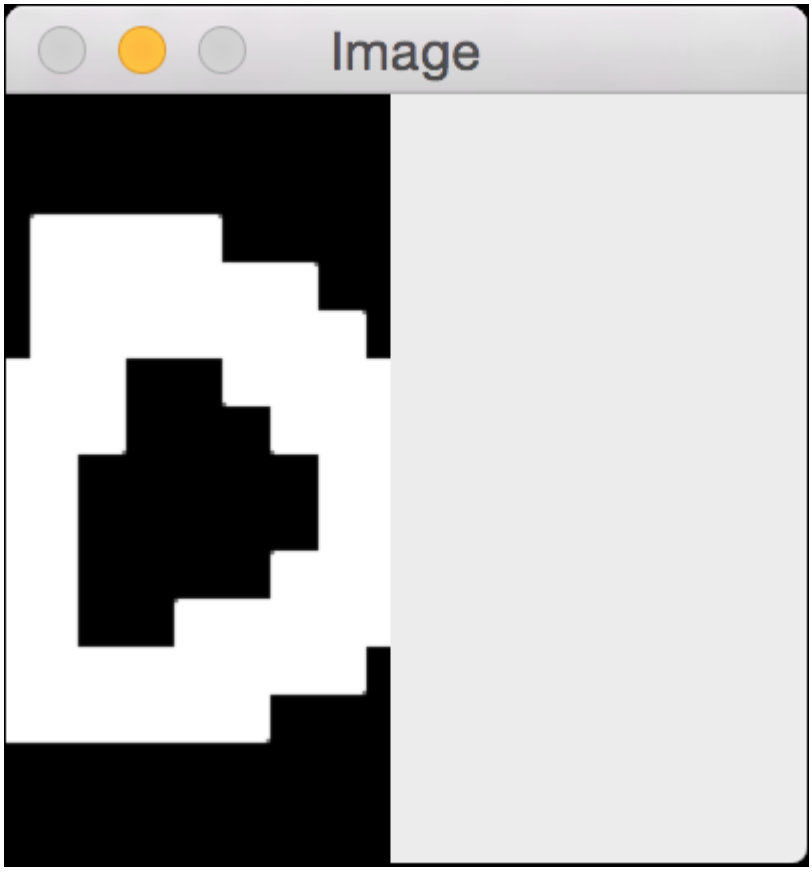


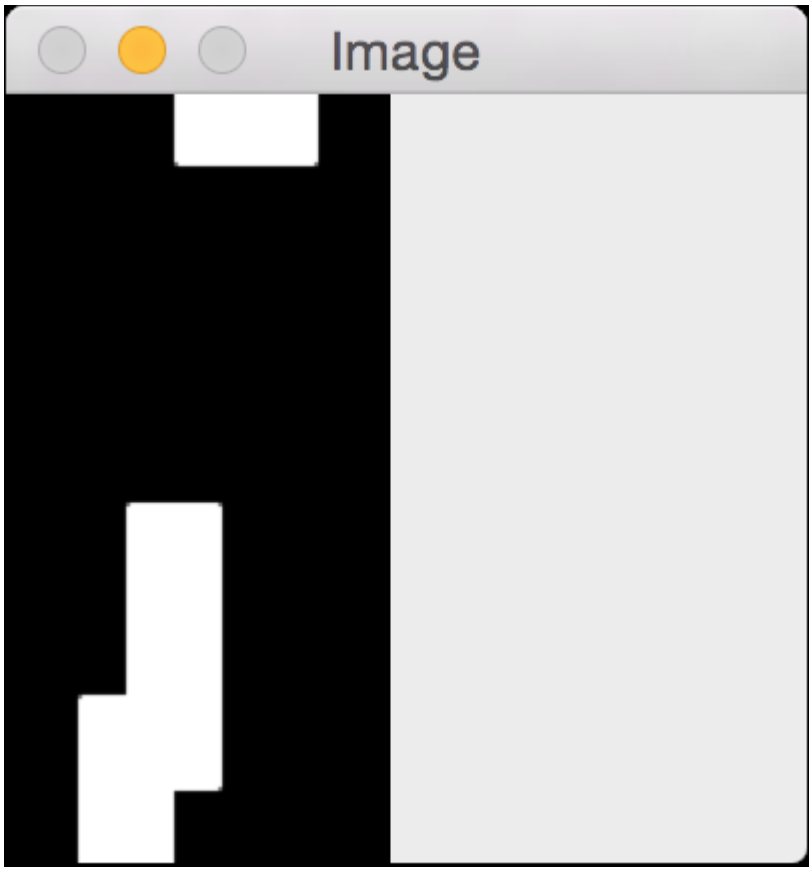
Figure 1
Error (MSE)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
200
400
600
800
1000
1200
Number of epochs
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
20
40
60
80
100
120
140
160
Original
Predicted




```
Epoch: 100; Error: 0.7378753203612153;
Epoch: 200; Error: 0.6276459886666788;
Epoch: 300; Error: 0.586316536629095;
Epoch: 400; Error: 0.7246461052491963;
Epoch: 500; Error: 0.7244266943409208;
Epoch: 600; Error: 0.5650581389122635;
Epoch: 700; Error: 0.5798180931911314;
Epoch: 800; Error: 0.19557566610789826;
Epoch: 900; Error: 0.10837074465396046;
Epoch: 1000; Error: 0.043308523919406 63;
Epoch: 1100; Error: 0.3073835343028226;
Epoch: 1200; Error: 0.0346852784161636 04;
The maximum number of train epochs is reached
```



Image

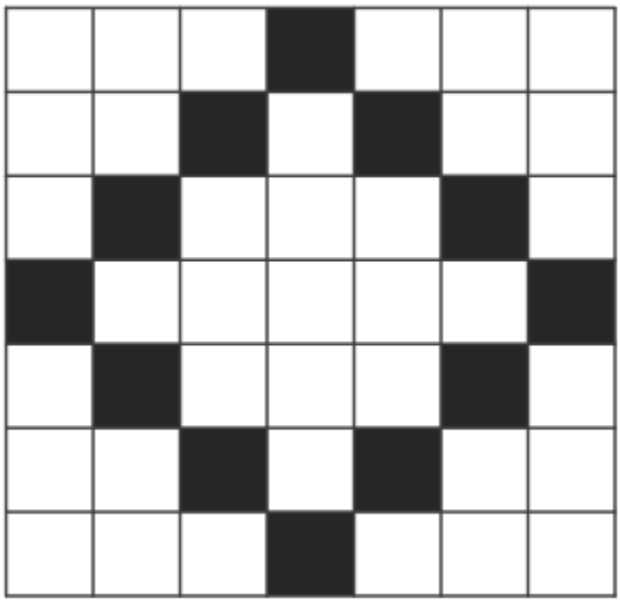


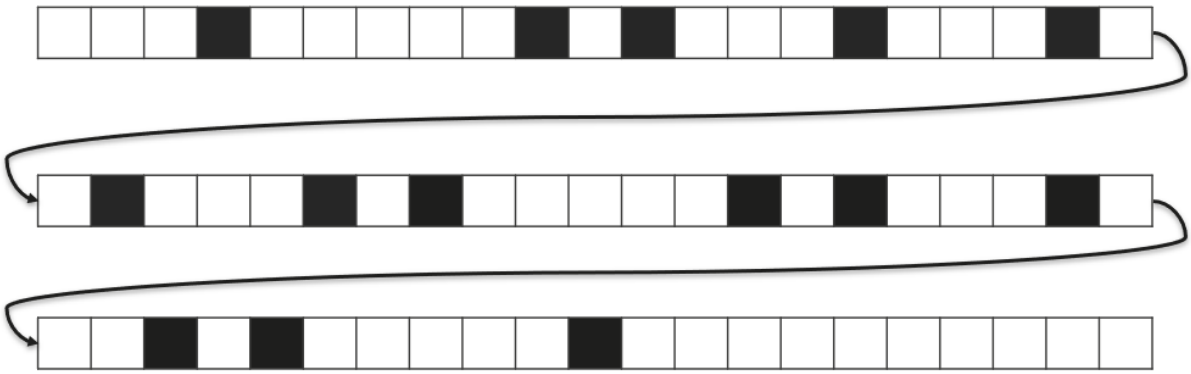
Image

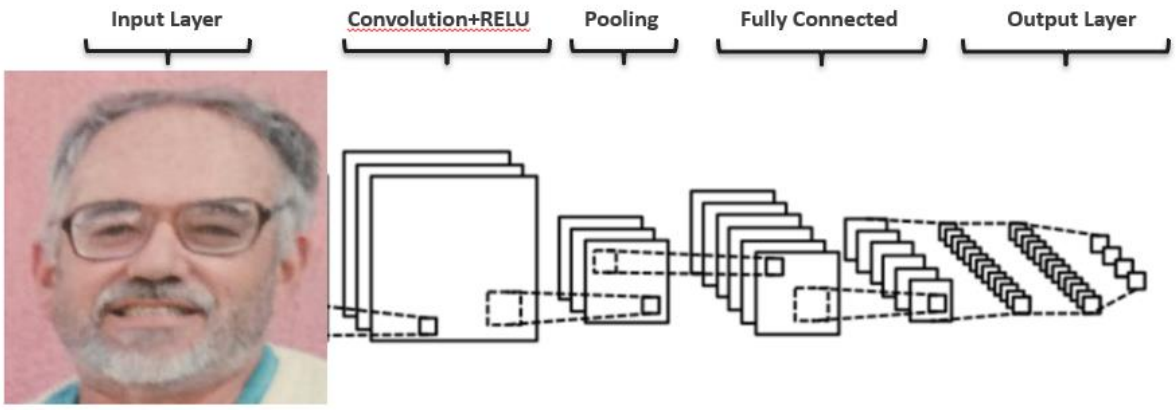
```
Epoch: 100; Error: 80.75182001223291;
Epoch: 200; Error: 49.823887961230206;
Epoch: 300; Error: 26.624261963923217;
Epoch: 400; Error: 31.131906412329677;
Epoch: 500; Error: 30.589610928772494;
Epoch: 600; Error: 23.129959531324324;
Epoch: 700; Error: 15.561849160600984;
Epoch: 800; Error: 9.52433563455828;
Epoch: 900; Error: 1.4032941634688987;
Epoch: 1000; Error: 1.1584148924740179;
Epoch: 1100; Error: 0.844934060039839;
Epoch: 1200; Error: 0.646187646028962;
Epoch: 1300; Error: 0.48881681329304894;
Epoch: 1400; Error: 0.4005475591737743;
Epoch: 1500; Error: 0.34145887283532067;
Epoch: 1600; Error: 0.29871068426249625;
Epoch: 1700; Error: 0.2657577763744411;
Epoch: 1800; Error: 0.23921810237252988;
Epoch: 1900; Error: 0.2172060084455509;
Epoch: 2000; Error: 0.19856823374761018;
Epoch: 2100; Error: 0.18253521958793384;
Epoch: 2200; Error: 0.16855895648078095;
```

```
Epoch: 9500; Error: 0.0324601810657982 95;
Epoch: 9600; Error: 0.0270448166001064 78;
Epoch: 9700; Error: 0.0220263289101642 13;
Epoch: 9800; Error: 0.0183533242339387 13;
Epoch: 9900; Error: 0.0157896925913686 8;
Epoch: 10000; Error: 0.0140642057702138 47;
The maximum number of train epochs is reached

Testing on unknown data:

Original: o
Predicted: o

Original: m
Predicted: n

Original: m
Predicted: m

Original: a
Predicted: d

Original: n
Predicted: n
```

Chapter 20: Deep Learning with Convolutional Neural Networks






Input Layer
Convolution+RELU
Pooling
Fully Connected
Output Layer

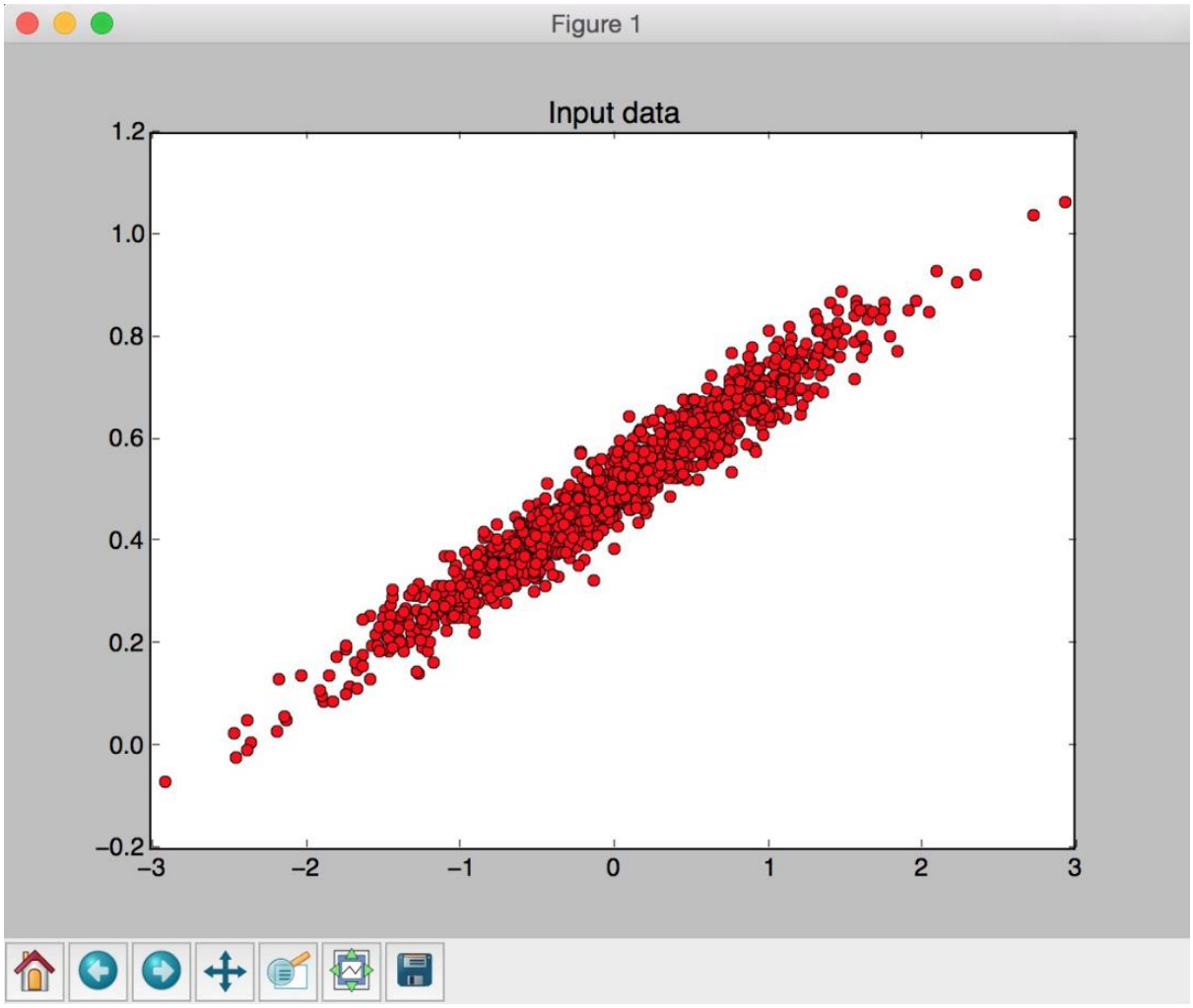


Figure 1
Input data
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−3
−2
−1
0
1
2
3

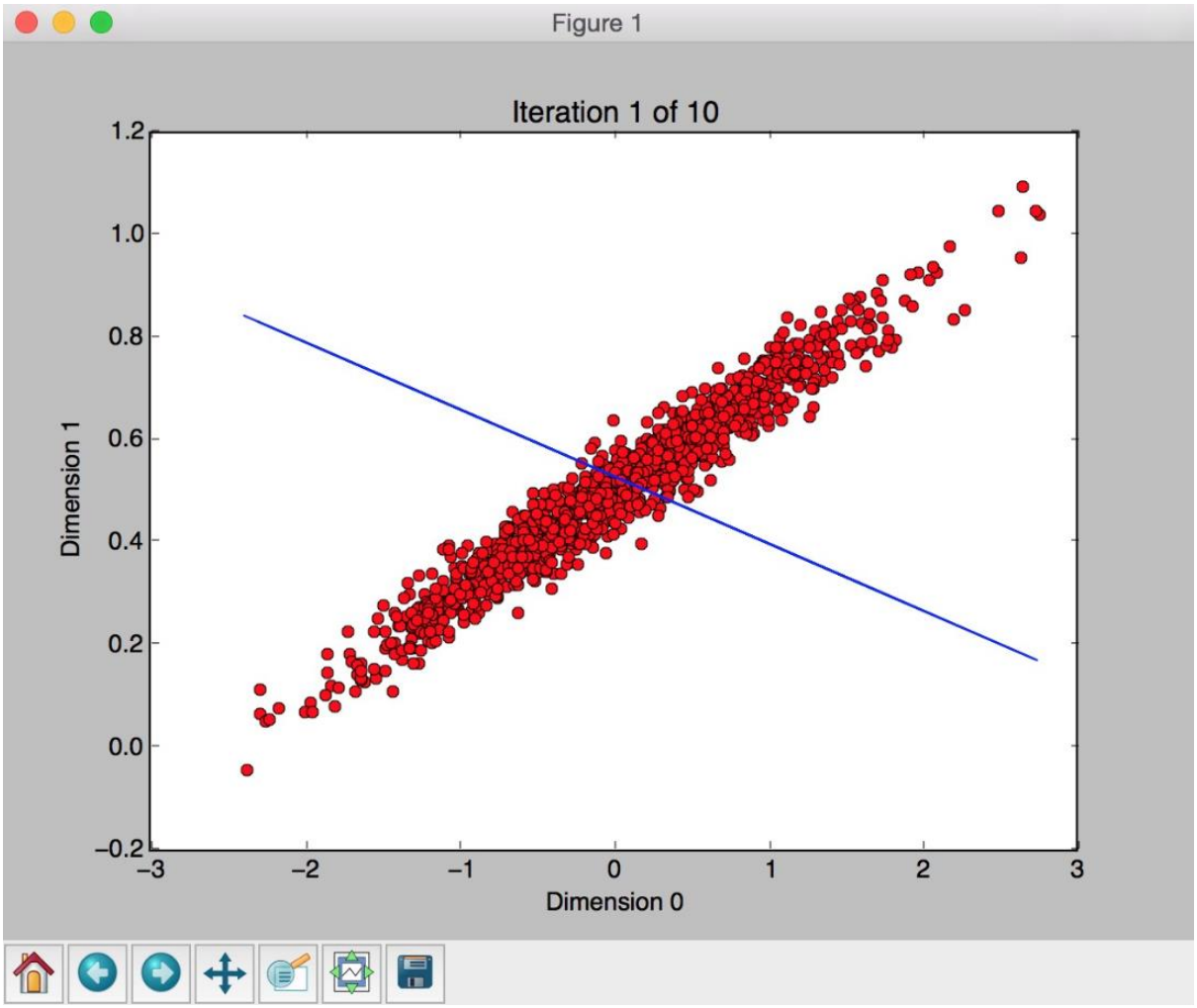


Figure 1
Iteration 1 of 10
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Dimension 1
−3
−2
−1
0
1
2
3
Dimension 0

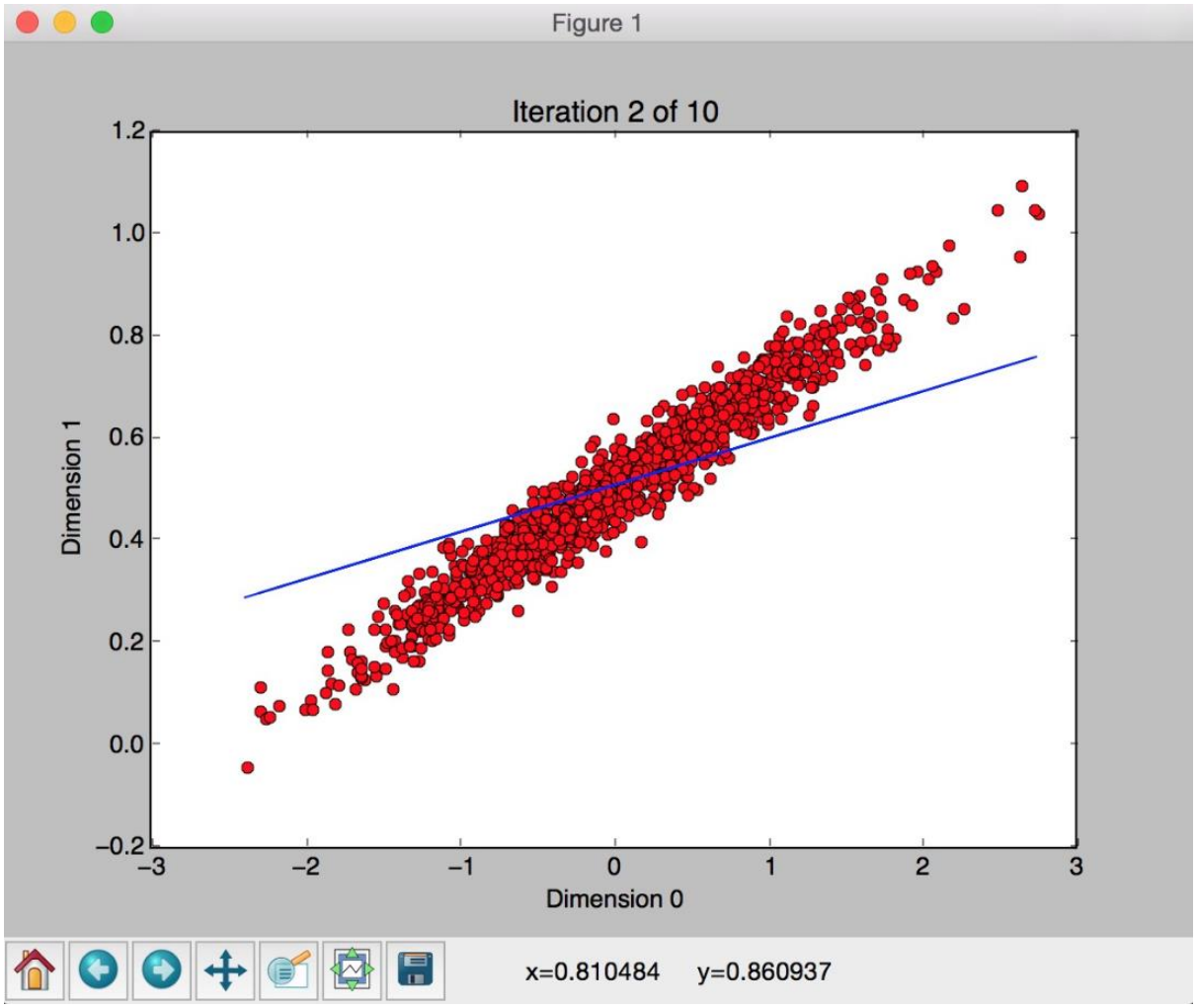


Figure 1
Iteration 2 of 10
Dimension 1
Dimension 0
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−3
−2
−1
0
1
2
3
x=0.810484
y=0.860937

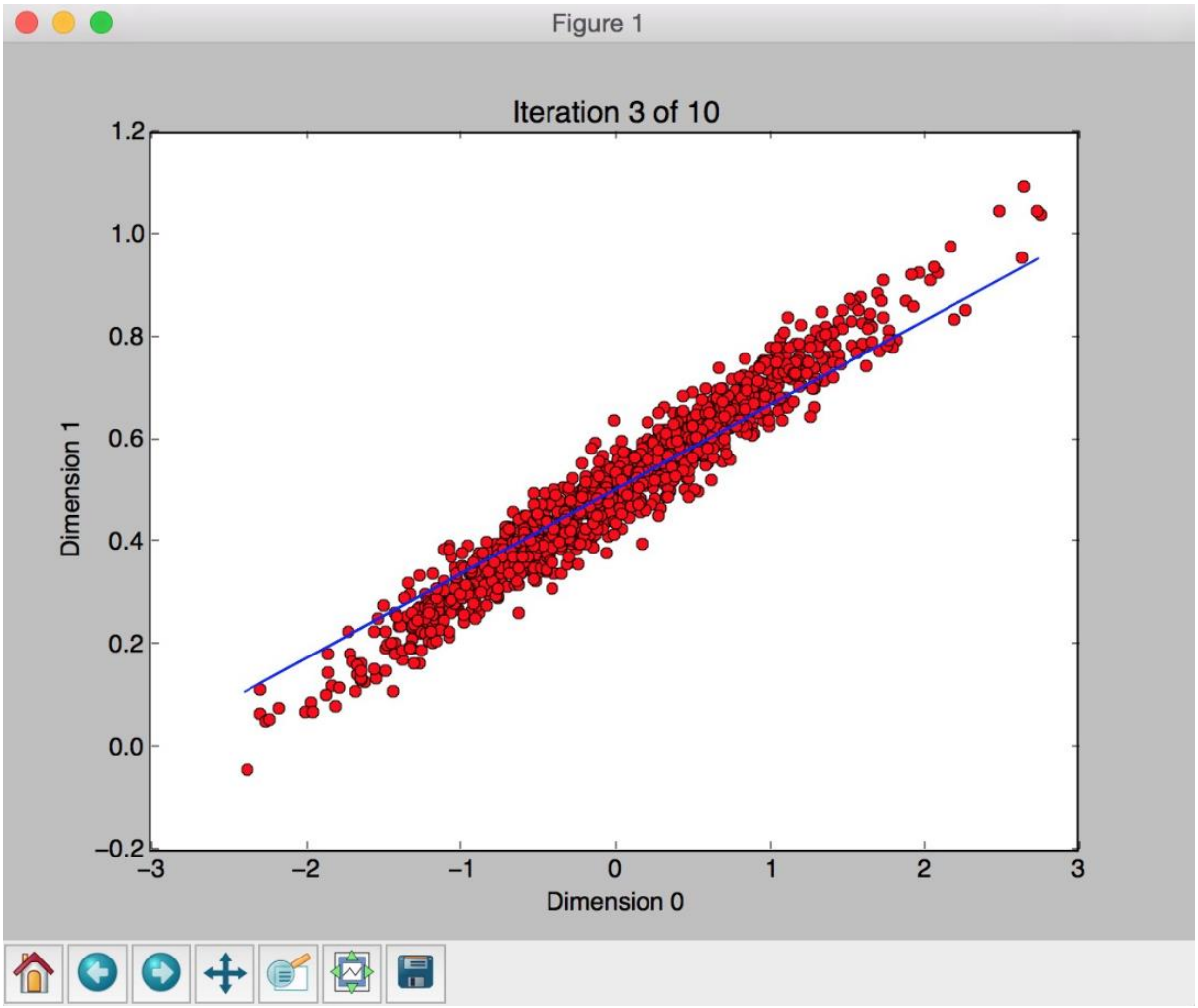


Figure 1
Iteration 3 of 10
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Dimension 1
−3
−2
−1
0
1
2
3
Dimension 0

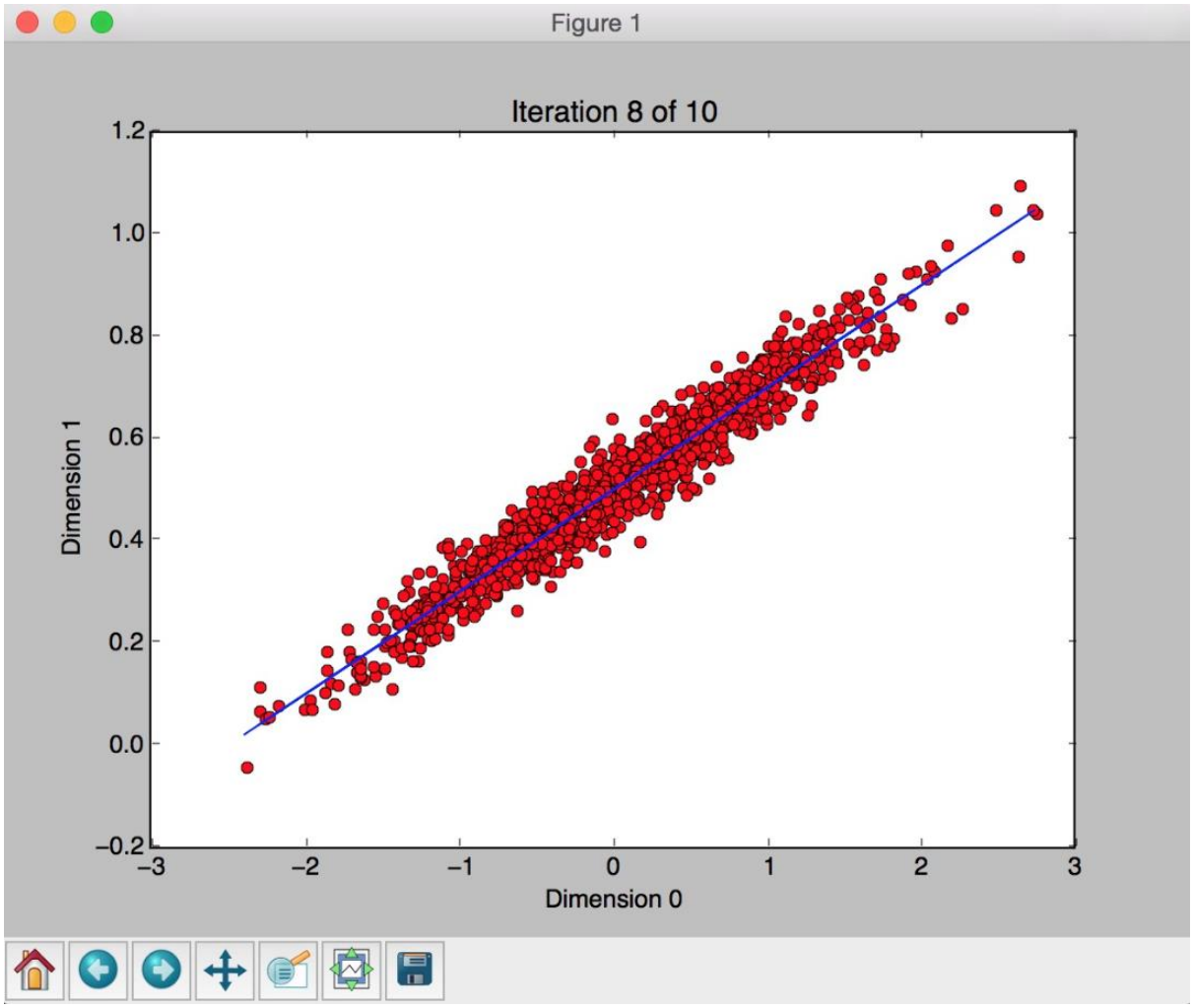


Figure 1
Iteration 8 of 10
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
Dimension 1
−3
−2
−1
0
1
2
3
Dimension 0

```
ITERATION 1
W = -0.130961
b = 0.53005
loss = 0.0760343

ITERATION 2
W = 0.0917911
b = 0.508959
loss = 0.00960302

ITERATION 3
W = 0.164665
b = 0.502555
loss = 0.00250165

ITERATION 4
W = 0.188492
b = 0.500459
loss = 0.0017425
```

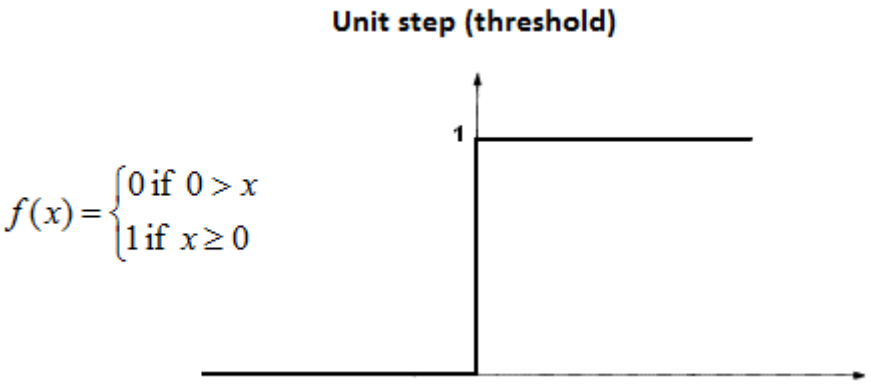
```
ITERATION 7
W = 0.199662
b = 0.499477
loss = 0.00165175

ITERATION 8
W = 0.199934
b = 0.499453
loss = 0.00165165

ITERATION 9
W = 0.200023
b = 0.499445
loss = 0.00165164

ITERATION 10
W = 0.200052
b = 0.499443
loss = 0.00165164
```

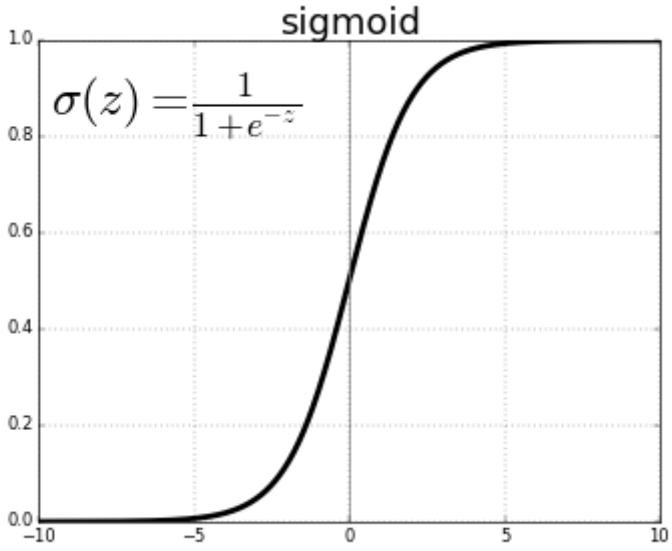
```
Extracting ./mnist_data/train-images-idx3-ubyte.gz
Extracting ./mnist_data/train-labels-idx1-ubyte.gz
Extracting ./mnist_data/t10k-images-idx3-ubyte.gz
Extracting ./mnist_data/t10k-labels-idx1-ubyte.gz

Accuracy = 0.921
```

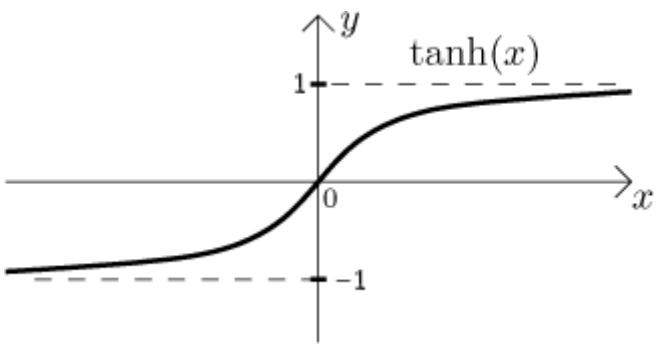
```
Extracting ./mnist_data/train-images-idx3-ubyte.gz
Extracting ./mnist_data/train-labels-idx1-ubyte.gz
Extracting ./mnist_data/t10k-images-idx3-ubyte.gz
Extracting ./mnist_data/t10k-labels-idx1-ubyte.gz

Training the model....
Iteration 0 , Accuracy = 0.0533333
Iteration 50 , Accuracy = 0.813333
Iteration 100 , Accuracy = 0.8
Iteration 150 , Accuracy = 0.906667
Iteration 200 , Accuracy = 0.84
Iteration 250 , Accuracy = 0.92
Iteration 300 , Accuracy = 0.933333
Iteration 350 , Accuracy = 0.866667
Iteration 400 , Accuracy = 0.973333
Iteration 450 , Accuracy = 0.933333
Iteration 500 , Accuracy = 0.906667
Iteration 550 , Accuracy = 0.853333
Iteration 600 , Accuracy = 0.973333
Iteration 650 , Accuracy = 0.973333
Iteration 700 , Accuracy = 0.96
Iteration 750 , Accuracy = 0.933333
```

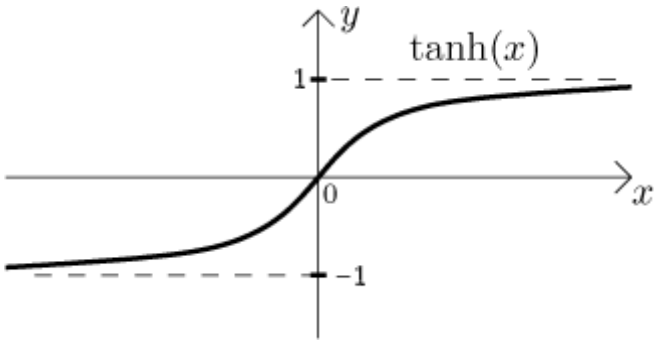
```
Iteration 2900 , Accuracy = 0.973333
Iteration 2950 , Accuracy = 1.0
Iteration 3000 , Accuracy = 0.973333
Iteration 3050 , Accuracy = 1.0
Iteration 3100 , Accuracy = 0.986667
Iteration 3150 , Accuracy = 1.0
Iteration 3200 , Accuracy = 1.0
Iteration 3250 , Accuracy = 1.0
Iteration 3300 , Accuracy = 1.0
Iteration 3350 , Accuracy = 1.0
Iteration 3400 , Accuracy = 0.986667
Iteration 3450 , Accuracy = 0.946667
Iteration 3500 , Accuracy = 0.973333
Iteration 3550 , Accuracy = 0.973333
Iteration 3600 , Accuracy = 1.0
Iteration 3650 , Accuracy = 0.986667
Iteration 3700 , Accuracy = 1.0
Iteration 3750 , Accuracy = 1.0
Iteration 3800 , Accuracy = 0.986667
Iteration 3850 , Accuracy = 0.986667
Iteration 3900 , Accuracy = 1.0
```

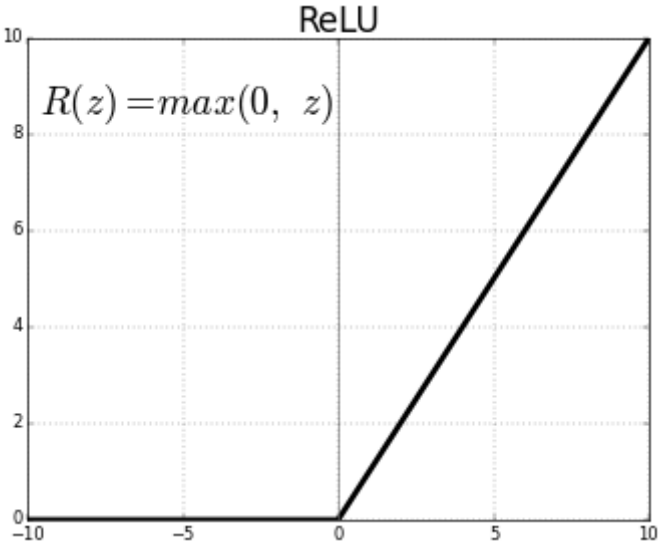
Chapter 21: Recurrent Neural Networks and Other Deep Learning Models

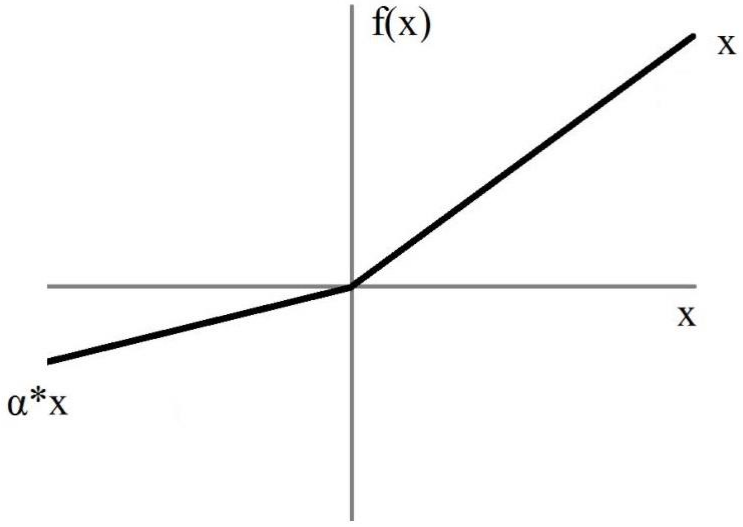


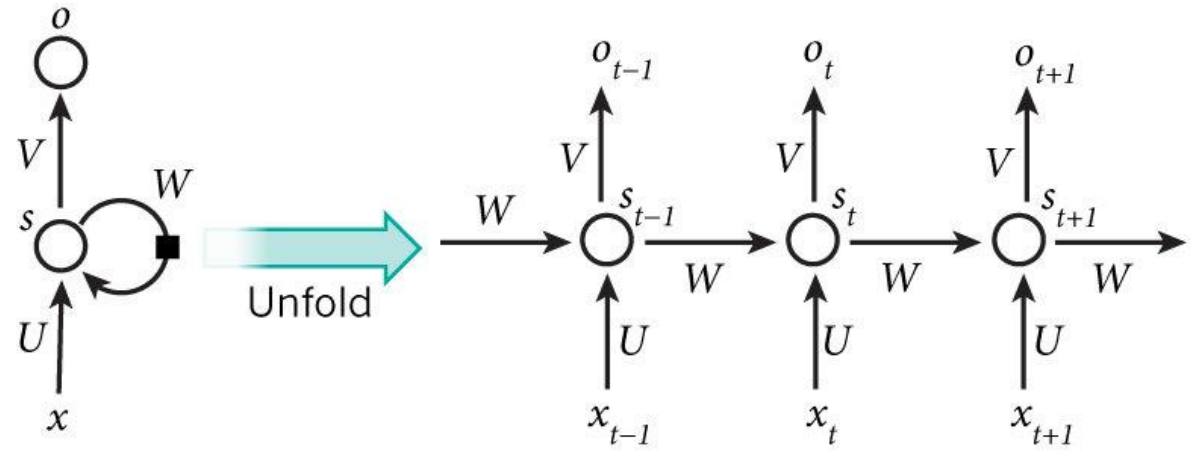


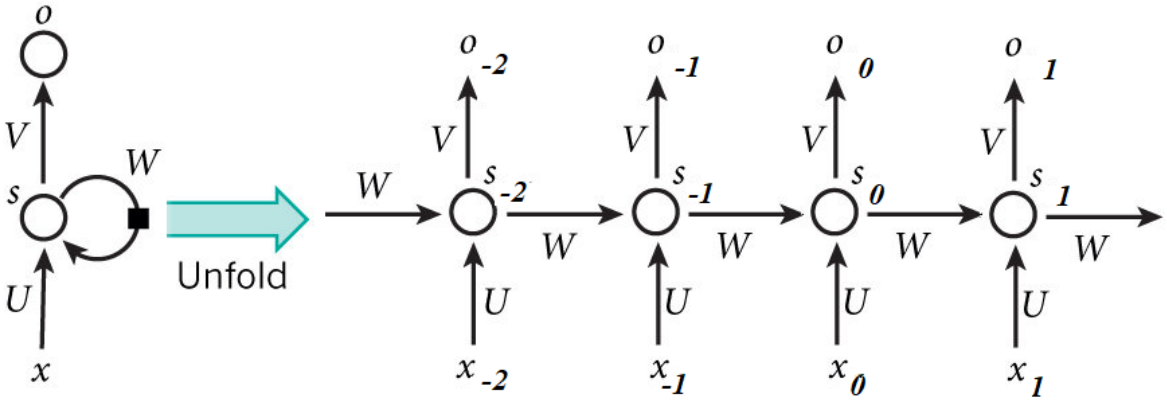


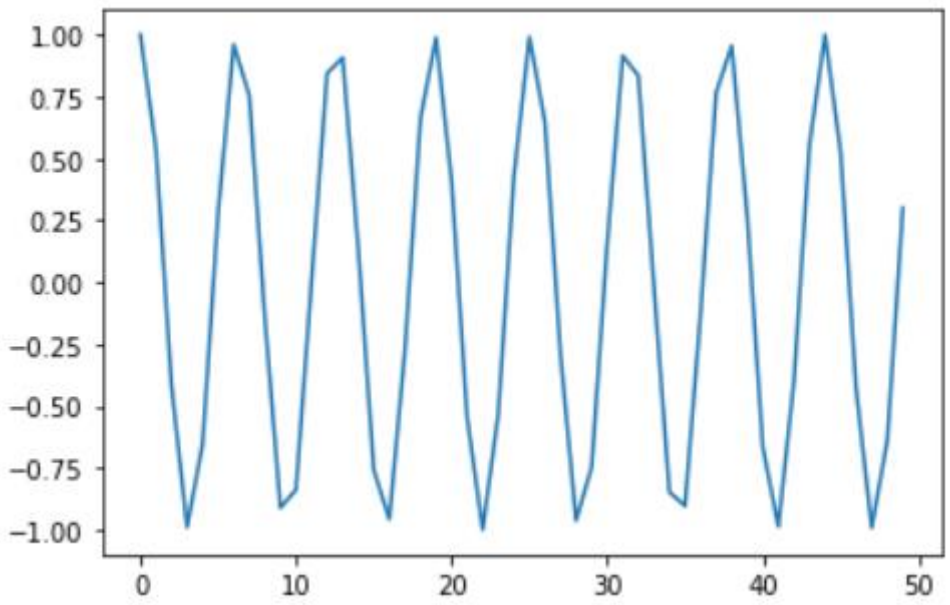

y
tanh(x)
1
0
x
−1


ReLU
R(z) =max(0, z)
10
8
6
4
2
0
−10
−5
0
5
10


f(x)
x
x
α*x

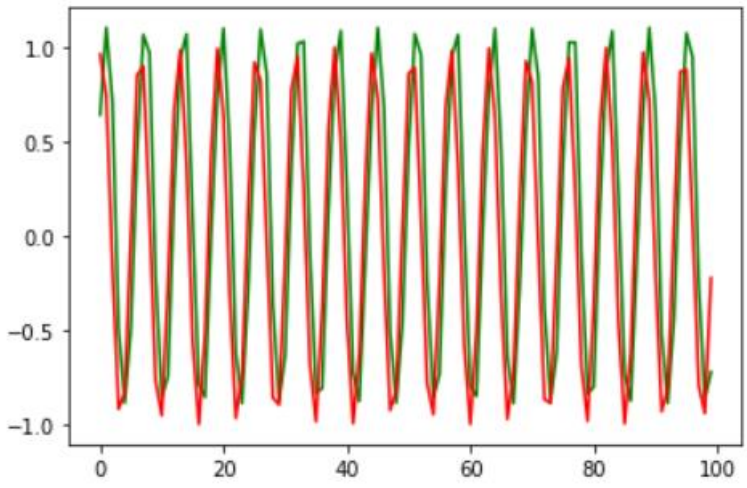

o
V
W
s
U
x
Unfold
o t−1
o t
o t+1
V
s t−1
s t
s t+1
W
U
x t−1
x t
x t+1


o
V
W
s
U
x
Unfold
o -2
o -1
o 0
o 1
s -2
s -1
s 0
s 1
x -2
x -1
x 0
x 1

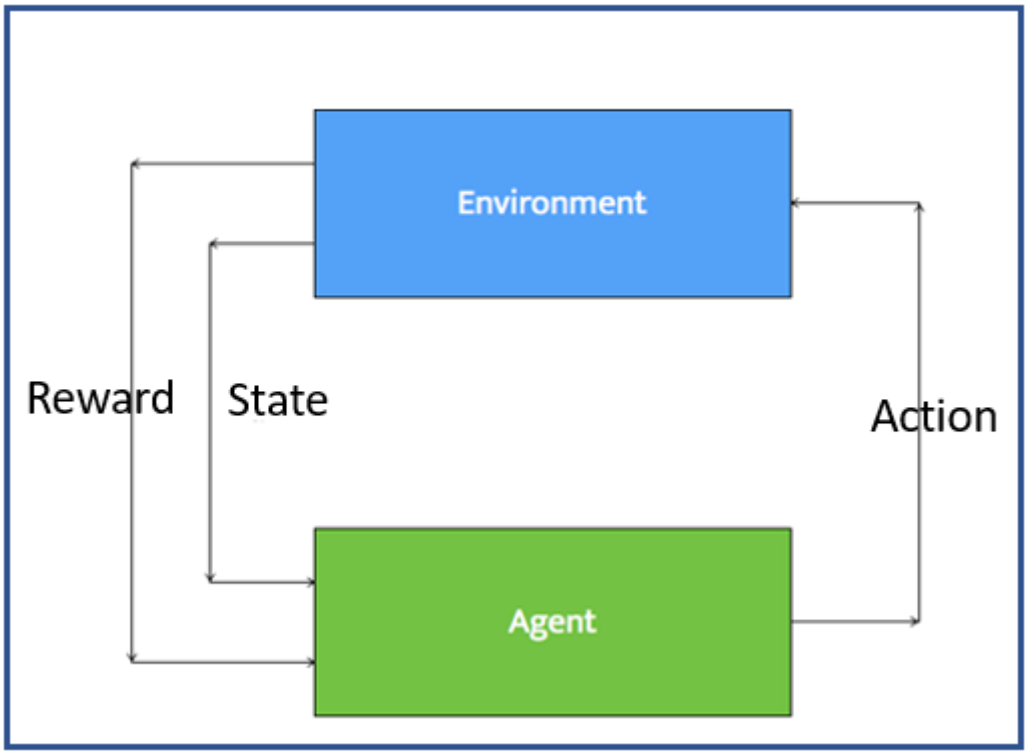



```
Epoch:  1 , Loss:  [[121041.93042362]] , Val Loss:  [[60516.00234376]]
Epoch:  2 , Loss:  [[76845.00778255]] , Val Loss:  [[38418.55786001]]
Epoch:  3 , Loss:  [[42648.08514127]] , Val Loss:  [[21321.11337615]]
Epoch:  4 , Loss:  [[18451.16022513]] , Val Loss:  [[9223.66775589]]
Epoch:  5 , Loss:  [[4238.41635421]] , Val Loss:  [[2118.31929096]]
```

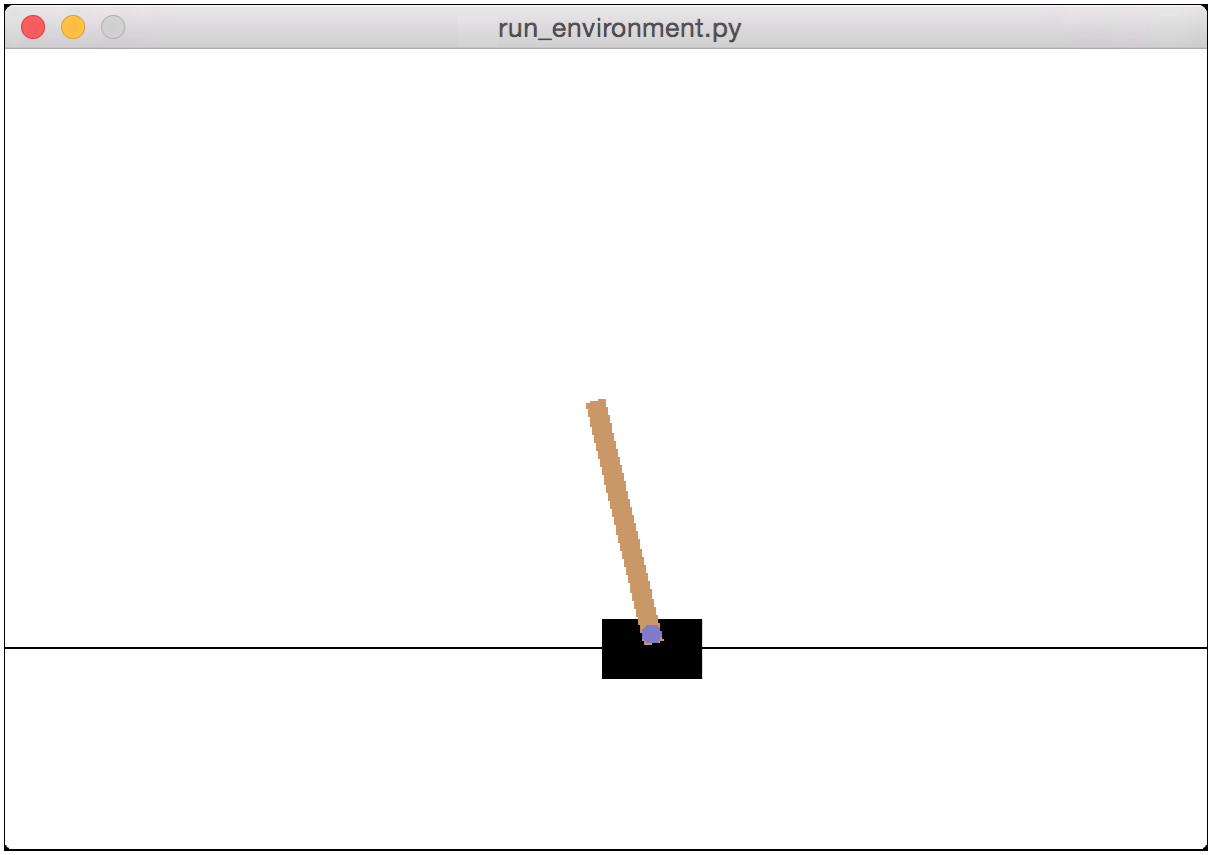
```
Epoch:  1 , Loss:  [[95567.55451649]] , Val Loss:  [[47779.37198851]]
Epoch:  2 , Loss:  [[56854.28788942]] , Val Loss:  [[28423.75551176]]
Epoch:  3 , Loss:  [[28141.02126203]] , Val Loss:  [[14068.13903485]]
Epoch:  4 , Loss:  [[9427.75131975]] , Val Loss:  [[4712.5209022]]
Epoch:  5 , Loss:  [[701.30645776]] , Val Loss:  [[350.32328326]]
Epoch:  6 , Loss:  [[24.4862044]] , Val Loss:  [[12.26924361]]
Epoch:  7 , Loss:  [[27.61131066]] , Val Loss:  [[13.83388386]]
Epoch:  8 , Loss:  [[28.77439377]] , Val Loss:  [[14.45462133]]
Epoch:  9 , Loss:  [[31.02608915]] , Val Loss:  [[15.53625882]]
Epoch:  10 , Loss:  [[25.79425679]] , Val Loss:  [[12.95839331]]
```

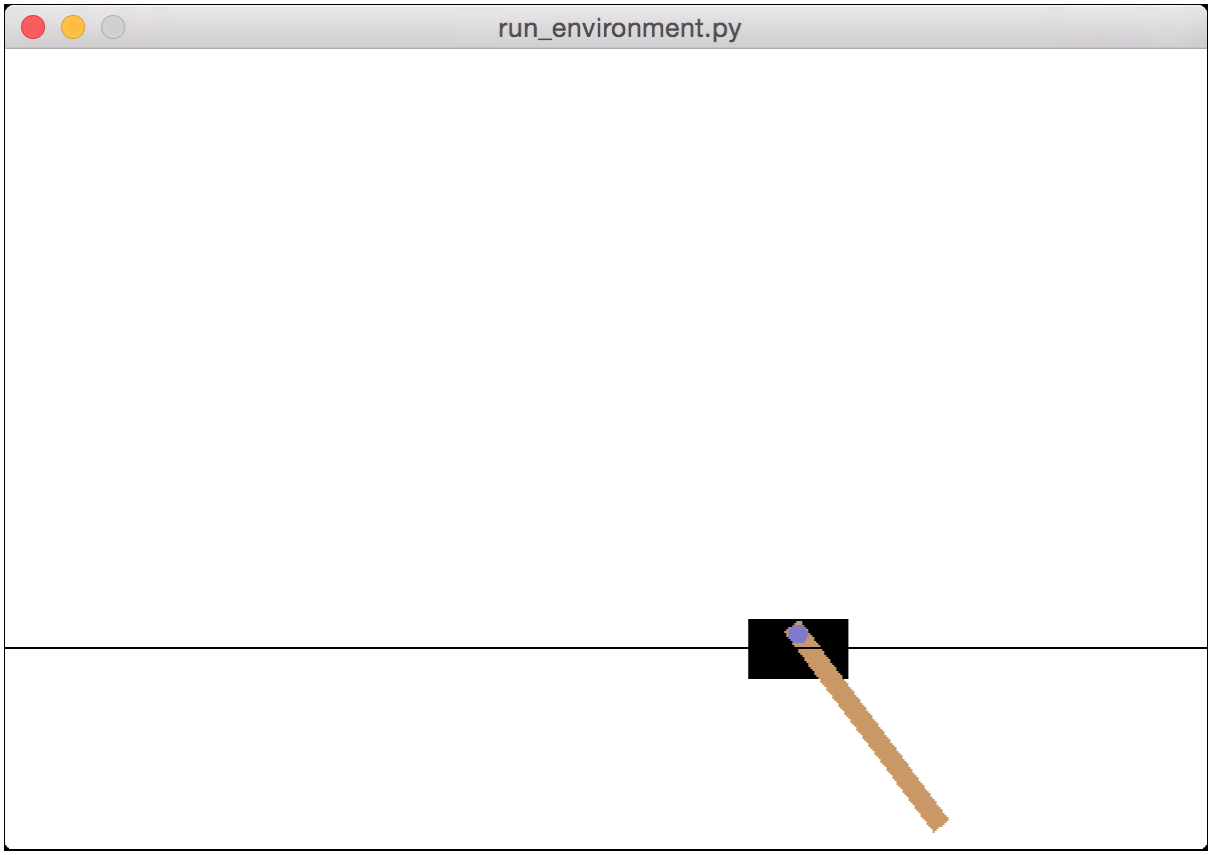

1.0
0.5
0.0
−0.5
−1.0
0
20
40
60
80
100

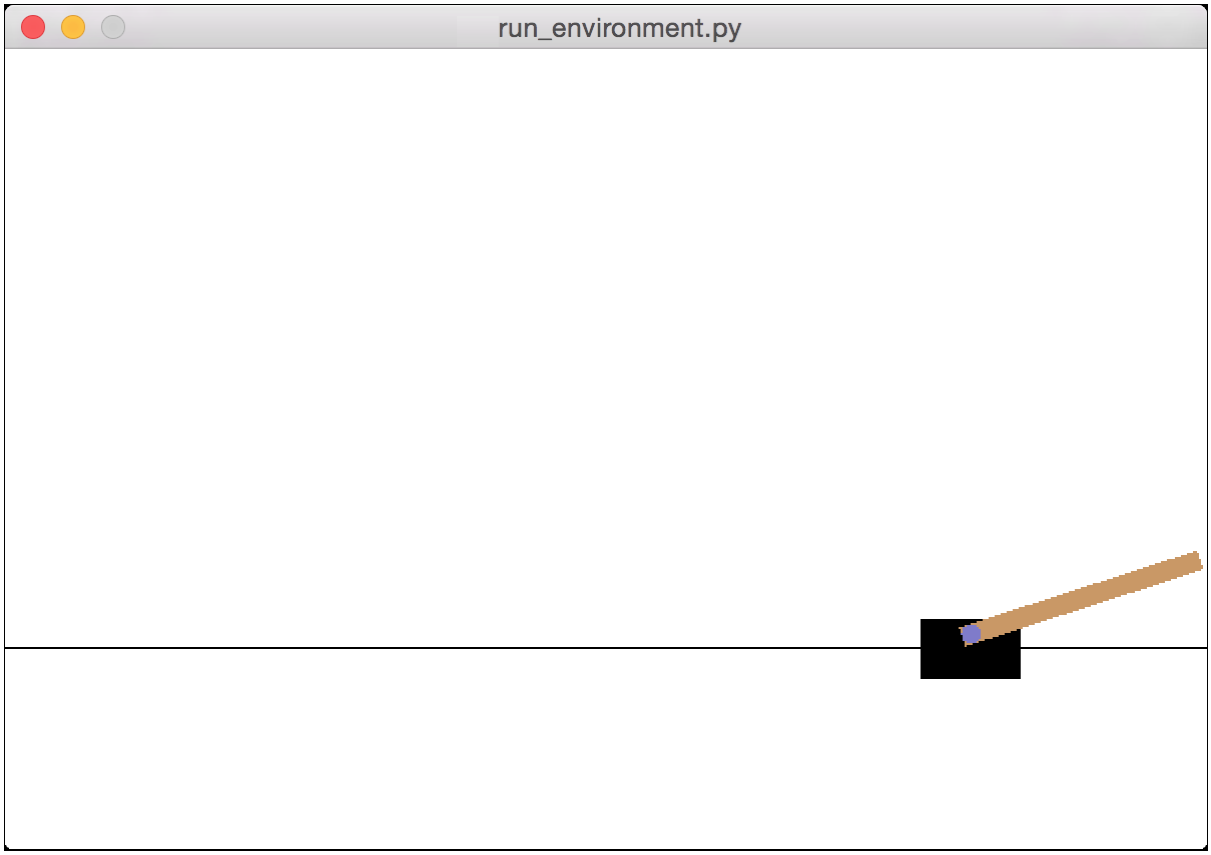
Chapter 22: Creating Intelligent Agents with Reinforcement Learning

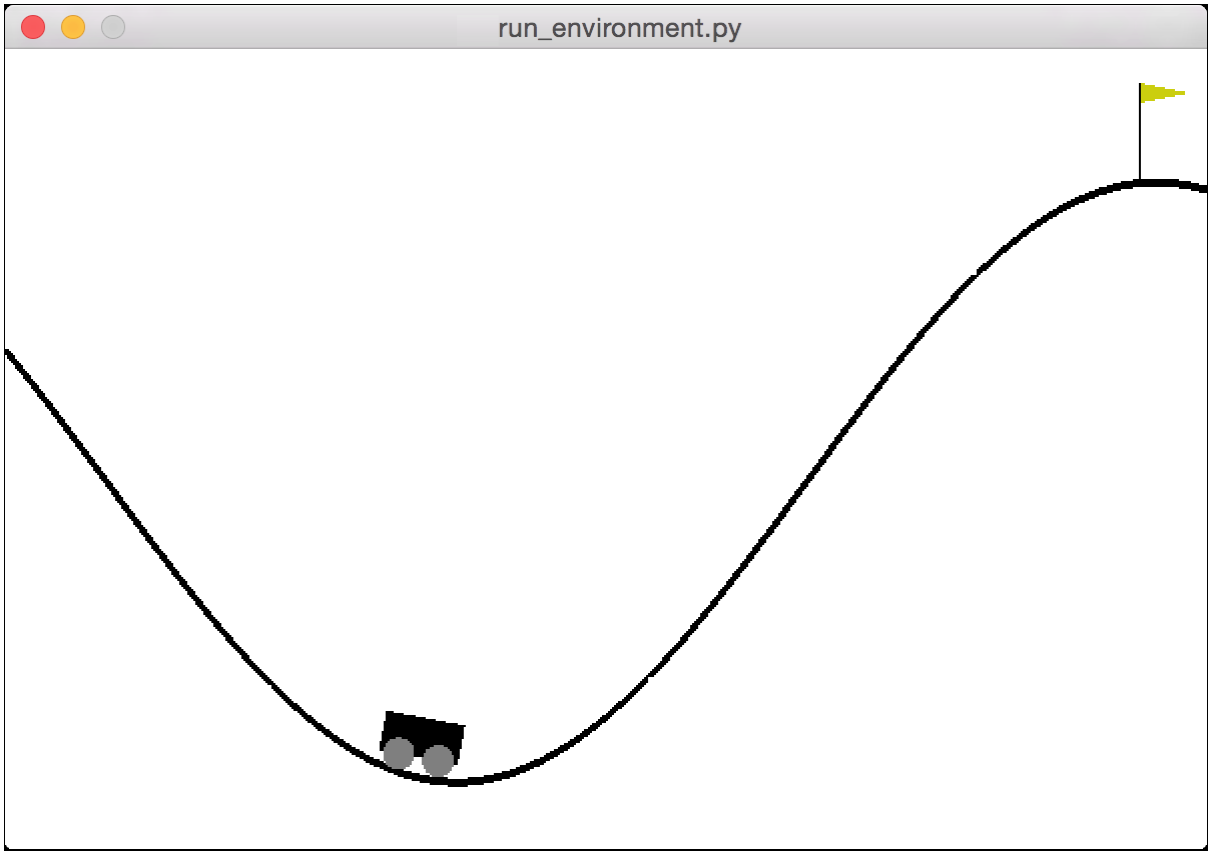


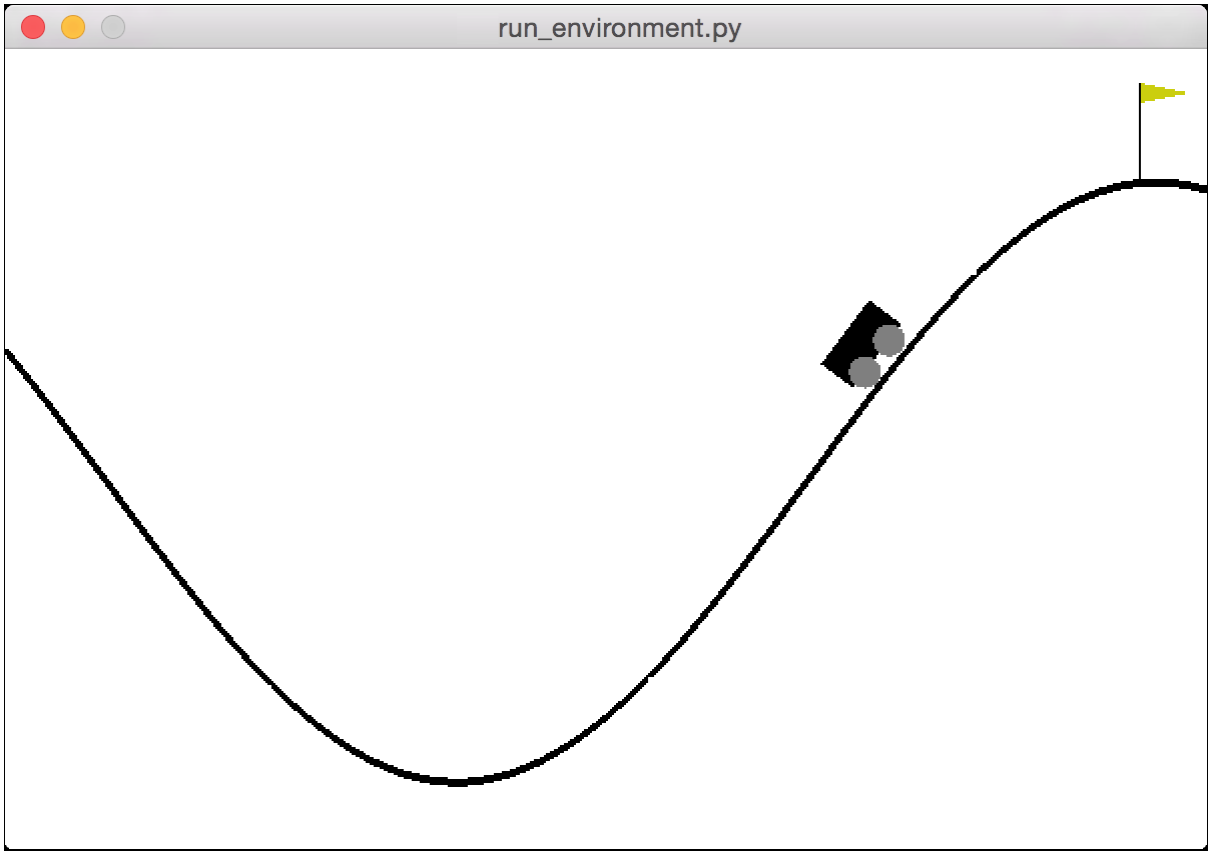

```
$ python3 run_environment.py --help
usage: run_environment.py [-h] --input-env
                          {cartpole,mountaincar,pendulum,taxi,lake}

Run an environment

optional arguments:
  -h, --help            show this help message and exit
  --input-env {cartpole,mountaincar,pendulum,taxi,lake}
                        Specify the name of the environment
```

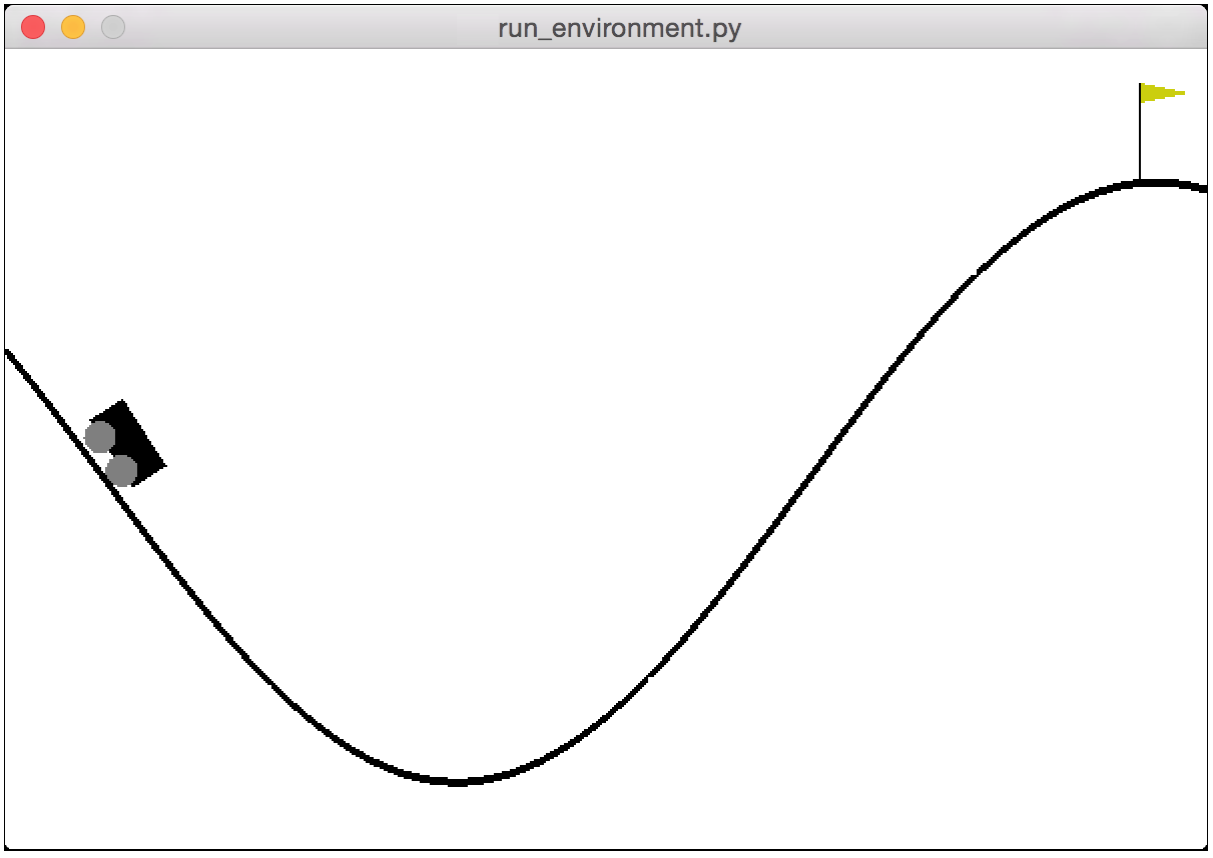

run_environment.py


run_environment.py

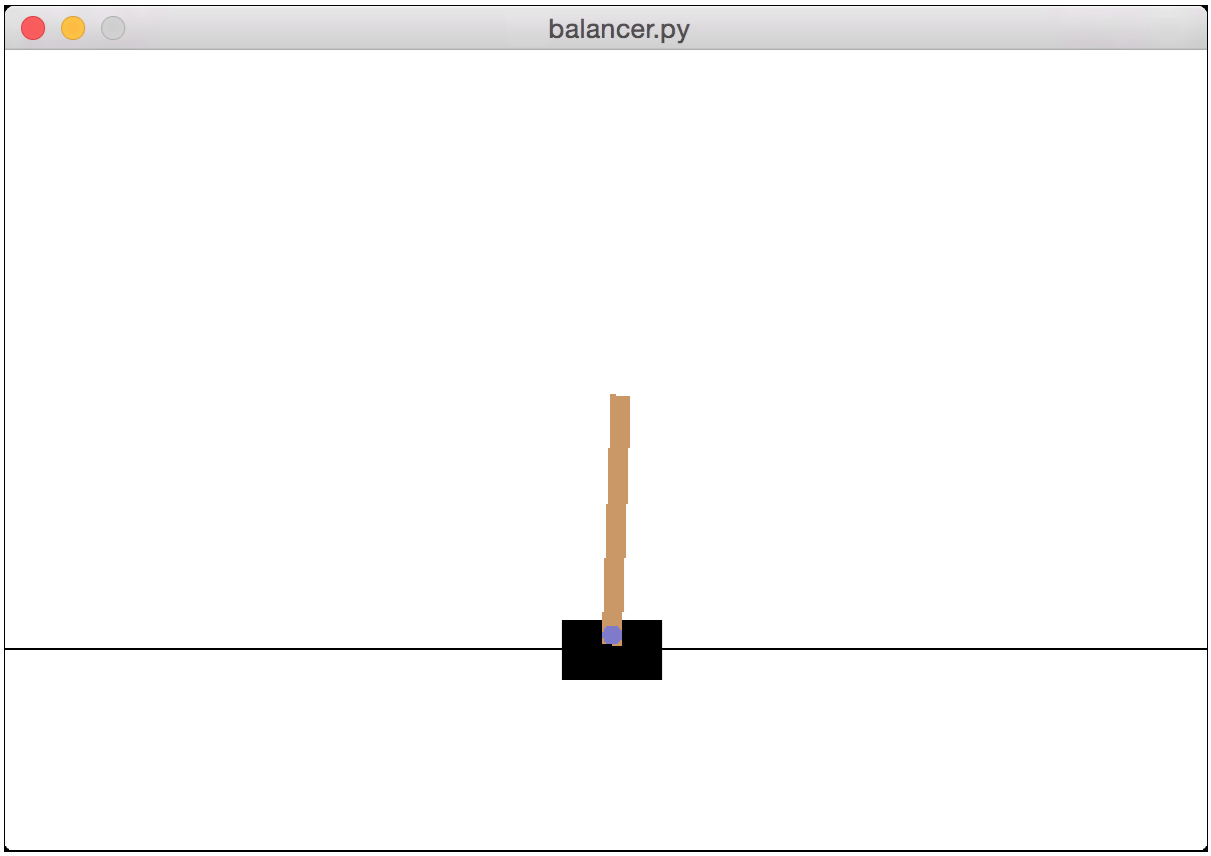

run_environment.py

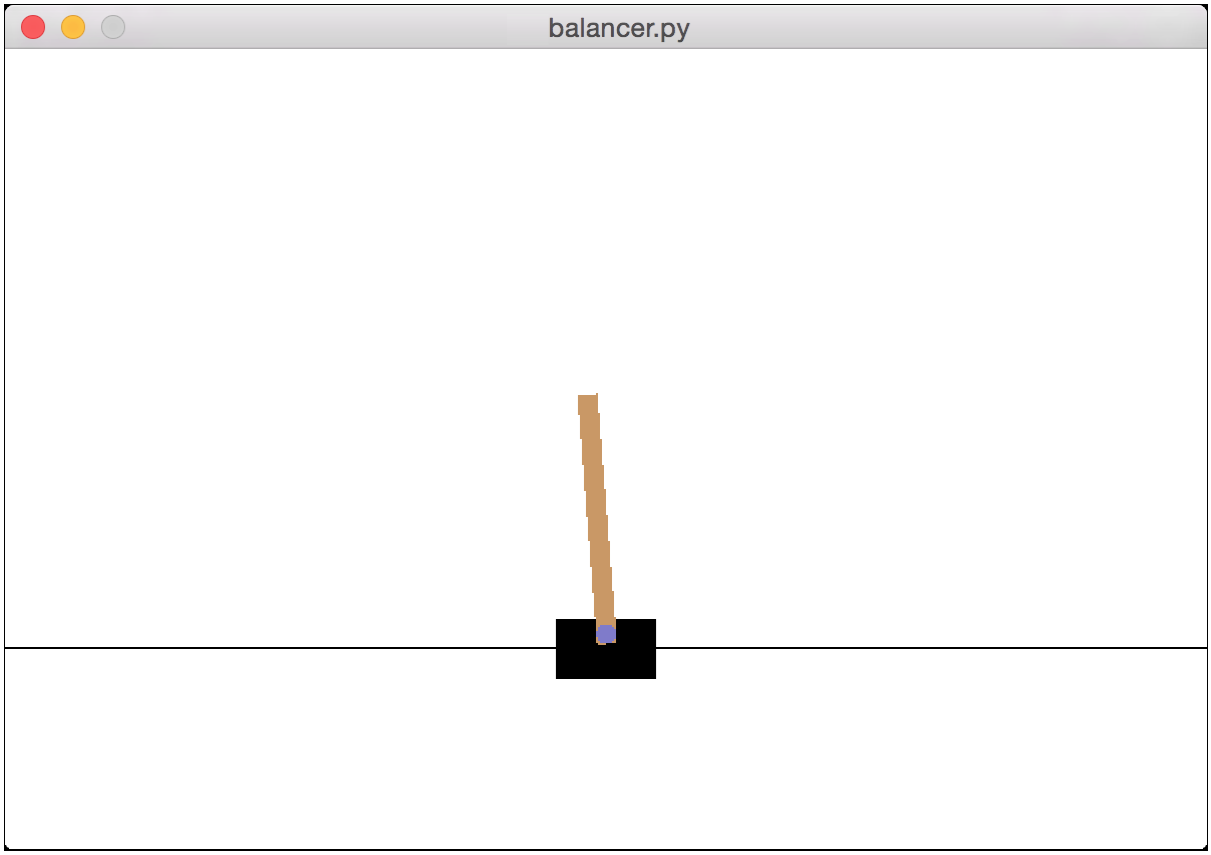

run_environment.py


run_environment.py


run_environment.py

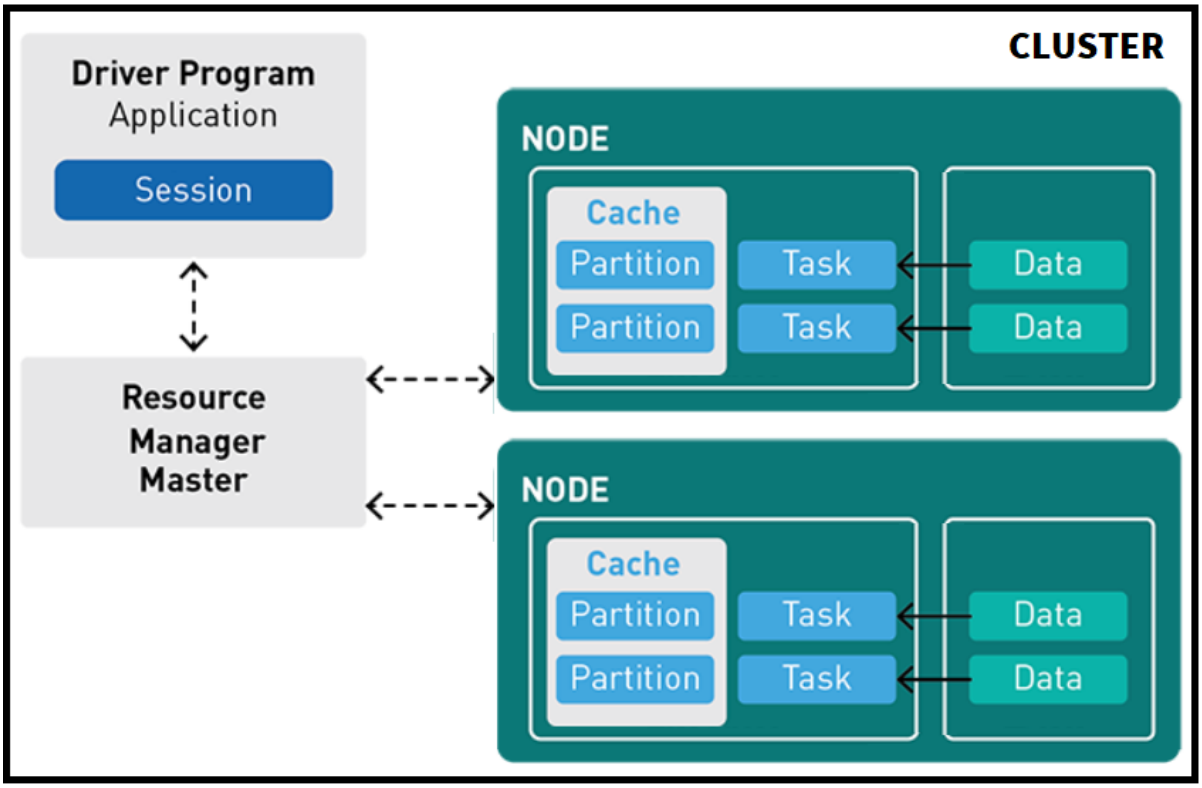
```
$ python3 balancer.py --help
usage: balancer.py [-h] --input-env {cartpole,mountaincar,pendulum}

Run an environment

optional arguments:
  -h, --help            show this help message and exit
  --input-env {cartpole,mountaincar,pendulum}
                        Specify the name of the environment
```




balancer.py

```
[ 0.01704777  0.03379922 -0.01628054  0.02868271]
[ 0.01772375 -0.16108552 -0.01570689  0.31618481]
[ 0.01450204  0.03425659 -0.00938319  0.01859014]
[ 0.01518717 -0.16072954 -0.00901139  0.30829785]
[ 0.01197258 -0.35572194 -0.00284543  0.59812526]
[ 0.00485814 -0.16056029  0.00911707  0.30454742]
[ 0.00164694 -0.35581098  0.01520802  0.60009165]
[-0.00546928 -0.16090505  0.02720986  0.31223756]
[-0.00868738 -0.35640386  0.03345461  0.61337594]
[-0.01581546 -0.55197696  0.04572213  0.91640525]
[-0.026855   -0.3575021   0.06405023  0.63843544]
[-0.03400504 -0.16332896  0.07681894  0.36659087]
[-0.03727162 -0.3594537   0.08415076  0.68247294]
[-0.04446069 -0.5556372   0.09780022  1.00041801]
[-0.05557344 -0.75192055  0.11780858  1.32214352]
[-0.07061185 -0.55846765  0.14425145  1.06853119]
[-0.0817812  -0.36551752  0.16562207  0.82437502]
[-0.08909155 -0.56247052  0.18210957  1.16423244]
[-0.10034096 -0.75943464  0.20539422  1.50803784]
Episode finished after 19 timesteps
```

Chapter 23: Artificial Intelligence and Big Data



boxing gloves for women

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