

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as sts
%matplotlib inline
```

## Считывание данных

In [2]:

```
file_obj = open('6.csv', 'r')

# массив данных
date = np.array([])

# значение лямбда
lam = file_obj.readline().split(' ')
lam = 1/float(lam[-1])

# t0
t0 = file_obj.readline().split(' ')
t0 = float(t0[-1])

# t
t = file_obj.readline().split(' ')
t = float(t[-1])

# приведение данных к float
for line in file_obj:
    line = line[:-1]
    date = np.append(date, float(line))
file_obj.close()

# сортировка данных по возрастанию
date.sort()
```

In [3]:

```
# прогноз количества серверов, которые сломаются в момент времени t
# в i-ой ячейке хранится предсказание, данное в i*t0 момент времени
break_servers = np.zeros(int(t/t0))

# количество серверов, сломавшихся к данному моменту
cur_broke_servers = 0

for time in np.arange(0, t, t0):
    # обновляем количество сломавшихся серверов к моменту времени time
    while cur_broke_servers < date.size and date[cur_broke_servers] <= time:
        cur_broke_servers += 1

    # прогноз, полученный в момент времени time
    break_servers[int(time/t0)] = lam*(t - time) + cur_broke_servers
```

## Вывод формулы $E(N_t|N_s)$

$E(N_t|N_s) = E(N_t - N_s|N_s) + E(N_s|N_s) \stackrel{\text{по св-ву условного матожидания}}{=} \\ = E(N_t - N_s|N_s) + E(N_s) \stackrel{\text{из независимости } (N_t - N_s) \text{ и } N_s}{=} \text{и т.к. рассматривается ситуация в момент времени } s \} = E(N_t - N_s) + N_s$

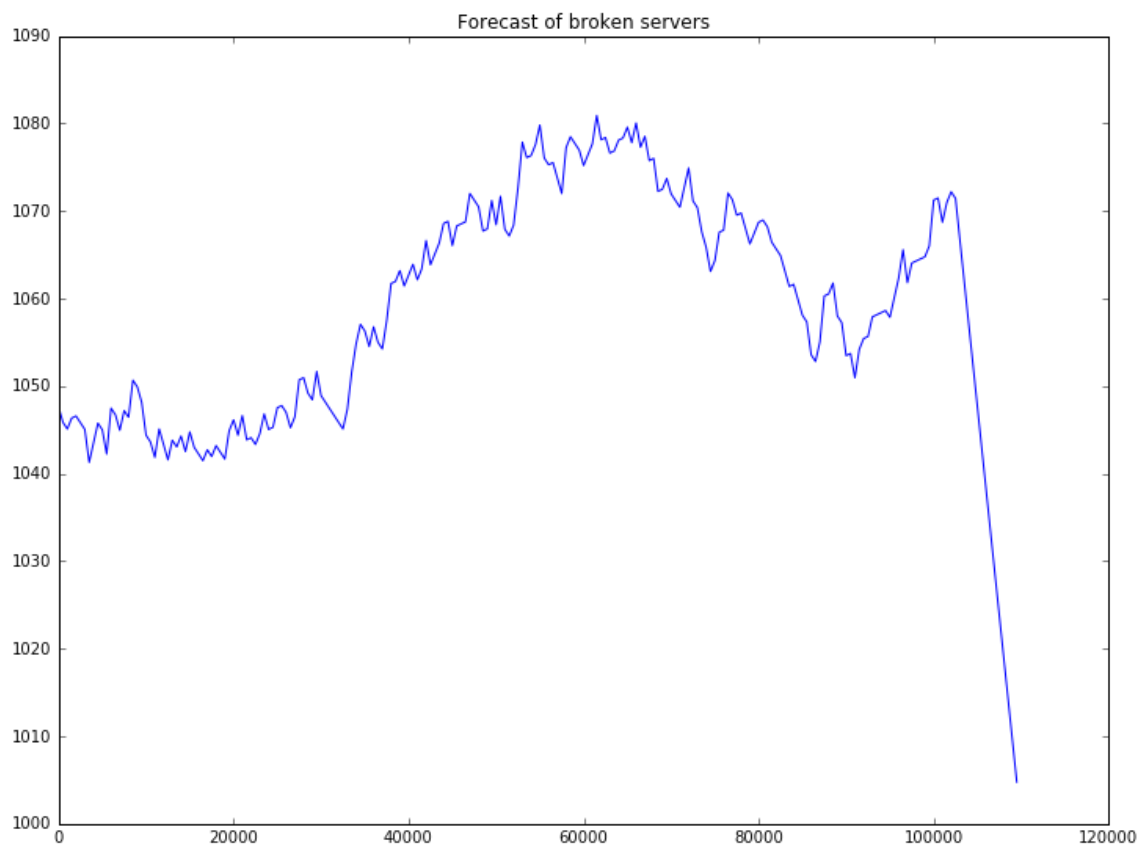
$$E(N_t - N_s) = \lambda * (t - s)$$

Таким образом:

$$E(N_t|N_s) = \lambda * (t - s) + N_s$$

In [4]:

```
# строим график прогноза от времени  
  
# время  
time = np.arange(0, t, t0)  
  
plt.figure(figsize=(12, 9))  
  
plt.plot(time, break_servers)  
plt.ylim(1000, 1090)  
plt.title('Forecast of broken servers')  
  
plt.show()
```



In [5]:

```
# на всякий случай печать прогноза  
print break_servers
```

[ 1047.61904762	1045.85714286	1045.0952381	1046.33333333	1
046.57142857				
1045.80952381	1045.04761905	1041.28571429	1043.52380952	1
045.76190476				
1045.	1042.23809524	1047.47619048	1046.71428571	1
044.95238095				
1047.19047619	1046.42857143	1050.66666667	1049.9047619	1
048.14285714				
1044.38095238	1043.61904762	1041.85714286	1045.0952381	1
043.33333333				
1041.57142857	1043.80952381	1043.04761905	1044.28571429	1
042.52380952				
1044.76190476	1043.	1042.23809524	1041.47619048	1
042.71428571				
1041.95238095	1043.19047619	1042.42857143	1041.66666667	1
044.9047619				
1046.14285714	1044.38095238	1046.61904762	1043.85714286	1
044.0952381				
1043.33333333	1044.57142857	1046.80952381	1045.04761905	1
045.28571429				
1047.52380952	1047.76190476	1047.	1045.23809524	1
046.47619048				
1050.71428571	1050.95238095	1049.19047619	1048.42857143	1
051.66666667				
1048.9047619	1048.14285714	1047.38095238	1046.61904762	1
045.85714286				
1045.0952381	1047.33333333	1051.57142857	1054.80952381	1
057.04761905				
1056.28571429	1054.52380952	1056.76190476	1055.	1
054.23809524				
1057.47619048	1061.71428571	1061.95238095	1063.19047619	1
061.42857143				
1062.66666667	1063.9047619	1062.14285714	1063.38095238	1
066.61904762				
1063.85714286	1065.0952381	1066.33333333	1068.57142857	1
068.80952381				
1066.04761905	1068.28571429	1068.52380952	1068.76190476	1
072.				
1071.23809524	1070.47619048	1067.71428571	1067.95238095	1
071.19047619				
1068.42857143	1071.66666667	1067.9047619	1067.14285714	1
068.38095238				
1072.61904762	1077.85714286	1076.0952381	1076.33333333	1
077.57142857				
1079.80952381	1076.04761905	1075.28571429	1075.52380952	1
073.76190476				
1072.	1077.23809524	1078.47619048	1077.71428571	1
076.95238095				
1075.19047619	1076.42857143	1077.66666667	1080.9047619	1
078.14285714				
1078.38095238	1076.61904762	1076.85714286	1078.0952381	1
078.33333333				
1079.57142857	1077.80952381	1080.04761905	1077.28571429	1
078.52380952				
1075.76190476	1076.	1072.23809524	1072.47619048	1
073.71428571				
1071.95238095	1071.19047619	1070.42857143	1072.66666667	1

```

074.9047619
  1071.14285714  1070.38095238  1067.61904762  1065.85714286  1
063.0952381
  1064.33333333  1067.57142857  1067.80952381  1072.04761905  1
071.28571429
  1069.52380952  1069.76190476  1068.          1066.23809524  1
067.47619048
  1068.71428571  1068.95238095  1068.19047619  1066.42857143  1
065.66666667
  1064.9047619  1063.14285714  1061.38095238  1061.61904762  1
059.85714286
  1058.0952381  1057.33333333  1053.57142857  1052.80952381  1
055.04761905
  1060.28571429  1060.52380952  1061.76190476  1058.          1
057.23809524
  1053.47619048  1053.71428571  1050.95238095  1054.19047619  1
055.42857143
  1055.66666667  1057.9047619  1058.14285714  1058.38095238  1
058.61904762
  1057.85714286  1060.0952381  1062.33333333  1065.57142857  1
061.80952381
  1064.04761905  1064.28571429  1064.52380952  1064.76190476  1
066.
  1071.23809524  1071.47619048  1068.71428571  1070.95238095  1
072.19047619
  1071.42857143  1066.66666667  1061.9047619  1057.14285714  1
052.38095238
  1047.61904762  1042.85714286  1038.0952381  1033.33333333  1
028.57142857
  1023.80952381  1019.04761905  1014.28571429  1009.52380952  1
004.76190476]

```

In [6]:

```
# на всякий случай печать исходных данных  
print lam, '\n', t0, '\n', t, '\n', date
```

0.00952380952381

500.0

110000.0

[ 198.4406 460.8092 494.1672 517.8483 560.4

633.9109

921.567 1158.8588 1274.4149 1287.2666 1328.93

48

1360.5433 1466.1662 1581.8253 1592.6818 1821.16

89

1821.574 1978.1997 2041.0241 2080.241 2267.94

37

2334.7124 2515.4969 2797.2978 2827.6293 2883.97

54

3005.4021 3518.4422 3640.7351 3677.105 3701.69

48

3836.6024 3874.7631 3893.9537 4061.5291 4198.89

96

4226.5964 4266.4072 4331.3636 4419.0845 4493.33

09

4632.8954 4841.545 4854.6571 4917.4448 5289.09

97

5341.4091 5505.4492 5515.7956 5574.0126 5711.17

51

5748.7882 5758.8604 5932.6071 5976.6869 5979.52

18

5979.74 6273.6398 6336.2478 6429.7853 6447.52

24

6589.2105 6626.7495 6857.621 7032.9753 7210.18

2

7229.9956 7370.2266 7375.1584 7458.1236 7467.76

02

7549.1966 7649.2758 7920.8578 7933.7474 8106.38

45

8148.2834 8160.8184 8223.7964 8234.5101 8287.69

9

8300.8639 8357.6157 8371.035 8507.08 8889.98

68

8970.8845 8992.371 9136.5452 9285.1659 9466.95

71

9826.7627 10019.8912 10330.1514 10424.8071 10495.69

91

10595.1228 10621.3687 10969.4783 11065.6358 11089.59

21

11104.2035 11144.2902 11183.8962 11184.6211 11193.14

91

11414.1819 11587.5524 11691.6212 11729.3666 12033.92

03

12082.042 12402.2028 12516.4022 12538.4642 12669.46

16

12670.8646 12749.5149 12778.7654 12886.7514 13209.14

87

13270.3539 13366.0482 13490.9278 13500.1439 13509.46

54

13561.7326 13728.1727 13892.0573 13987.6753 14074.88

41

14369.6151 14443.9096 14515.7884 14530.4876 14543.63

06



08	14865.3176	14926.5647	14987.2605	14999.1581	15075.13
7	15085.8427	15344.2632	15530.1176	15715.1789	15778.33
38	15851.81	16138.4394	16141.6965	16353.7992	16581.11
49	16013.0438	16138.4394	16141.6965	16353.7992	16581.11
63	16581.8651	16596.8048	16661.92	16667.0497	16971.55
55	17042.2722	17072.6697	17199.27	17329.2784	17518.24
69	17567.6207	17591.4941	17766.7852	17785.8047	17795.59
84	18104.9975	18327.9242	18419.3775	18498.0124	18697.64
59	18825.6093	18951.0019	18980.4652	19079.3652	19083.91
25	19090.7049	19149.5465	19195.708	19287.8536	19380.62
73	19491.424	19545.6561	19588.2367	19614.8531	19617.87
05	19778.9189	19958.0036	20139.5023	20448.3286	20455.99
41	20618.9989	20619.1092	20666.9317	20751.6735	20897.06
9	20918.2173	20939.6648	21235.2633	21357.8327	21575.92
6	21650.8065	21855.5143	21878.9643	21967.1083	22005.64
5	22056.3098	22390.1757	22459.8703	22507.1727	22644.37
39	22725.7527	22804.4241	22935.5377	22961.2749	23040.11
17	23112.6132	23154.0185	23178.7242	23245.2068	23363.50
88	23407.7153	23589.6478	23707.3862	23739.0186	24100.78
1	24140.4859	24159.0623	24414.5285	24439.5622	24506.03
34	24595.3745	24634.2227	24780.2192	24790.3395	24849.47
29	24956.748	25072.2256	25092.4643	25150.0499	25168.50
67	25468.8685	25514.1468	25704.7445	25721.1483	25739.48
1	26013.865	26244.7956	26481.1452	26554.2068	26577.54
62	26687.3774	26887.9086	26954.3653	26986.4754	27040.75
79	27118.6686	27126.602	27237.9219	27299.8843	27327.05
15	27392.8404	27403.6314	27493.8138	27555.9628	27665.99
94	27865.2897	27916.5605	27932.9349	28030.037	28096.44
	28400.5865	28605.5884	28771.4682	28840.6398	28990.18
	29087.5932	29136.9677	29207.811	29250.7742	29323.50

74	29355.0333	29386.6032	29407.5789	29585.6795	29701.09
47	30044.1611	30137.6325	30353.6023	30479.1865	30685.50
98	30763.2704	30787.6534	30833.3521	31000.1177	31110.45
01	31347.6677	31393.2223	31562.8646	31703.8797	31735.89
37	31860.2996	32063.7306	32085.9182	32273.0142	32411.56
14	32539.8796	32599.4339	32644.0284	32645.987	32829.89
32	32971.0103	32985.7815	33036.9579	33084.0716	33226.61
61	33226.6507	33273.9312	33312.4291	33351.1214	33397.70
1	33399.4407	33609.9533	33672.5605	33748.4726	33765.70
1	33842.3669	33863.2243	33887.6639	33960.8311	34053.16
29	34098.1141	34117.6851	34273.4458	34398.1148	34455.07
69	34498.3066	34785.3546	34892.9889	34896.866	34983.58
01	35130.2556	35311.9036	35352.5641	35538.3249	35571.03
92	35690.2041	35769.2146	35812.7005	35830.7949	35873.35
72	36195.7565	36376.9091	36451.9962	36612.2841	36717.99
93	36782.6523	36814.3867	37075.8611	37086.2	37183.80
33	37196.5695	37312.3719	37418.0092	37454.4838	37472.92
58	37542.2663	37568.3675	37631.2187	37641.4571	37675.79
19	37706.1112	37806.6226	37945.6895	37947.4303	38081.66
48	38116.5129	38336.1319	38339.6965	38498.1868	38639.74
86	38644.8054	38783.9427	38833.0396	38847.7694	38982.18
74	39329.0717	39371.8613	39396.0967	39555.5548	39585.20
21	39664.8633	39816.1815	39876.5727	39923.163	40031.74
73	40162.9337	40306.5078	40403.3095	40453.2389	40457.28
78	40804.5978	40904.9852	40914.565	41113.2897	41146.29
68	41296.6757	41303.5108	41306.1863	41348.0268	41584.70
05	41602.1985	41660.9861	41718.5723	41828.1462	41944.80
39	41993.2352	41994.9838	42260.4018	42267.8845	42601.19
16					

76	42643.1884	42664.189	42781.8227	42939.7659	42944.18
39	43038.5009	43082.3966	43147.578	43189.7371	43415.82
07	43423.9062	43562.8997	43596.5611	43733.9337	43880.69
18	43907.4666	43924.628	43969.8729	44034.3445	44144.75
75	44177.4894	44271.3667	44391.5455	44629.9569	44909.30
49	45061.7523	45100.407	45134.5827	45208.0959	45411.35
51	45449.2006	45476.9502	45560.4726	45644.2112	45818.80
09	45882.3763	45962.0763	46105.011	46198.6397	46269.07
72	46270.042	46460.8759	46508.0627	46547.0312	46575.57
58	46613.5206	46629.7275	46645.5435	46664.0633	46797.64
62	47126.3813	47188.0114	47275.1449	47374.4617	47505.33
93	47647.972	47821.3828	47855.7809	48204.0636	48301.33
78	48532.1953	48708.0126	48809.5837	48948.5413	48999.02
75	49041.8355	49069.5605	49075.4414	49148.4637	49204.32
19	49240.0687	49423.3067	49447.277	49917.9817	49918.38
24	50008.1834	50174.0621	50186.3494	50284.7543	50341.40
43	50343.0879	50379.2918	50422.9733	50735.7839	51187.06
84	51287.957	51388.999	51487.1311	51825.7688	51867.01
92	51872.0557	51931.8478	51952.5012	51979.4435	52224.94
08	52228.2815	52270.4699	52338.9627	52387.5281	52407.30
7	52466.4983	52468.788	52476.3494	52591.7585	52646.22
27	52670.0617	52704.9011	52710.4466	52711.258	52731.57
25	52736.8841	52772.921	52909.0317	53339.0662	53340.36
6	53344.9119	53521.8111	53528.2973	53884.0651	53915.05
39	53990.119	54024.1084	54172.6228	54178.6683	54256.50
65	54440.1999	54468.8743	54503.9041	54511.2033	54521.99
21	54578.3302	54706.6202	54724.3049	54878.1129	55179.56
1	55542.6998	55567.6391	55755.0109	55926.4759	56094.20
	56200.08				
	56206.1067	56395.703	56420.4373	56545.2393	56572.51

66					
	56746.6476	57044.1662	57108.3975	57427.5815	57519.27
68					
	57542.8333	57556.0732	57565.2038	57611.3716	57727.75
76					
	57793.5515	57794.67	57859.3802	57873.429	58281.87
54					
	58309.1237	58348.9499	58351.7114	58412.0387	58463.74
57					
	58589.085	58674.0961	58739.2244	58973.1935	59077.82
8					
	59084.7352	59192.2379	59326.539	59664.1191	59772.99
84					
	59859.3096	60024.7407	60039.0528	60064.1294	60311.32
29					
	60399.259	60419.4971	60593.1832	60635.59	60722.50
19					
	60743.2641	60811.8148	60813.3543	61064.0413	61107.05
8					
	61129.6462	61149.3288	61257.7816	61303.811	61327.96
3					
	61339.9049	61597.8999	61721.8055	62094.0309	62355.68
62					
	62371.3986	62461.8157	62469.463	62581.0127	62633.36
65					
	62909.5382	63049.993	63066.495	63071.5224	63428.35
11					
	63482.0046	63654.8086	63688.335	63689.226	63693.67
	63703.8208	63825.7572	64086.772	64303.5269	64356.27
39					
	64446.7921	64480.2545	64510.7858	64543.8524	64675.17
16					
	64676.8229	64832.0362	64912.3547	65093.6474	65121.84
81					
	65229.7611	65564.2121	65578.1181	65695.7882	65715.39
8					
	65790.8613	65902.8764	65934.6063	66443.7286	66490.76
24					
	66766.2584	66828.0018	66892.8525	66913.6283	66981.37
68					
	66984.5481	67093.347	67262.9172	67711.824	67758.65
44					
	67890.5175	67982.8634	67993.8663	68073.8022	68618.92
18					
	68630.9743	68655.9248	68667.4571	68840.825	69071.19
73					
	69135.4098	69153.6295	69246.0587	69255.8872	69465.76
55					
	69550.2147	69699.592	69798.4332	70160.387	70181.67
48					
	70249.2344	70417.6431	70556.7333	70780.4992	70905.91
86					
	70932.0536	71059.1974	71117.9412	71139.5278	71218.55
61					
	71322.4381	71483.347	71499.8089	71566.6667	71652.26
98					
	71687.9335	71734.1633	71737.8312	71939.5199	71952.87

63					
	72231.1586	72529.2313	72541.1307	72595.771	72792.31
12					
	73362.7759	73483.852	73765.157	73873.0047	73951.84
61					
	74161.0742	74481.2302	74513.7086	74572.6141	74635.17
59					
	74743.935	74829.2987	74839.6225	75070.2462	75214.46
79					
	75293.6079	75336.2335	75367.6723	75384.8351	75434.28
91					
	75474.1485	75580.2461	75619.6621	75921.0063	75961.54
94					
	75988.9517	76030.8838	76136.2029	76158.5114	76177.03
58					
	76262.8806	76266.4858	76439.2161	76441.6094	76449.83
3					
	76737.769	76755.2649	76866.0471	76938.6922	77221.84
53					
	77270.2565	77430.4336	77580.1257	77717.7947	77731.78
95					
	77769.9325	77817.2476	78153.3478	78285.6833	78394.66
36					
	78500.2302	78809.583	78812.2345	79096.5885	79100.00
25					
	79191.7269	79277.678	79348.8651	79456.8268	79502.61
86					
	79547.6647	79560.4543	79687.1024	79807.9141	79893.87
18					
	80050.327	80267.9136	80280.3978	80360.2078	80393.69
62					
	80514.4431	80671.3988	80859.3767	80924.9982	81088.64
35					
	81122.1371	81196.6982	81694.7815	81757.0568	81792.03
09					
	81820.8013	82014.989	82272.2056	82284.2752	82405.99
15					
	82670.2024	82784.7426	82916.489	83008.0939	83315.54
22					
	83427.019	83520.9254	83547.8566	83724.4714	83787.29
86					
	83942.8328	84014.5902	84146.0288	84223.9631	84648.39
86					
	84736.8777	84975.6135	85076.5913	85247.0513	85343.36
16					
	85376.5709	85687.0515	86014.0628	86023.0831	86024.01
93					
	86082.5852	86616.448	86662.536	86696.0274	86781.29
65					
	86836.1881	86964.0984	86988.0592	87058.1764	87074.32
87					
	87154.1264	87182.6053	87301.2616	87308.1218	87339.37
02					
	87362.3025	87477.092	87492.5133	87513.796	87549.25
77					
	87694.8164	87788.6081	87965.9615	88195.8186	88273.78
21					

91	88281.4767	88353.1846	88404.1533	88432.4105	88730.21
23	89132.3796	89335.0687	89428.7647	89471.7033	89533.43
45	90082.4495	90141.4246	90317.1984	90381.4446	90452.93
49	90690.7361	90931.0869	91024.8893	91048.1169	91116.25
66	91152.1332	91237.0551	91308.5699	91404.5983	91484.64
8	91538.826	91674.3434	91777.0572	91844.0409	91942.82
49	91944.4002	92413.405	92423.5986	92436.9538	92442.95
52	92463.5711	92773.9047	92781.1105	92821.5993	92826.34
29	92856.9187	92964.4782	92989.4863	93077.7232	93167.38
53	93247.071	93404.1736	93421.6399	93508.8624	93695.75
71	93705.4526	93715.2655	93906.5697	94008.5579	94119.49
4	94176.2769	94355.7538	94422.6448	94579.5859	94706.34
97	94856.8437	94989.5785	95031.5213	95037.5504	95069.80
63	95072.1235	95099.3747	95131.6266	95251.5601	95526.85
5	95615.6724	95665.6719	95685.2121	95856.2455	95930.85
83	95946.0797	96076.158	96113.1355	96150.4139	96190.80
28	96240.1203	96247.501	96375.9978	96492.6308	96968.24
25	97070.0417	97099.1047	97155.3411	97168.1709	97203.58
05	97253.3379	97307.8178	97527.3546	97586.4809	97647.19
21	97705.364	97977.7579	98102.5839	98214.1689	98267.73
02	98290.2744	98450.2213	98735.5908	98789.0169	98790.25
35	98832.7424	98845.758	99027.4627	99233.9354	99255.74
59	99257.8046	99268.1027	99354.5974	99516.2548	99574.33
61	99594.3499	99657.7584	99678.9908	99710.2509	99811.50
54	99902.7182	99961.537	99980.5398	100259.485	100265.80
23	100403.9968	100414.3286	100416.0976	100565.6536	100958.69
61	101038.0486	101054.1576	101184.5783	101194.2818	101267.27
88	101296.1406	101389.0339	101574.3905	101714.2041	101731.43
	101858.6164	101888.1739	101889.971	102076.7983	102086.15

89

102184.8758 102280.5151]