1 Overview

Following libraries will be used

```
source("./generators.R")
source("./Model.R")
```

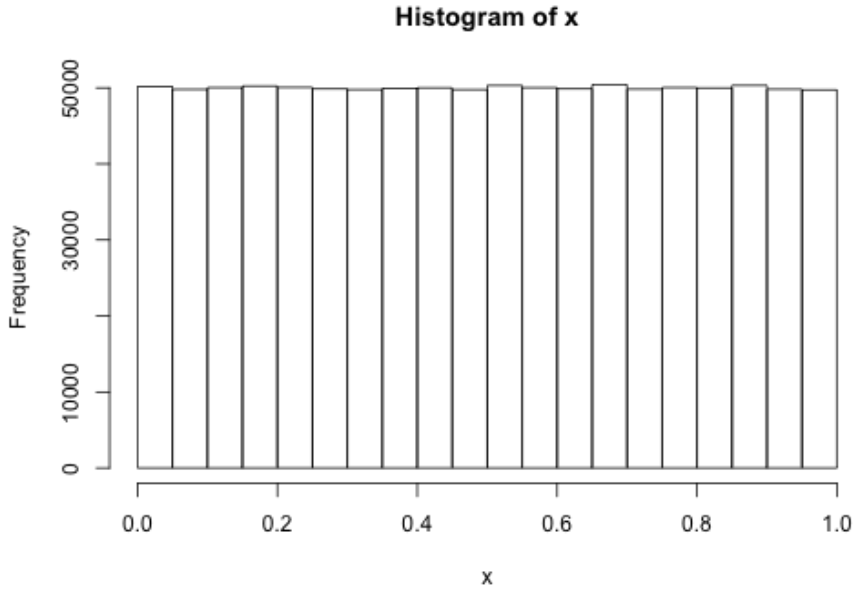
Set random seed

```
set.seed(1)
```

2 Random number generators

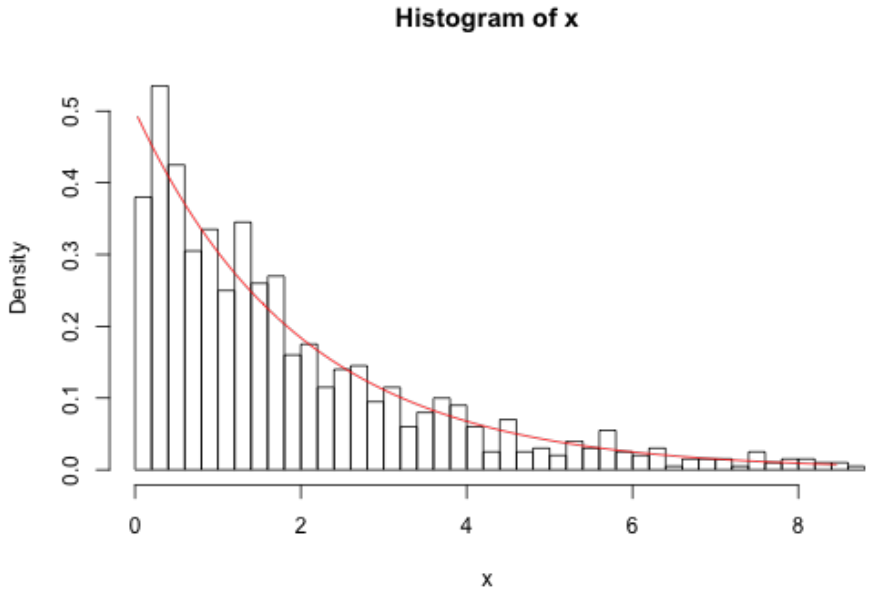
2.1 Uniform Distribution

```
x = runif(n = 1e+06, min = 0, max = 1)
```



2.2 Exponential Distribution

```
lambda = 2
x <- expDist(1/lambda, 1000)
```



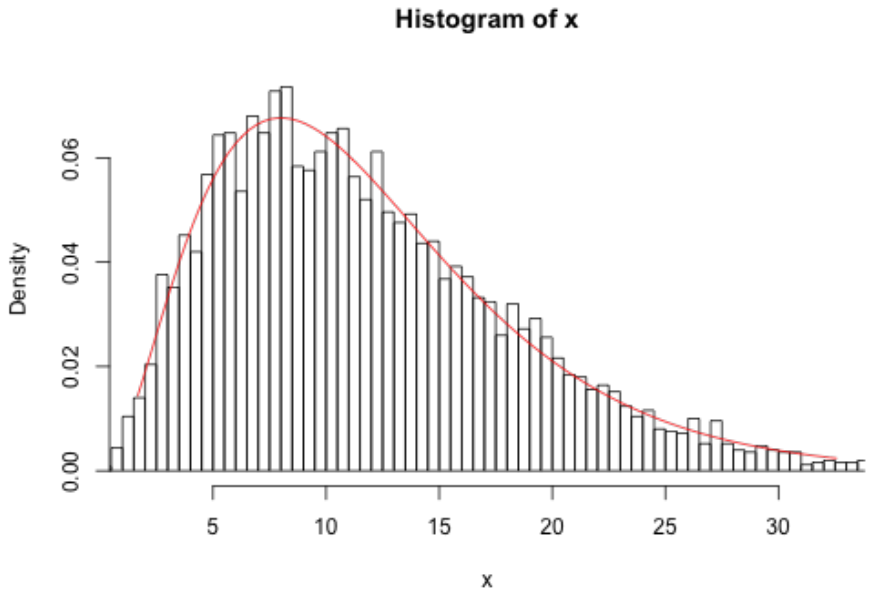
Real.Mean	Real.S.D.	Expected.Mean	Expected.S.D.
1.96	1.973	2	2

2.2.1 Distribution fitting

```
## Warning:  Chi-squared approximation may be incorrect
## $ks
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  x
## D = 0.0333, p-value = 0.2173
## alternative hypothesis: two-sided
##
##
## $chisq1
## [1] FALSE
##
## $chisq2
##
##  Chi-squared test for given probabilities
##
## data:  xHist$counts
## X-squared = 7.348, df = 14, p-value = 0.9204
```

2.3 Erlang distribution

```
l = 3
lambda = 0.25
x <- NULL
for (i in 1:1000) {
    x <- c(x, erlangDist(l, lambda))
    # x <- c(x,erlangDist(l, 1/lambda))
}
```



Real.Mean	Real.S.D.	Expected.Mean	Expected.S.D.
11.78	7.085	12	6.928

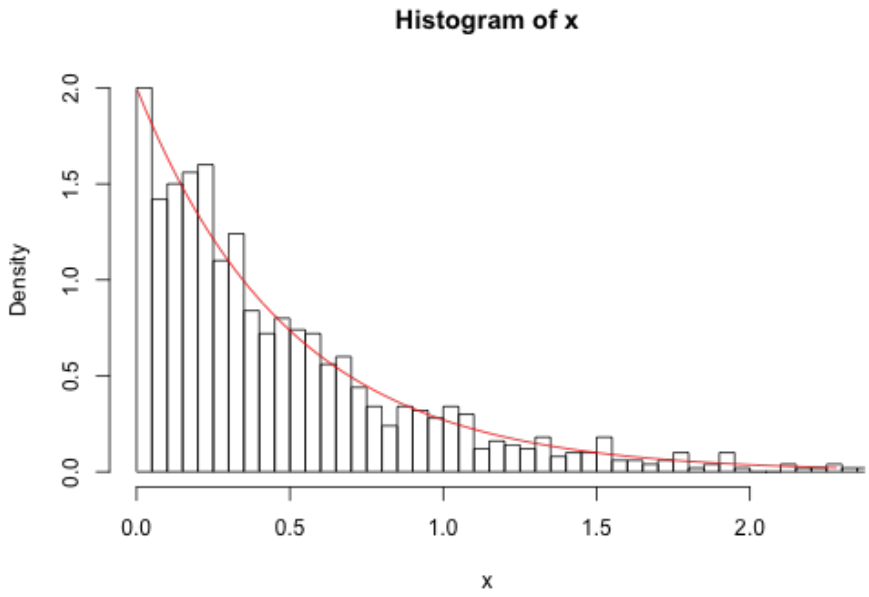
2.3.1 Distribution fitting

```
## Warning:  Chi-squared approximation may be incorrect
## $ks
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  x
## D = 0.0294, p-value = 0.3535
## alternative hypothesis: two-sided
##
```

```
##
## $chisq1
## [1] FALSE
##
## $chisq2
##
##  Chi-squared test for given probabilities
##
## data:  xHist$counts
## X-squared = 22.03, df = 11, p-value = 0.02412
```

2.3.2 Poisson distribution

```
lambda = 0.5
x <- expDist(1/lambda, 1000)
```



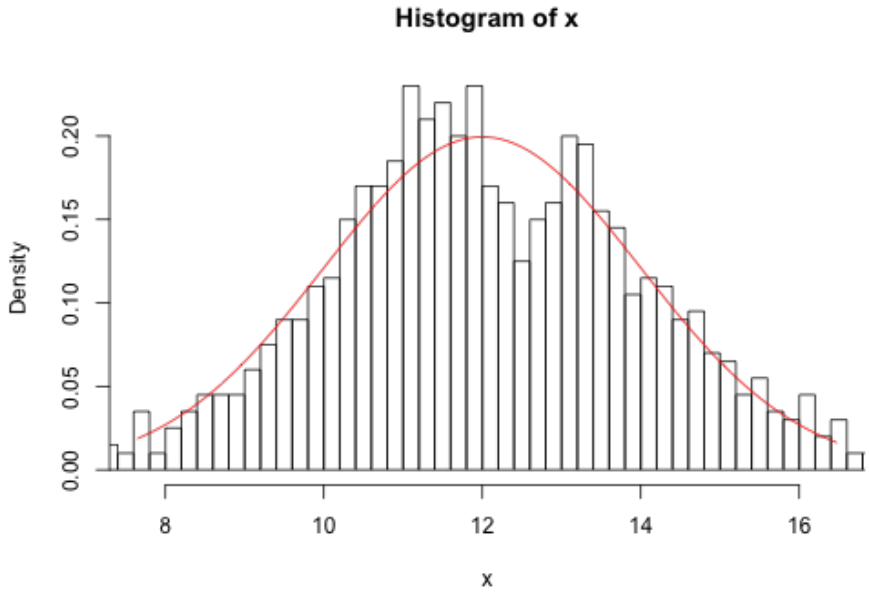
Real.Mean	Real.S.D.	Expected.Mean	Expected.S.D.
0.4956	0.4928	0.5	0.5

2.3.3 Distribution fitting

```
## Warning:  Chi-squared approximation may be incorrect
## $ks
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  x
## D = 0.0208, p-value = 0.7807
## alternative hypothesis: two-sided
##
##
## $chisq1
## [1] FALSE
##
## $chisq2
##
##  Chi-squared test for given probabilities
##
## data:  xHist$counts
## X-squared = 0.9792, df = 6, p-value = 0.9864
```

2.4 Normal distribution

```
mu = 12
sigma = 2
n = 120000
x <- NULL
for (i in 1:1000) {
    x <- c(x, normDist(mu, sigma, n))
}
```



Real.Mean	Real.S.D.	Expected.Mean	Expected.S.D.
12.05	1.957	12	2

2.4.1 Distribution fitting

```
## Warning:  Chi-squared approximation may be incorrect
## $ks
##
##  One-sample Kolmogorov-Smirnov test
##
## data:  x
## D = 0.0275, p-value = 0.4381
## alternative hypothesis: two-sided
##
##
## $chisq1
## [1] FALSE
##
## $chisq2
##
##  Chi-squared test for given probabilities
##
## data:  xHist$counts
## X-squared = 14.23, df = 13, p-value = 0.3581
```

3 Queueing System model

```
q <- new("QueueingSystem")
q <- mm1(q)
```

3.1 Queue statistics

3.1.1 Queue length statistics

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0     230     460     455     680     907
```

3.1.2 Queue time statistics

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0     126     262     252     368     500
```

3.1.3 Queue zero time statistics

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.8   126.0   262.0   252.0   368.0   500.0
```

3.1.4 Server statistics

Entries.count	Total.time	Util..time	Avg..time
181	496.7	0.9935	2.744

3.2 Report

eventType	time	S	n	e1	e2	h	Q
	0.00	0	0	18.65	0.80	501.00	
e2	0.80	1	0	18.65	1.30	5.45	
e2	1.30	1	1	18.65	1.53	5.45	2
e2	1.53	1	2	18.65	2.18	5.45	2, 2
e2	2.18	1	3	18.65	2.35	5.45	2, 2, 2
e2	2.35	1	4	18.65	3.01	5.45	2, 2, 2, 2
e2	3.01	1	5	18.65	3.03	5.45	2, 2, 2, 2, 2
e2	3.03	1	6	18.65	3.19	5.45	2, 2, 2, 2, 2, 2
e2	3.19	1	7	18.65	3.43	5.45	2, 2, 2, 2, 2, 2, 2
e2	3.43	1	8	18.65	3.65	5.45	2, 2, 2, 2, 2, 2, 2, 2
e2	3.65	1	9	18.65	4.68	5.45	2, 2, 2, 2, 2, 2, 2, 2, 2
e2	4.68	1	10	18.65	4.77	5.45	2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	4.77	1	11	18.65	5.43	5.45	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	5.43	1	12	18.65	6.38	5.45	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
h	5.45	1	11	18.65	6.38	5.50	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
h	5.50	1	10	18.65	6.38	6.13	2, 2, 2, 2, 2, 2, 2, 2, 2, 2
h	6.13	1	9	18.65	6.38	7.22	2, 2, 2, 2, 2, 2, 2, 2, 2
e2	6.38	1	10	18.65	6.49	7.22	2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	6.49	1	11	18.65	8.21	7.22	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
h	7.22	1	10	18.65	8.21	9.86	2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	8.21	1	11	18.65	8.24	9.86	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	8.24	1	12	18.65	9.11	9.86	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	9.11	1	13	18.65	9.29	9.86	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	9.29	1	14	18.65	10.60	9.86	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
h	9.86	1	13	18.65	10.60	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	10.60	1	14	18.65	10.60	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	10.60	1	15	18.65	10.70	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	10.70	1	16	18.65	10.82	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	10.82	1	17	18.65	11.26	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	11.26	1	18	18.65	11.31	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	11.31	1	19	18.65	11.38	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	11.38	1	20	18.65	12.05	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	12.05	1	21	18.65	12.12	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2
e2	12.12	1	22	18.65	13.72	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	13.72	1	23	18.65	13.96	13.94	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
h	13.94	1	22	18.65	13.96	15.33	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	13.96	1	23	18.65	14.11	15.33	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	14.11	1	24	18.65	17.64	15.33	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
h	15.33	1	23	18.65	17.64	17.11	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
h	17.11	1	22	18.65	17.64	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	17.64	1	23	18.65	18.37	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	18.37	1	24	18.65	18.65	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e1	18.65	1	25	25.15	18.65	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	18.65	1	26	25.15	19.31	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	19.31	1	27	25.15	19.49	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	19.49	1	28	25.15	20.65	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	20.65	1	29	25.15	21.85	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	21.85	1	30	25.15	22.87	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	22.87	1	31	25.15	23.23	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
e2	23.23	1	32	25.15	23.42	23.55	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,

	eventType	time	S	n	e1	e2	h	Q
1222	e2	481.6	1	866	491.2	481.8	481.8	2, 2, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, ...
1223	h	481.8	1	865	491.2	481.8	482.4	2, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1224	e2	481.8	1	866	491.2	483.1	482.4	2, 2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1225	h	482.4	1	865	491.2	483.1	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1226	e2	483.1	1	866	491.2	484.5	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1227	e2	484.5	1	867	491.2	484.7	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1228	e2	484.7	1	868	491.2	485.0	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1229	e2	485.0	1	869	491.2	485.5	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1230	e2	485.5	1	870	491.2	486.4	485.6	2, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1231	h	485.6	1	869	491.2	486.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1232	e2	486.4	1	870	491.2	487.1	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1233	e2	487.1	1	871	491.2	487.8	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1234	e2	487.8	1	872	491.2	488.3	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1235	e2	488.3	1	873	491.2	488.5	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1236	e2	488.5	1	874	491.2	488.7	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1237	e2	488.7	1	875	491.2	490.5	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1238	e2	490.5	1	876	491.2	491.0	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1239	e2	491.0	1	877	491.2	491.1	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1240	e2	491.1	1	878	491.2	491.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1241	e1	491.2	1	879	495.7	491.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1242	e2	491.4	1	880	495.7	491.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1243	e2	491.4	1	881	495.7	491.8	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1244	e2	491.8	1	882	495.7	491.9	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1245	e2	491.9	1	883	495.7	492.1	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1246	e2	492.1	1	884	495.7	492.3	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1247	e2	492.3	1	885	495.7	492.3	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1248	e2	492.3	1	886	495.7	492.5	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1249	e2	492.5	1	887	495.7	492.6	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1250	e2	492.6	1	888	495.7	493.1	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1251	e2	493.1	1	889	495.7	493.1	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1252	e2	493.1	1	890	495.7	493.2	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1253	e2	493.2	1	891	495.7	493.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1254	e2	493.4	1	892	495.7	493.8	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1255	e2	493.8	1	893	495.7	495.7	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1256	e2	495.7	1	894	495.7	495.8	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1257	e1	495.7	1	895	498.8	495.8	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1258	e2	495.8	1	896	498.8	495.9	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1259	e2	495.9	1	897	498.8	495.9	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1260	e2	495.9	1	898	498.8	496.9	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1261	e2	496.9	1	899	498.8	497.2	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1262	e2	497.2	1	900	498.8	497.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1263	e2	497.4	1	901	498.8	497.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1264	e2	497.4	1	902	498.8	497.5	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1265	e2	497.5	1	903	498.8	498.4	497.6	1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1266	h	497.6	1	902	498.8	498.4	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1267	e2	498.4	1	903	498.8	499.7	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1268	e1	498.8	1	904	503.9	499.7	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1269	e2	499.7	1	905	503.9	499.9	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1270	e2	499.9	1	906	503.9	500.3	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...
1271	e2	500.3	1	907	503.9	500.5	505.8	2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, ...