3_1

March 28, 2016

```
In [42]: __author__ = 'Security'
         import numpy as np
         import scipy.stats as stats
         %matplotlib inline
         import matplotlib.pyplot as plt
         from multiprocessing.dummy import Pool
         from math import factorial

In [17]: class Distribution:
             sample = stats.norm.rvs(size=1)
             discription = ""
             def __init__(self, sample, discription):
                 self.sample = sample
                 self.discription = discription

In [18]: def normal(size, theta):
             return Distribution(stats.norm.rvs(size=size, loc=theta[0], scale=theta[1]), 'normal')

In [19]: def gamma(size, theta):
             return Distribution(stats.gengamma.rvs(theta[1], theta[0], size=size), 'gamma')

In [20]: def uniform(size, theta):
             return Distribution(stats.uniform.rvs(size=size, loc=theta[0], scale=(theta[1]-theta[0])),

In [21]: def pois(size, theta):
             return Distribution(stats.poisson.rvs(theta, size=size), 'poisson')

In [22]: def bin(size, theta):
             return Distribution(stats.binom.rvs(theta[0], theta[1], size=size), 'binomial')

In [23]: def geom(size, theta):
             return Distribution(stats.geom.rvs(theta, size=size), 'geometric')

In [24]: def beta(size, theta):
             return Distribution(stats.beta.rvs(theta[0], theta[1], size=size), 'beta')

In [25]: class distGen(stats.rv_continuous):
             def _pdf(self, x, a, b):
                 if (x < b):
                     return 0
                 return np.exp((float(b)-x)/float(a))/(float(a))

In [26]: def distrFrom3Task(size, theta):
             distr = distGen(name='distr')
             return Distribution(distr.rvs(theta[0], theta[1], size=size), 'Distribution from 3 task')
         distrFrom3Task(50, (1, 1))
```

```
Out[26]: <__main__.Distribution at 0x10a6f6f60>

In [27]: def parametrizedBootstrapSample(disribution: Distribution, size, theta):
             return disribution(size, theta).sample

In [28]: def arrayOfSamples(sample, size):
             return np.array([sample[:n] for n in range(1, size)])

In [29]: def randomIndexes(l, r):
             return [np.random.randint(l, r)]

In [16]: def nonParametrizedBootstrapSample(distribution: Distribution, size, theta):
             sample = distribution(size, theta).sample
             randIndexes = randomIndexes(0, size)
             return np.array([sample[i] for i in randIndexes])

In [ ]: grid = np.arange(-2, 2, 0.001)
        weibullSample = [float(line.rstrip('\n')) for line in open('499 Малышев Александр.txt', 'r')]


        def likelihoodLogFunction(gamma, sample):
            return np.sum([(gamma - 1) * np.log(x) - x**(gamma) + np.log(gamma) for x in sample])


        def likelihoodFunctionValues(sample, grid):
            return [likelihoodLogFunction(10**gamma, sample) for gamma in grid]


        def estimationForWeibullSample(sample, grid):
            return grid[np.argmax(likelihoodFunctionValues(sample, grid))]

        for sample in [weibullSample[:4 * 365], weibullSample]:
            plt.figure(figsize=(15, 9))
            plt.plot(grid, likelihoodFunctionValues(sample, grid))
            plt.show()
            print('Estimation for first {:} years = {:}'.format(len(sample) // 365, estimationForWeibul

In [45]: N = 1000
         theta = 1
         sample = stats.expon.rvs(scale = theta, size=N)

         slices = [sample[:n] for n in range(0, N)]

         def getStatistics(k, n):
             sampleSlice = sample[:n] ** k
             return (factorial(k) / (sampleSlice.mean())) ** (1/float(k))

In [46]: def getMean(k, theta):
             return np.min(np.array([abs(getStatistics(k, n) - theta) for n in range(1, N)]))

In [47]: def configurePlot(theta, ymin, ymax):
             plt.figure(figsize=(15, 9))
             plt.title(r"$\theta= {0:}$".format(int(theta)))
             plt.ylabel(r"$|\hat{\theta} - \theta|$")
             plt.ylim(ymin, ymax)
         def addPlot(k, theta):
             plt.plot(np.array([abs(getStatistics(k, n) - theta) for n in range(1, N)]), label='k = {:}

         def drawPlot(ks, theta, ymin = 0, ymax = 1):
             configurePlot(theta, ymin, ymax)
             for k in ks:
                 addPlot(k, theta)
             plt.legend(loc='best')
             plt.show()
```

```
In [51]: def getBestK(theta):
             subres = [] #здесь будем хранить разницу значений в зависимости от k
             for _ in range(10):
                 pool = Pool(4)
                 results = pool.map(getMean, range(1, 12), theta)
                 subres.append(np.argmin(results))
             return np.argmax(subres) + 1
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In [52]: for th in range(1, 30):
             drawPlot([1, 5, 10, 25, 50], th, ymin = 0, ymax = th + 1)
```
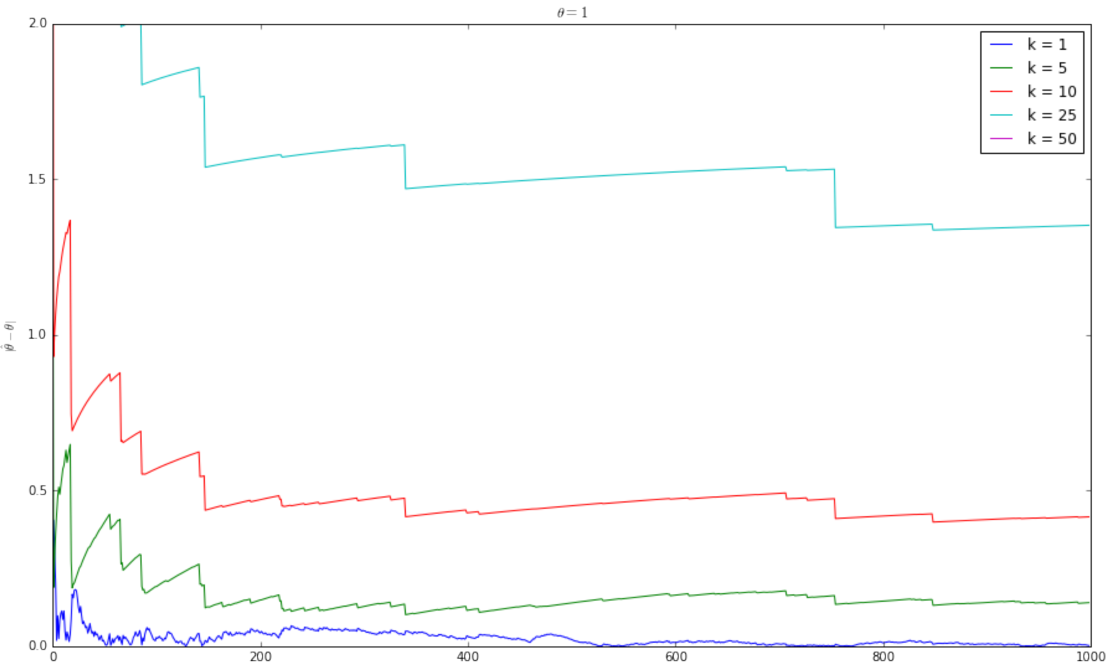
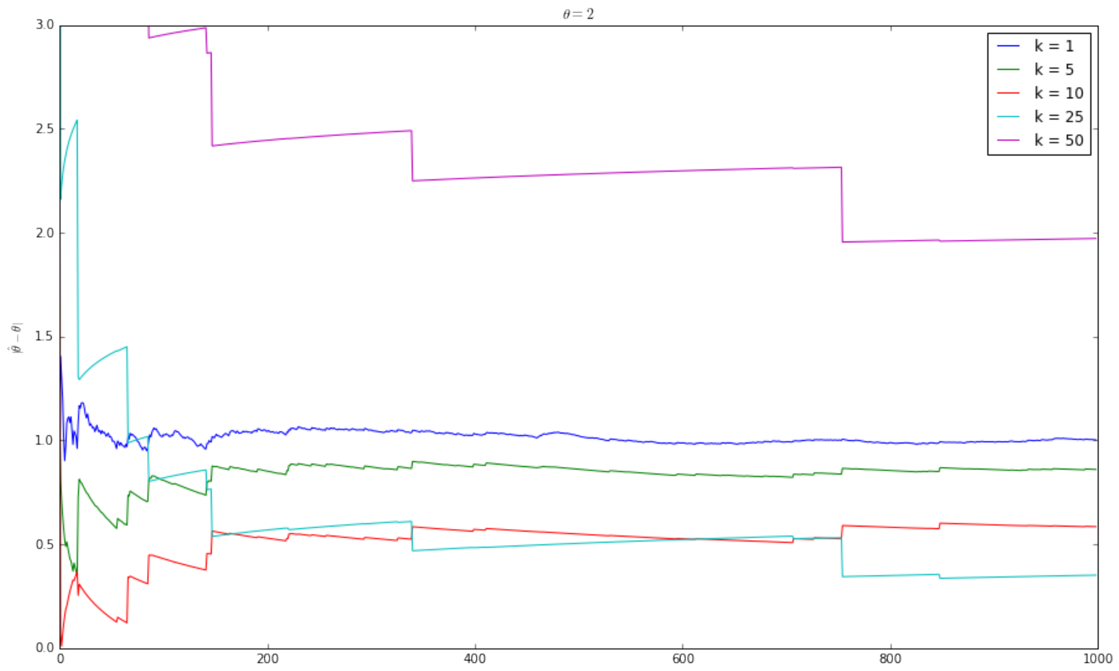
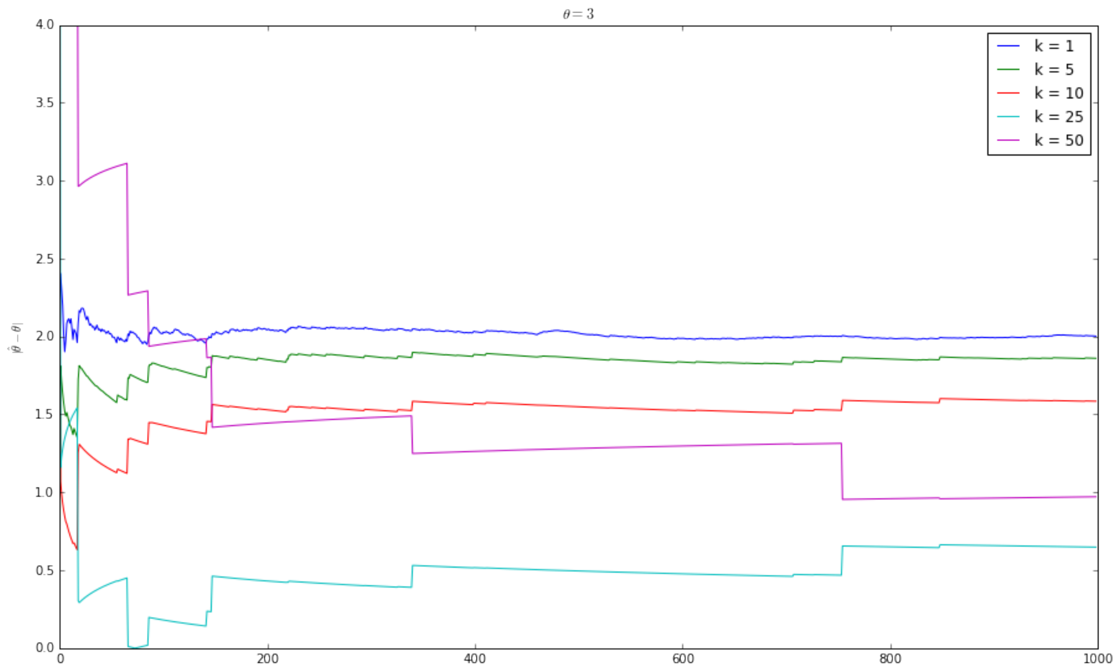
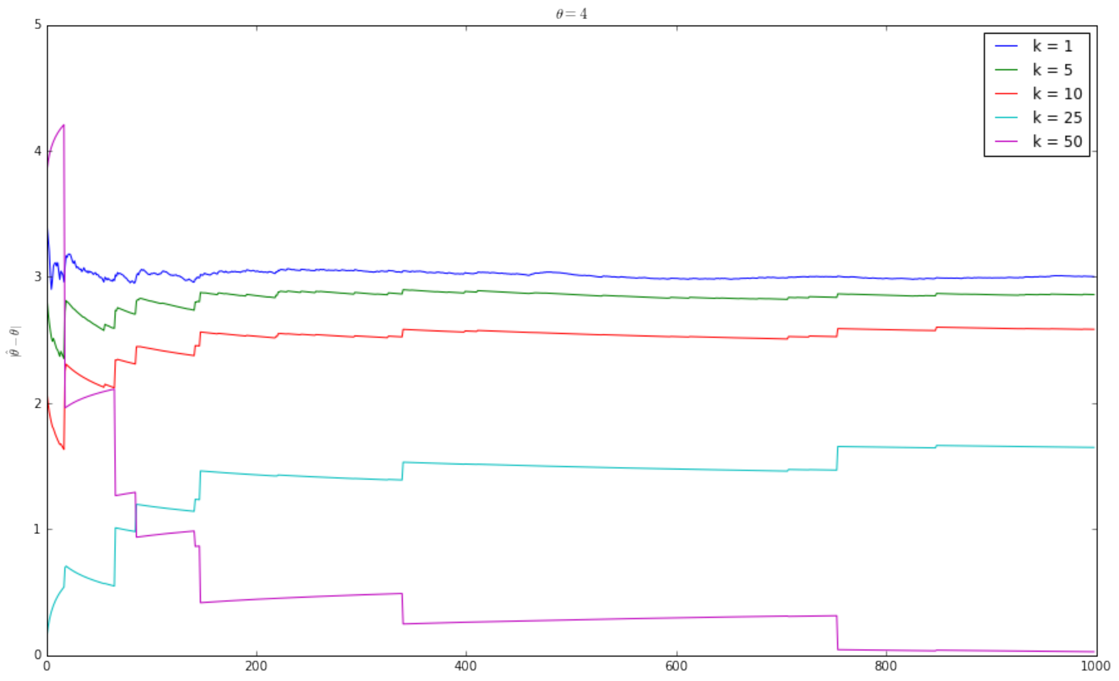
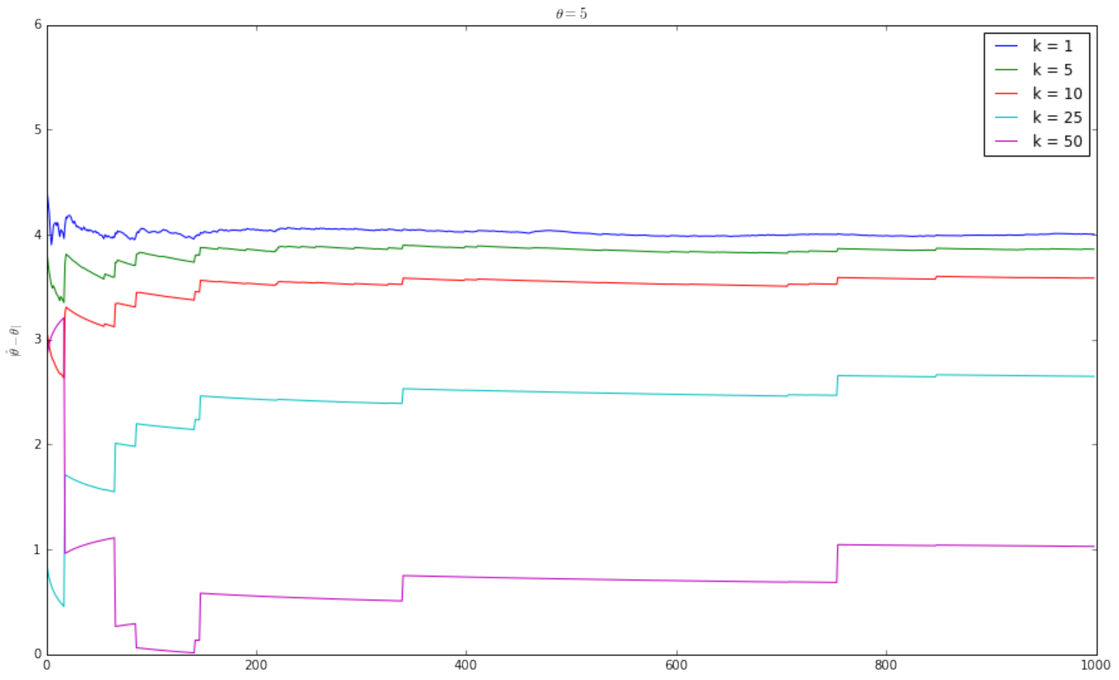
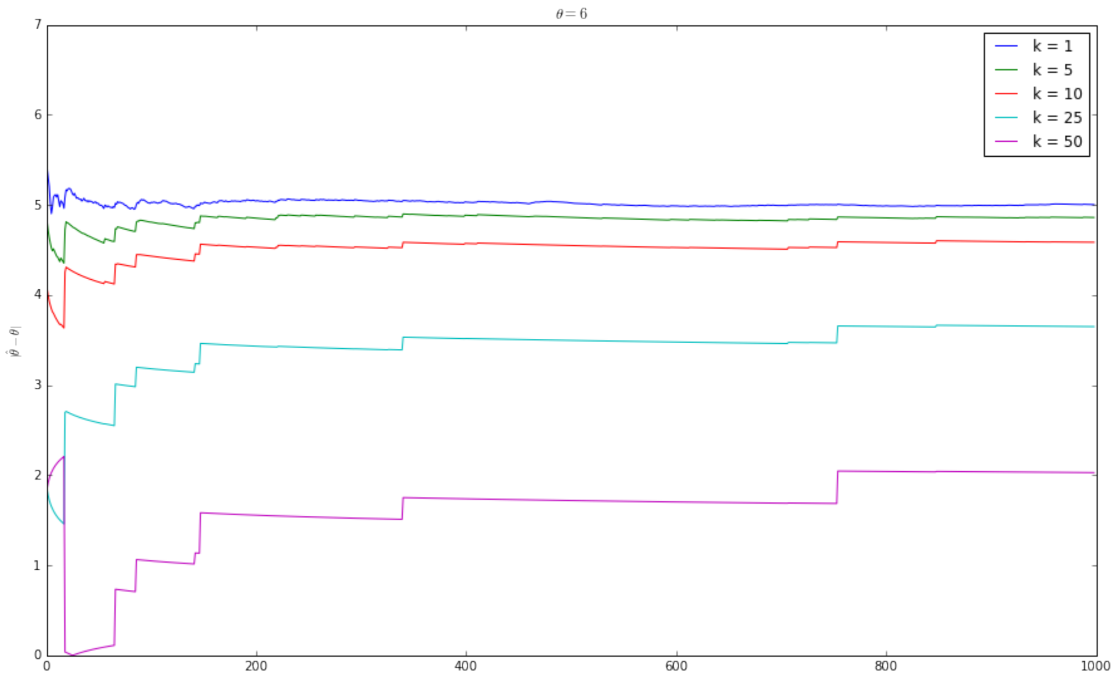



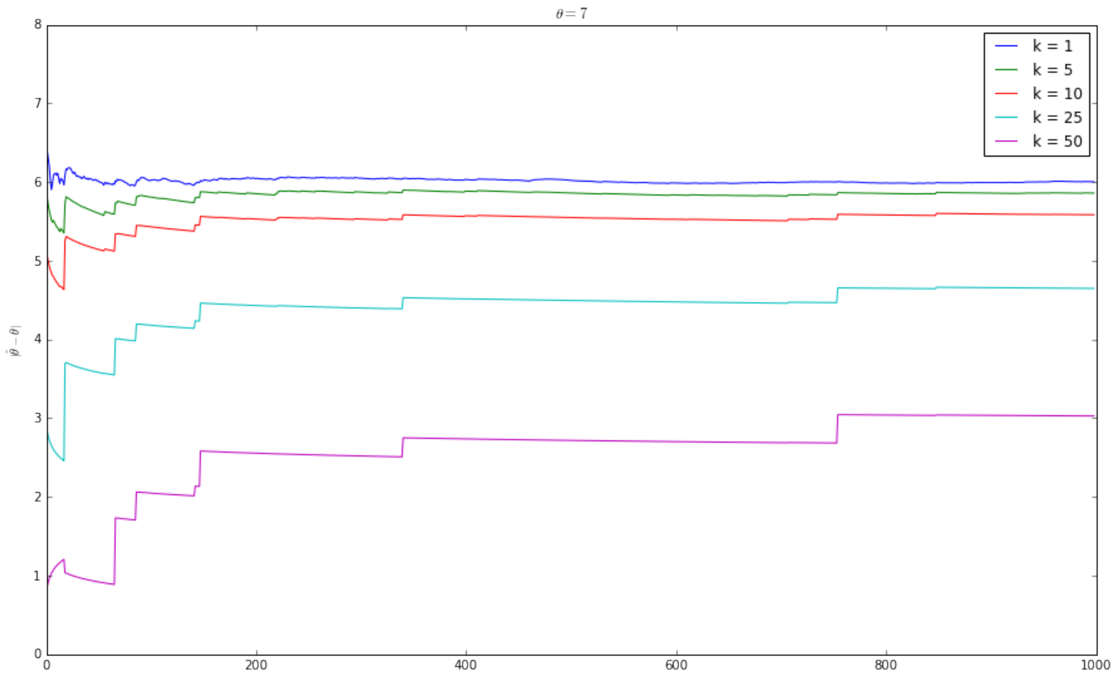

$\theta = 2$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0
200
400
600
800
1000

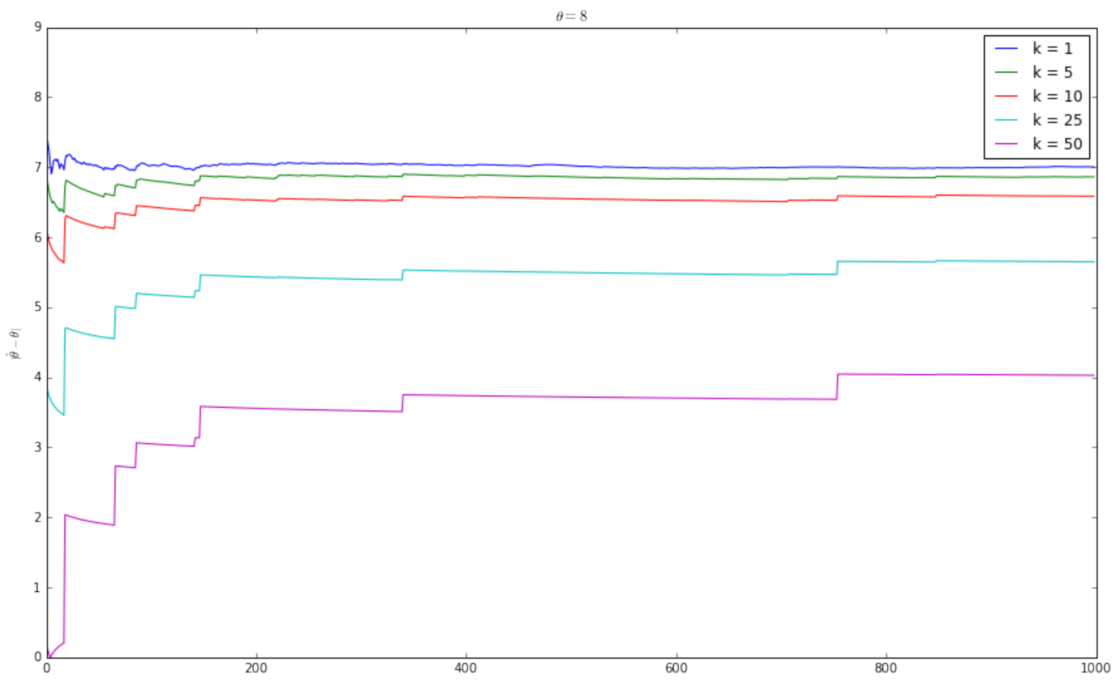

$\theta = 3$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
200
400
600
800
1000

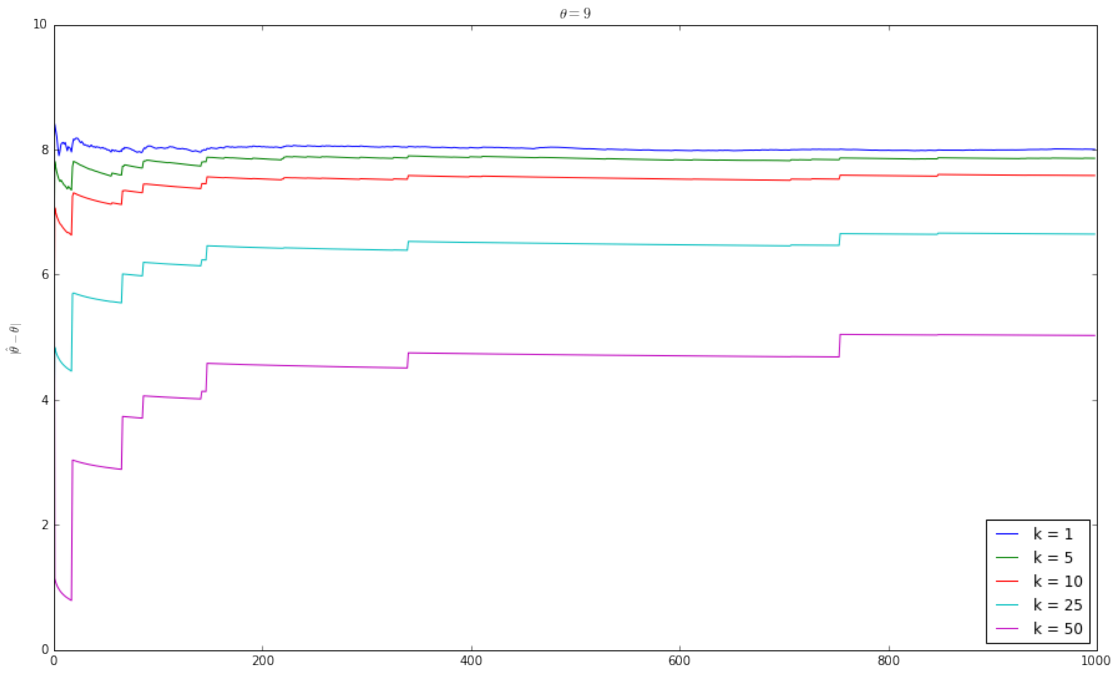

$\theta = 4$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
1
2
3
4
5
0
200
400
600
800
1000

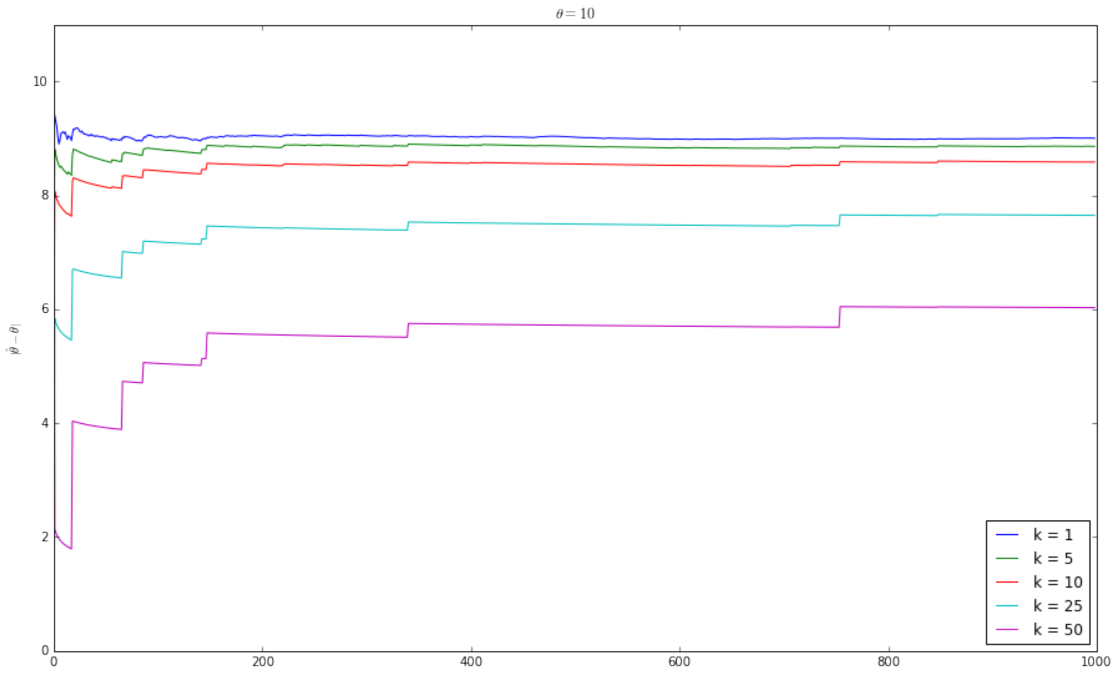

$\theta = 5$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
1
2
3
4
5
6
0
200
400
600
800
1000


$\theta = 6$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
1
2
3
4
5
6
7
0
200
400
600
800
1000

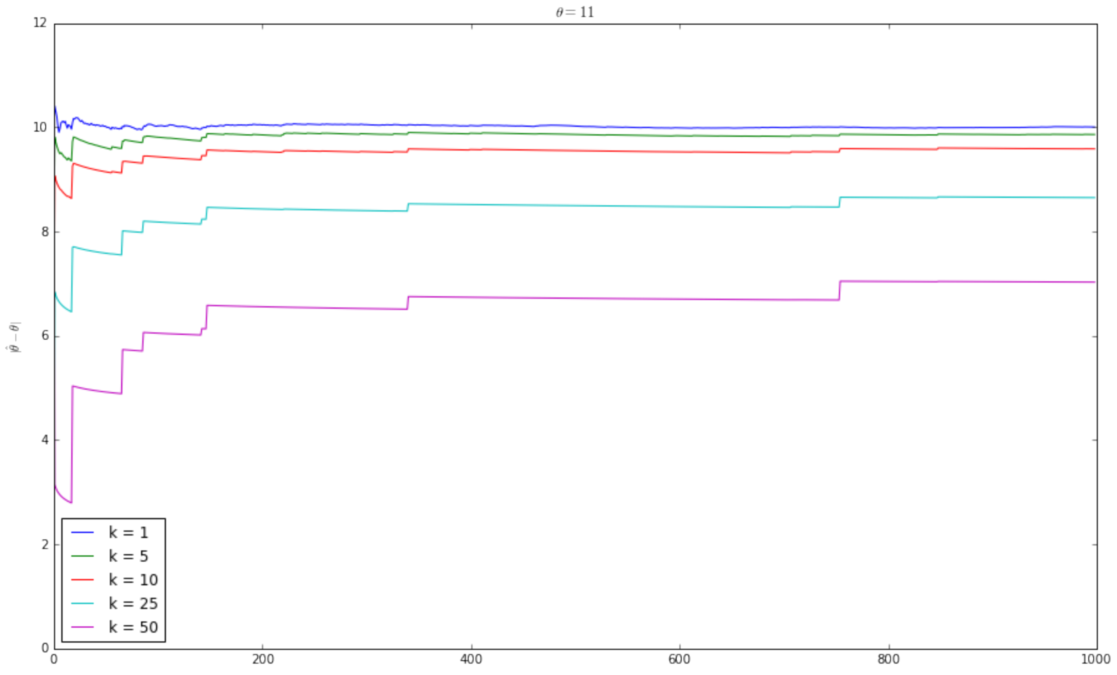

$\theta = 7$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
1
2
3
4
5
6
7
8
0
200
400
600
800
1000


$\theta = 8$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

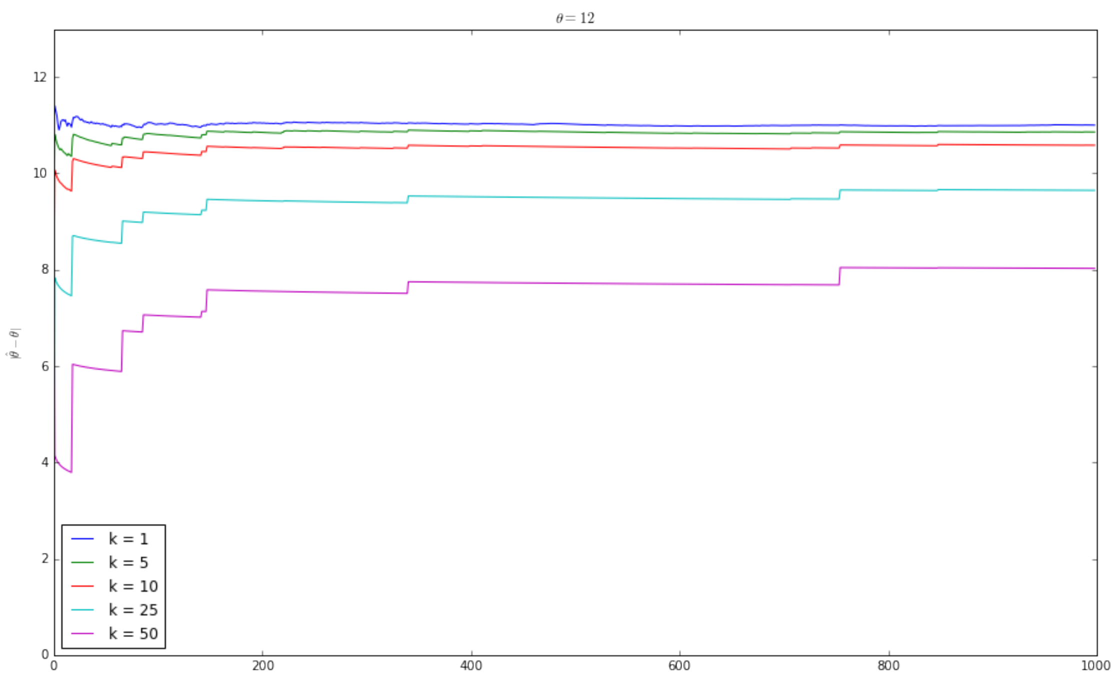

$\theta = 9$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



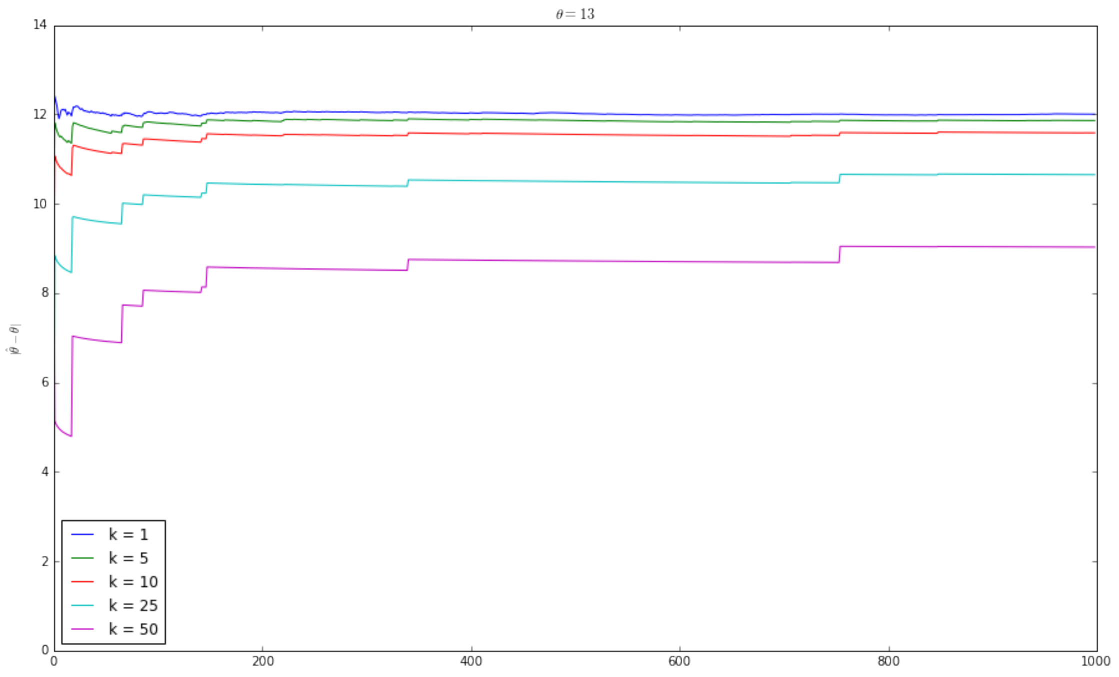
$\theta = 10$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



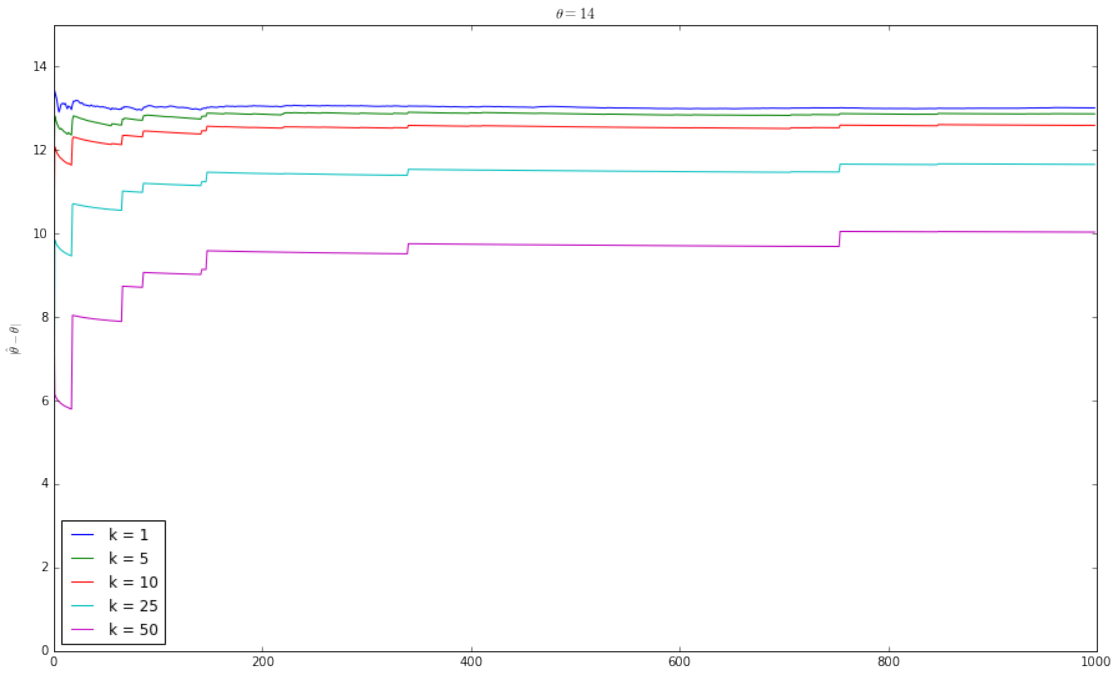
$\theta = 11$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

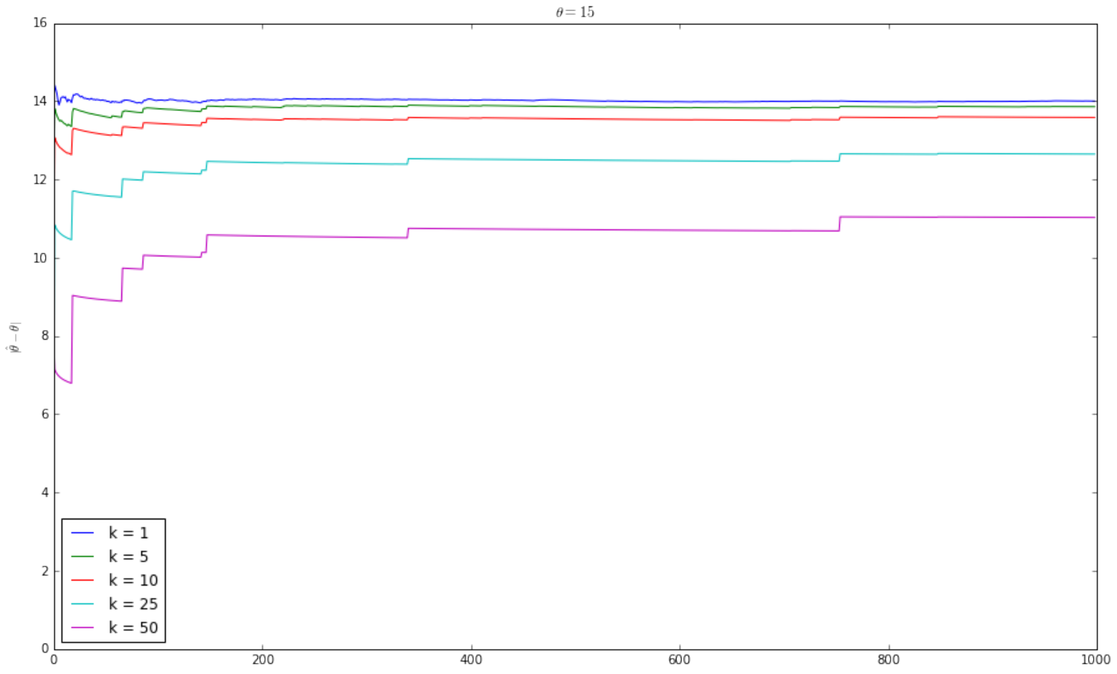


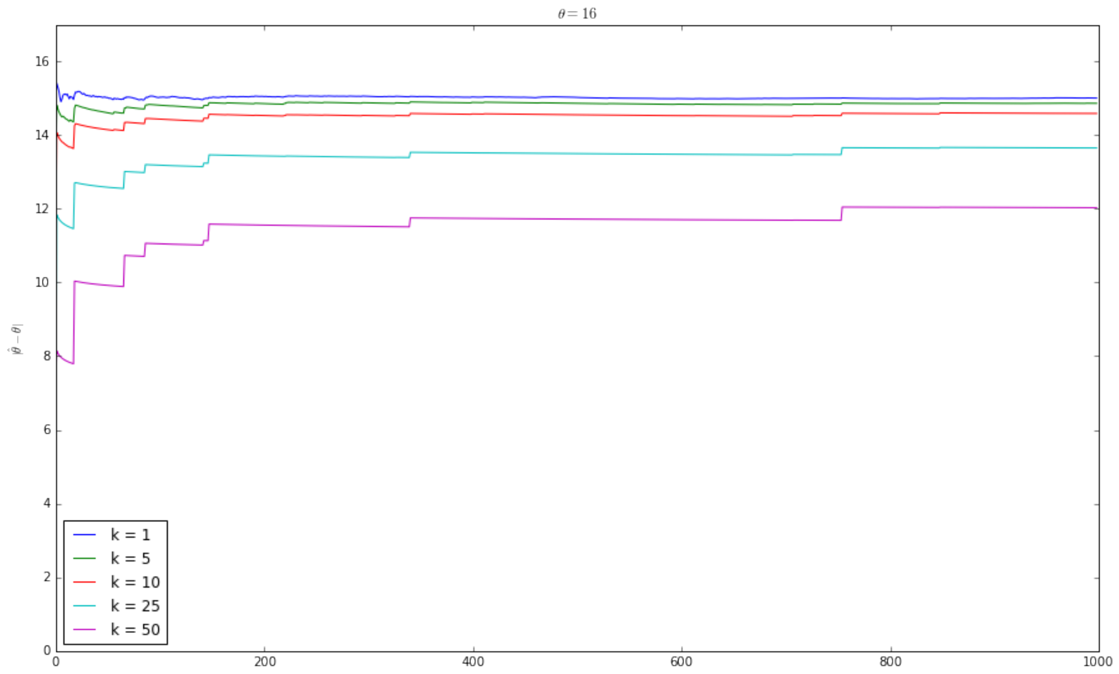
$\theta = 12$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
2
4
6
8
10
12
0
200
400
600
800
1000



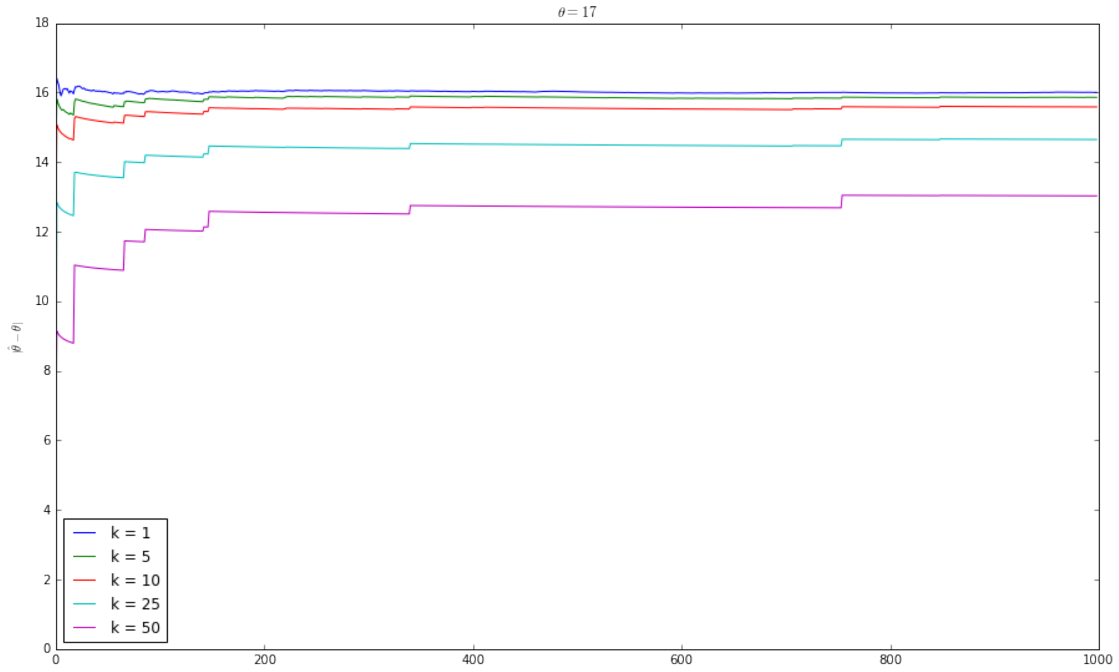
$\theta = 13$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
2
4
6
8
10
12
14
0
200
400
600
800
1000


$\theta = 14$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

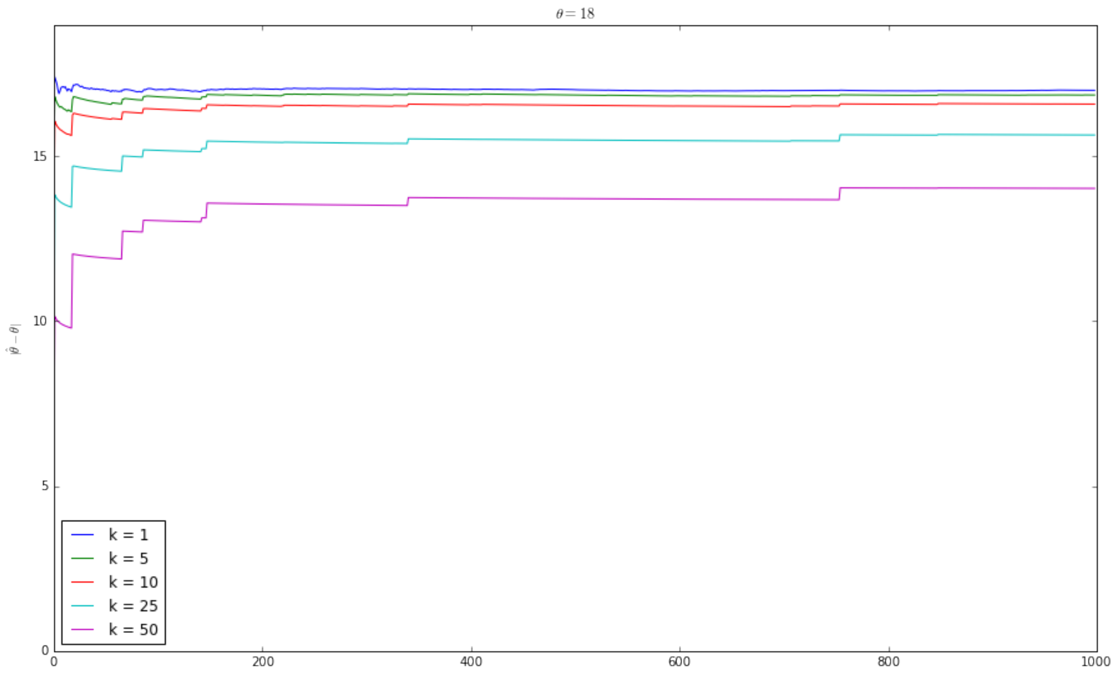

$\theta = 15$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

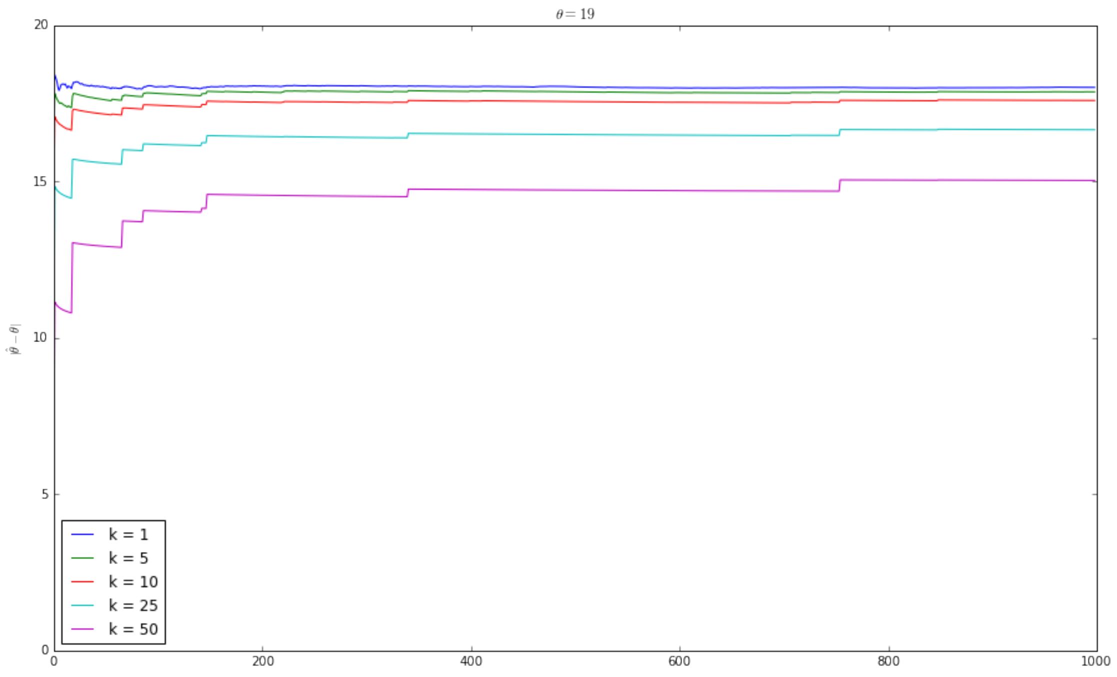


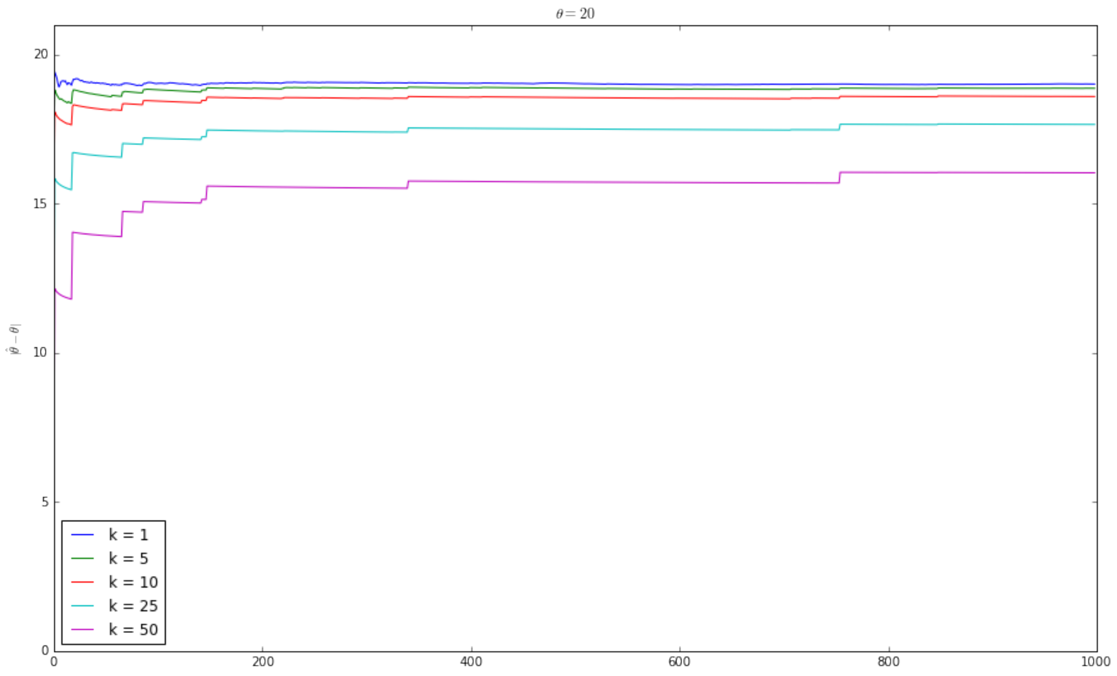
$\theta = 16$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

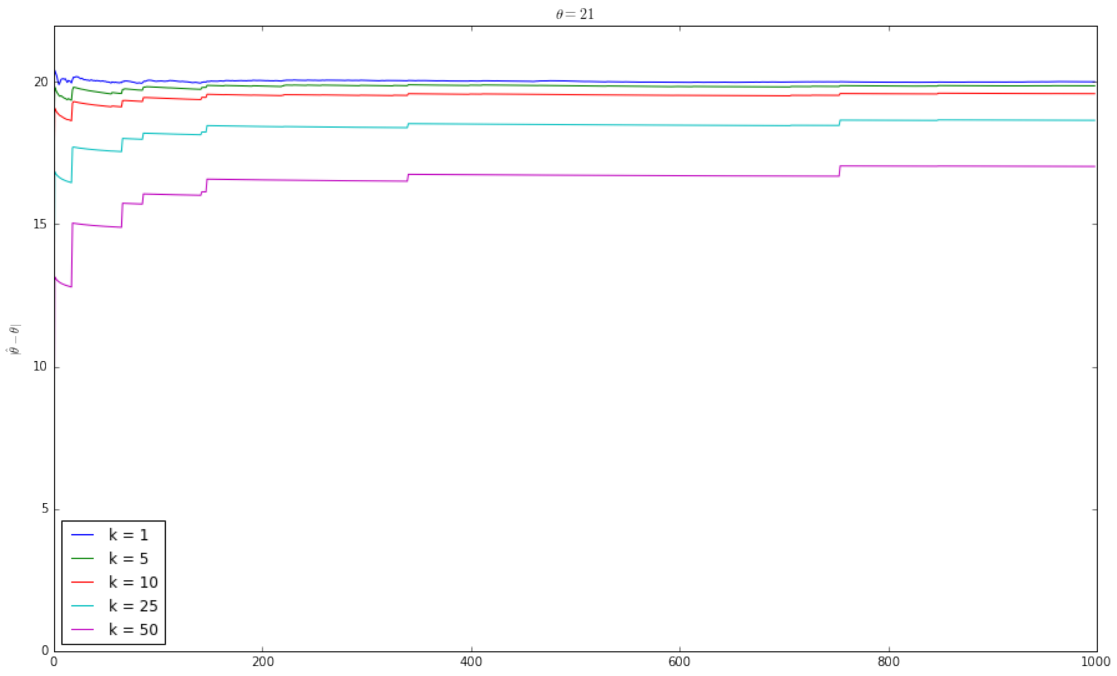


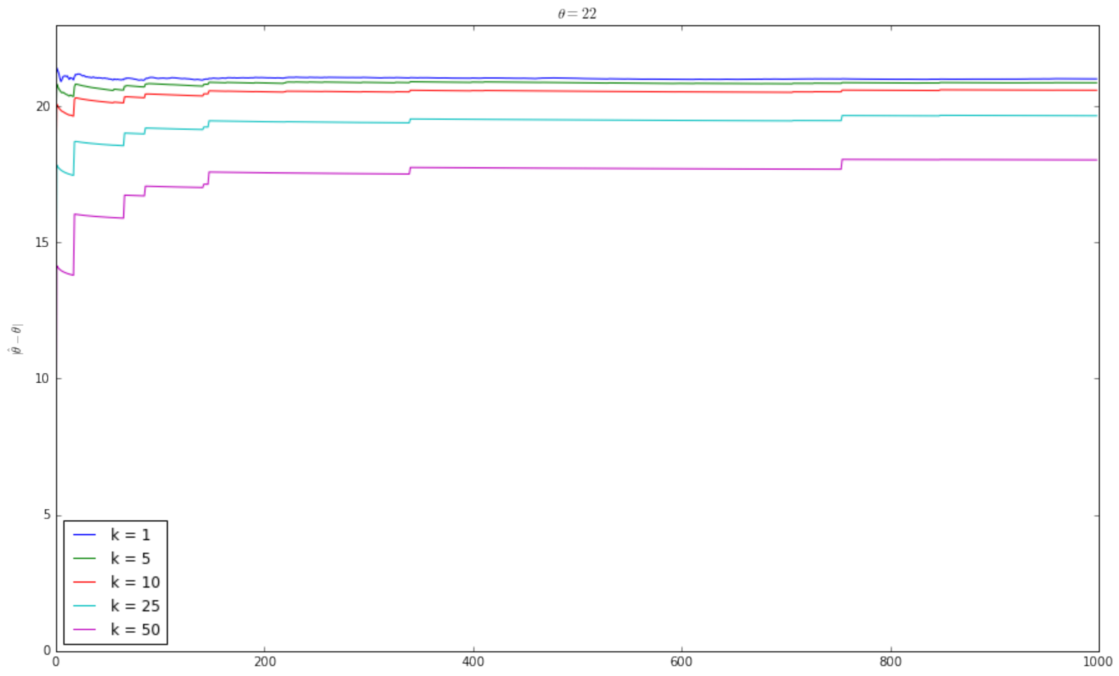
$\theta = 17$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 18$
$|\hat{\theta} - \theta|$
0
5
10
15
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

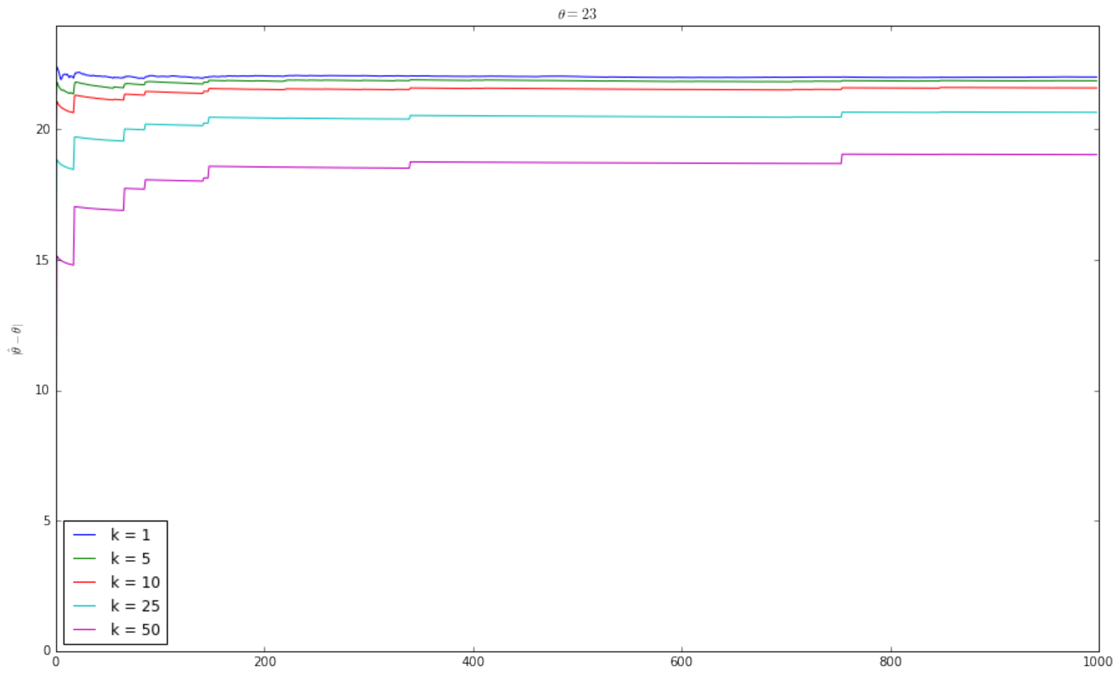

$\theta = 19$
$|\hat{\theta} - \theta|$
0
5
10
15
20
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 20$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

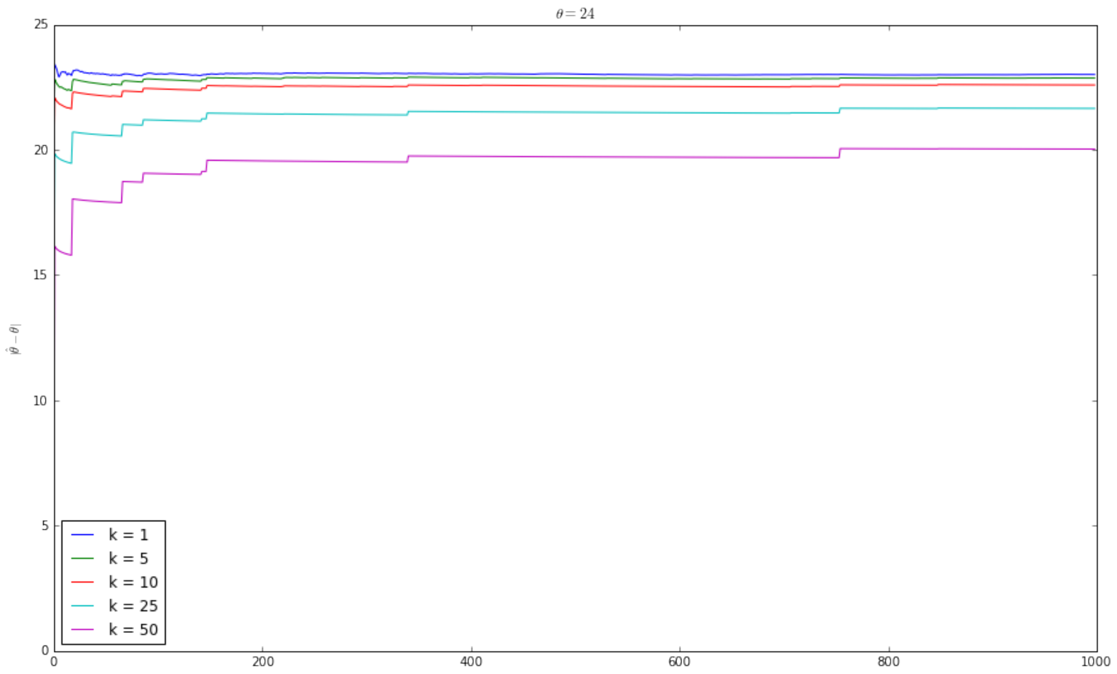

$\theta = 21$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

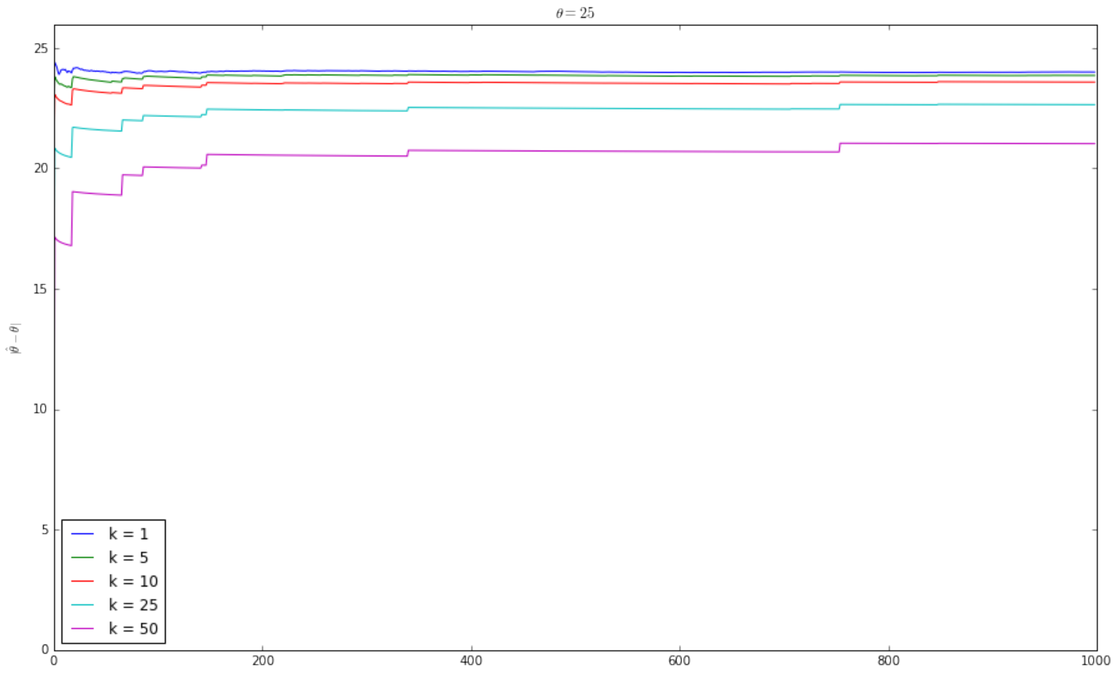


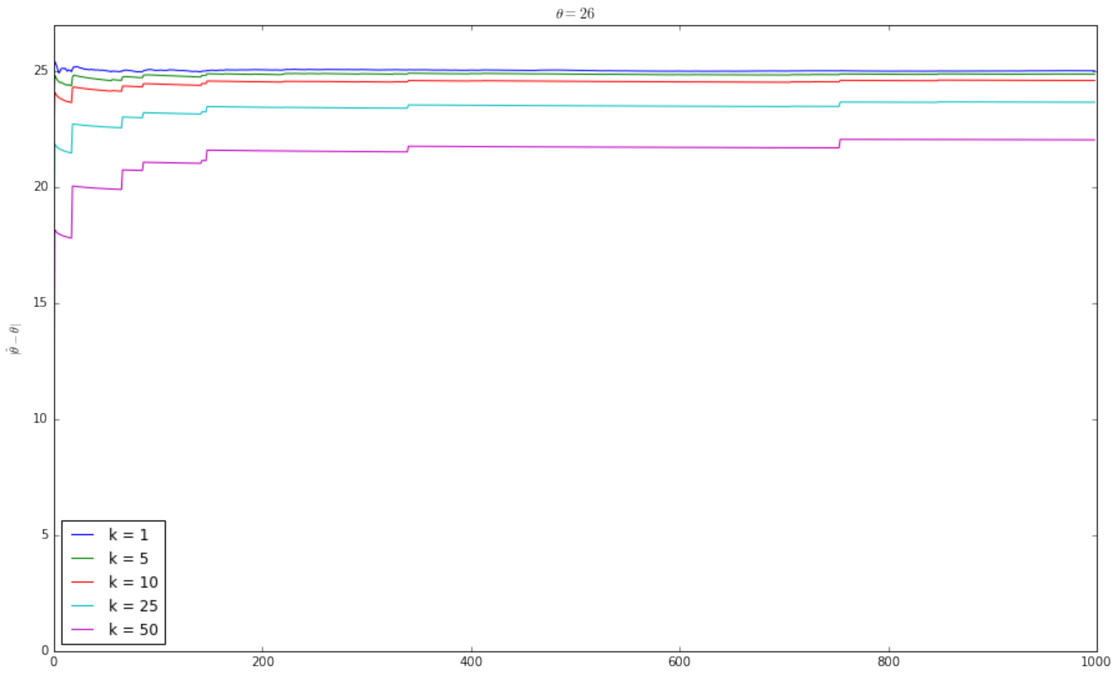
$\theta = 22$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
0
200
400
600
800
1000



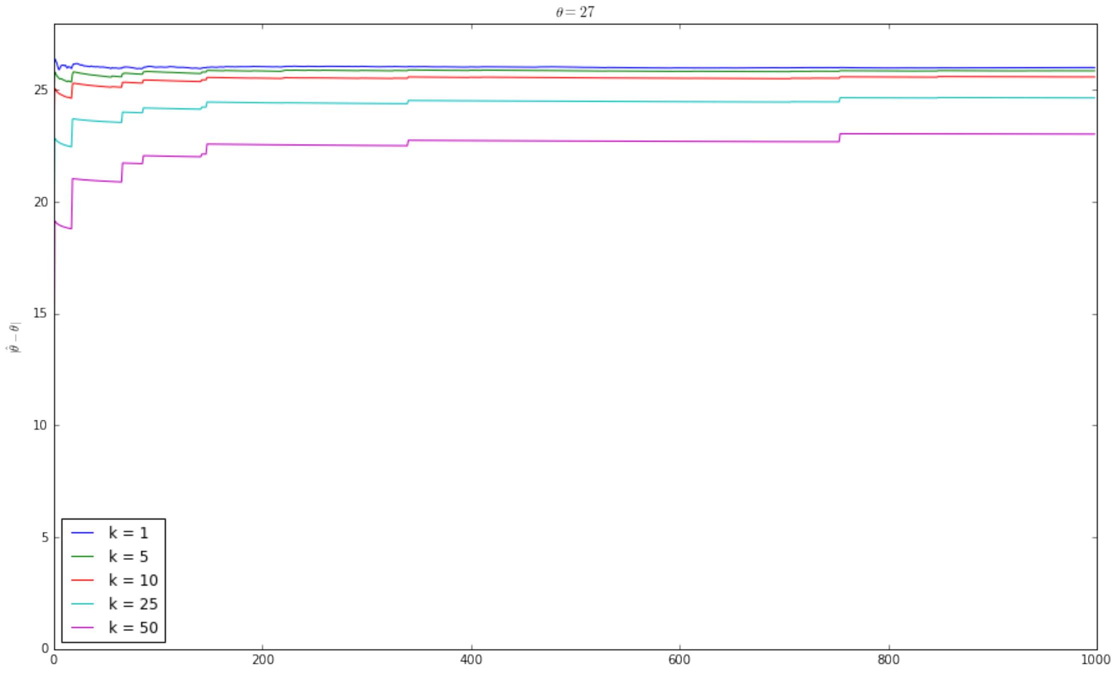
$\theta = 23$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
0
200
400
600
800
1000


$\theta = 24$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

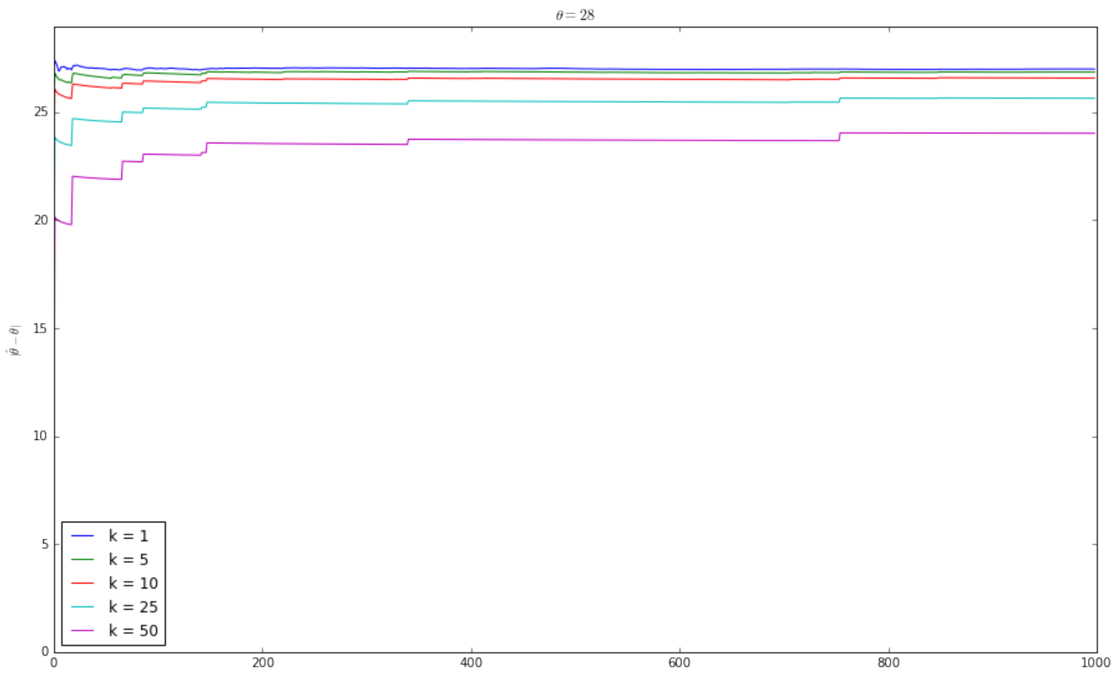

$\theta = 25$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

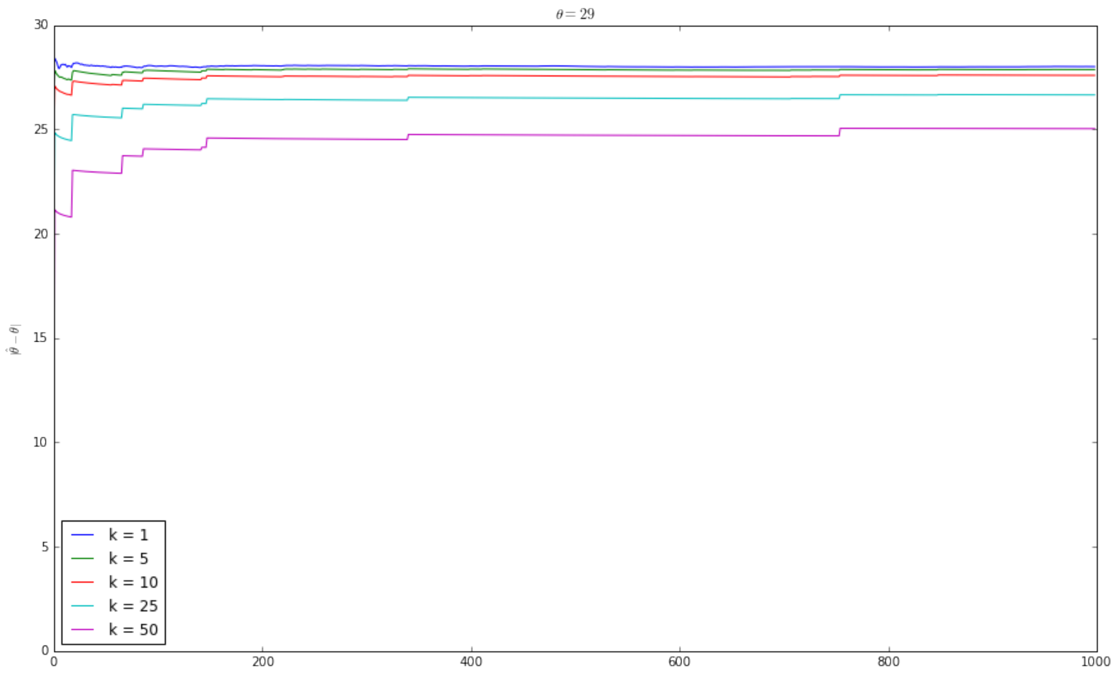


$\theta = 26$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



$\theta = 27$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50





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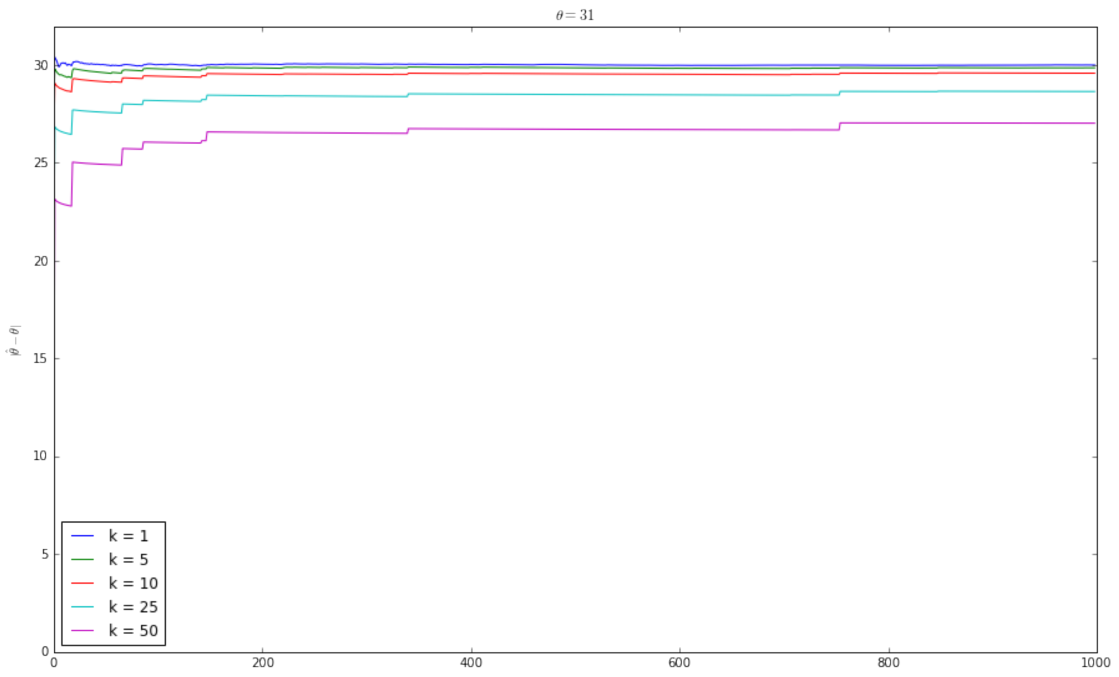
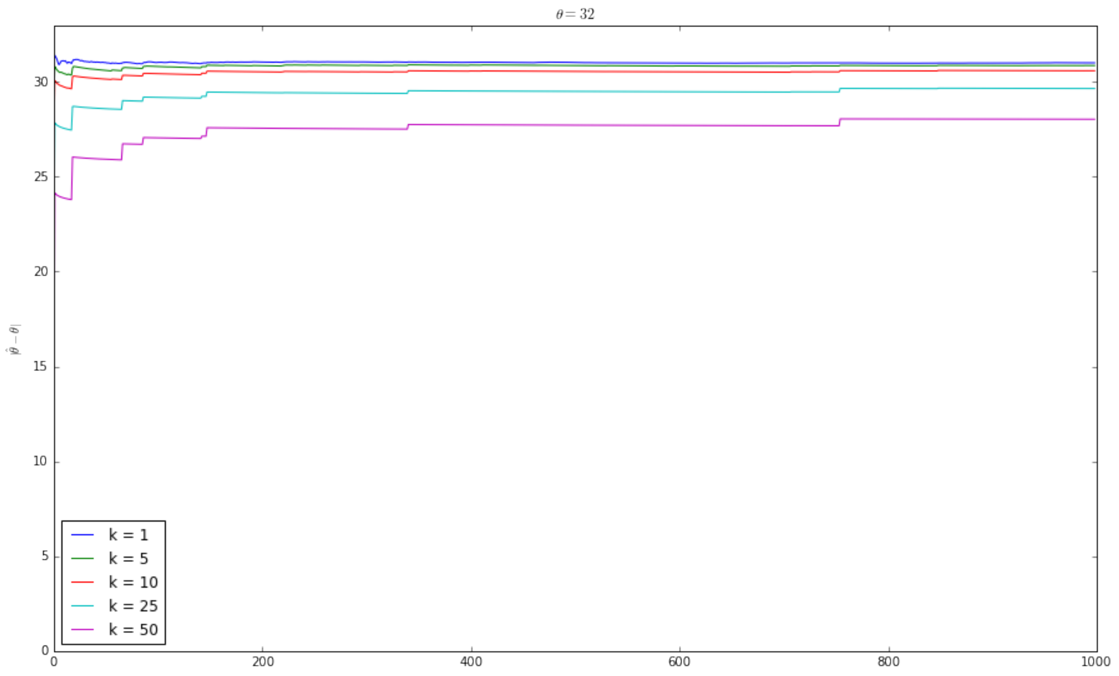
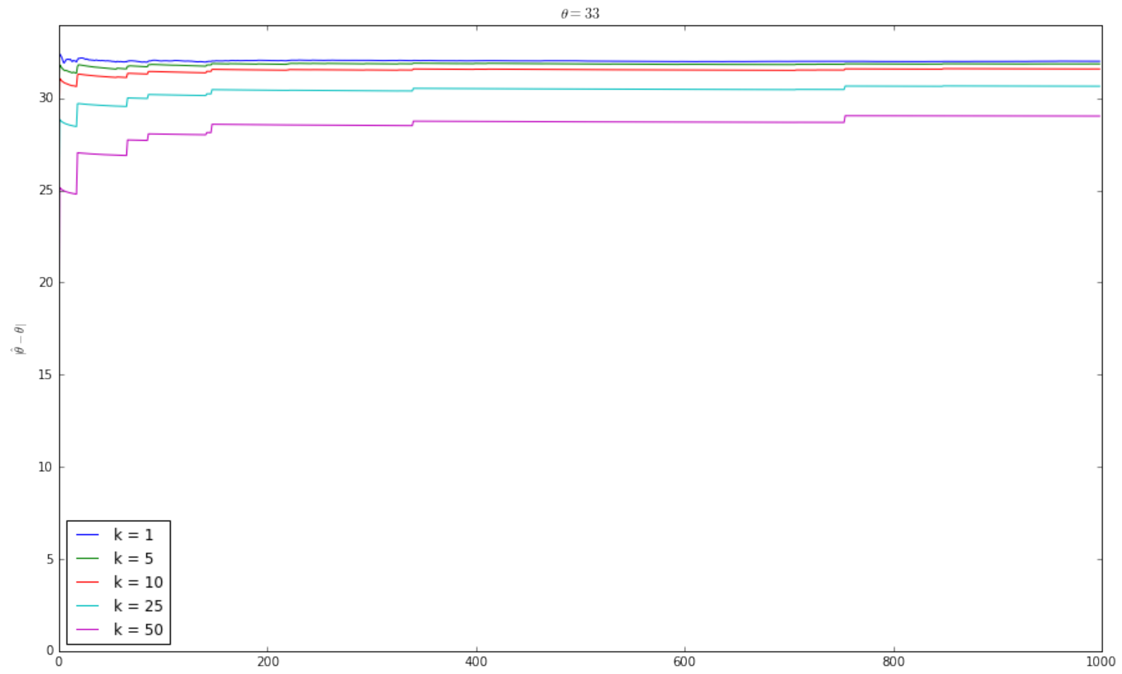
In [54]: for th in range(31, 60):
             drawPlot([1, 5, 10, 25, 50], th, ymin = 0, ymax = th + 1)
```

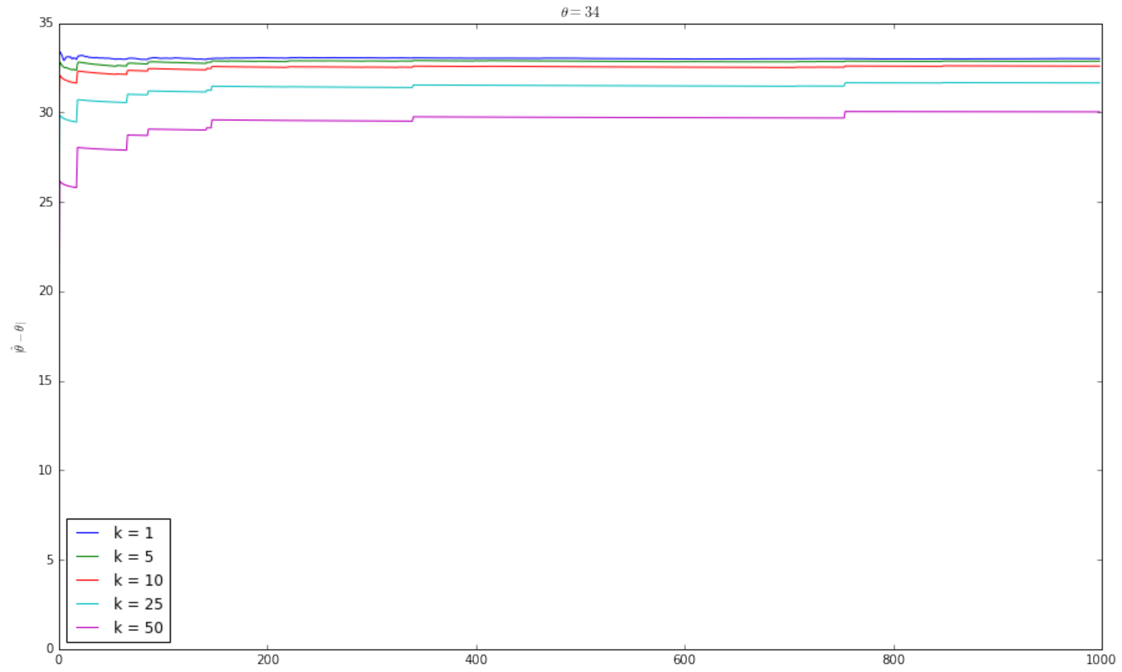


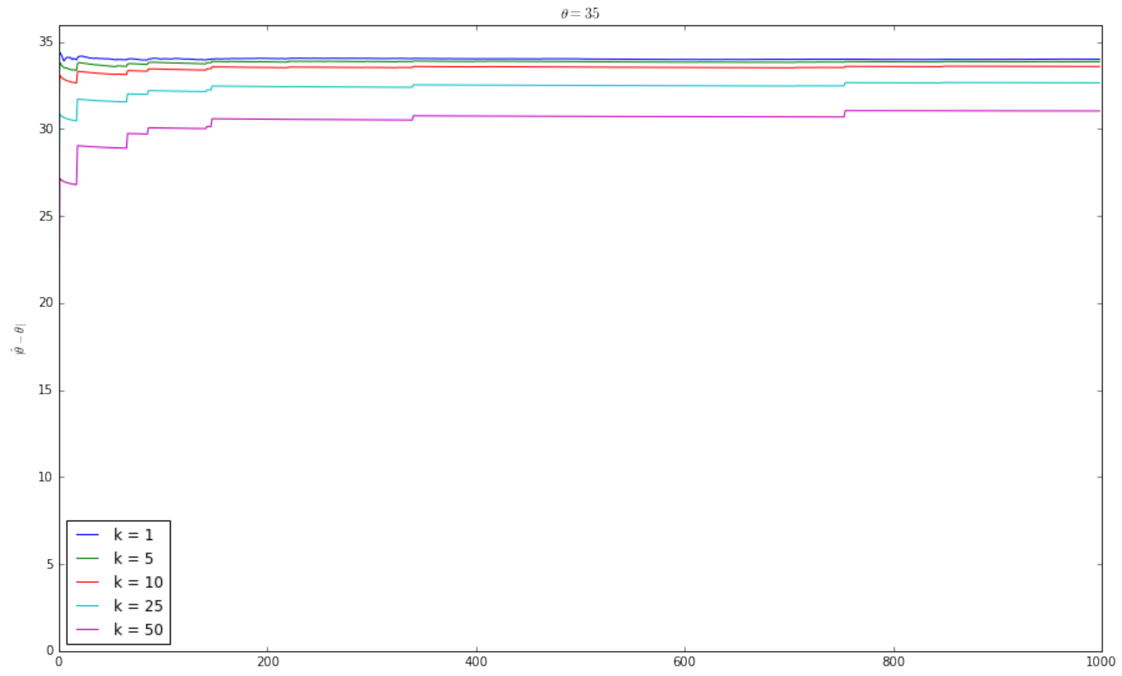
$\theta = 31$
$|\hat{\theta} - \theta|$
0
5
10
15
20
25
30
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

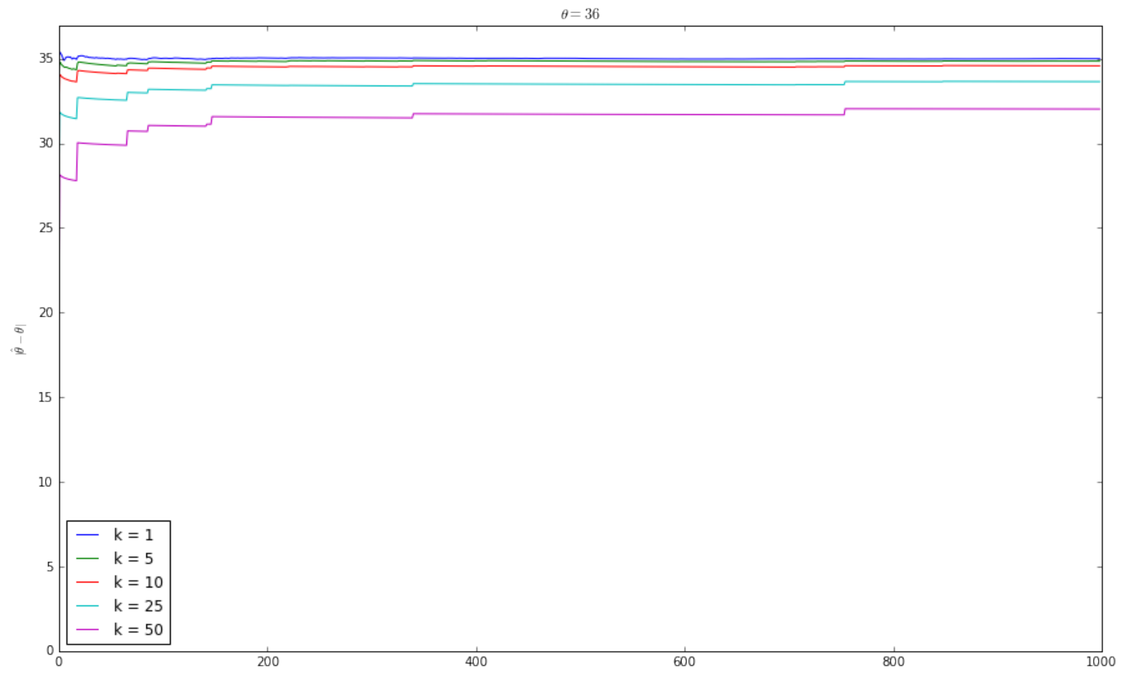


$\theta = 32$
$|\hat{\theta} - \theta|$
0
5
10
15
20
25
30
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 33$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 34$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 35$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
0
200
400
600
800
1000


$\theta = 36$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
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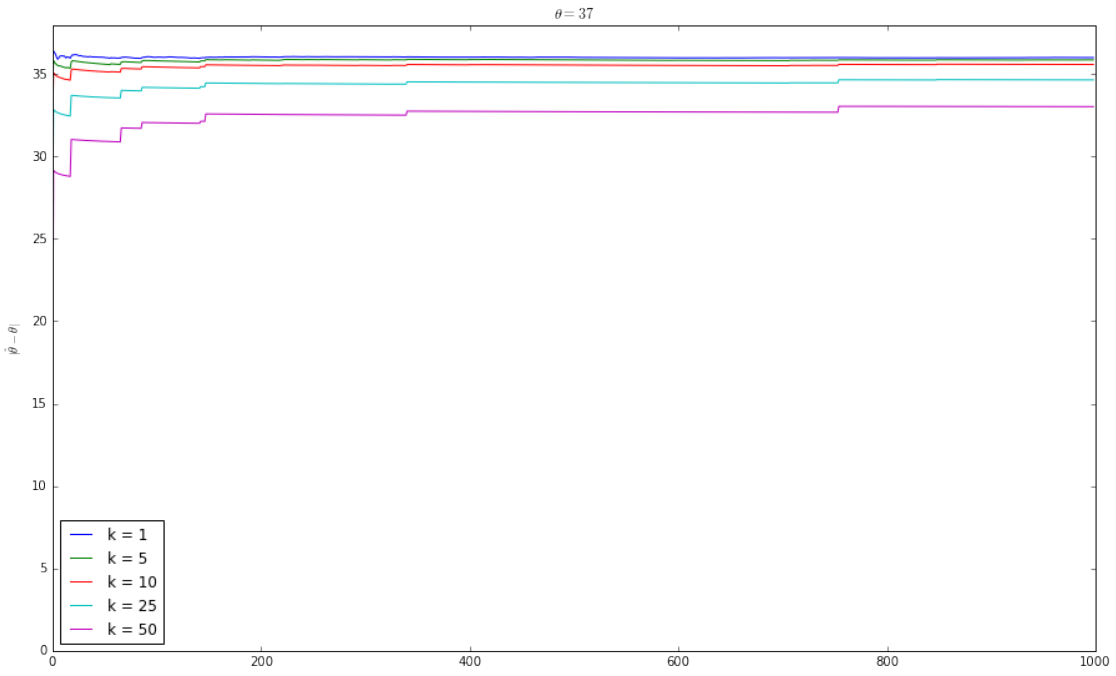
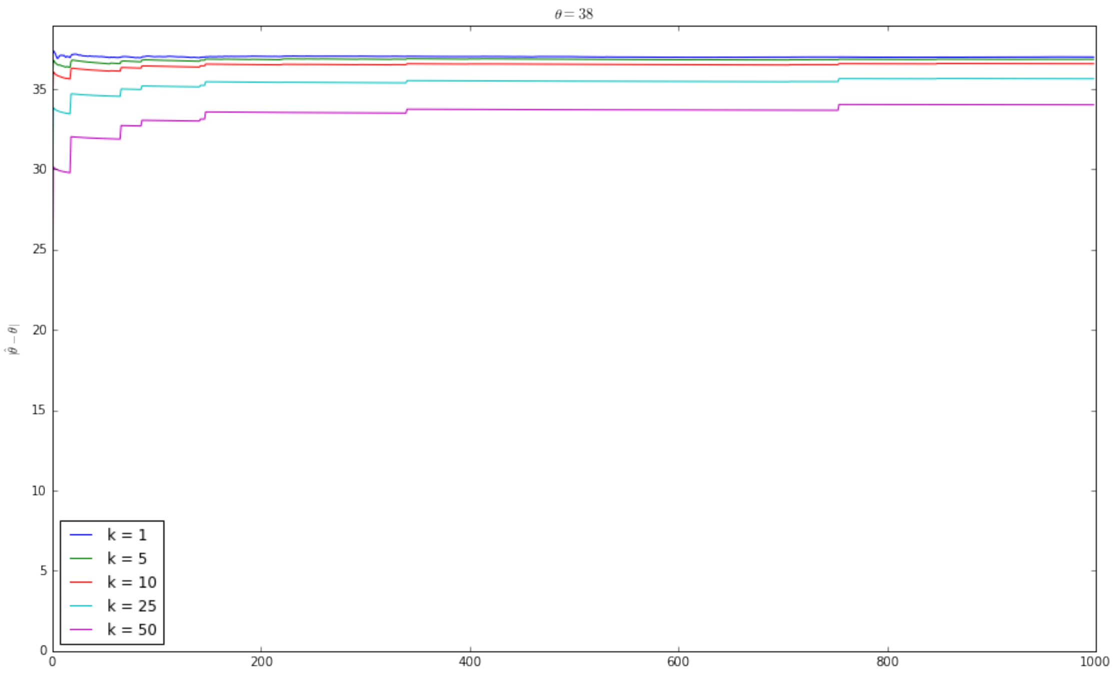
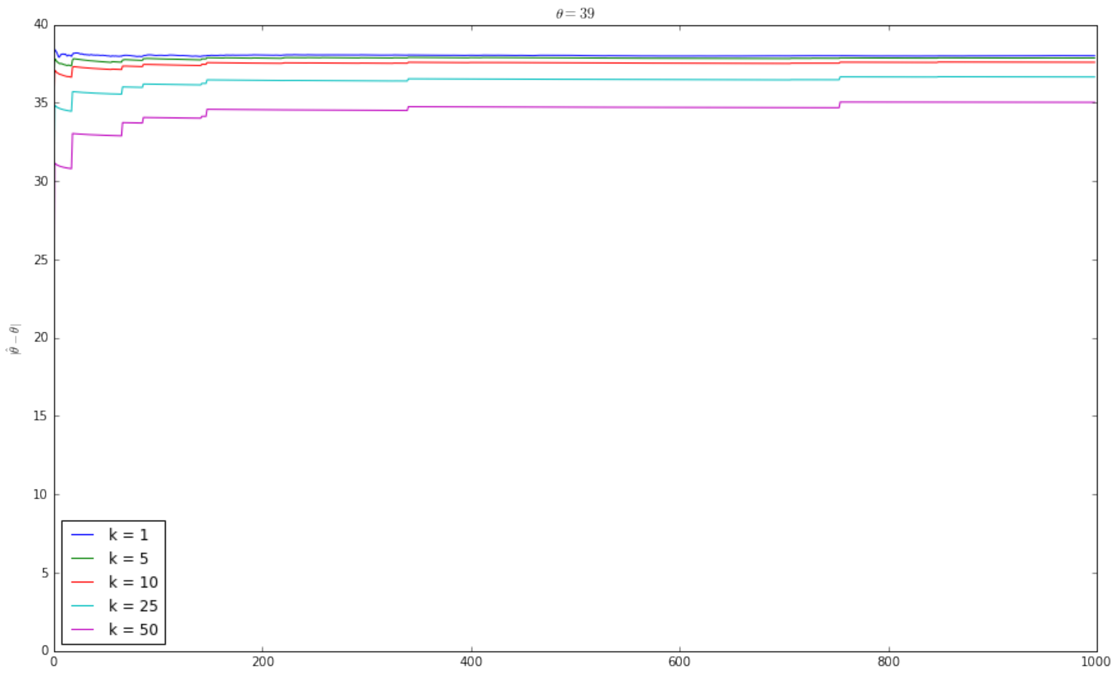
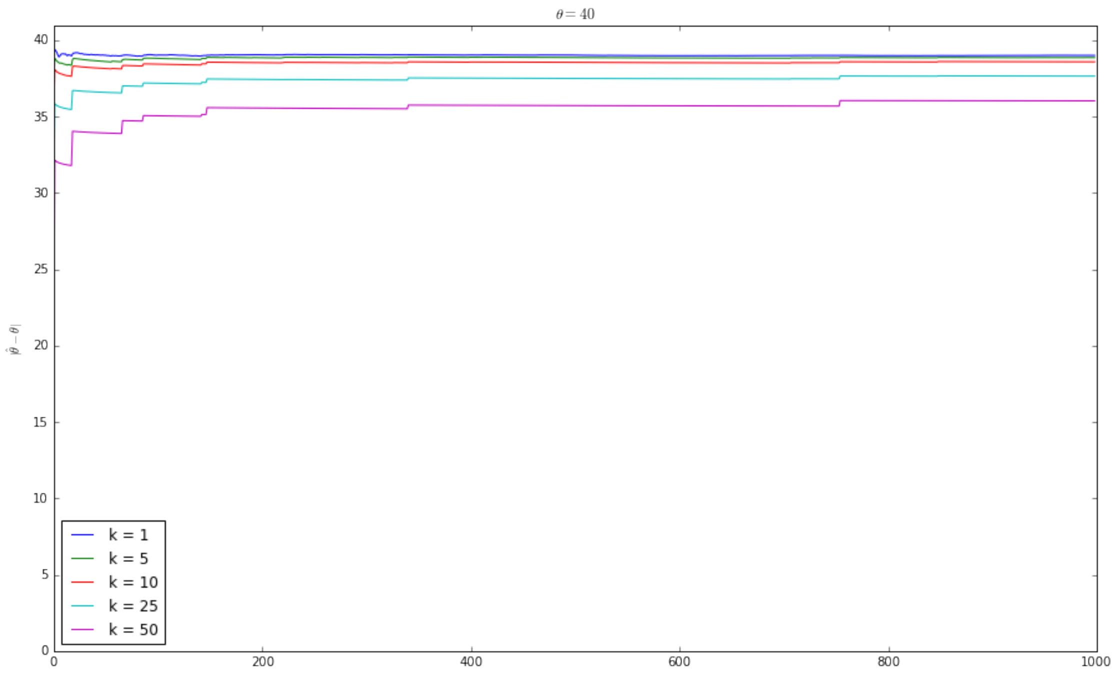
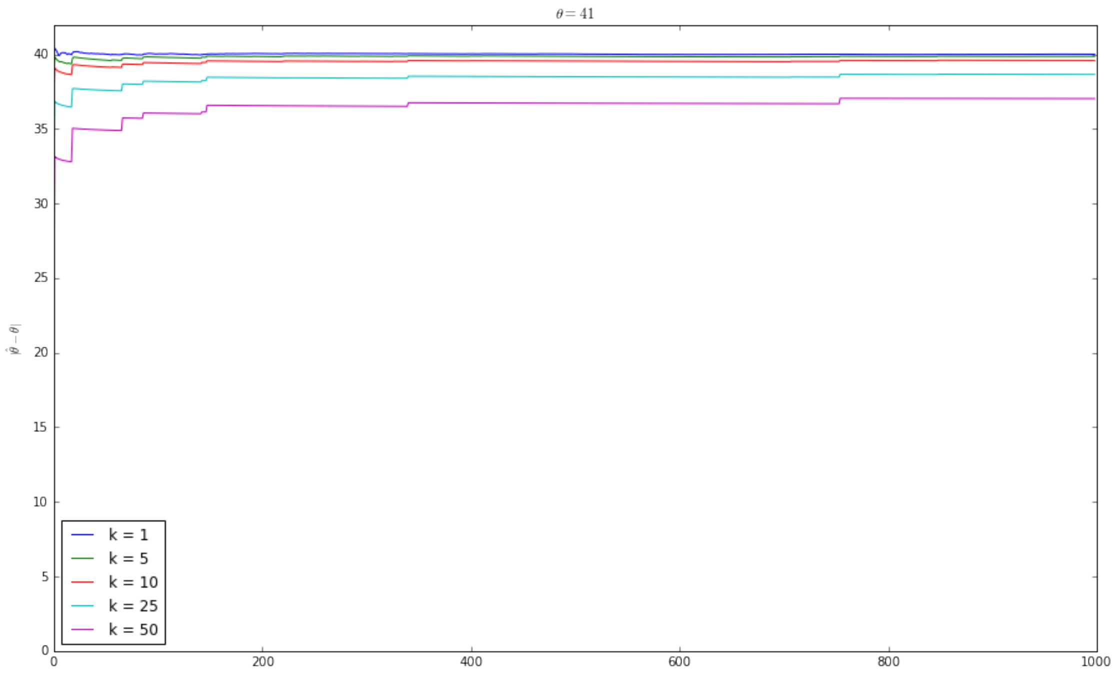
25
30
35
0
200
400
600
800
1000


$\theta = 37$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
0
200
400
600
800
1000

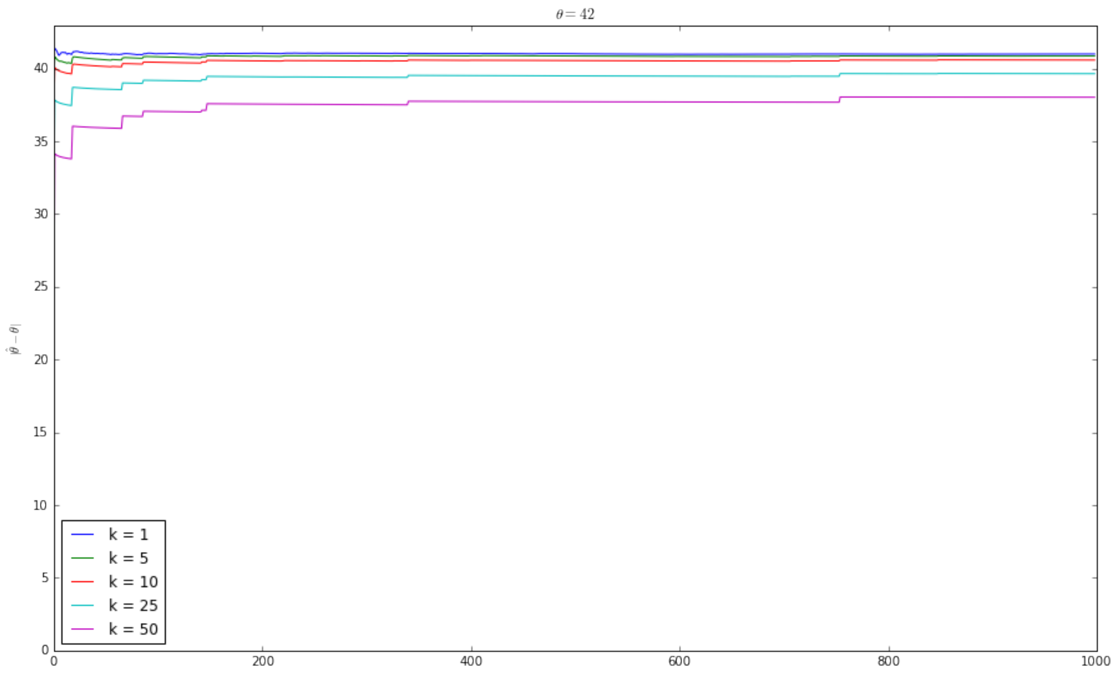

$\theta = 38$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
0
200
400
600
800
1000


$\theta = 39$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
40
200
400
600
800
1000

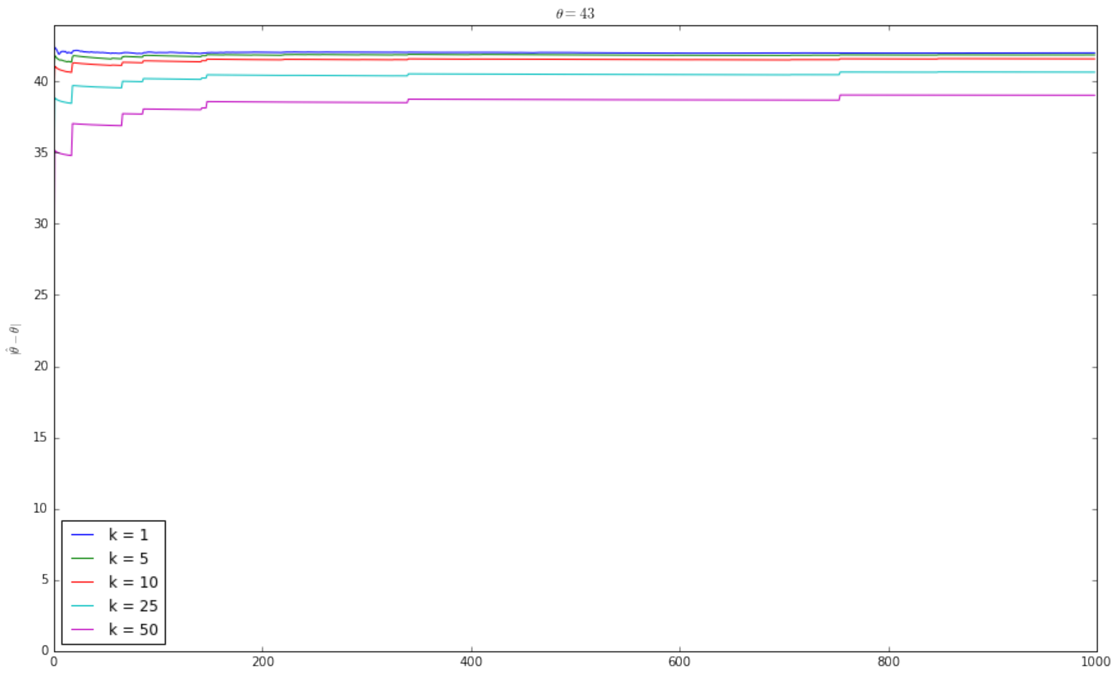

$\theta = 40$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
40
200
400
600
800
1000

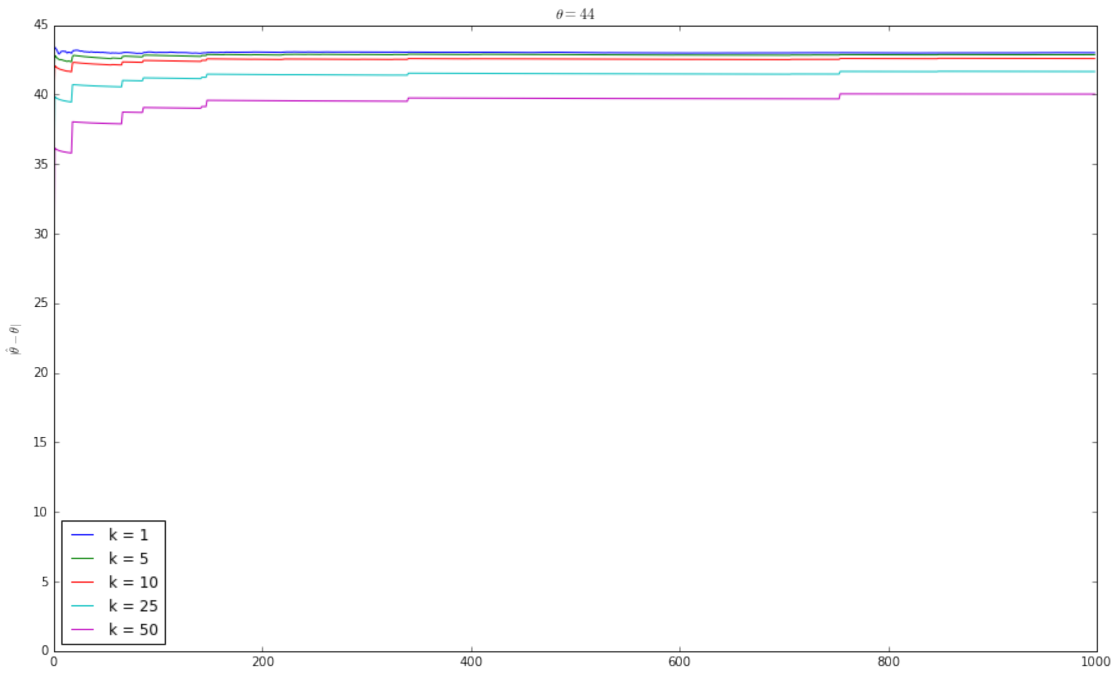


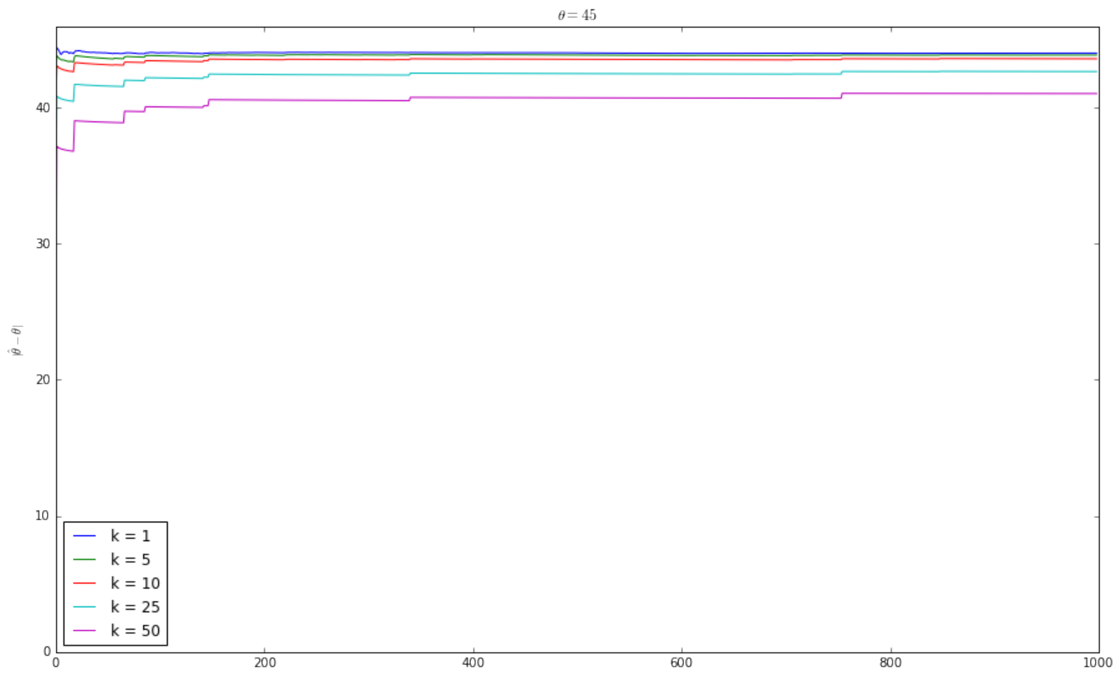
$\theta = 41$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

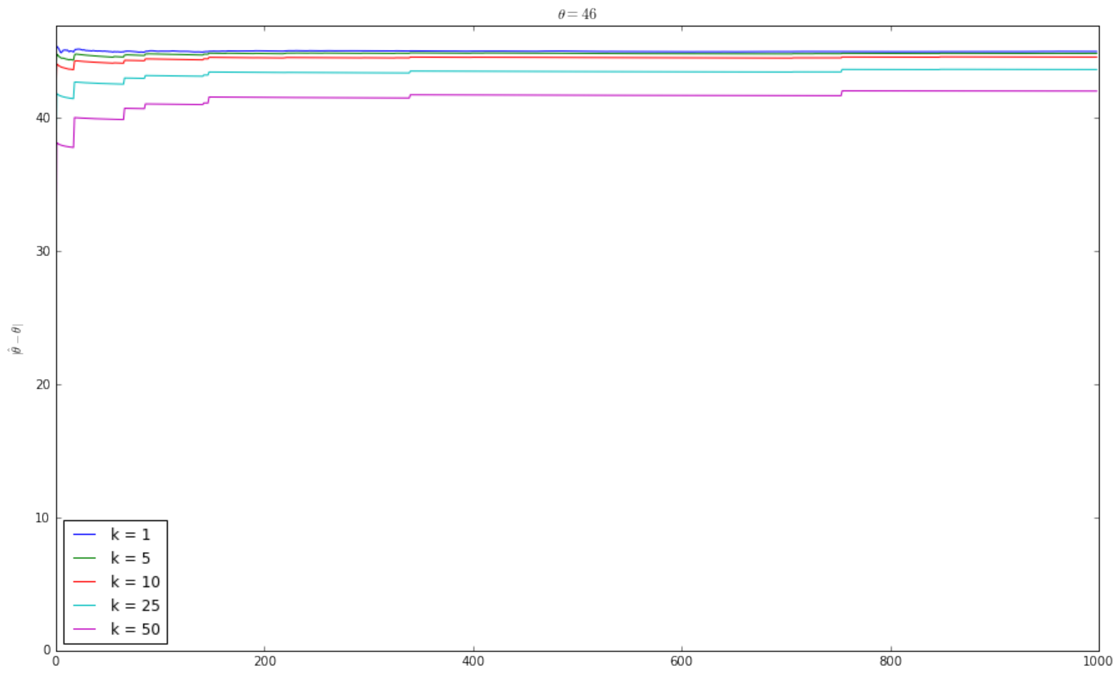


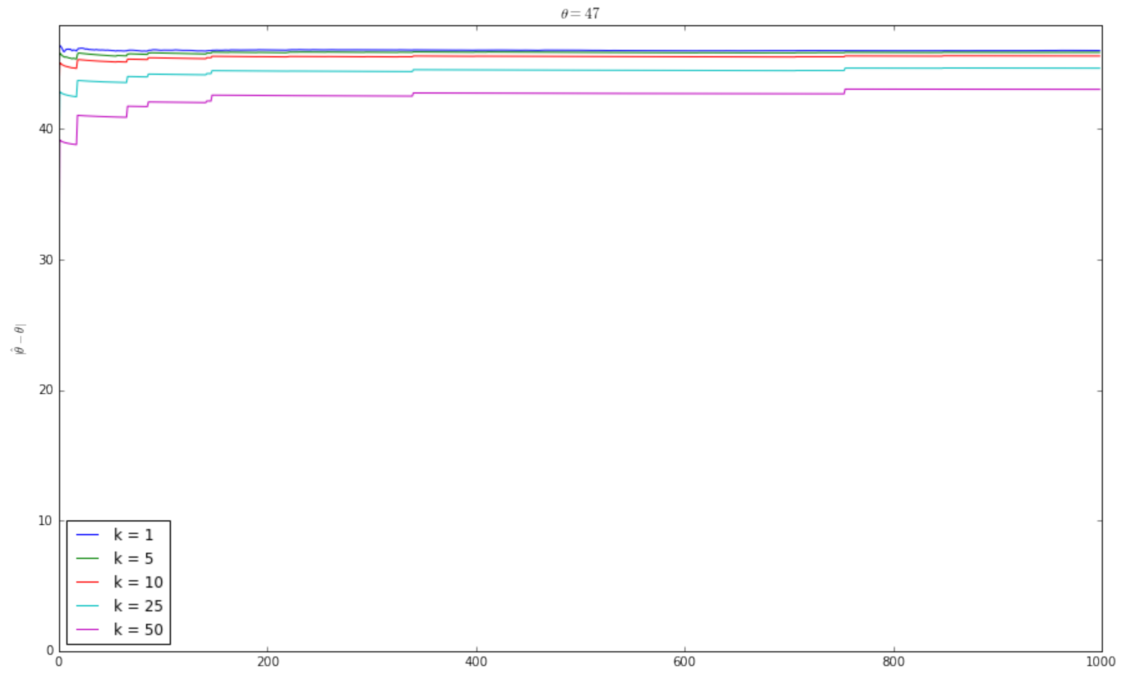
$\theta = 42$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 43$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
40
0
200
400
600
800
1000

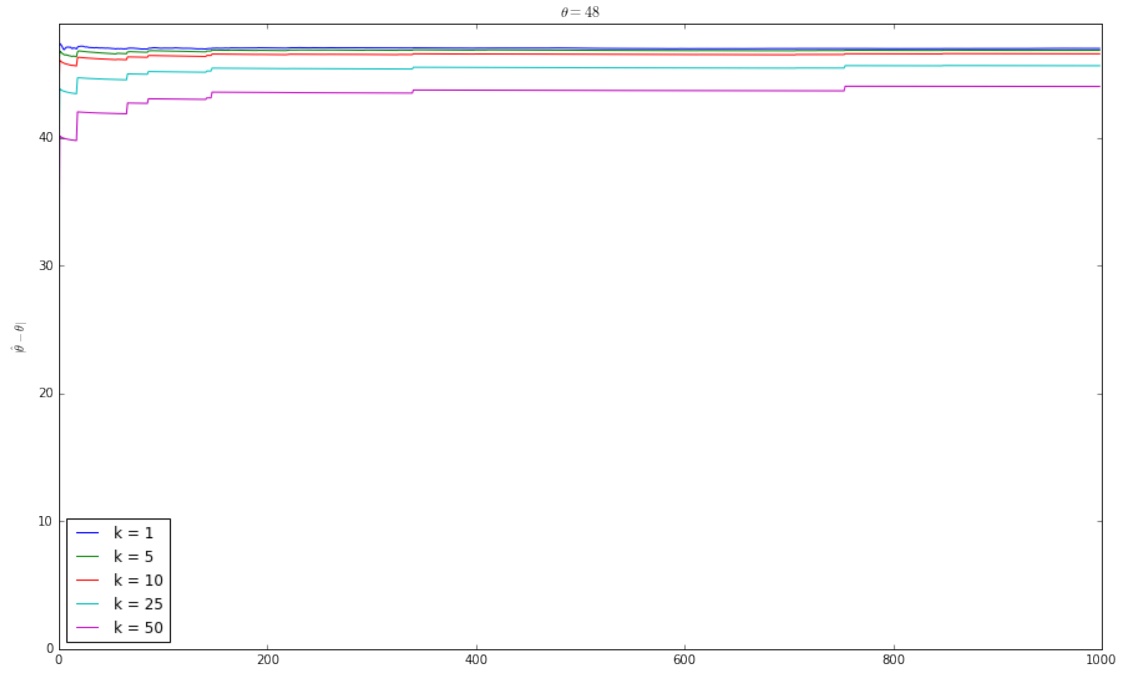

$\theta = 44$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
5
10
15
20
25
30
35
40
45
0
200
400
600
800
1000


$\theta = 45$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

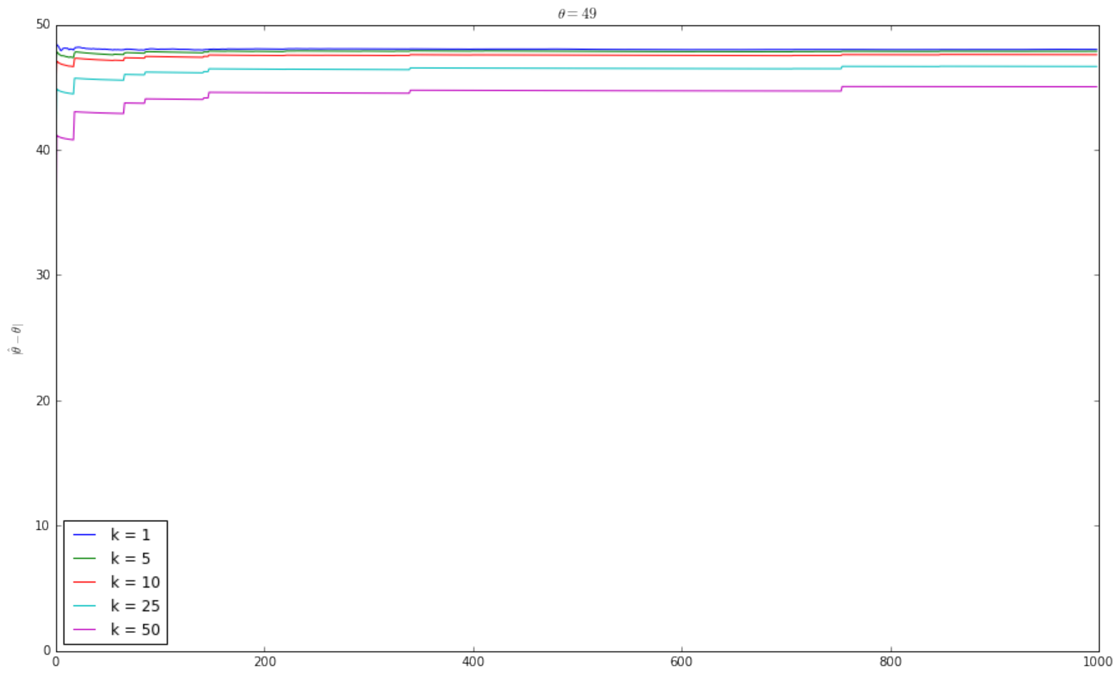

$\theta = 46$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



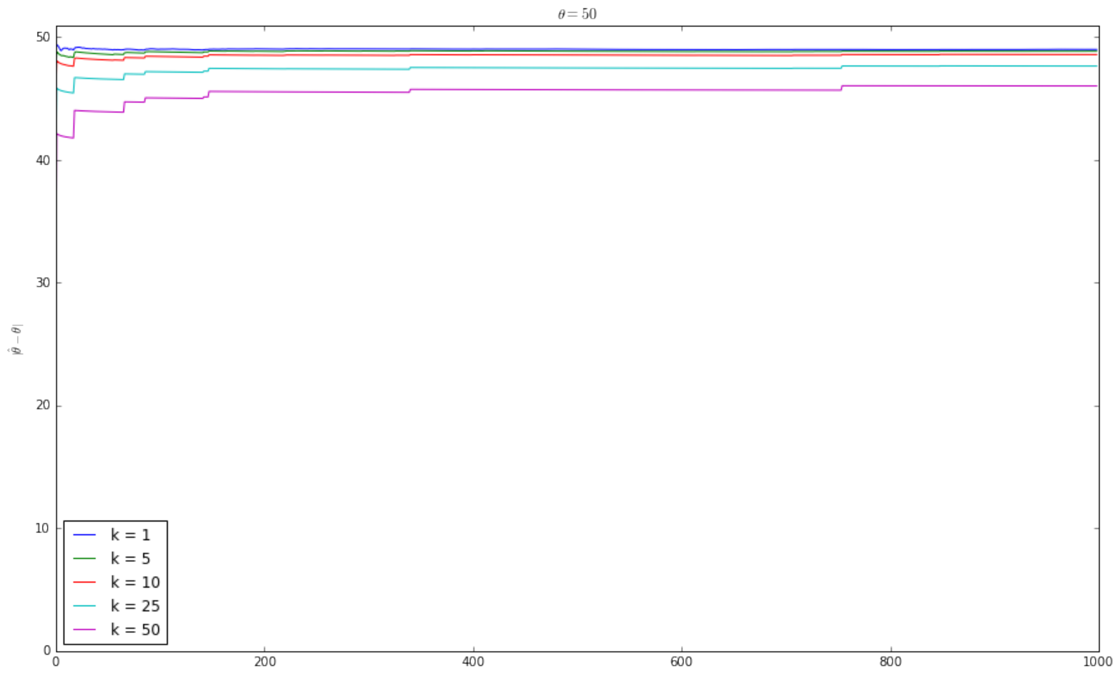
$\theta = 47$
$|\hat{\theta} - \theta|$
0
10
20
30
40
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50



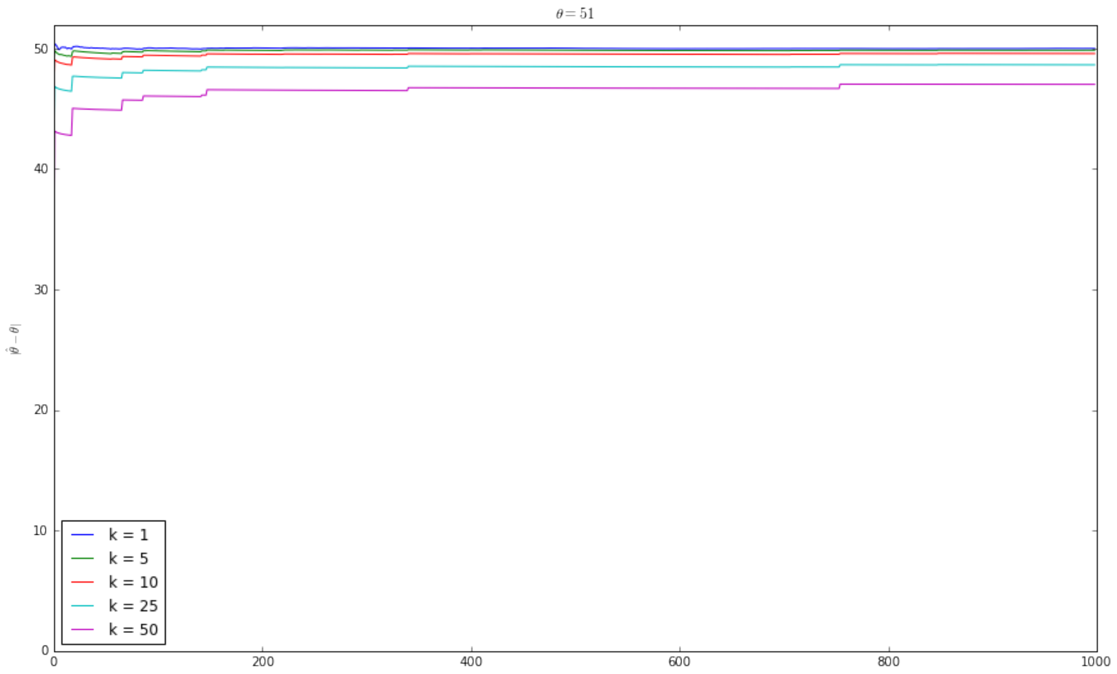
$\theta = 48$
$|\hat{\theta} - \theta|$
0
10
20
30
40
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

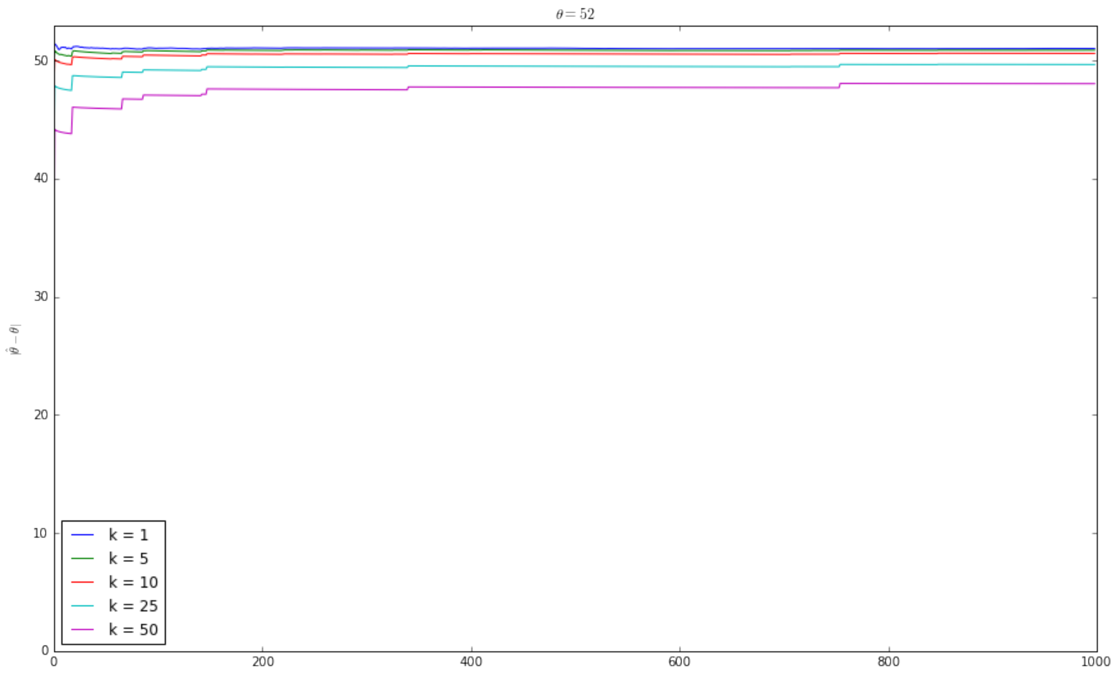


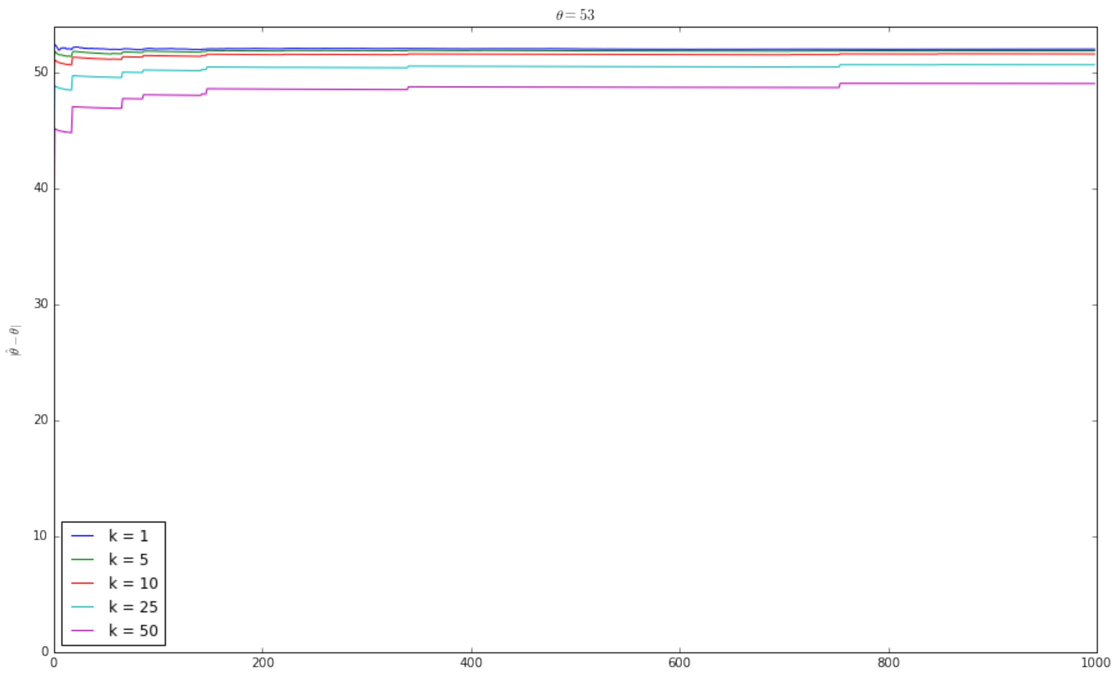
$\theta = 49$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

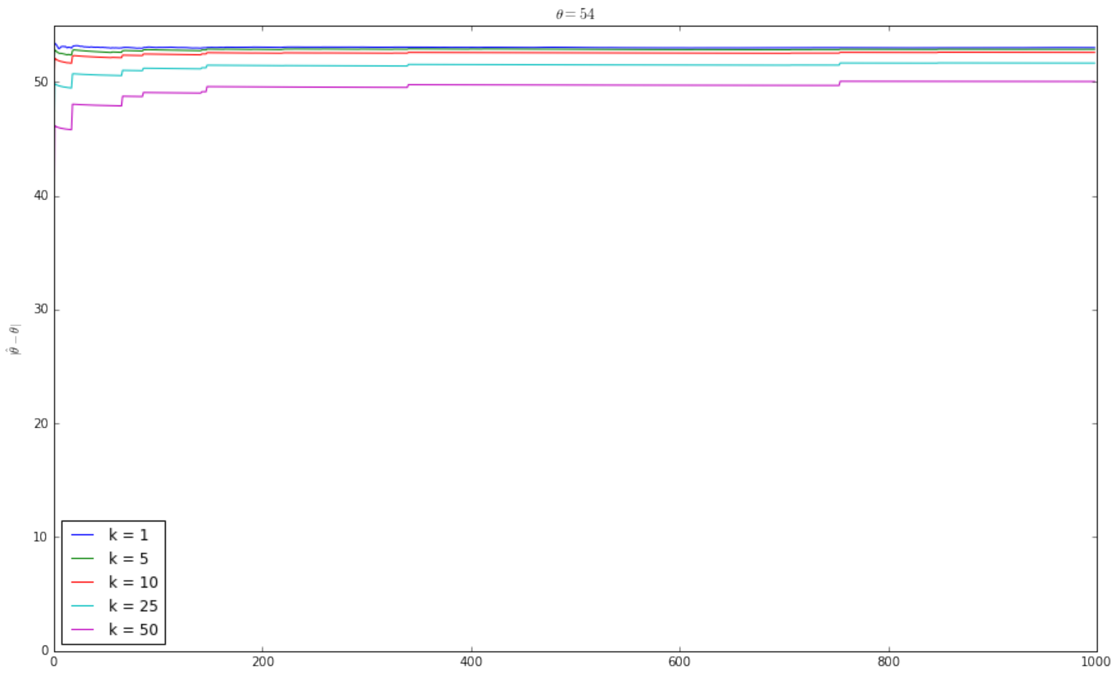


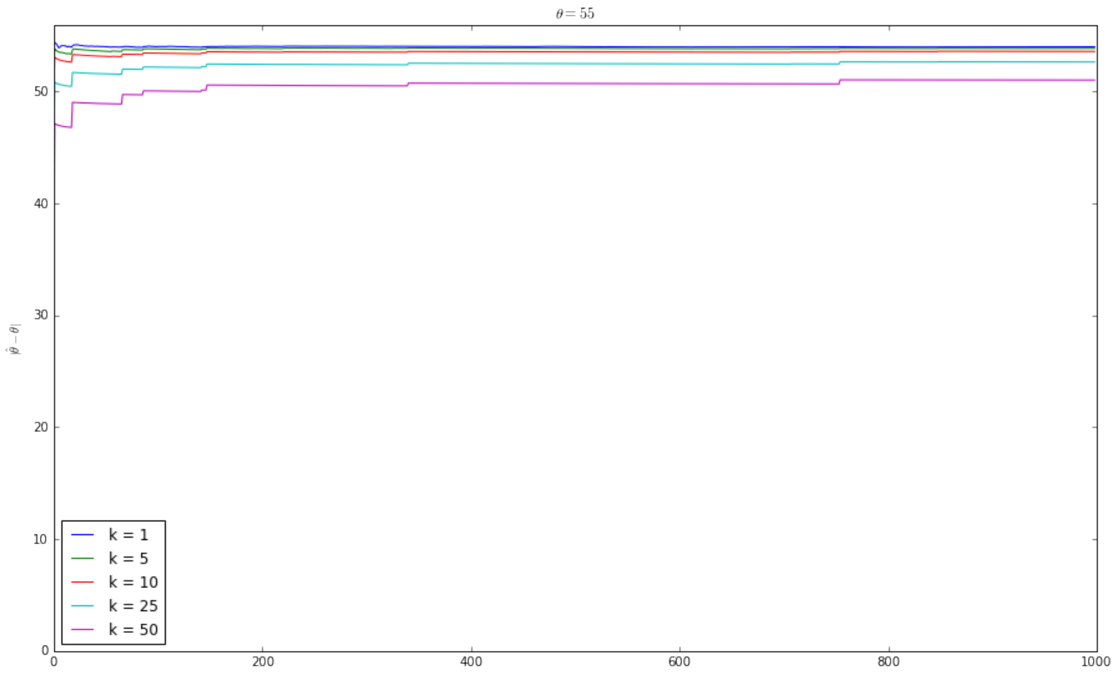
$\theta = 50$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

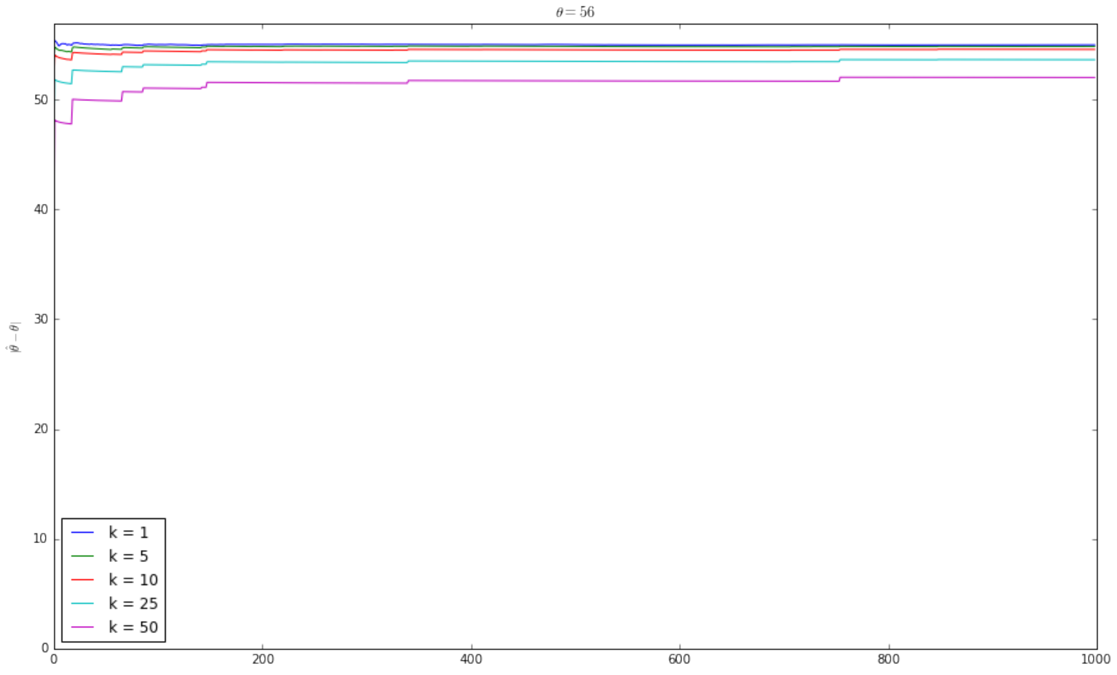

$\theta = 51$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
0
200
400
600
800
1000

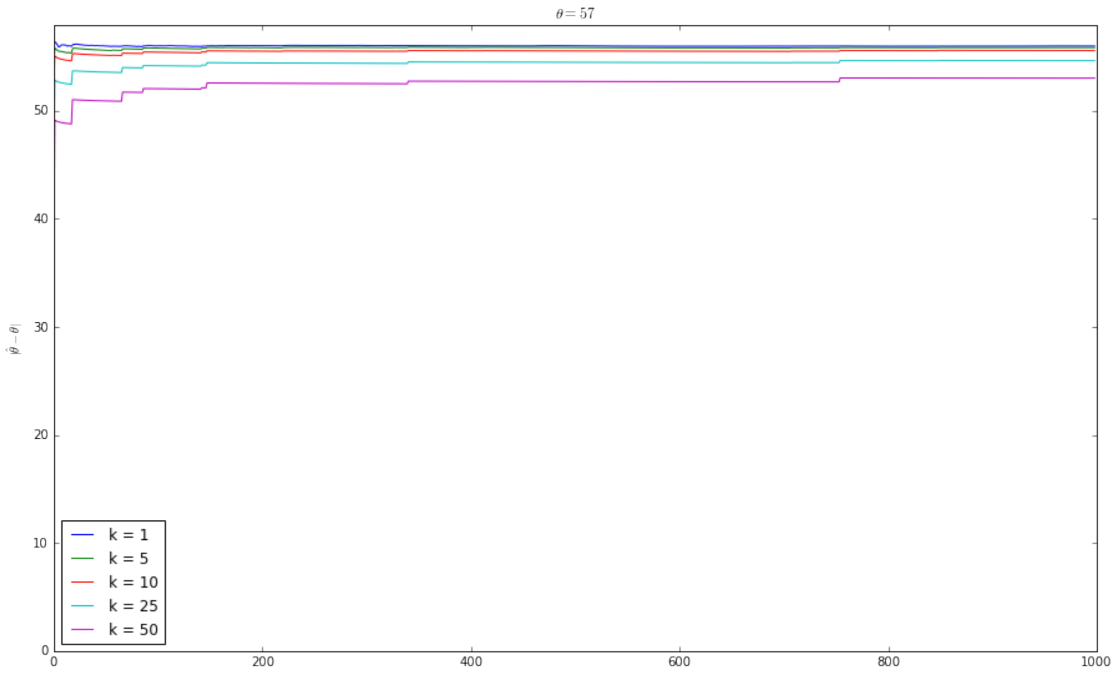

$\theta = 52$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
0
200
400
600
800
1000


$\theta = 53$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
200
400
600
800
1000

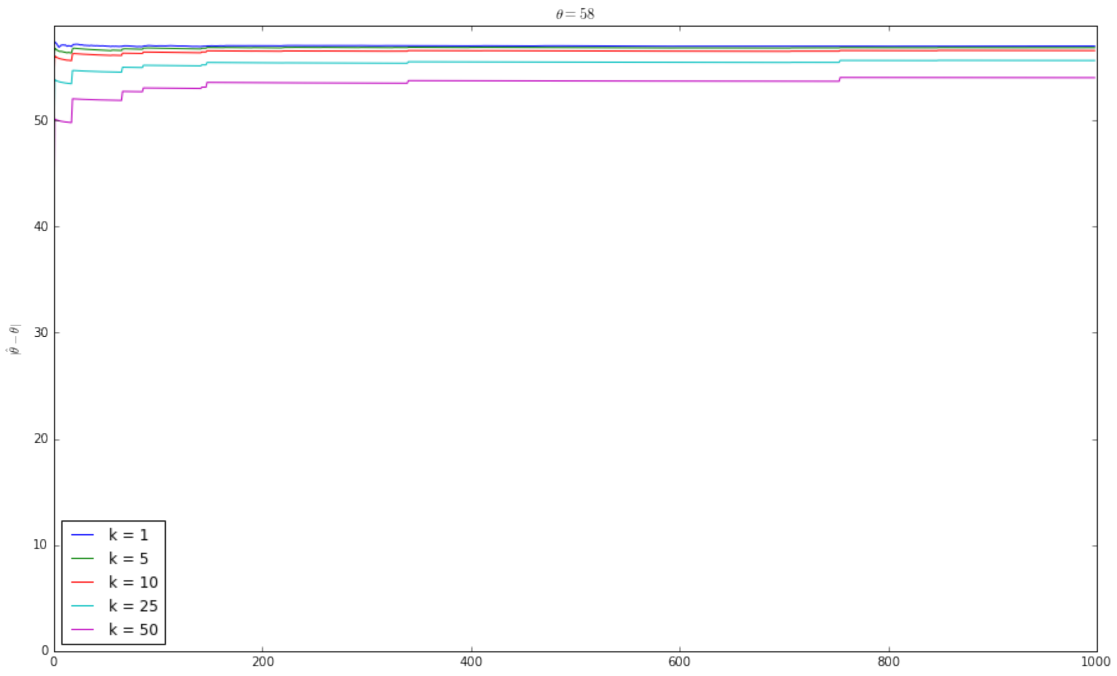

$\theta = 54$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
200
400
600
800
1000


$\theta = 55$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

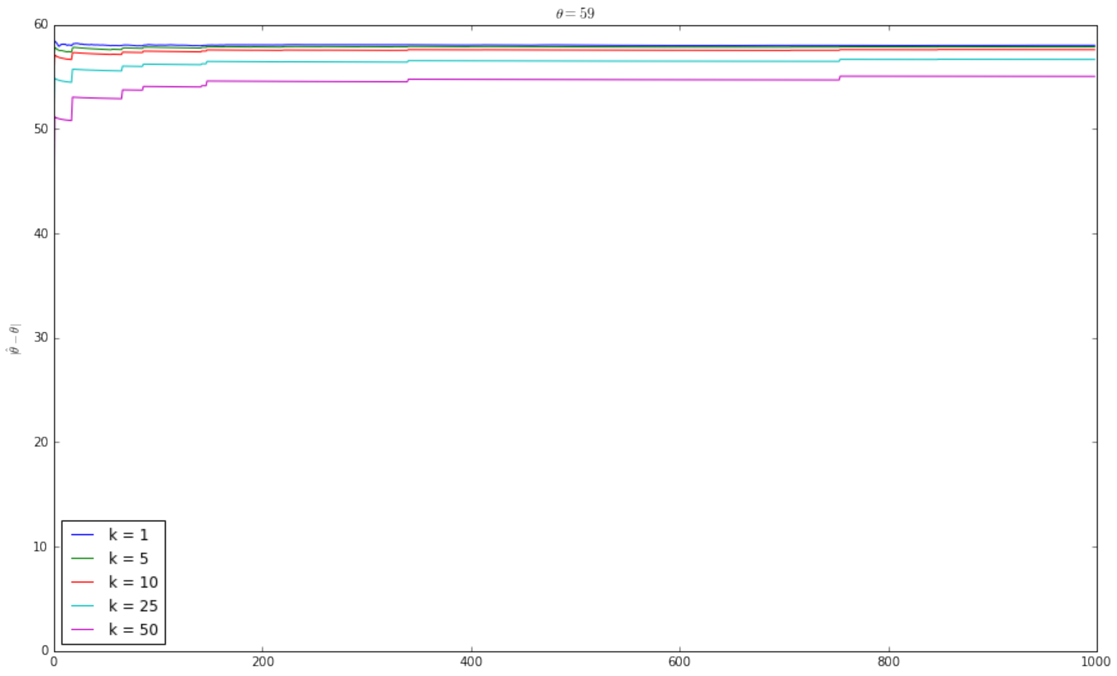

$\theta = 56$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



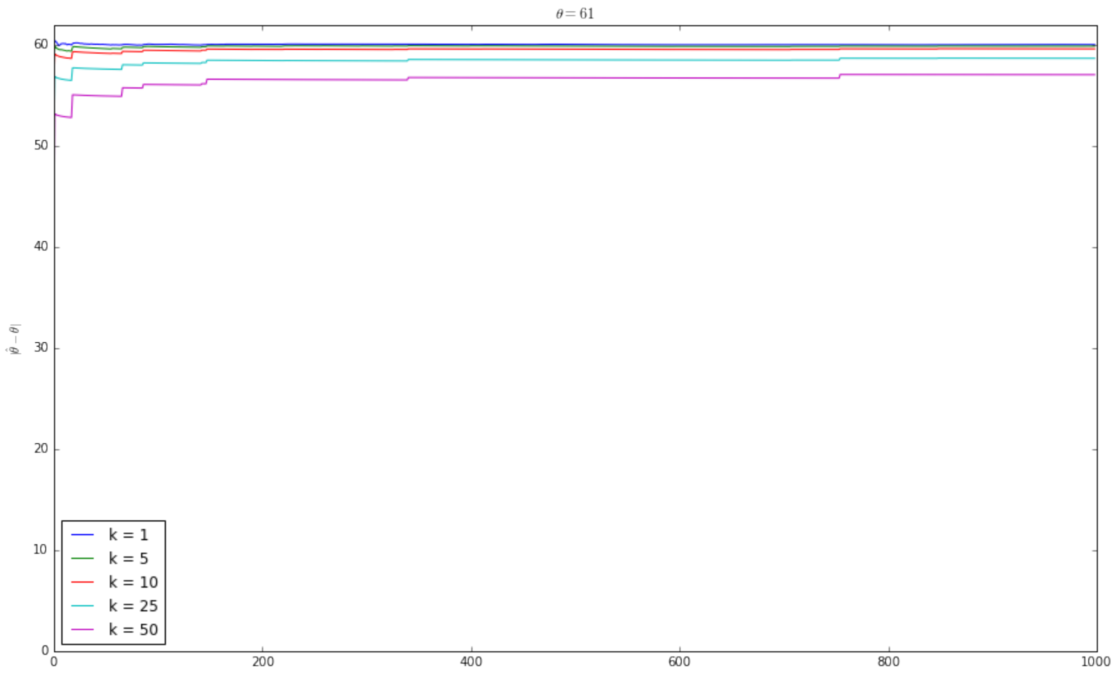
$\theta = 57$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

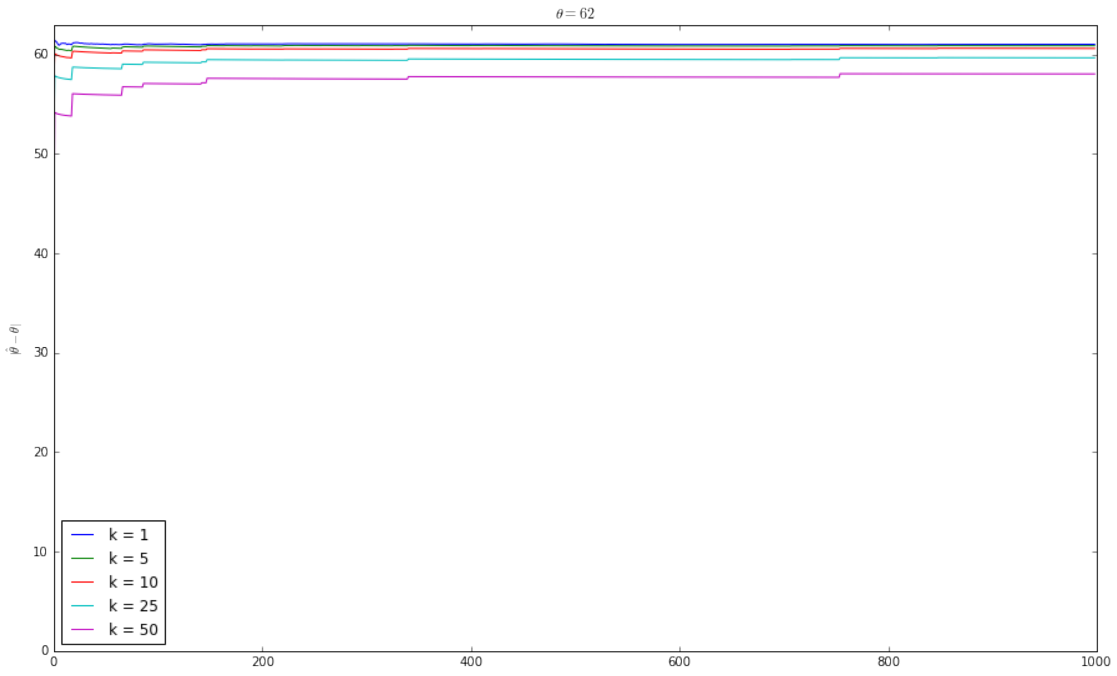


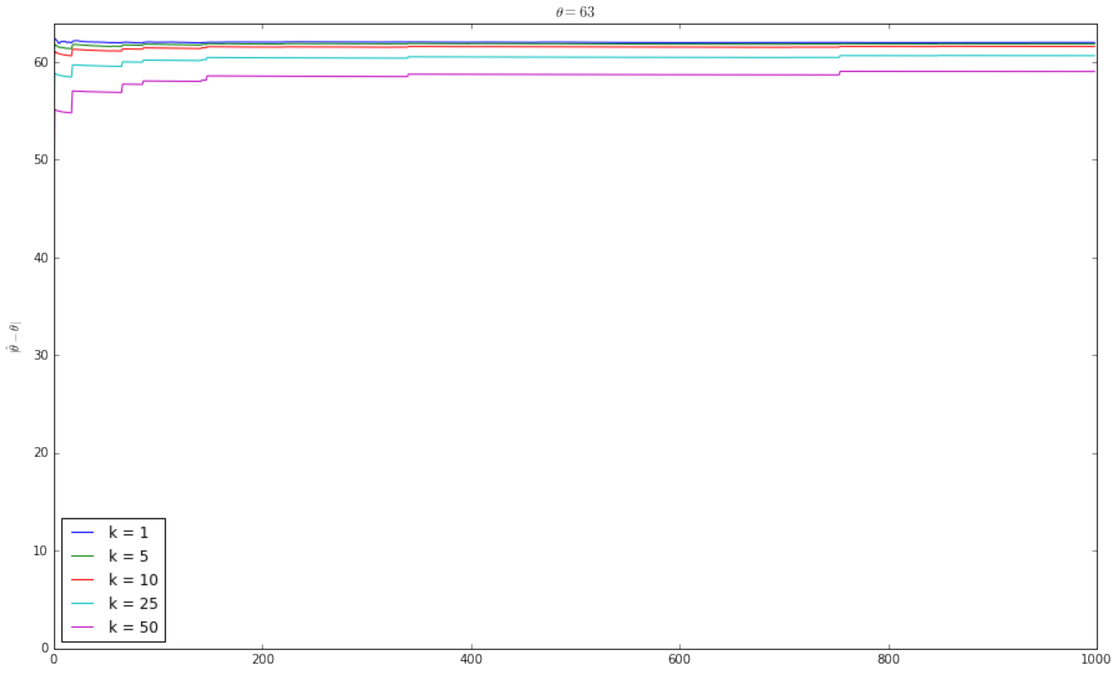
$\theta = 58$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

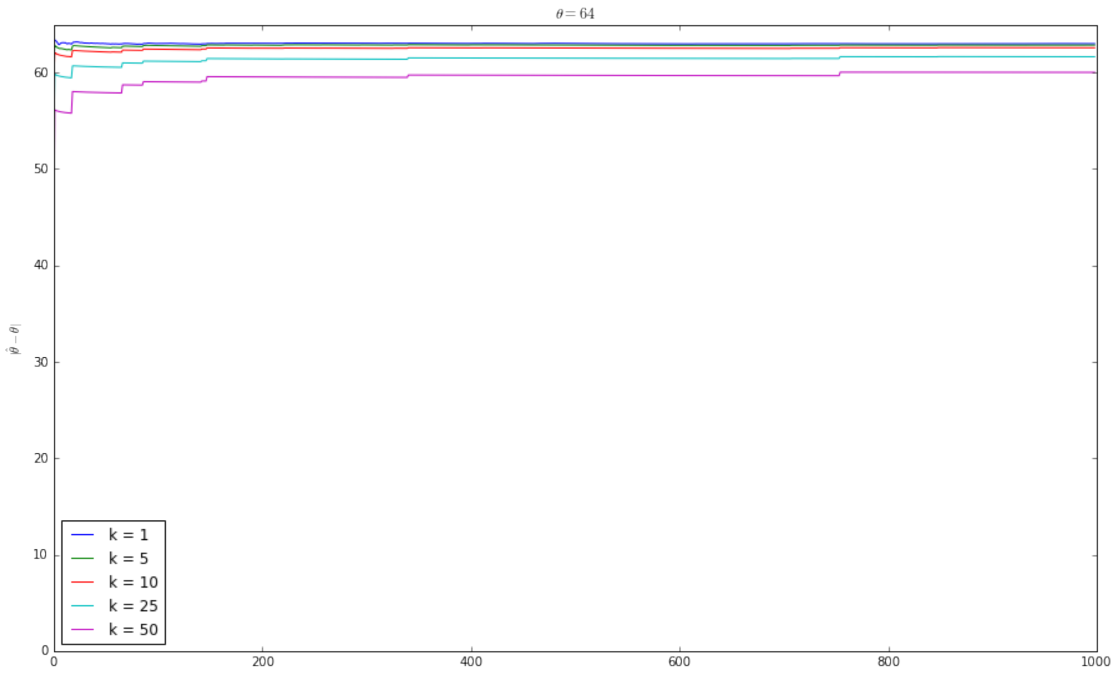


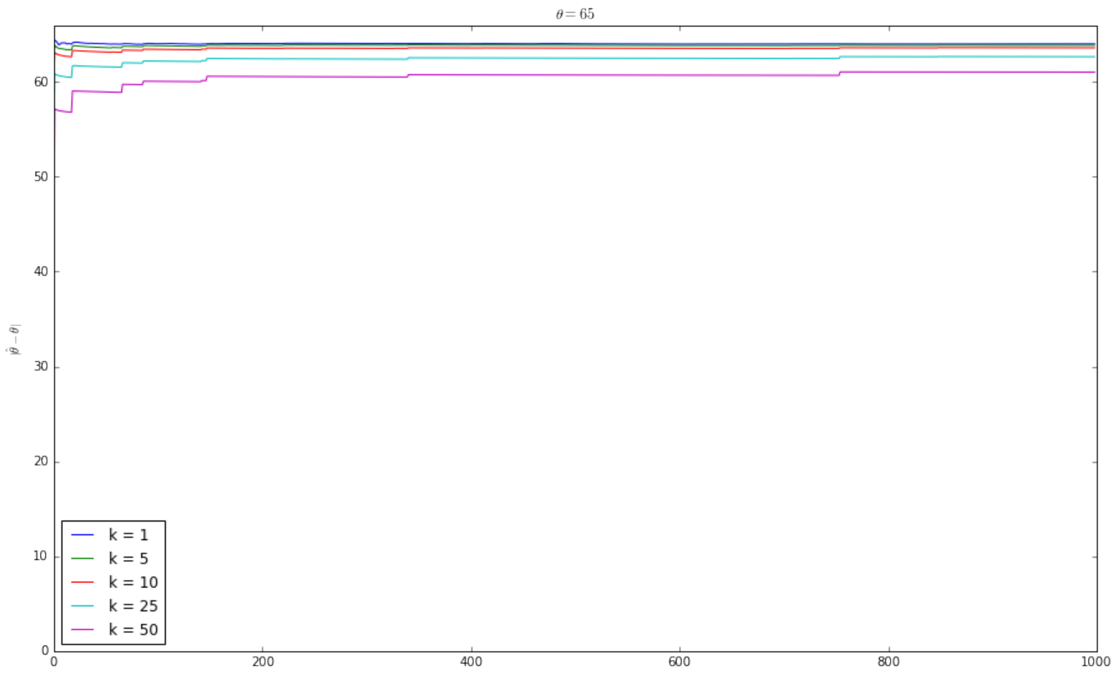
```
In [55]: for th in range(61, 90):
             drawPlot([1, 5, 10, 25, 50], th, ymin = 0, ymax = th + 1)
```

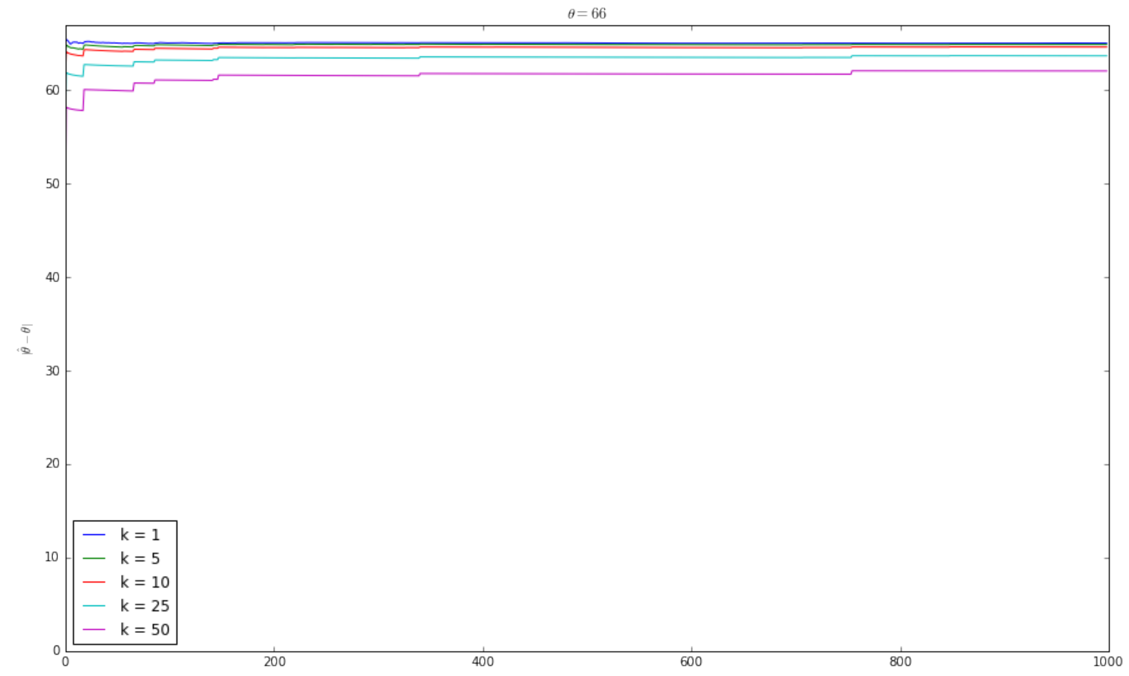


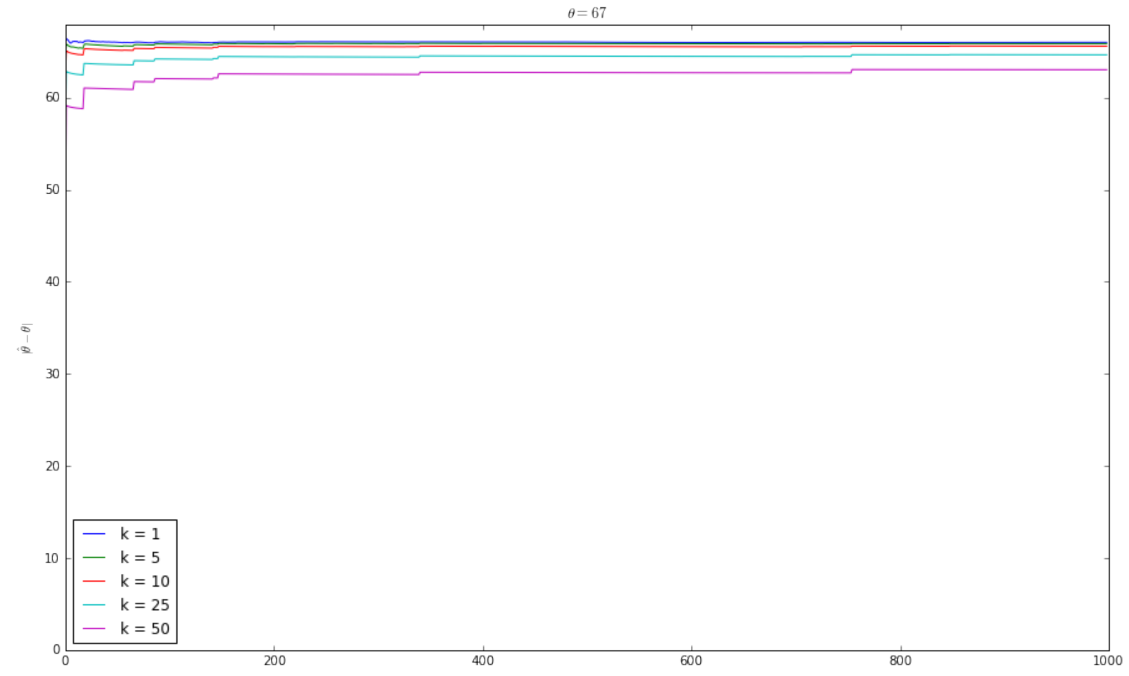

$\theta = 62$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
0
200
400
600
800
1000

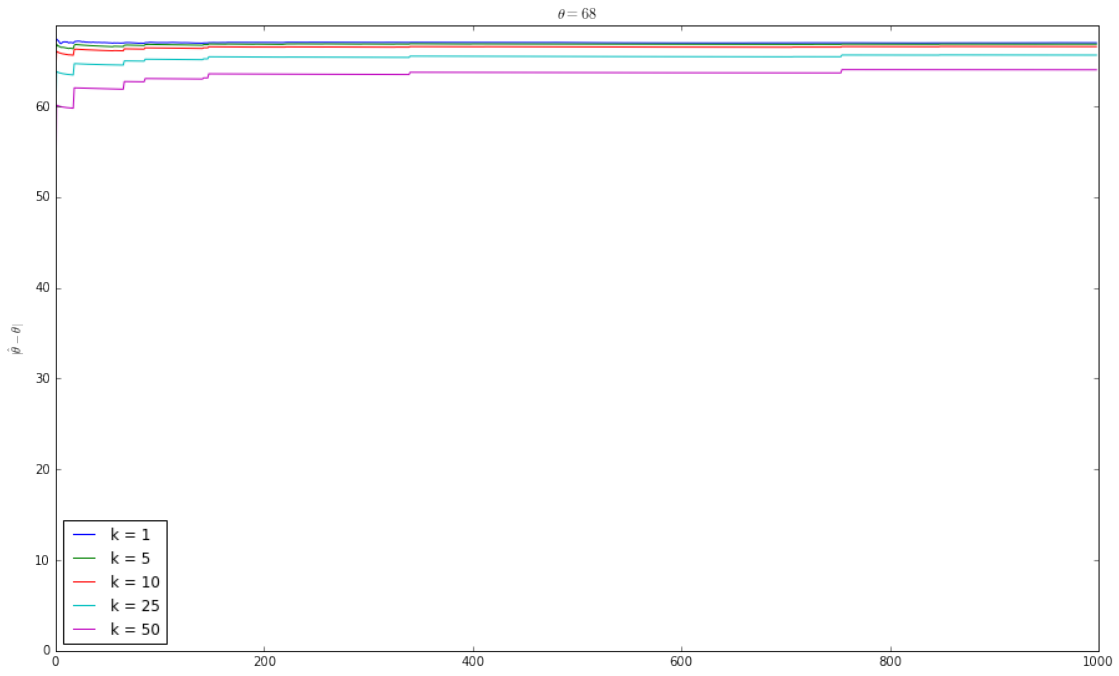

$\theta = 63$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
0
200
400
600
800
1000


$\theta = 64$
$|\hat{\theta} - \theta|$
0
10
20
30
40
50
60
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

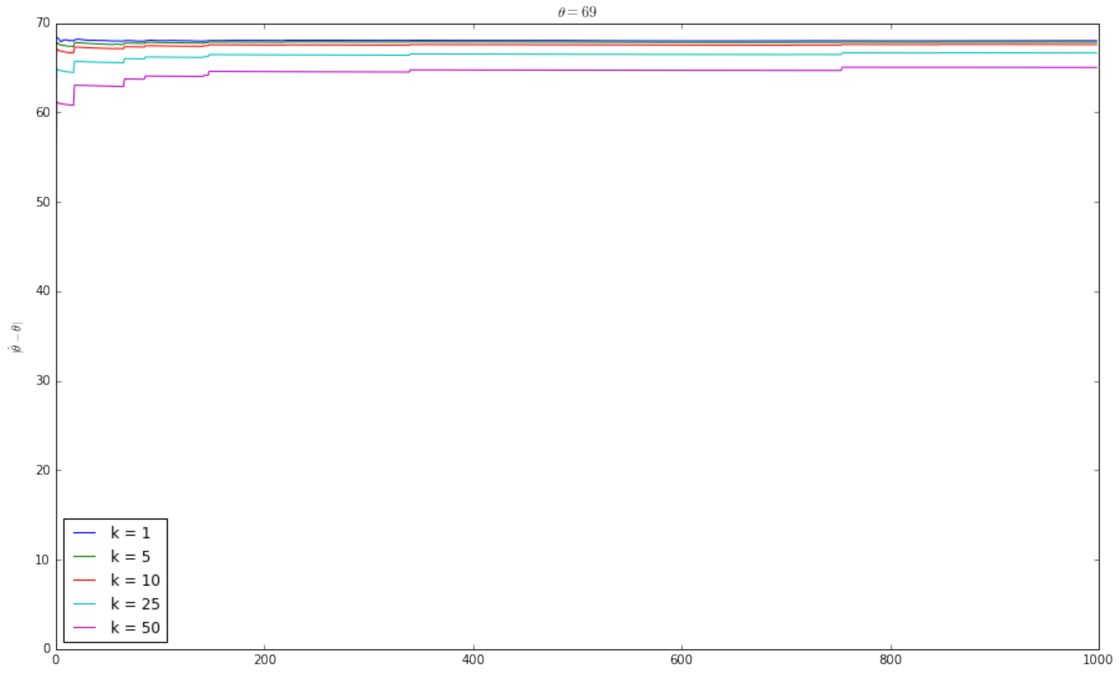

$\theta = 65$
$|\hat{\theta} - \theta|$
0
10
20
30
40
50
60
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 66$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
0
200
400
600
800
1000

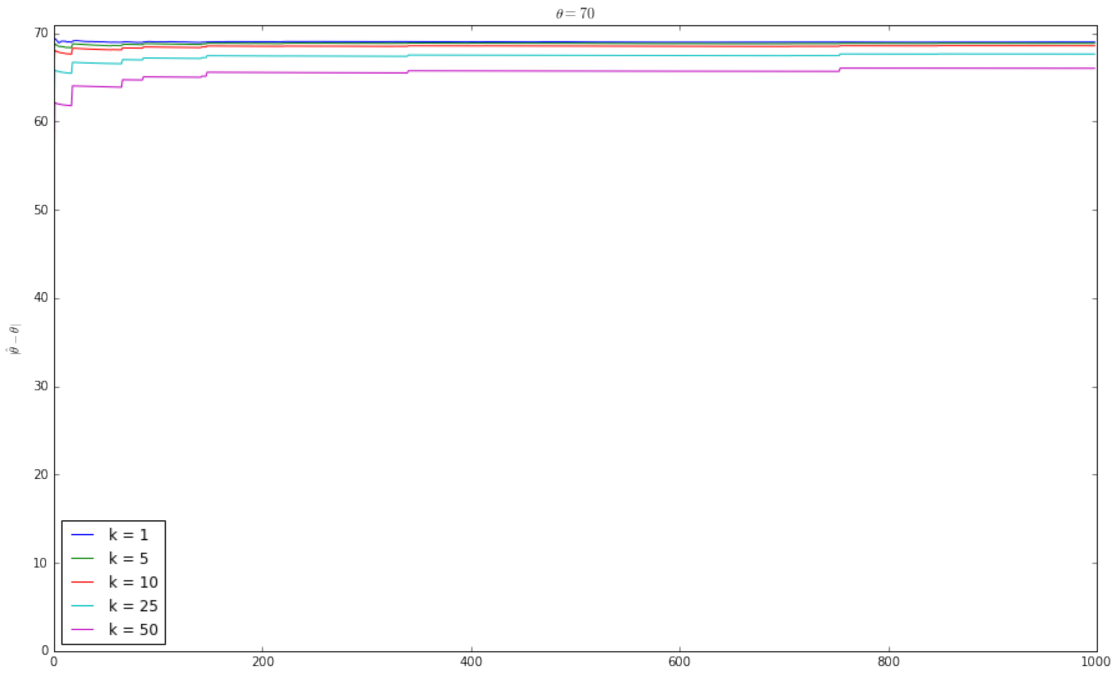

$\theta = 67$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
0
200
400
600
800
1000

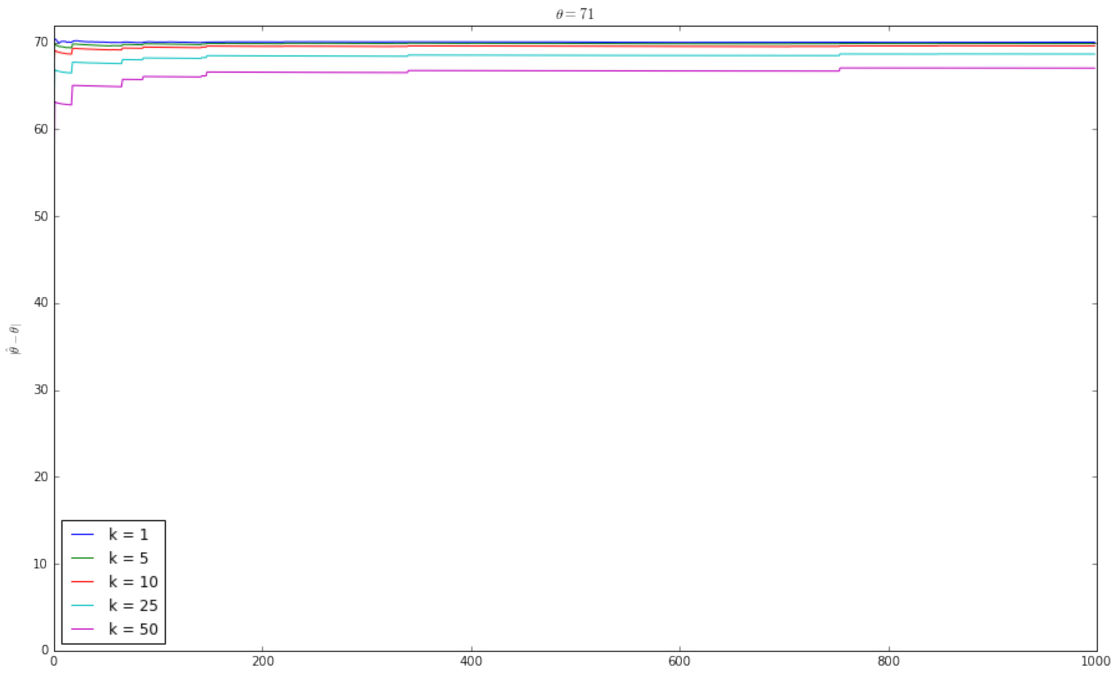


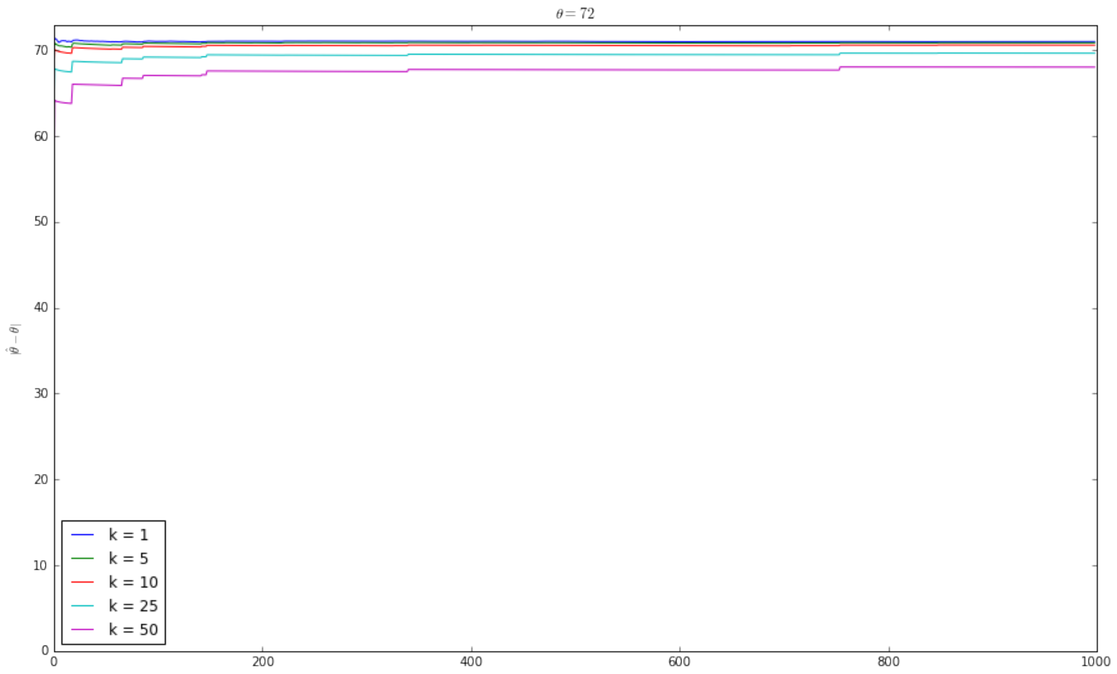
$\theta = 68$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

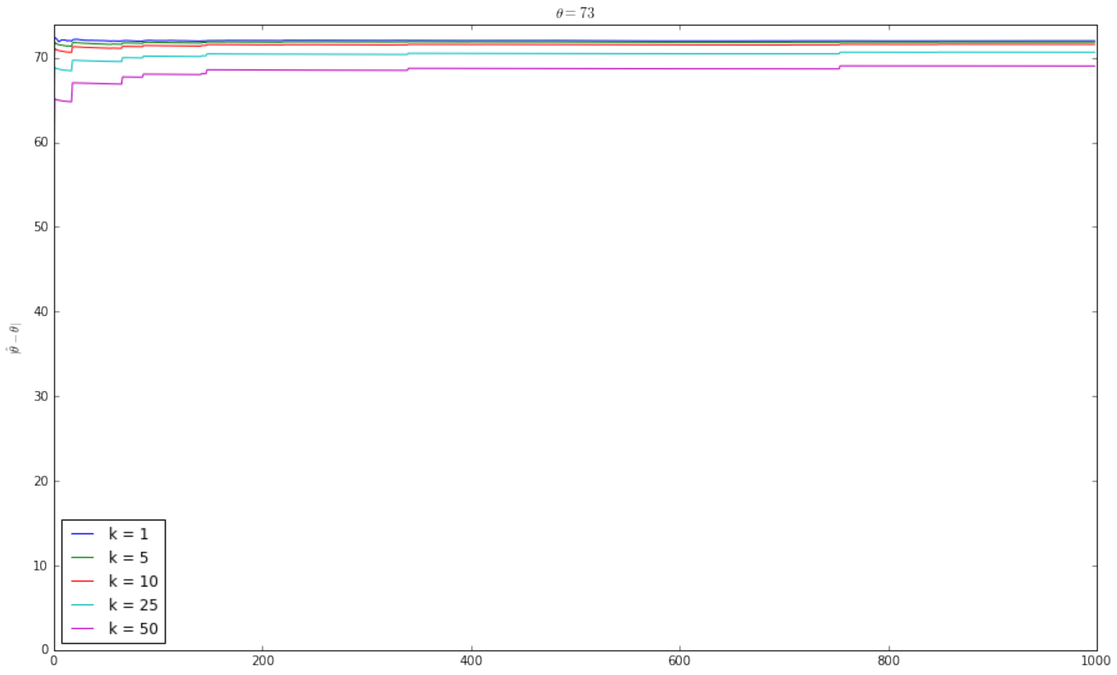


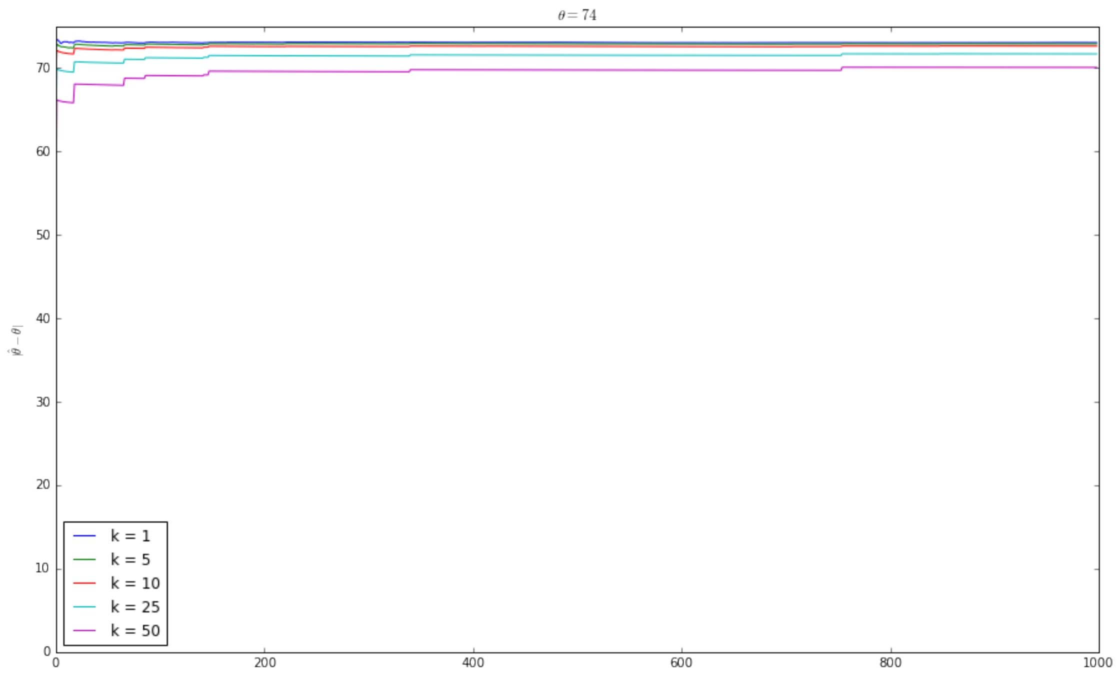
$\theta = 69$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

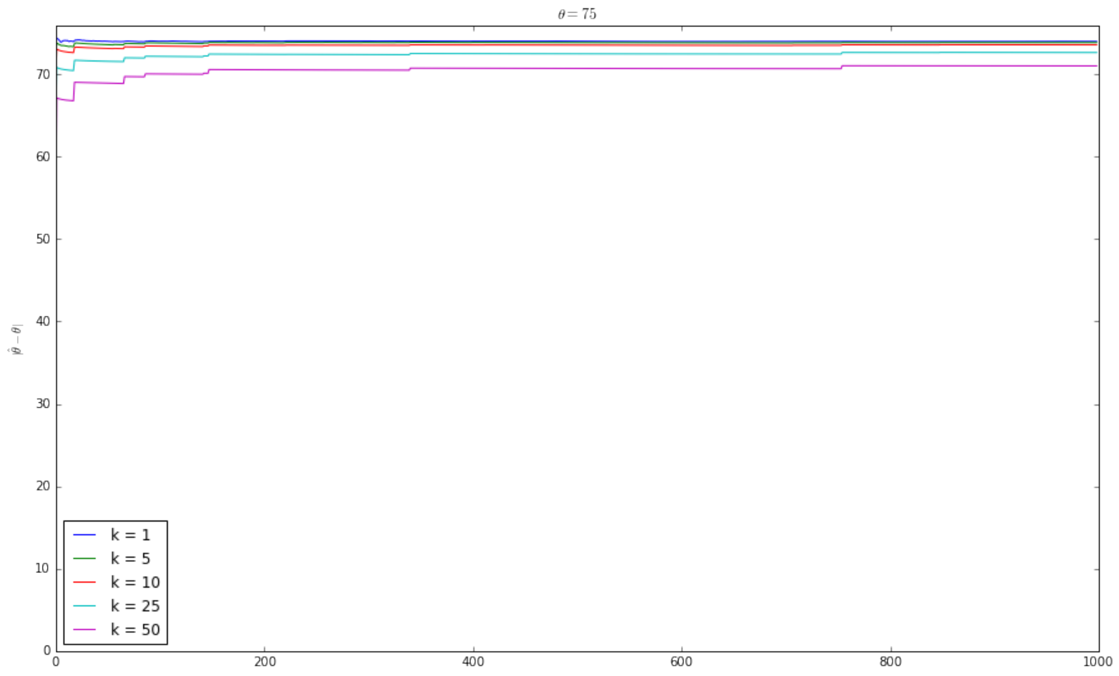

$\theta = 70$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

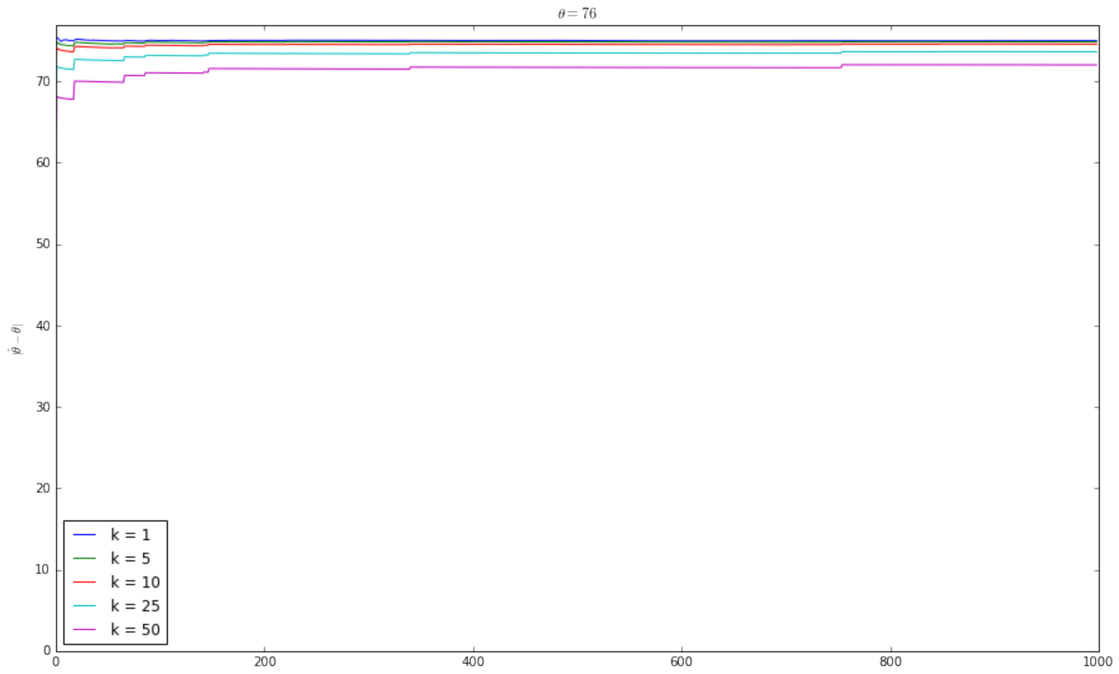

$\theta = 71$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 72$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

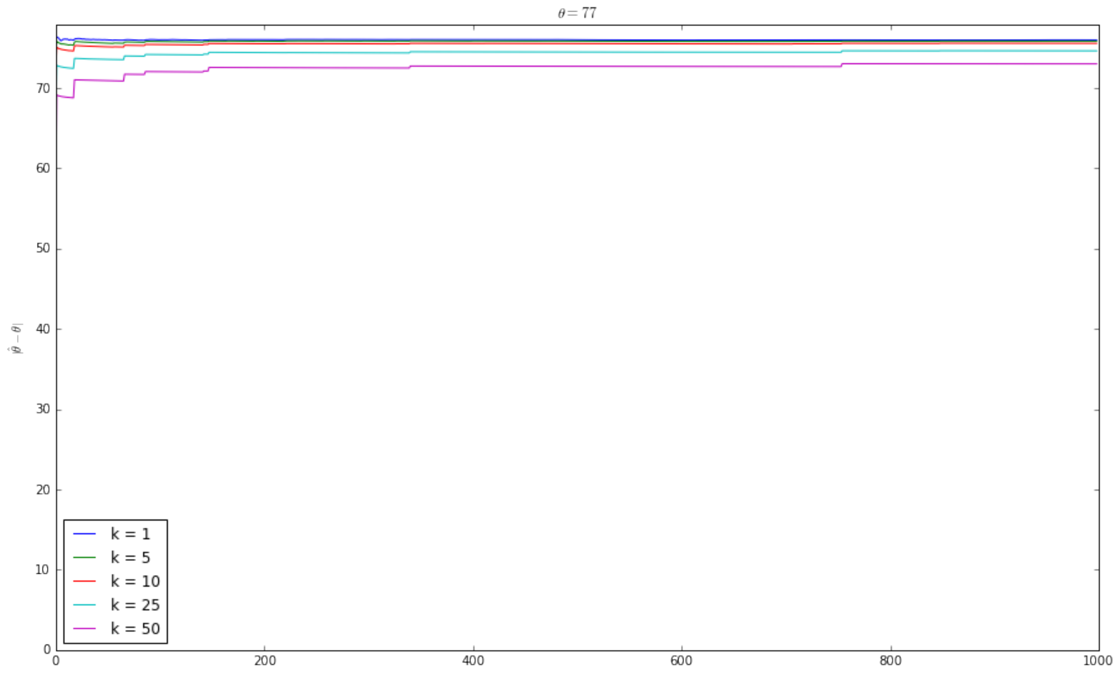

$\theta = 73$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 74$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

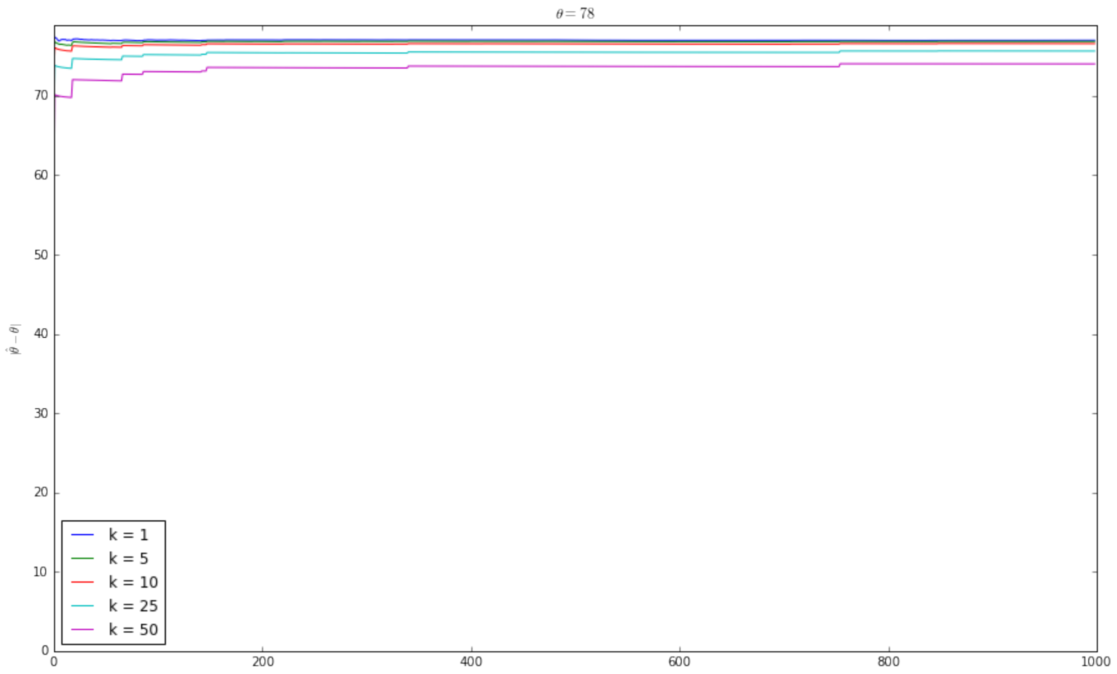

$\theta = 75$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

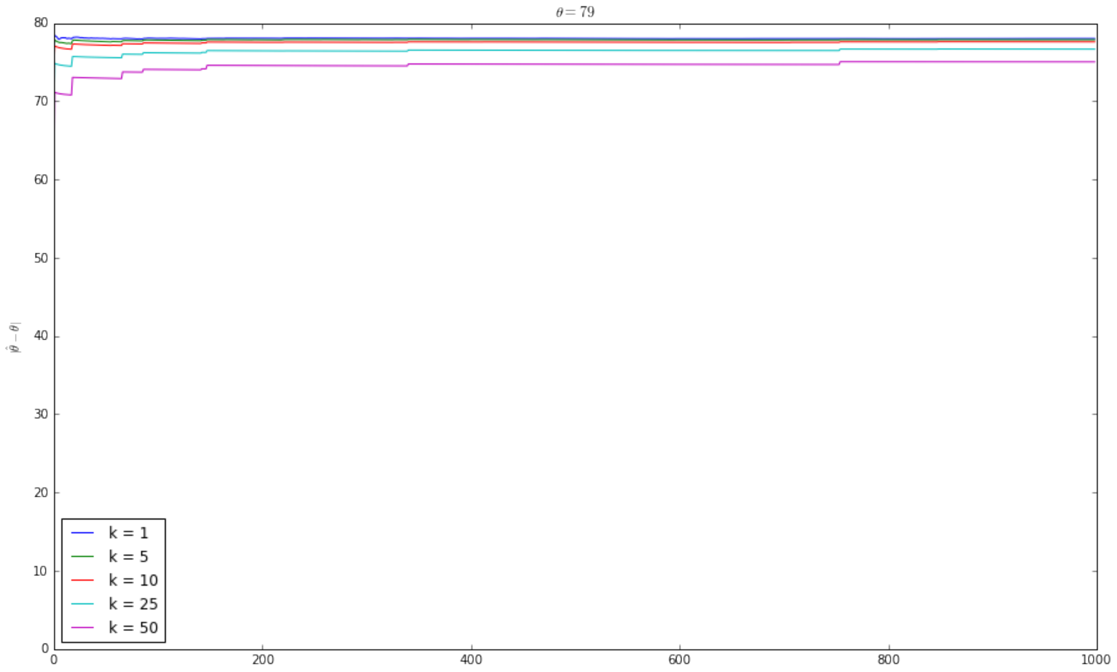


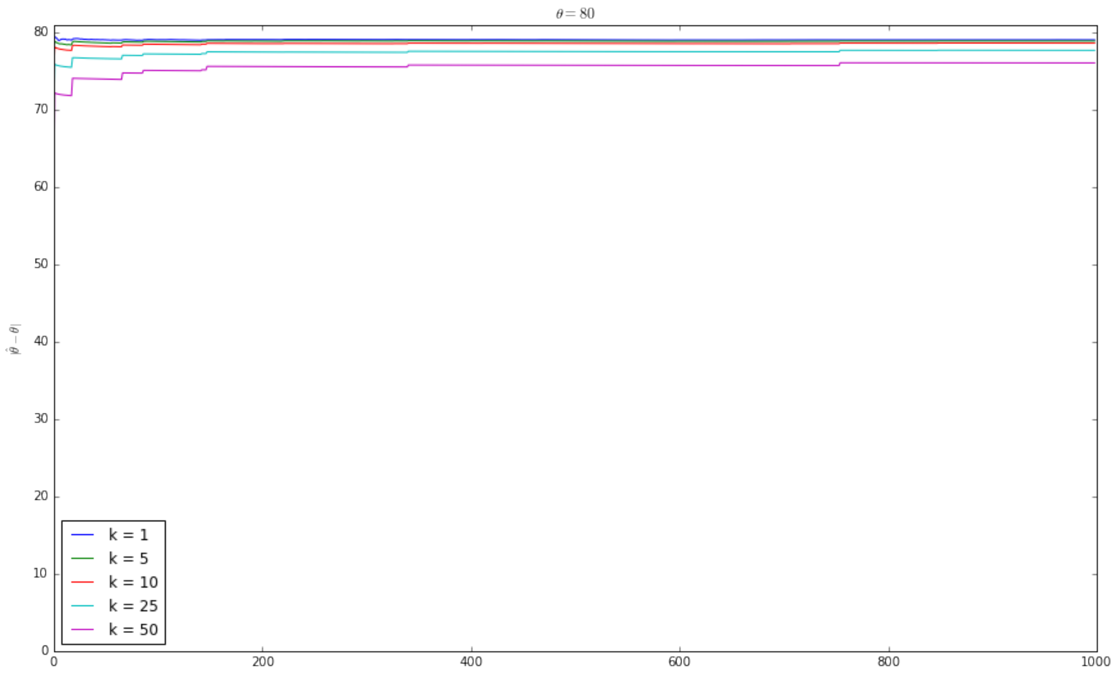
$\theta = 76$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



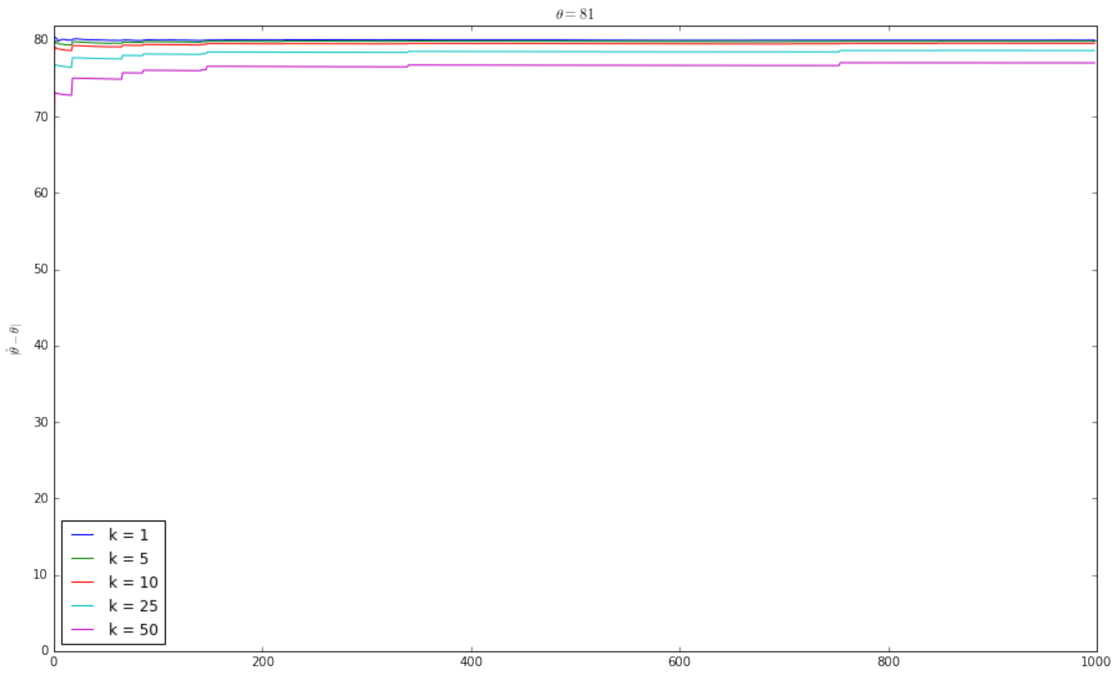
$\theta = 77$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 78$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

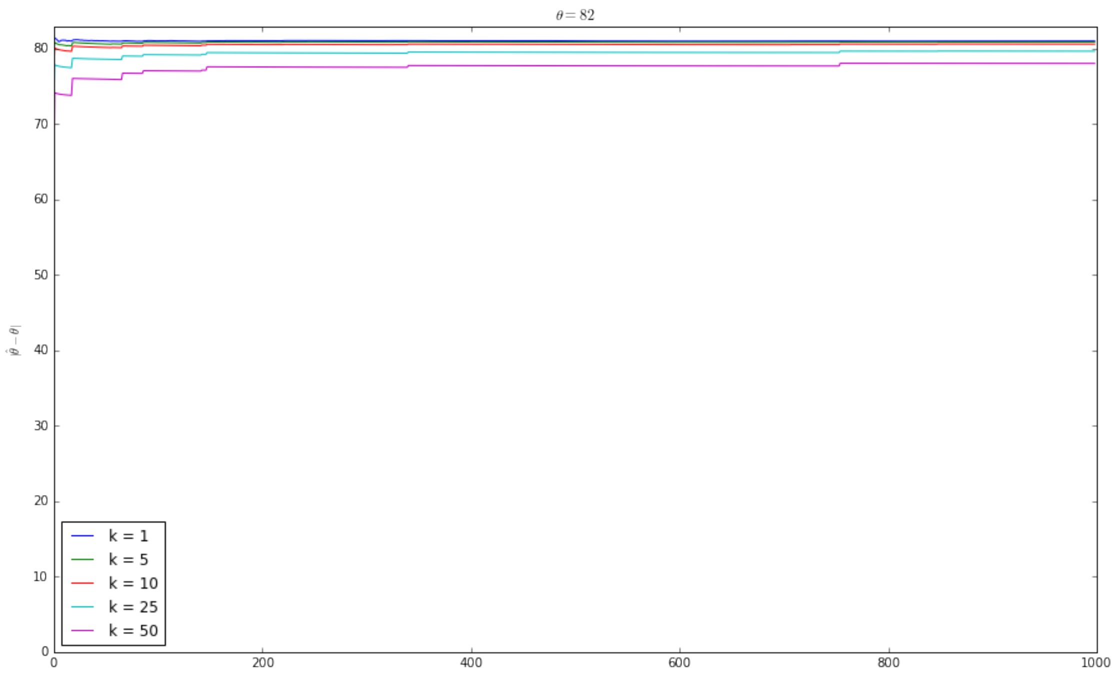

$\theta = 79$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

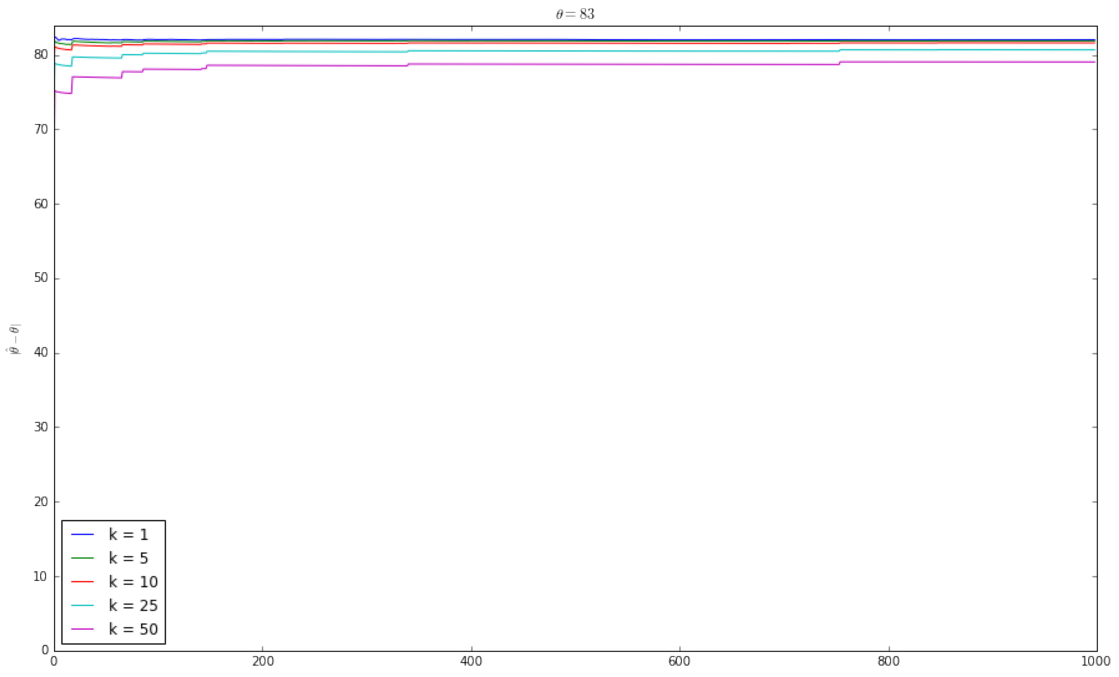


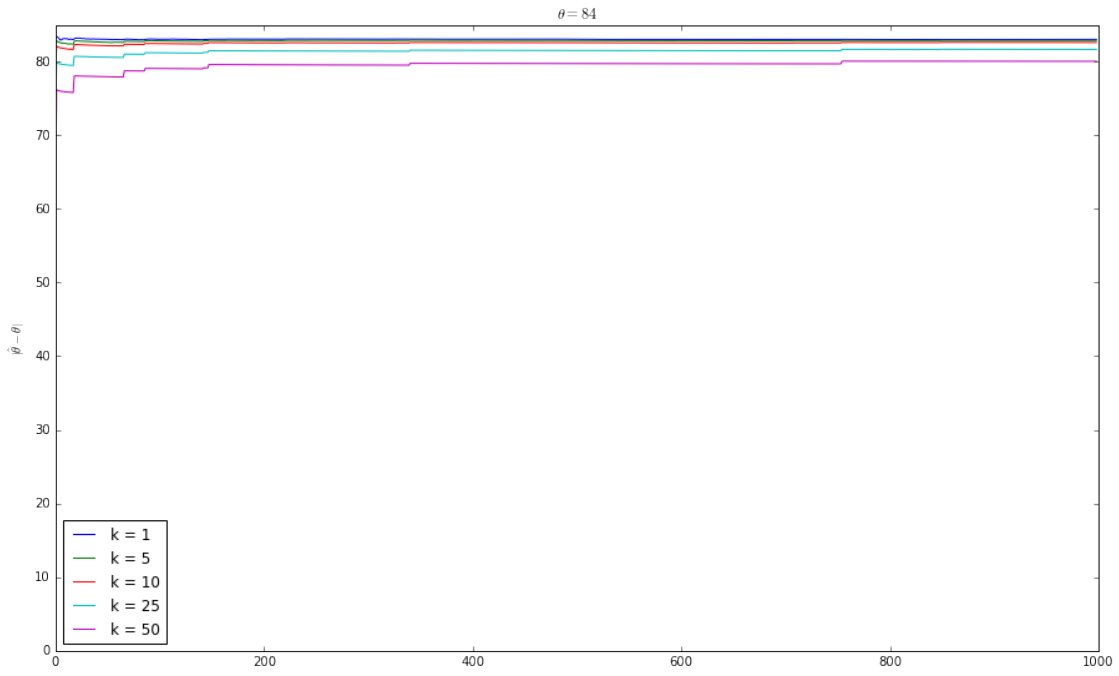
$\theta = 80$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
200
400
600
800
1000



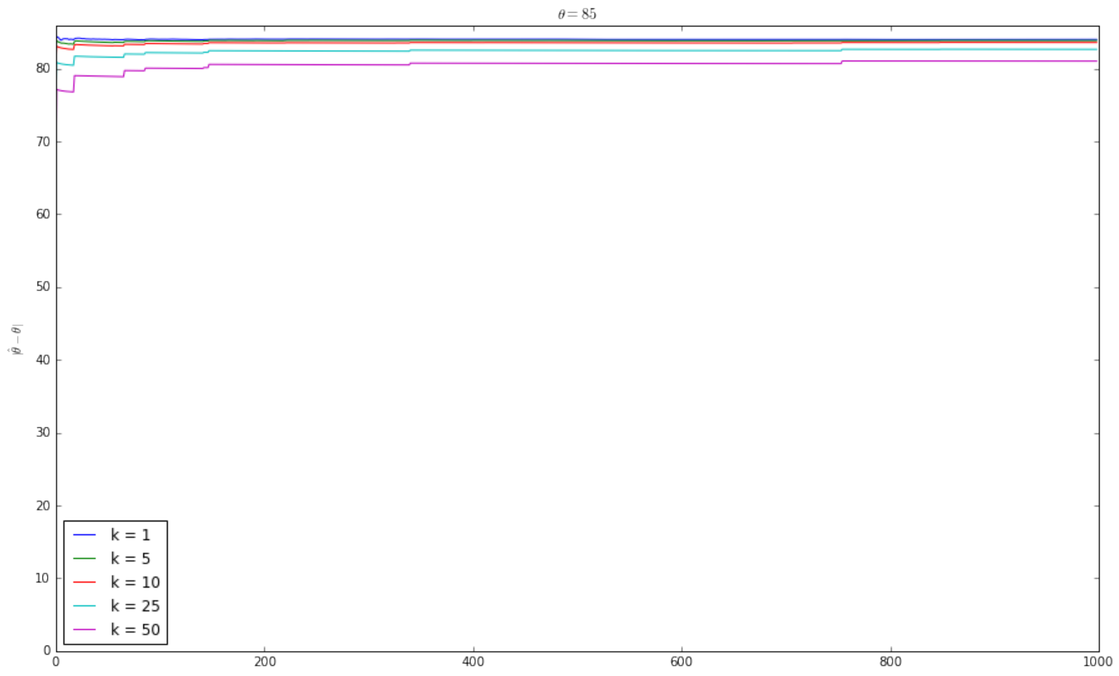
$\theta = 81$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
200
400
600
800
1000


$\theta = 82$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
0
200
400
600
800
1000

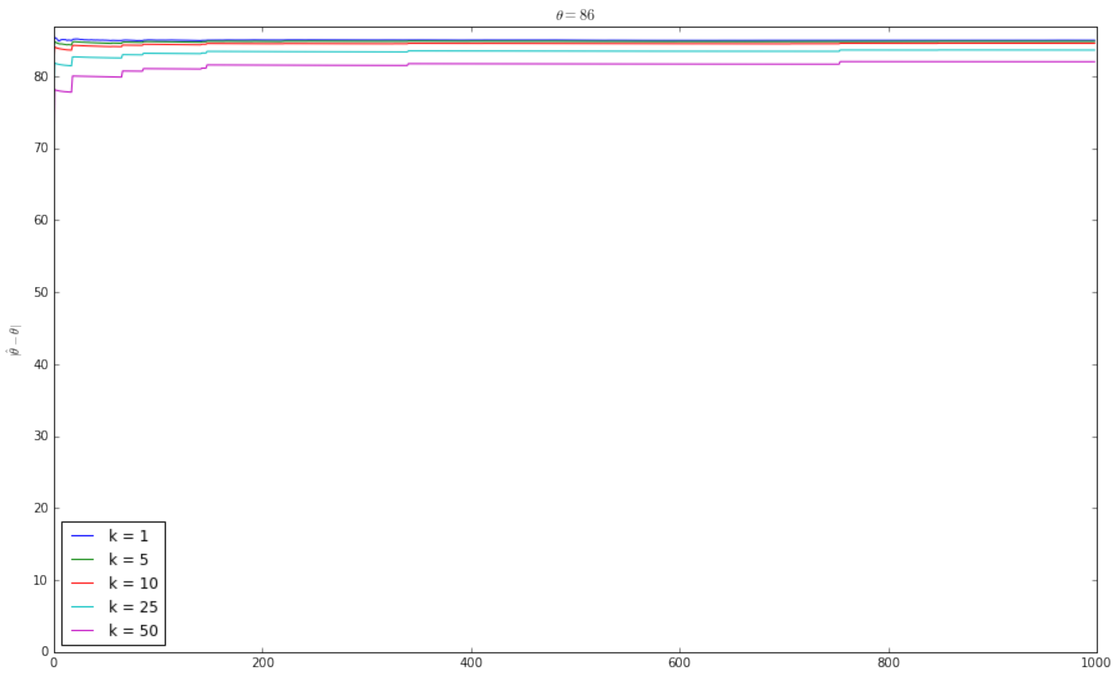

$\theta = 83$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
0
200
400
600
800
1000



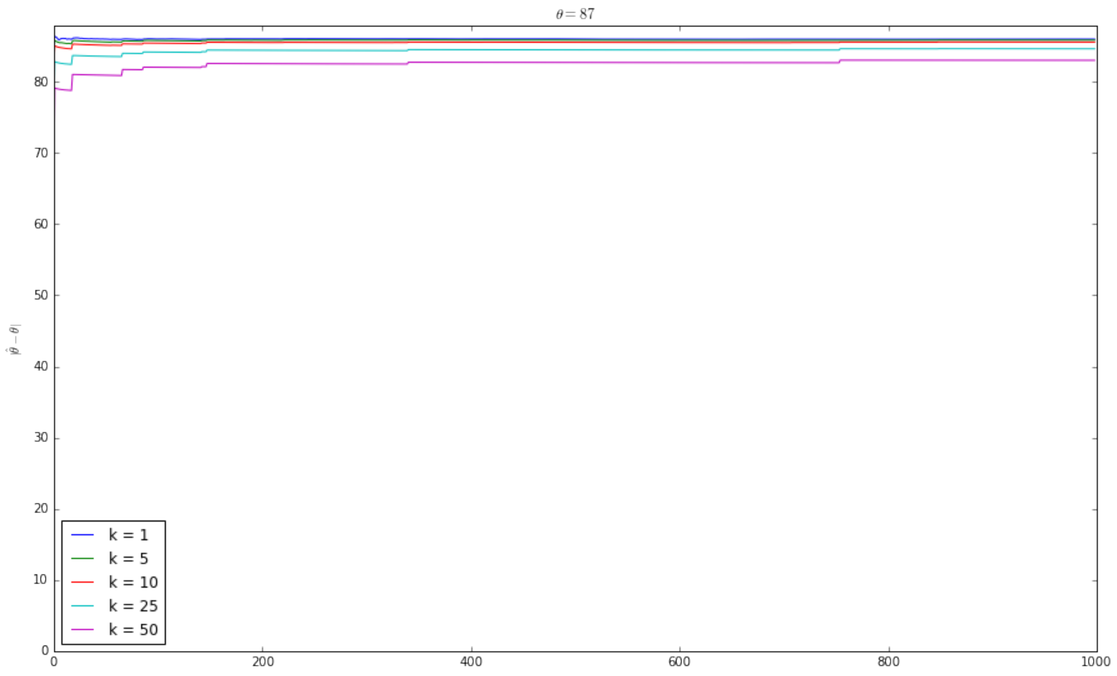
$\theta = 84$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
200
400
600
800
1000



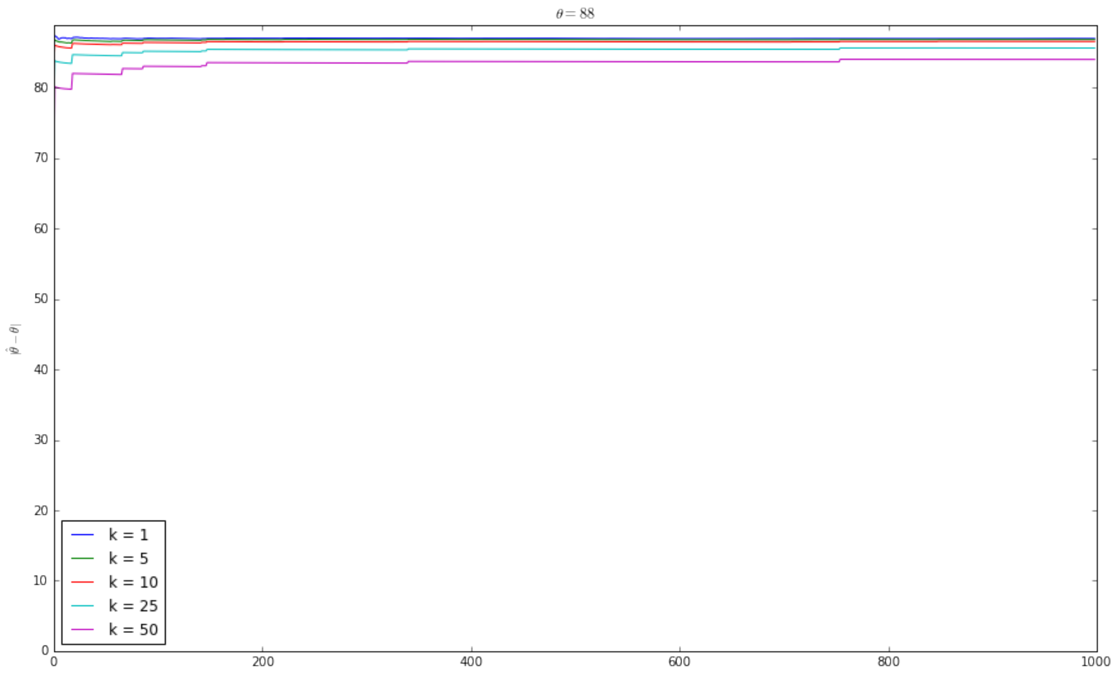
$\theta = 85$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
10
20
30
40
50
60
70
80
200
400
600
800
1000

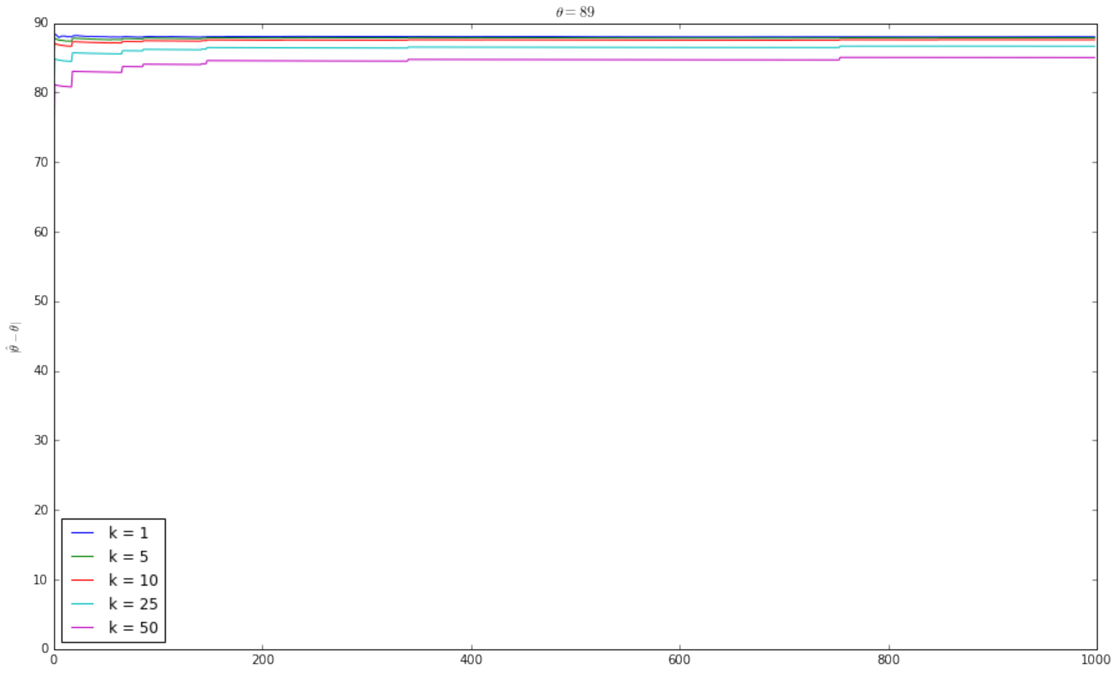


$\theta = 86$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

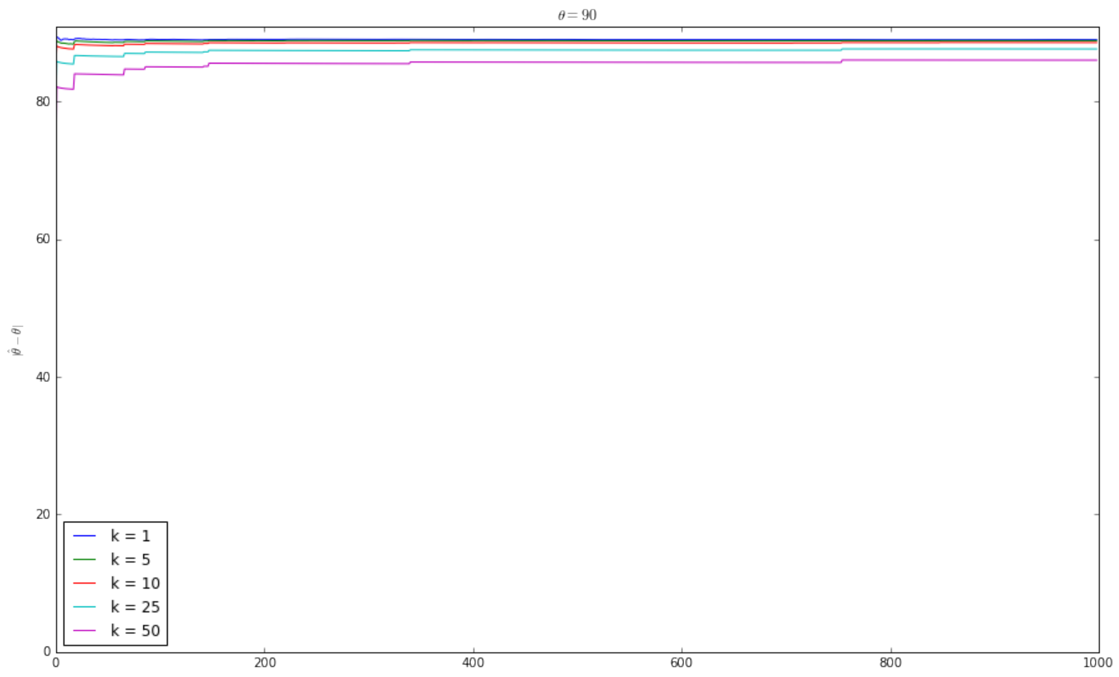


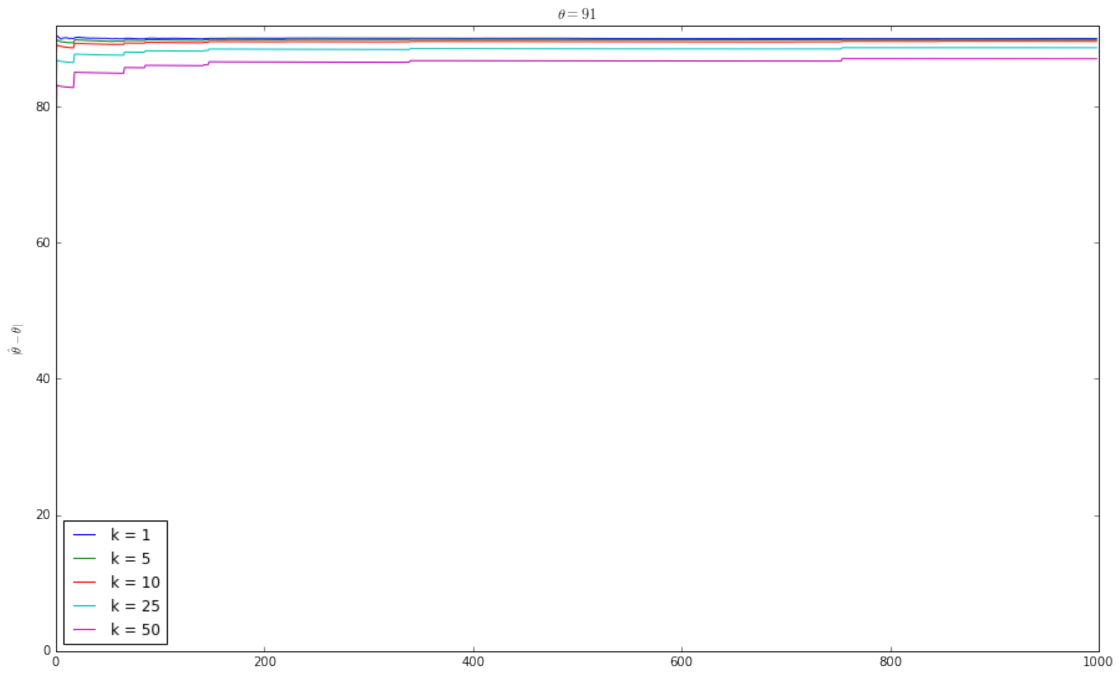
$\theta = 87$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

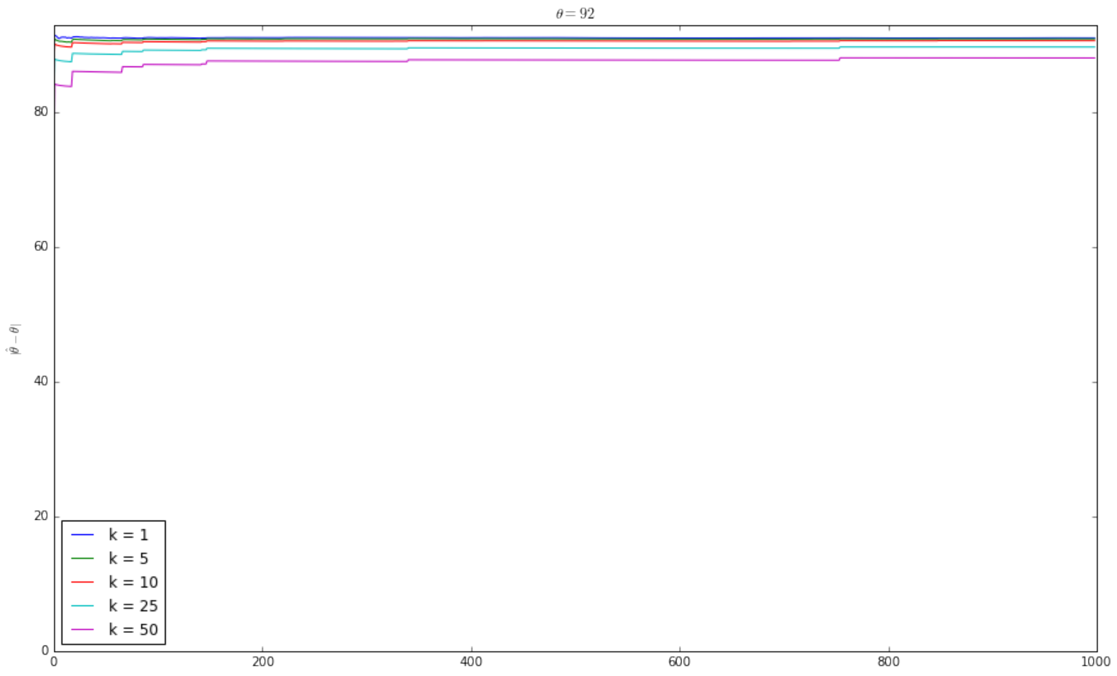




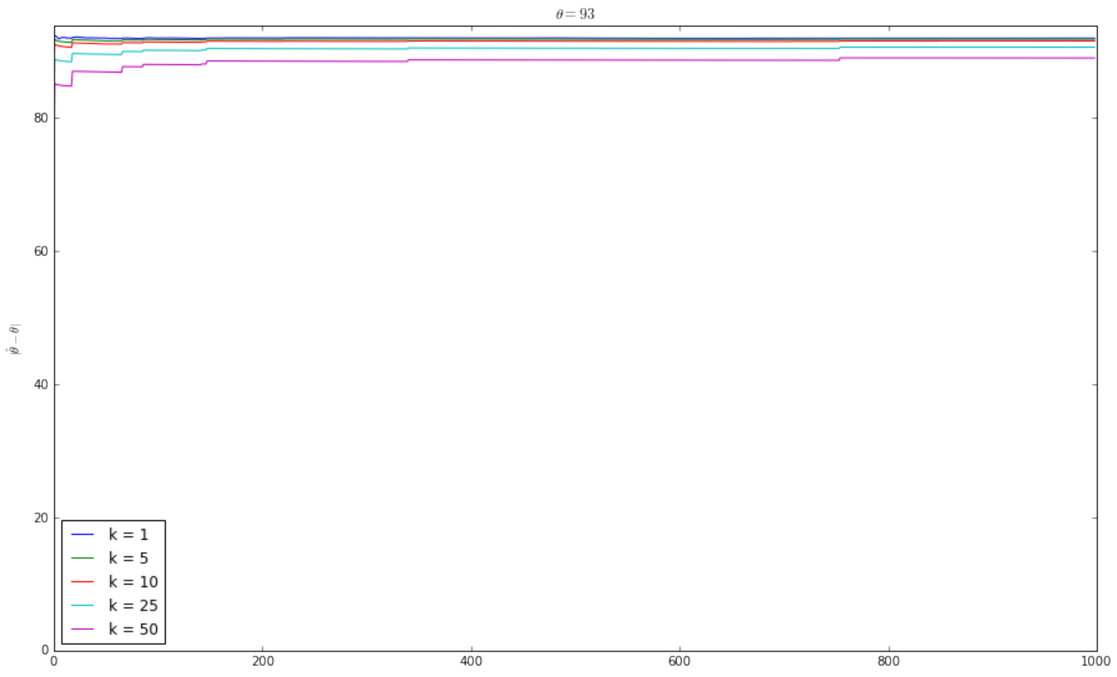
```
In [56]: for th in range(90, 120):
             drawPlot([1, 5, 10, 25, 50], th, ymin = 0, ymax = th + 1)
```


$\theta = 90$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
200
400
600
800
1000

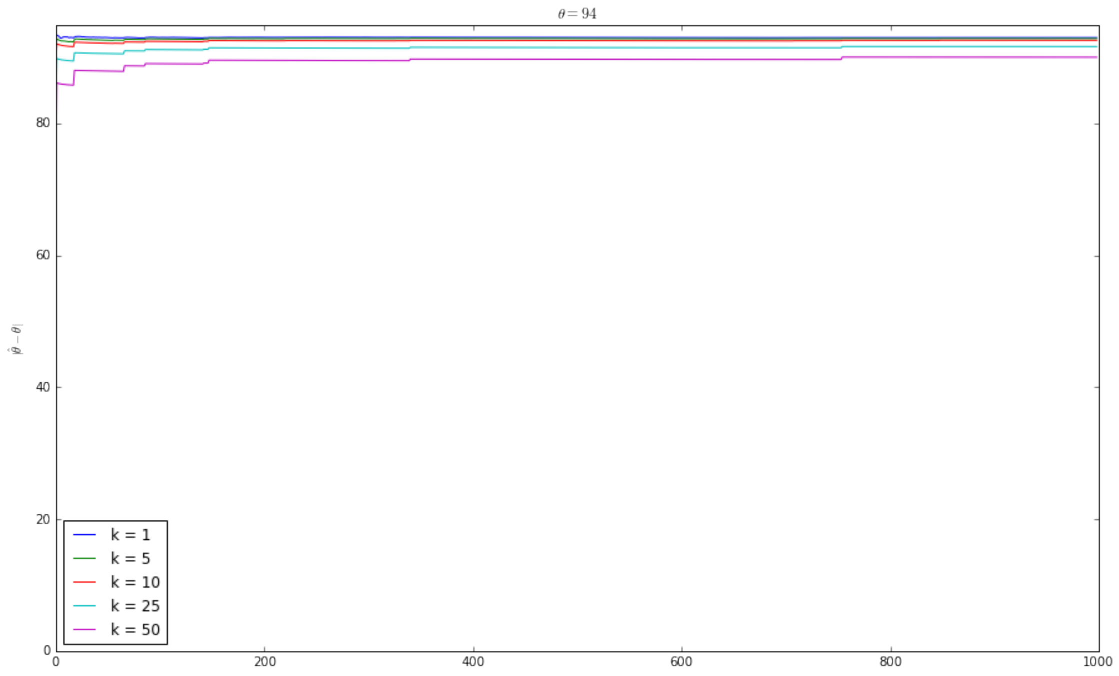

$\theta = 91$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
200
400
600
800
1000



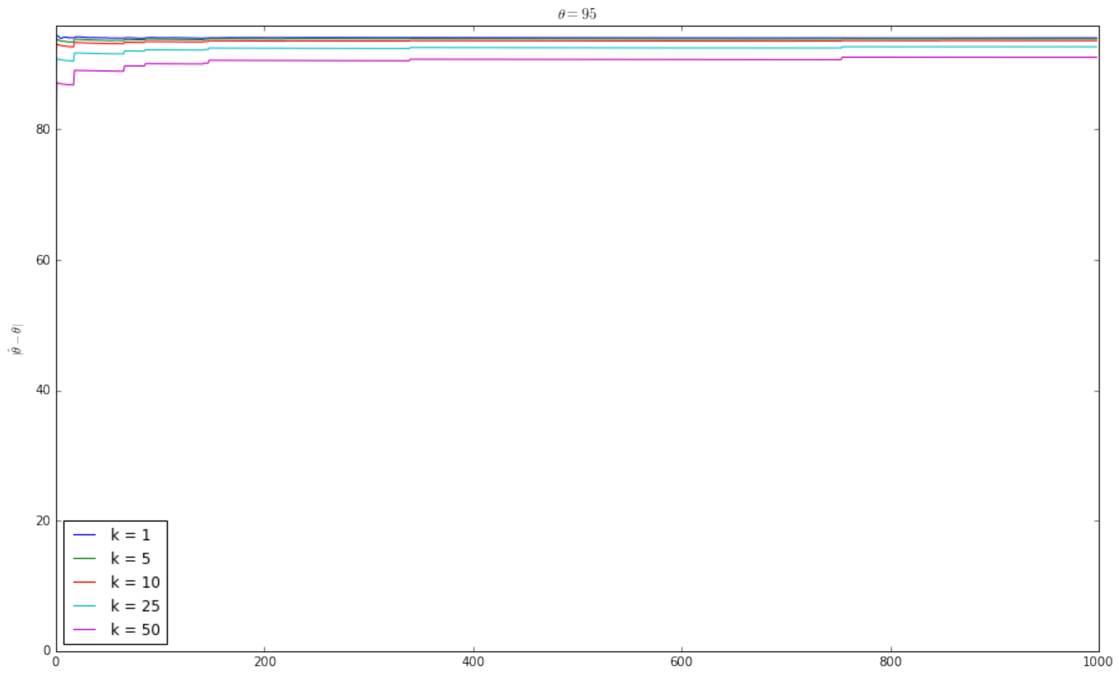
$\theta = 92$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



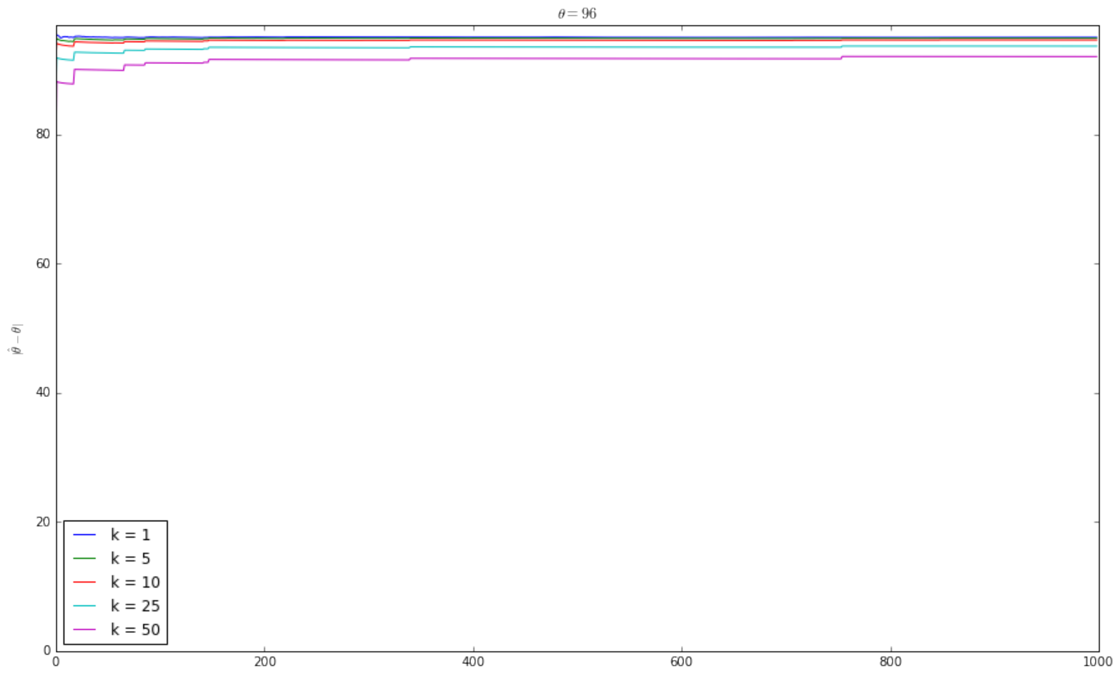
$\theta = 93$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

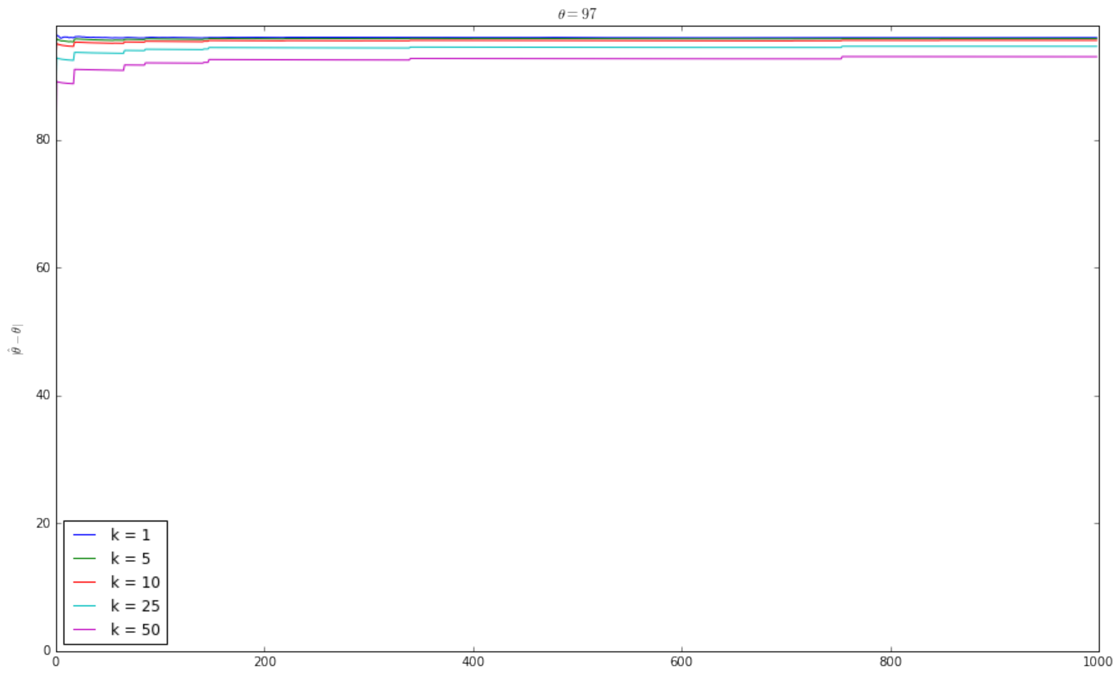


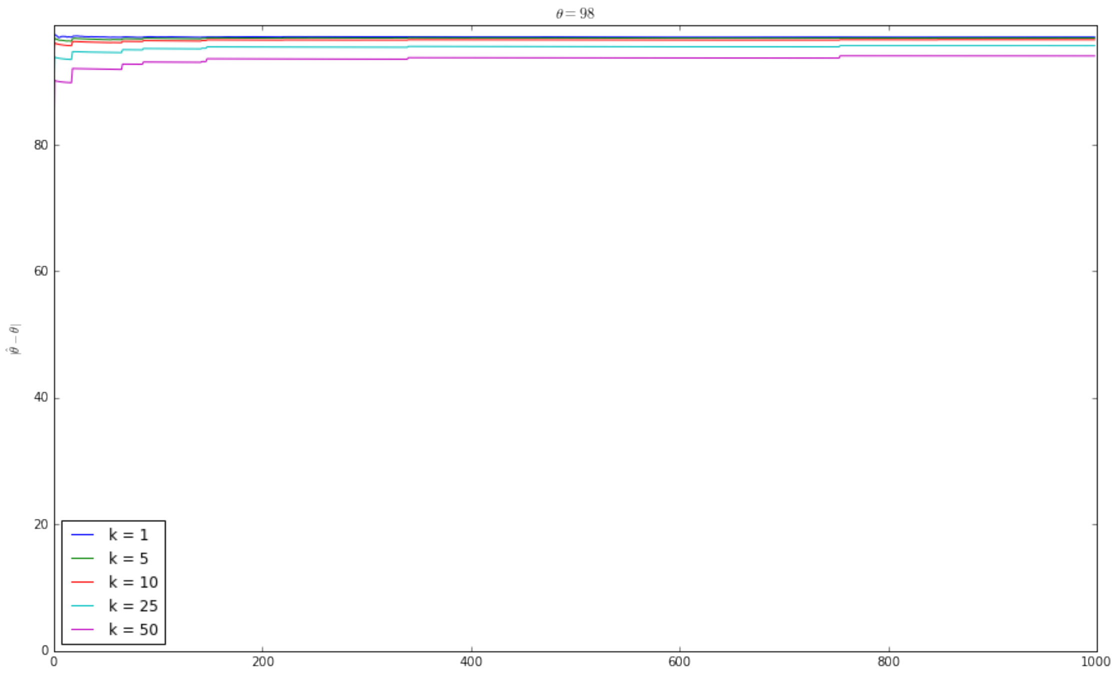
$\theta = 94$
$|\hat{\theta} - \theta|$
0
20
40
60
80
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50



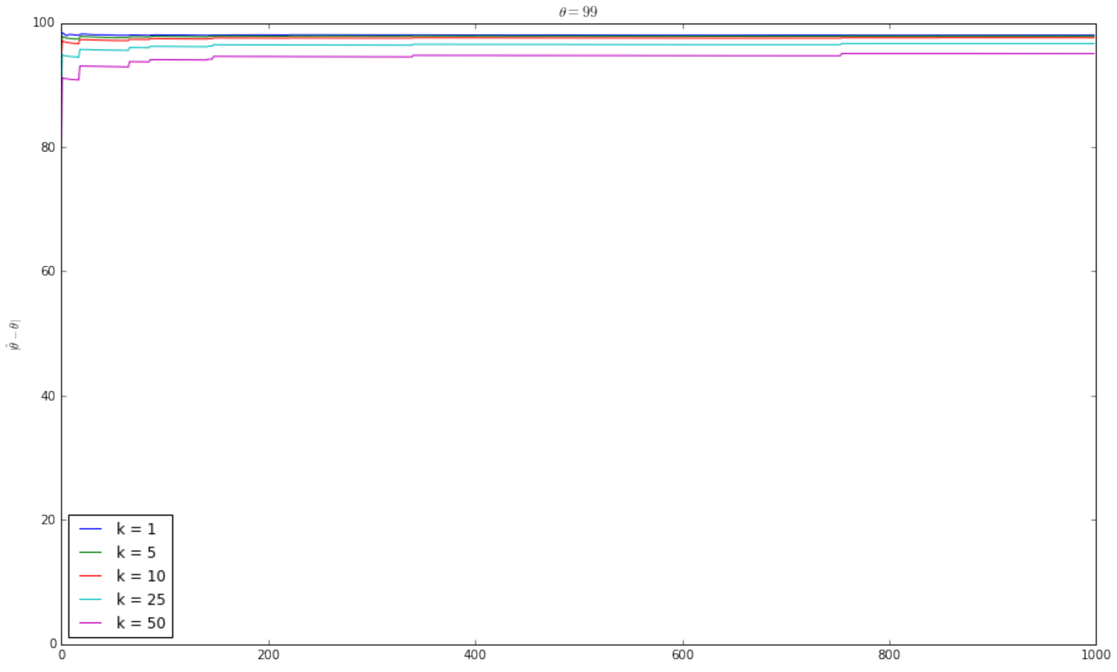
$\theta = 95$
$|\hat{\theta} - \theta|$
0
20
40
60
80
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 96$
$|\hat{\theta} - \theta|$
0
20
40
60
80
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

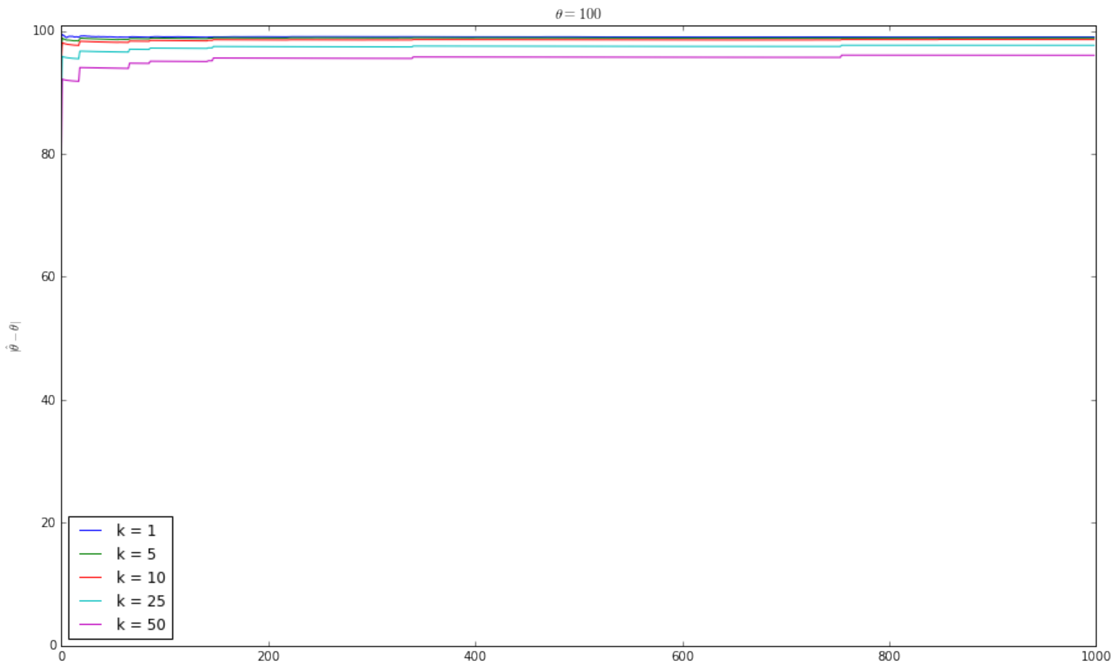

$\theta = 97$
$|\hat{\theta} - \theta|$
0
20
40
60
80
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50



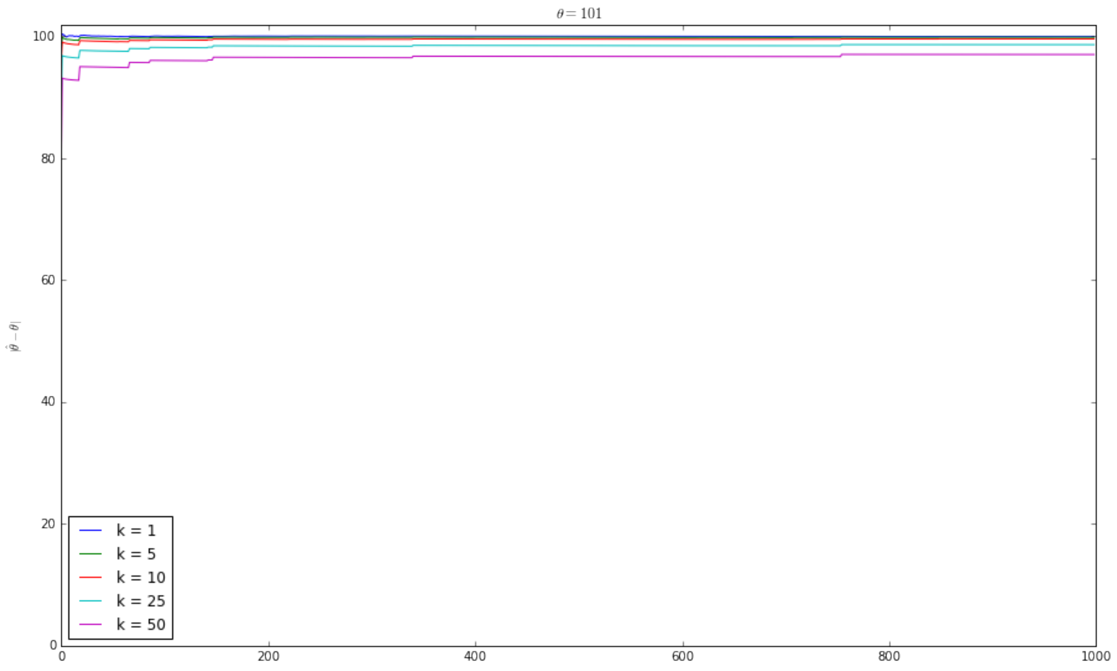
$\theta = 98$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



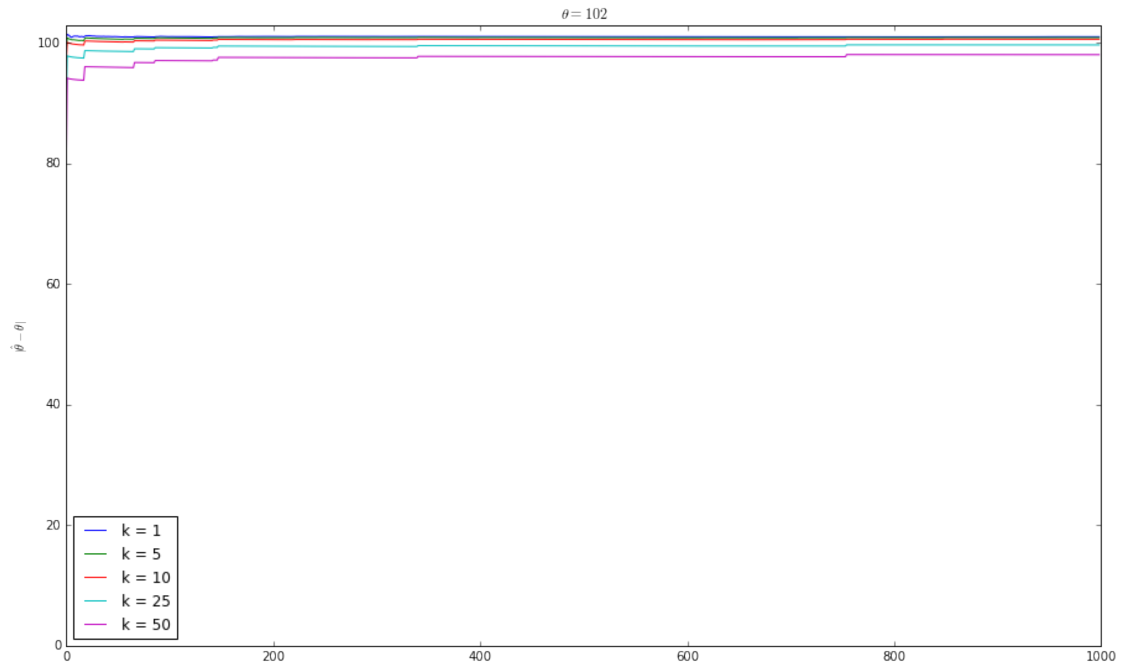
$\theta = 99$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

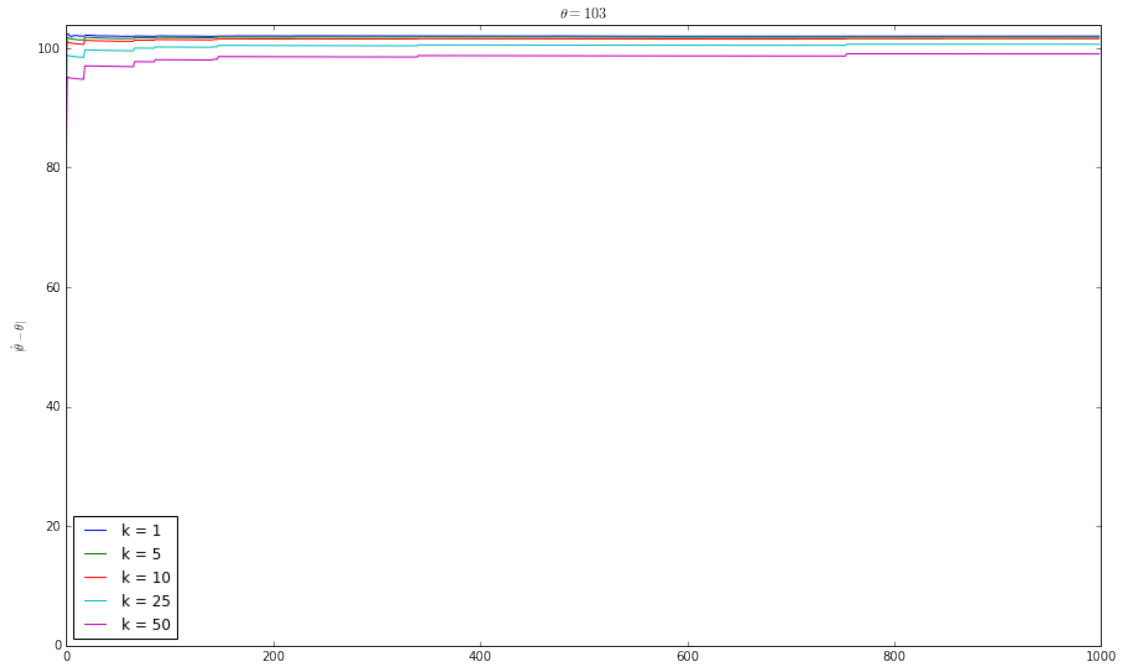


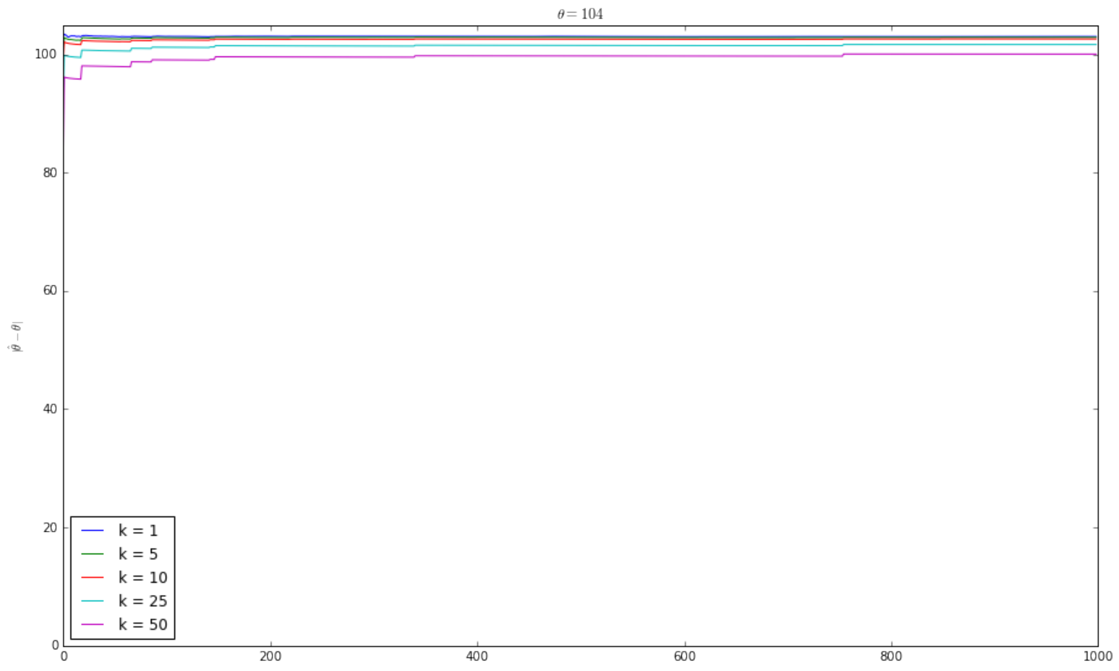
$\theta = 100$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000



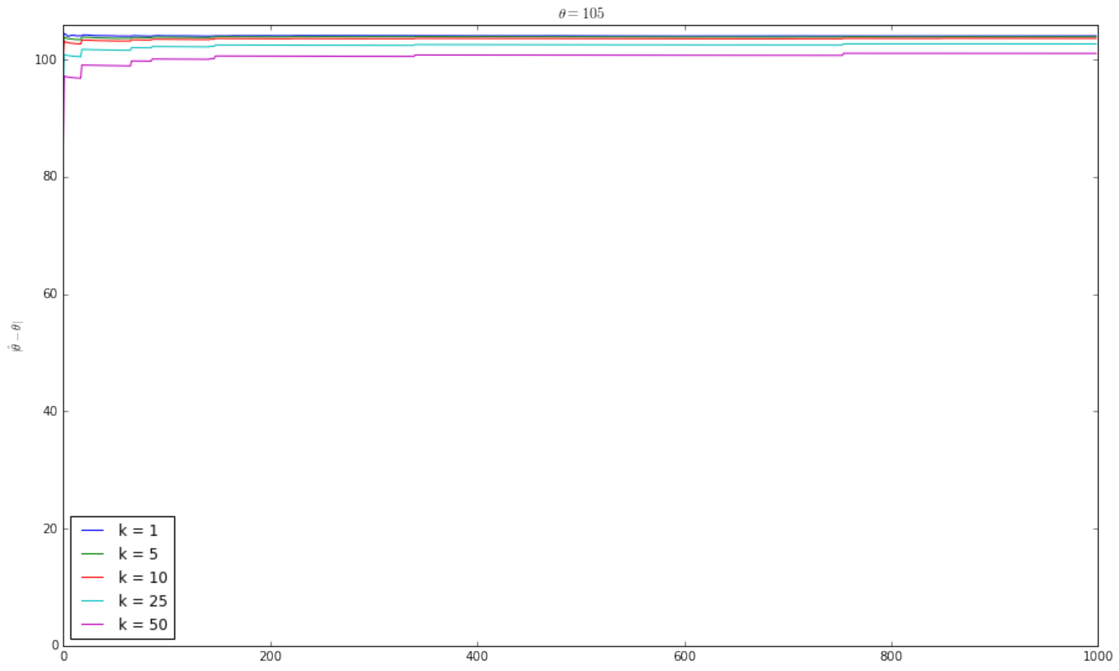
$\theta = 101$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000


$\theta = 102$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000

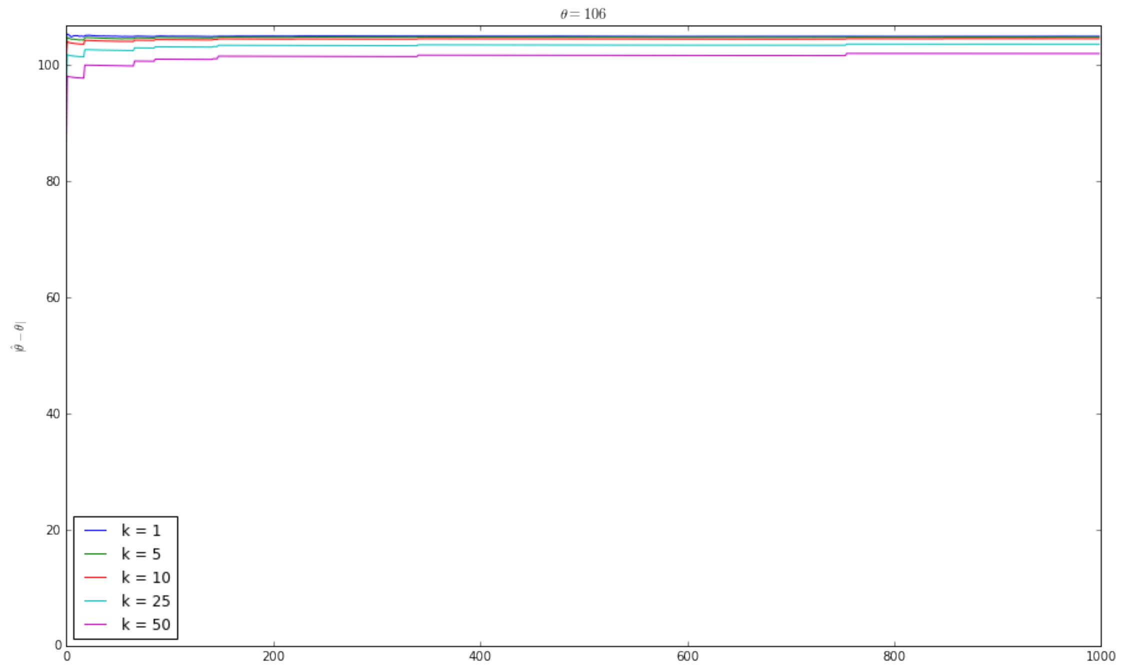

$\theta = 103$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000

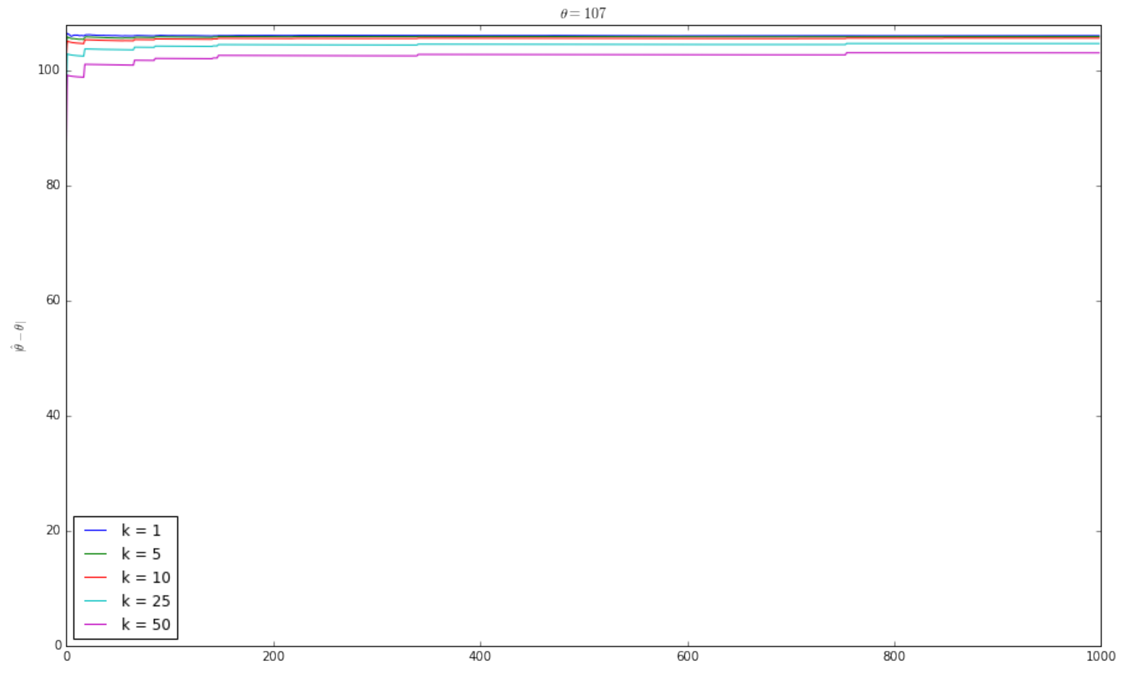


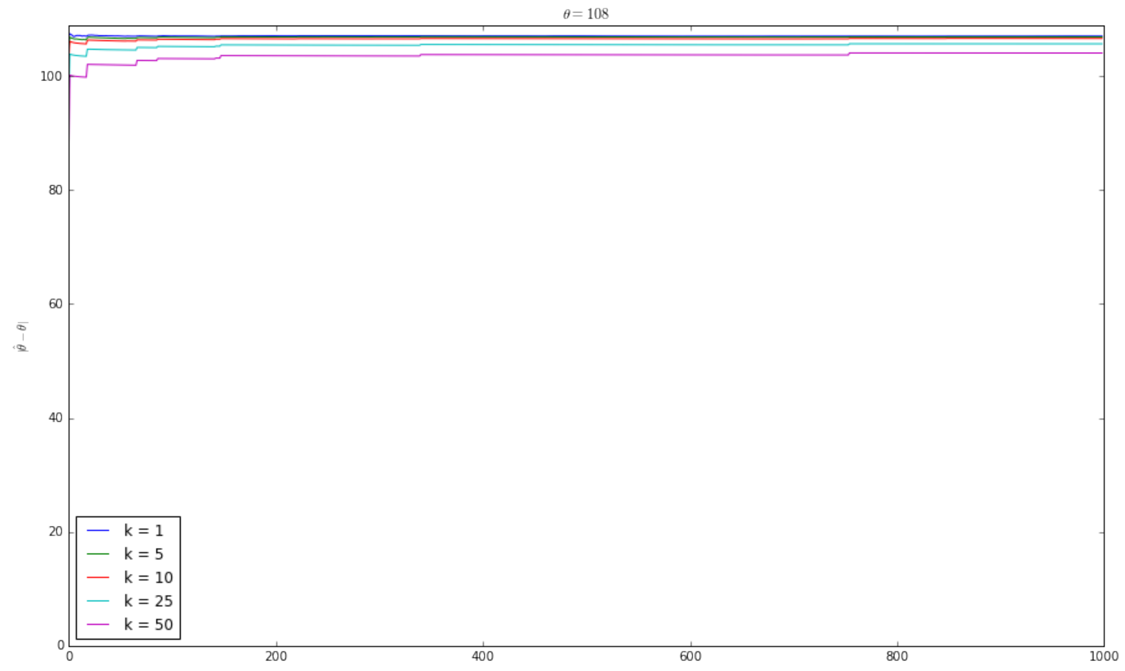
$\theta = 104$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



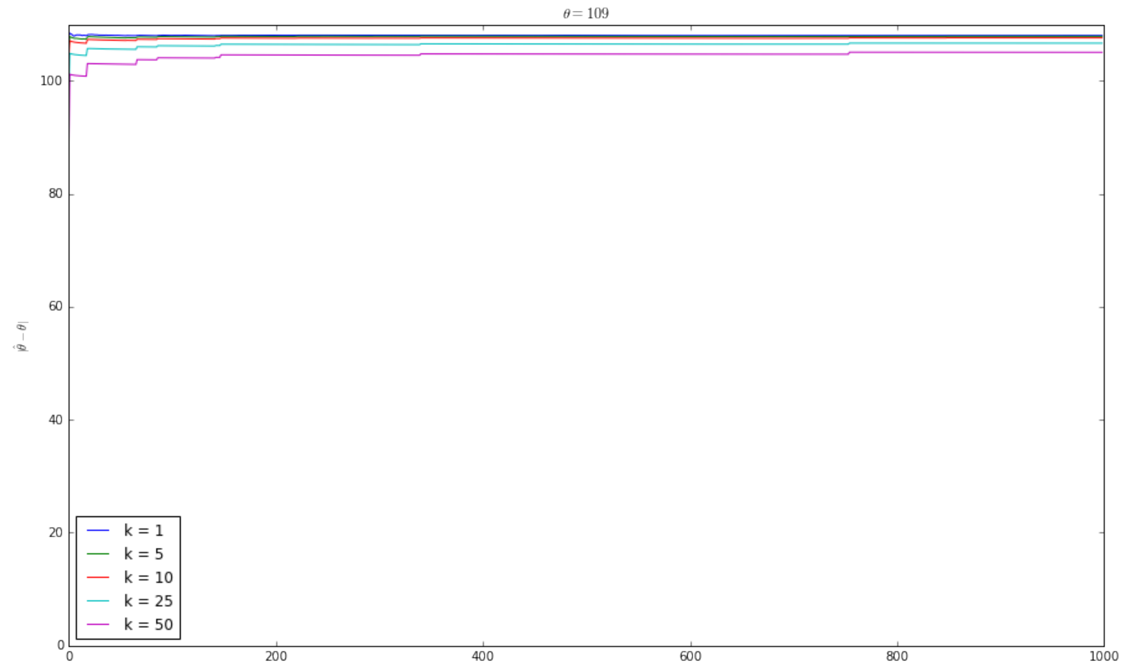
$\theta = 105$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 106$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
200
400
600
800
1000

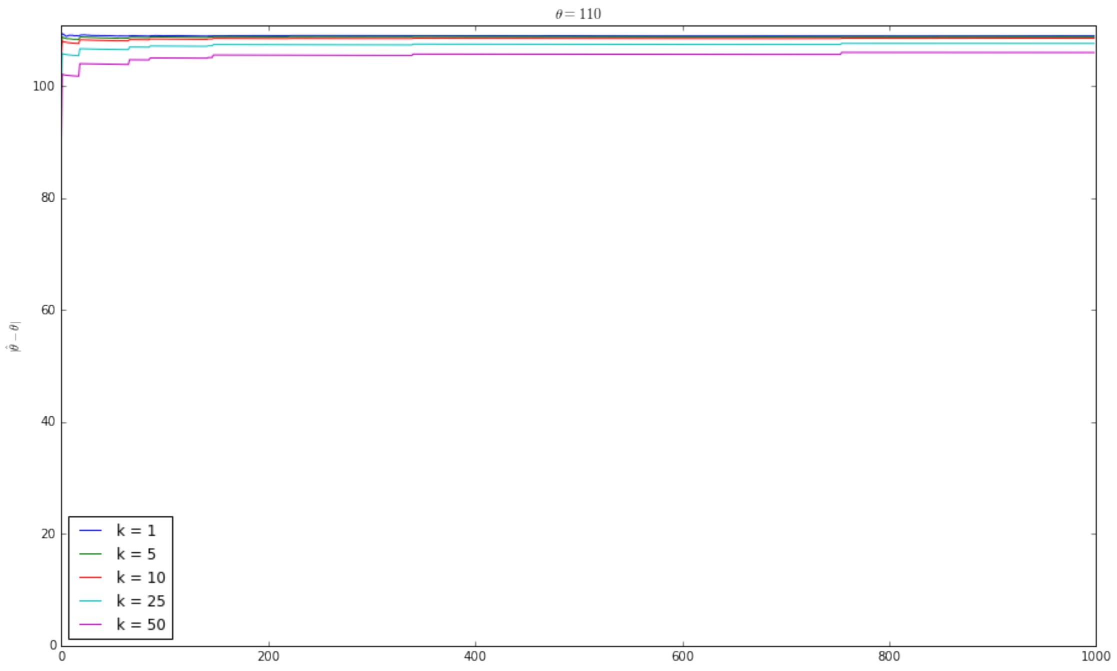

$\theta = 107$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
200
400
600
800
1000

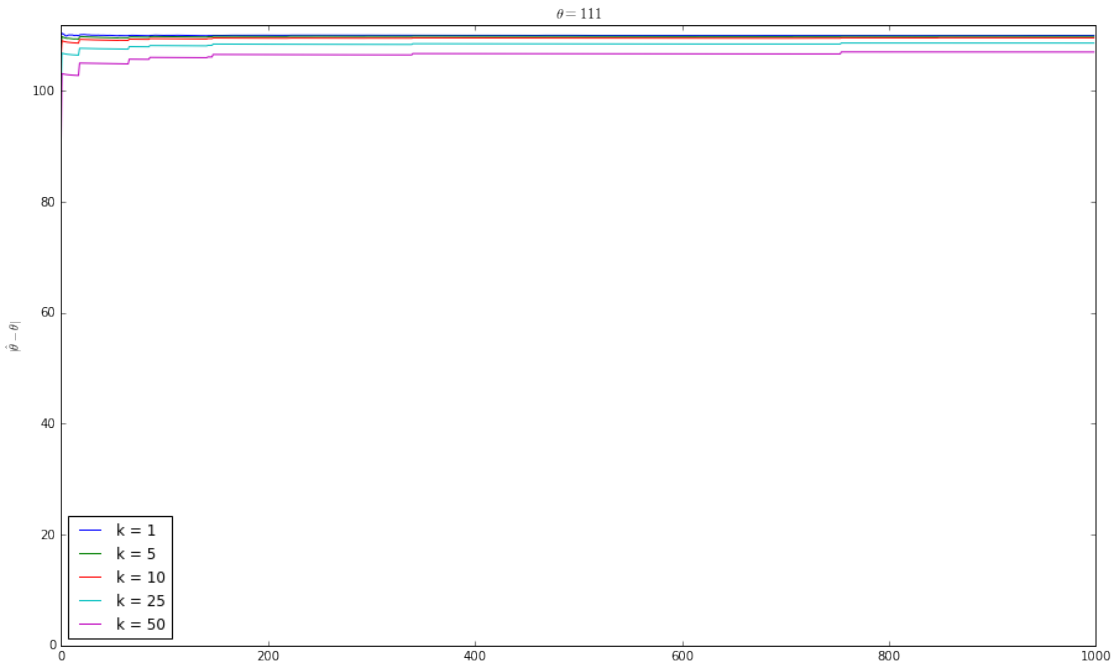


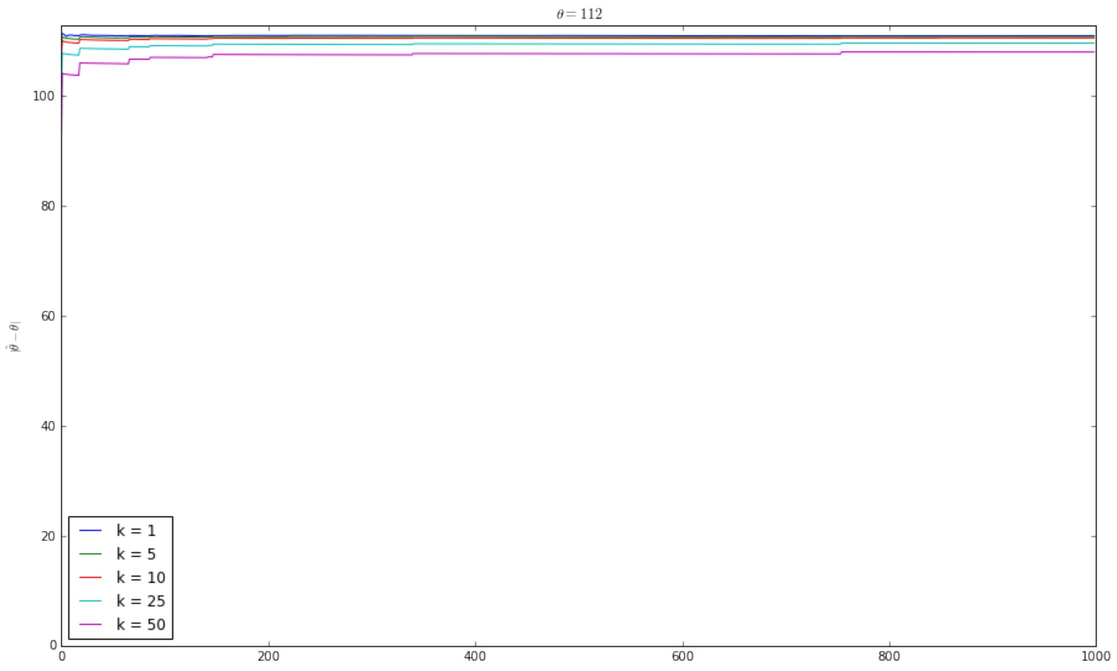
$\theta = 108$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

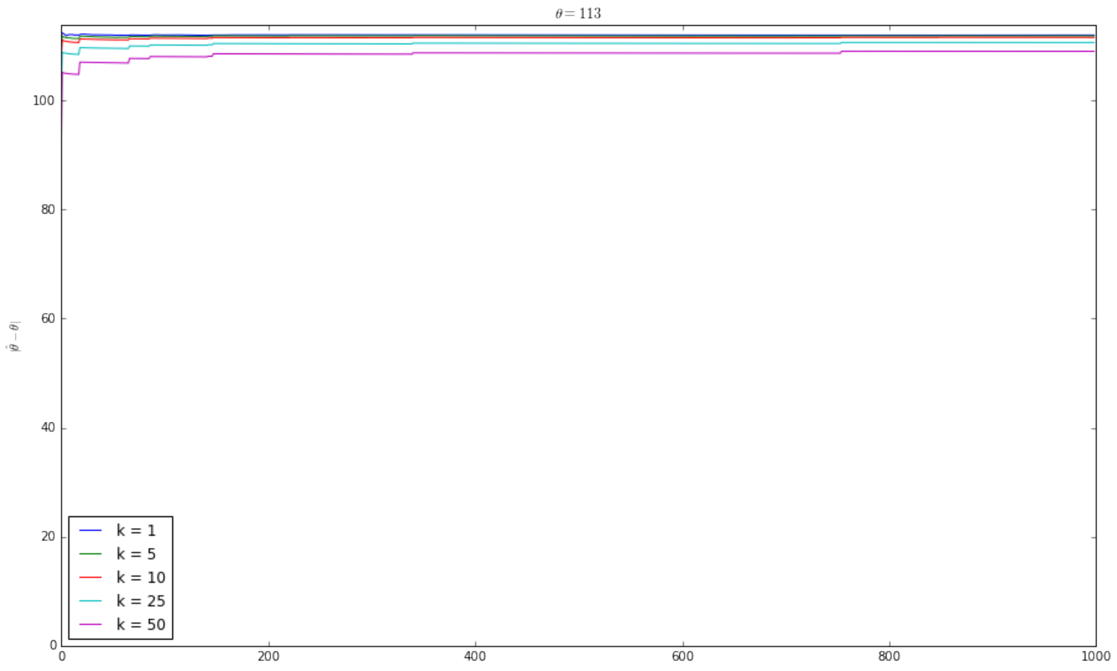


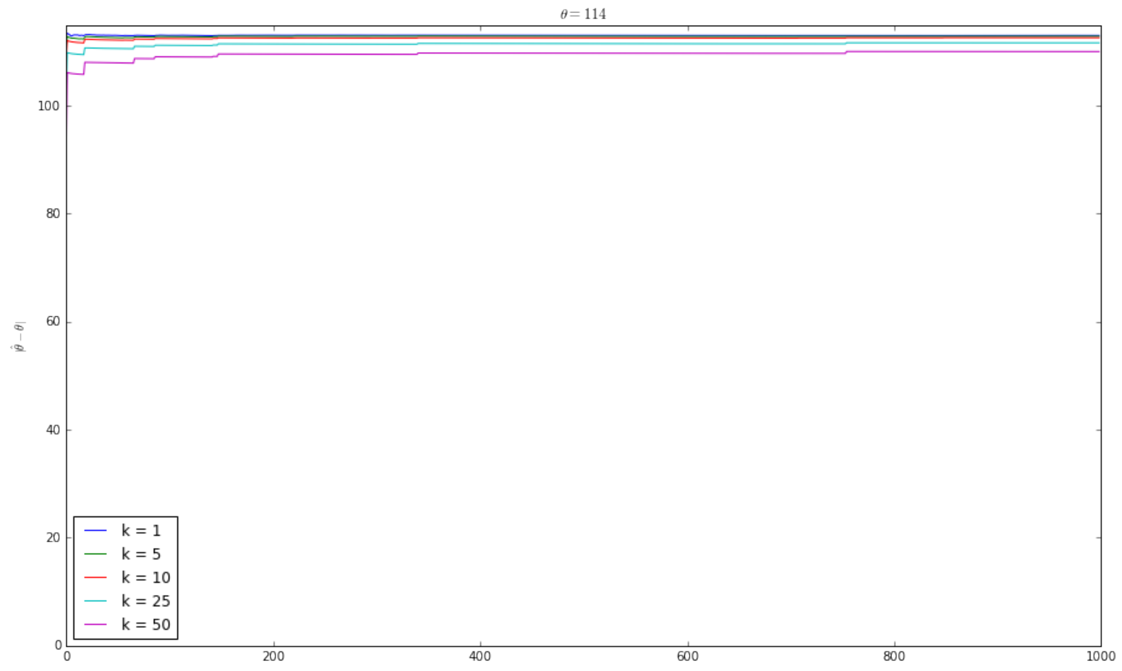
$\theta = 109$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

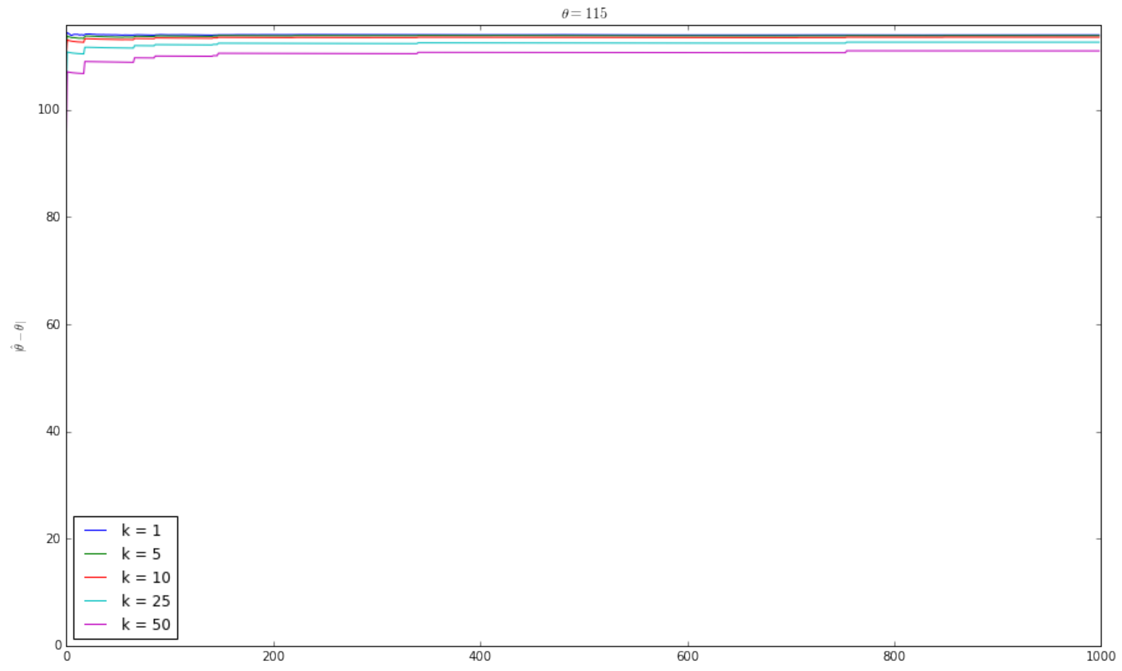

$\theta = 110$
$|\hat{\theta} - \theta|$
0
20
40
60
80
100
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

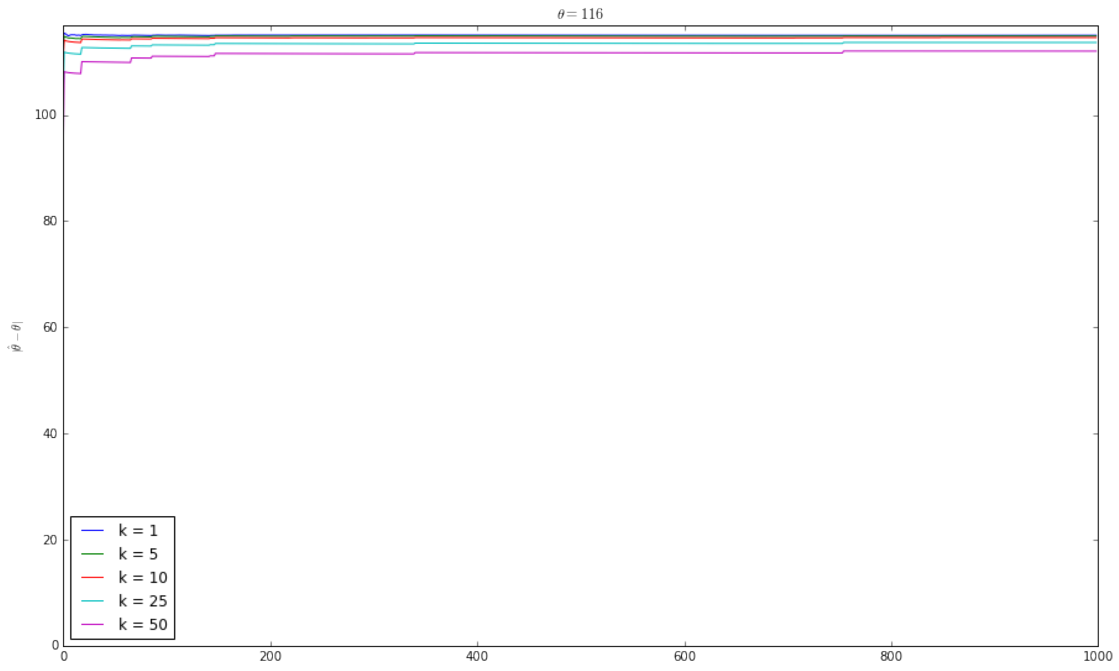

$\theta = 111$
$|\hat{\theta} - \theta|$
0
20
40
60
80
100
0
200
400
600
800
1000
k = 1
k = 5
k = 10
k = 25
k = 50

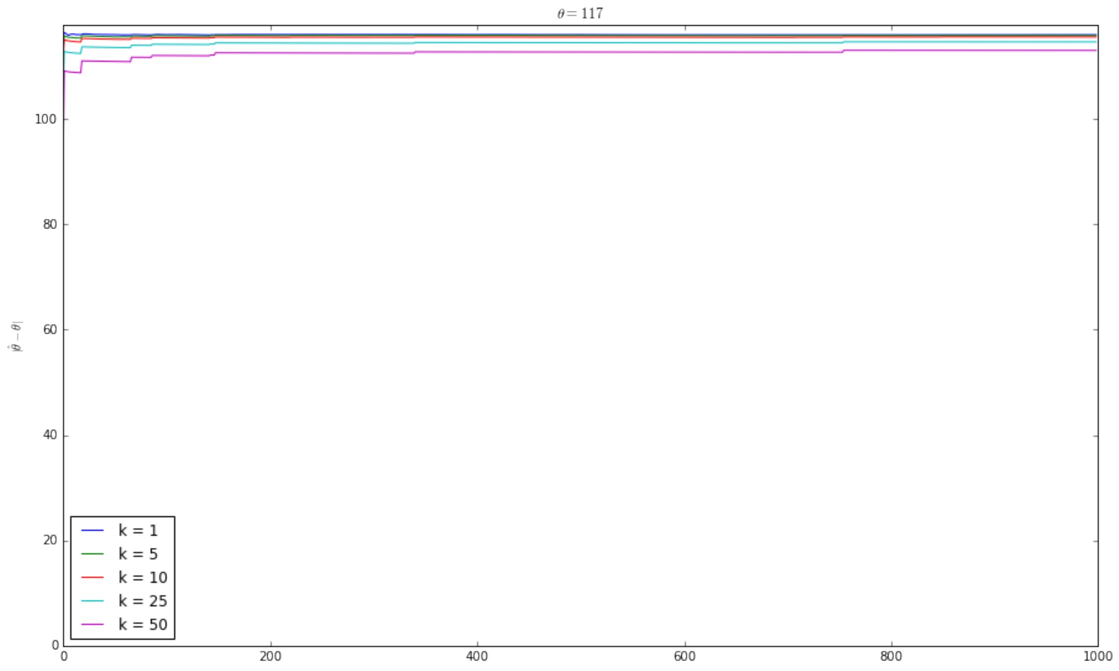

$\theta = 112$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
200
400
600
800
1000

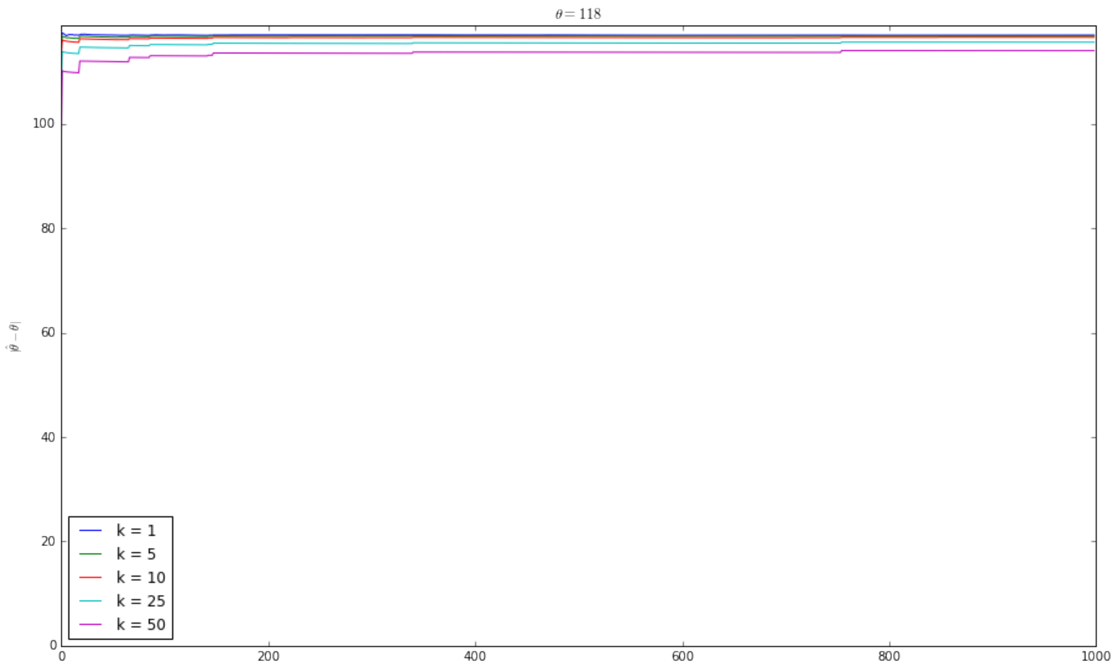

$\theta = 113$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
200
400
600
800
1000

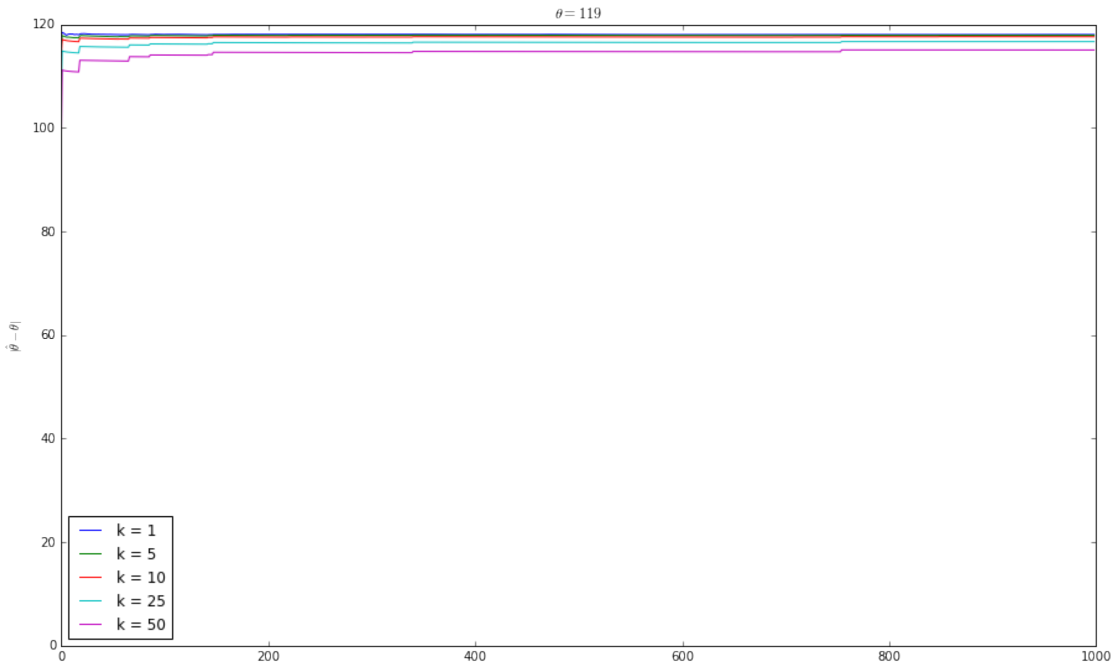

$\theta = 114$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000


$\theta = 115$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
0
200
400
600
800
1000

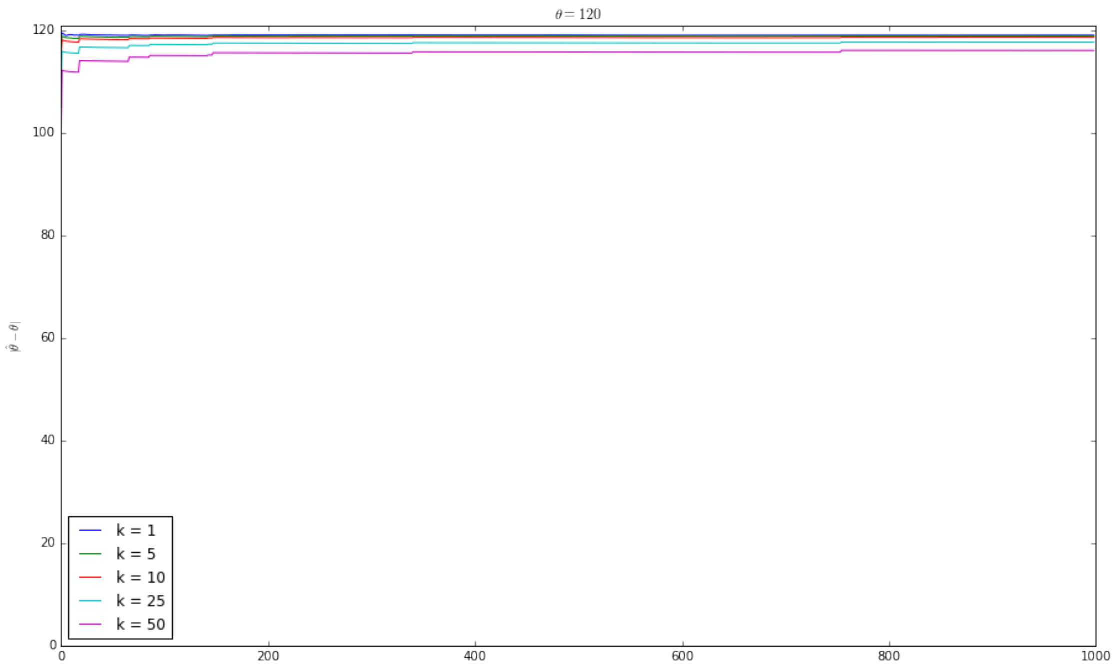

$\theta = 116$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

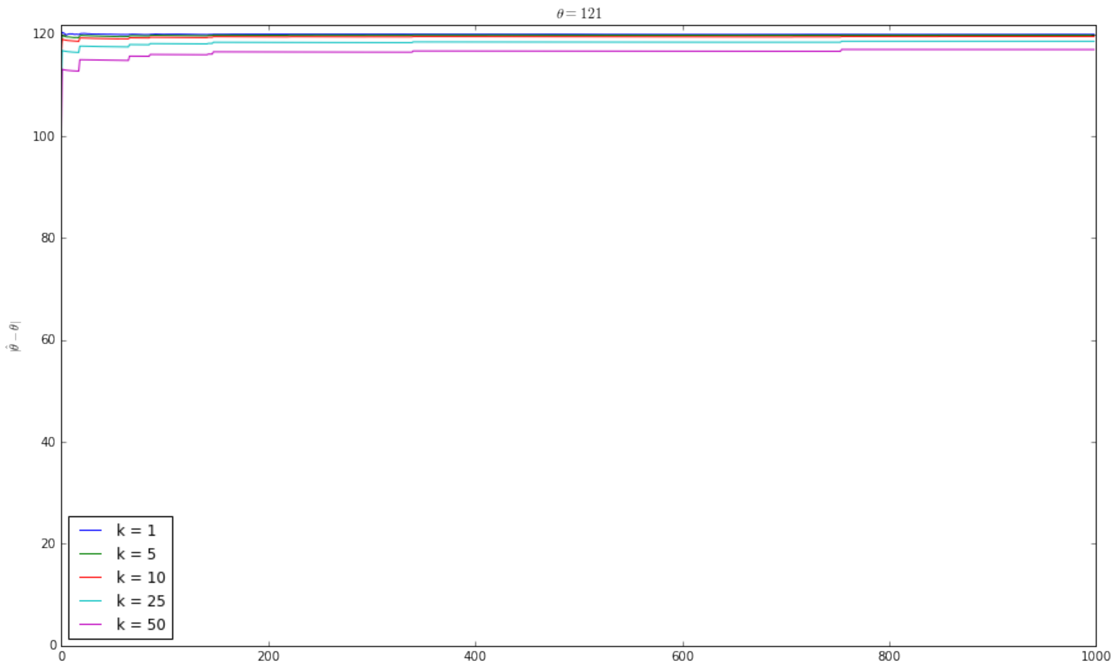

$\theta = 117$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

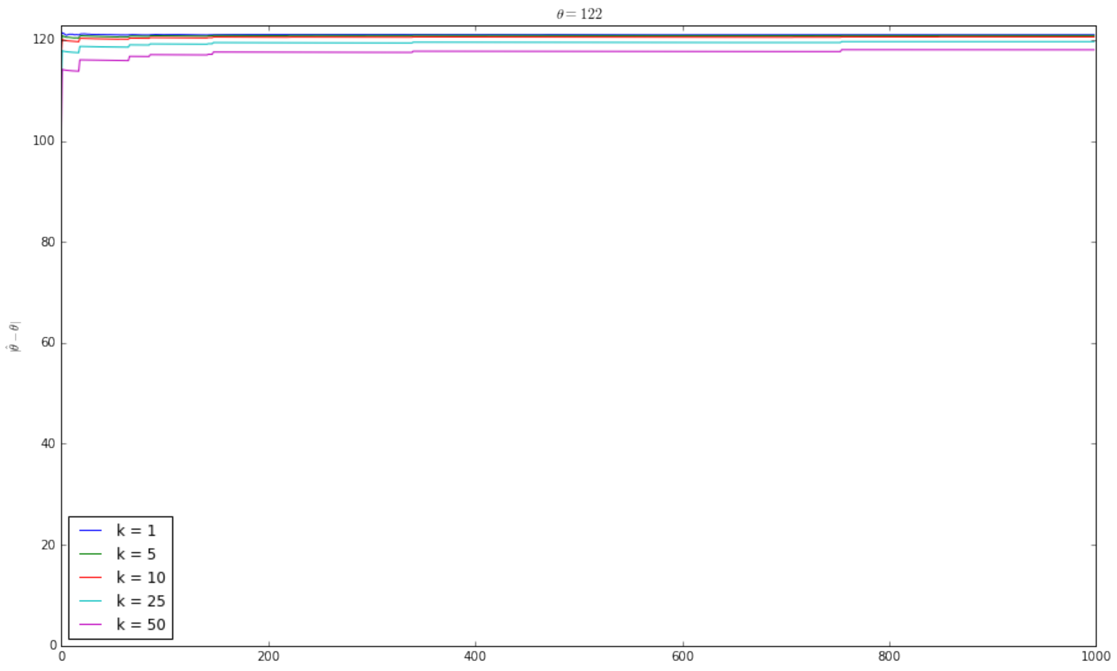


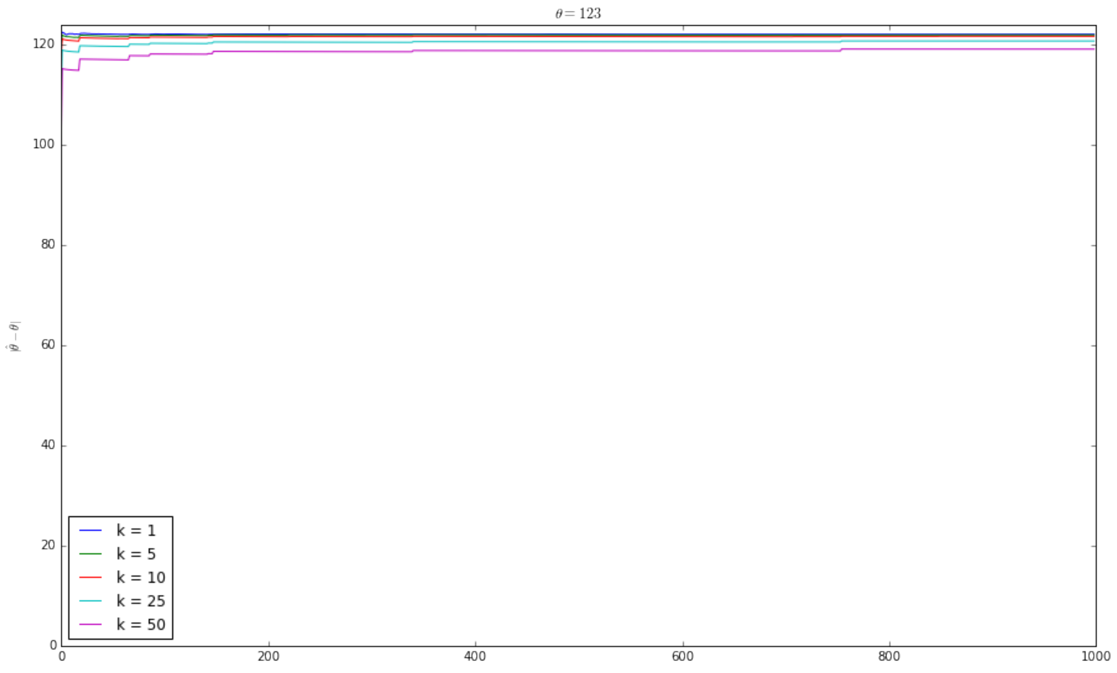


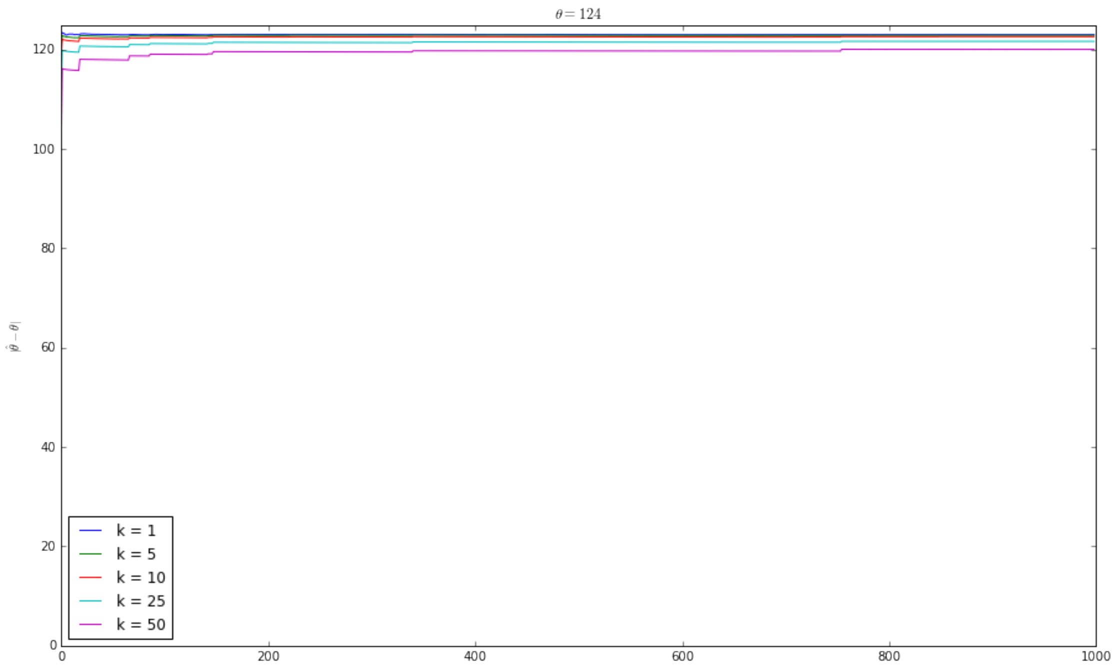
```
In [57]: for th in range(120, 150):
             drawPlot([1, 5, 10, 25, 50], th, ymin = 0, ymax = th + 1)
```

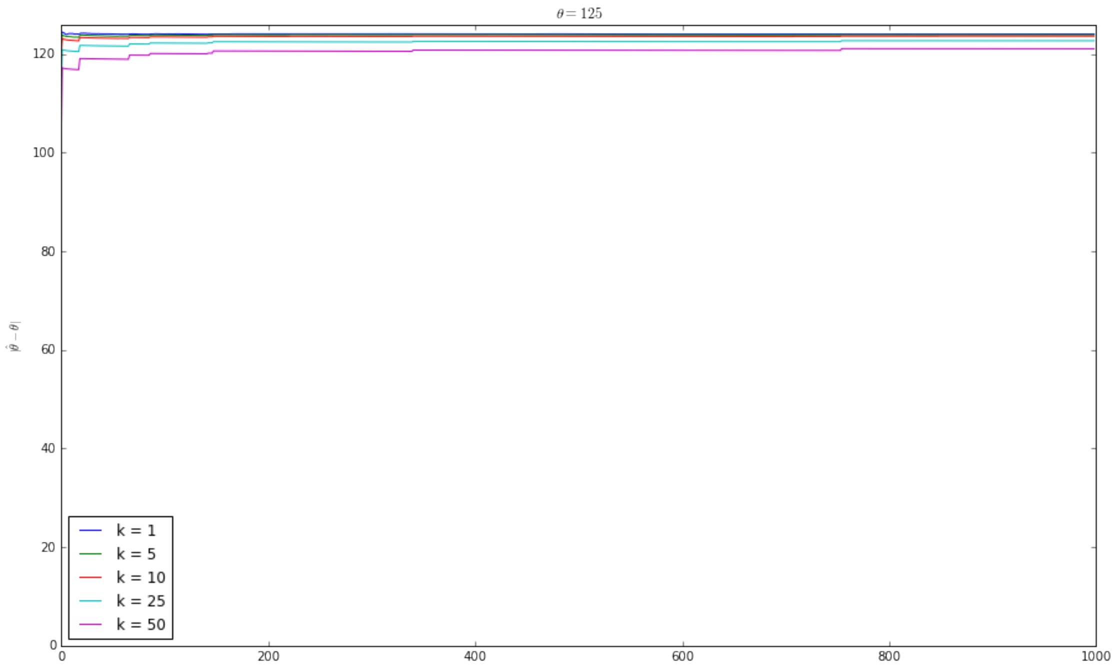

$\theta = 120$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
200
400
600
800
1000

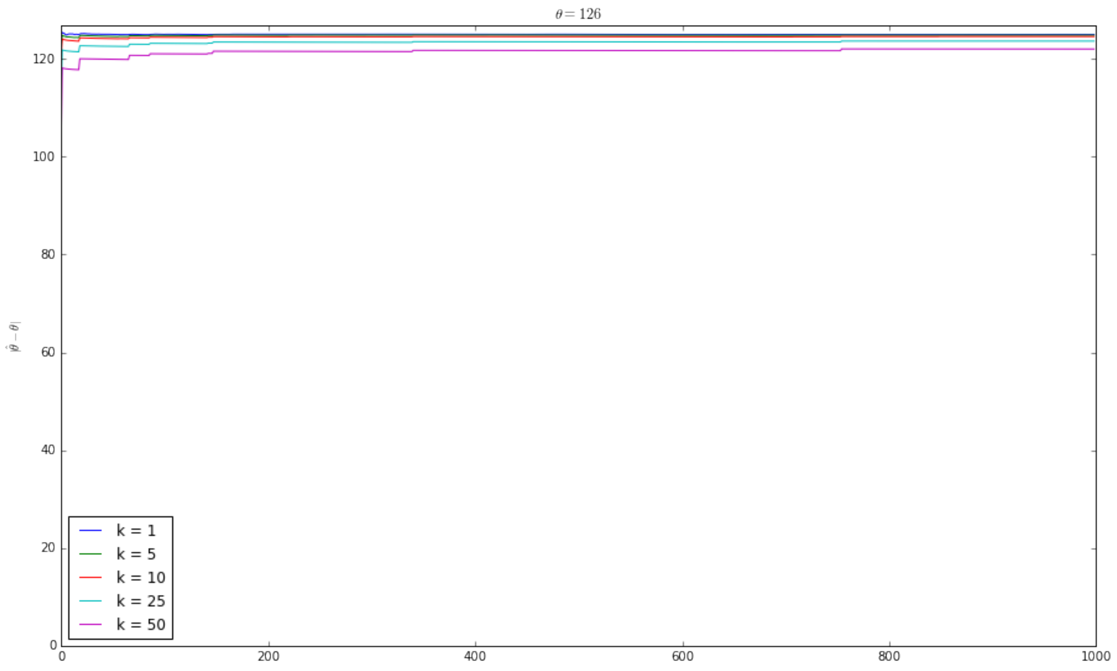

$\theta = 121$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
200
400
600
800
1000


$\theta = 122$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

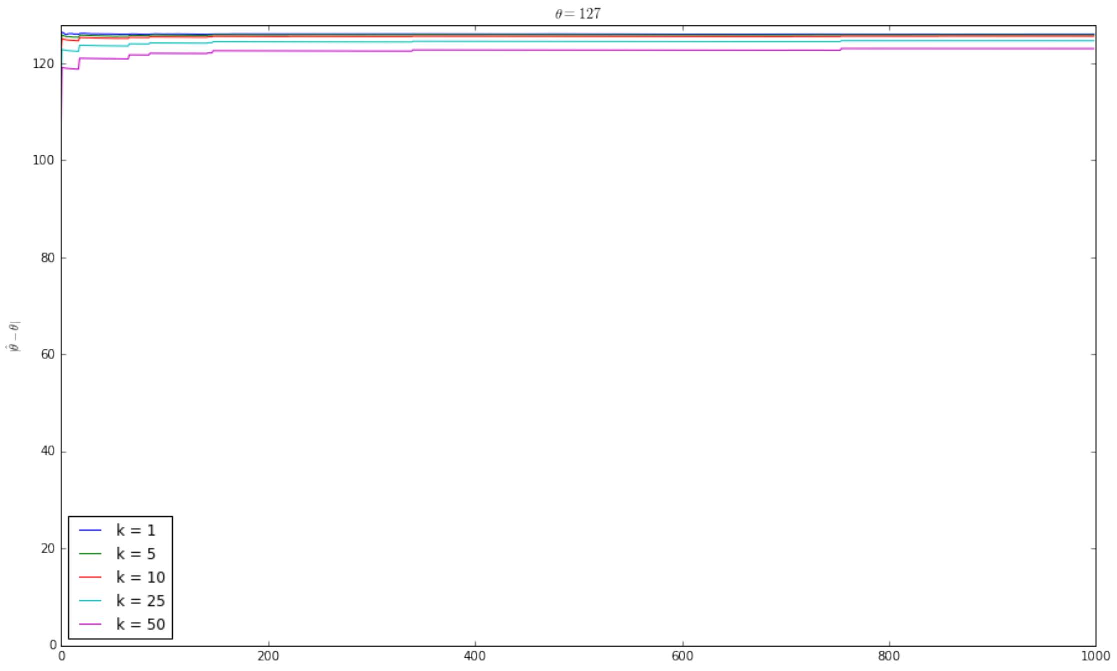

$\theta = 123$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 124$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

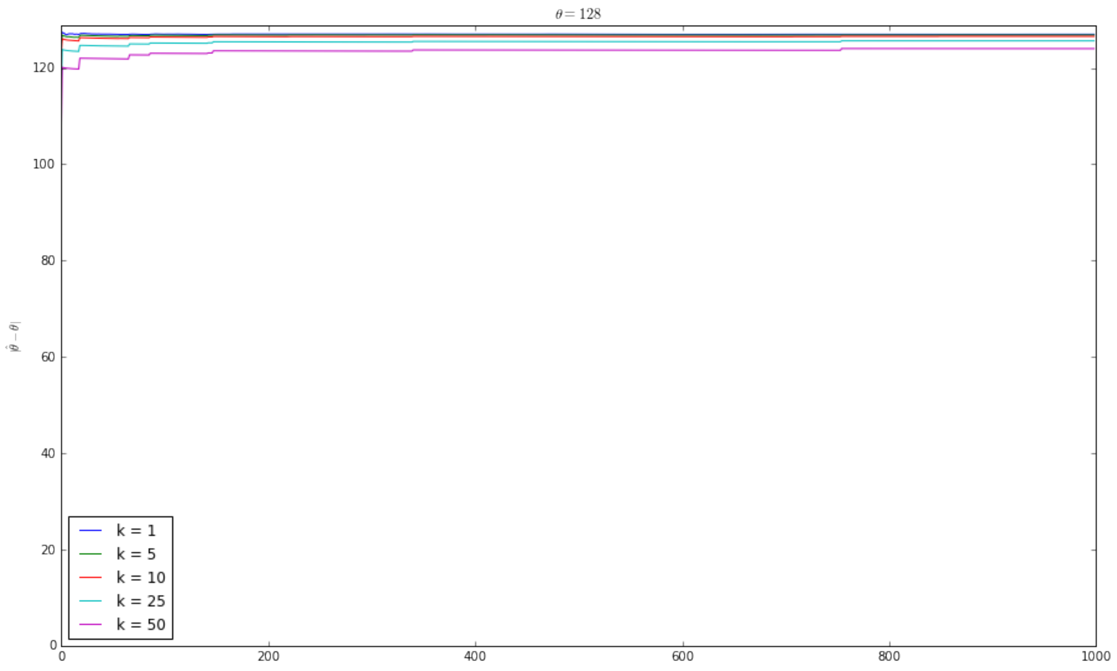

$\theta = 125$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

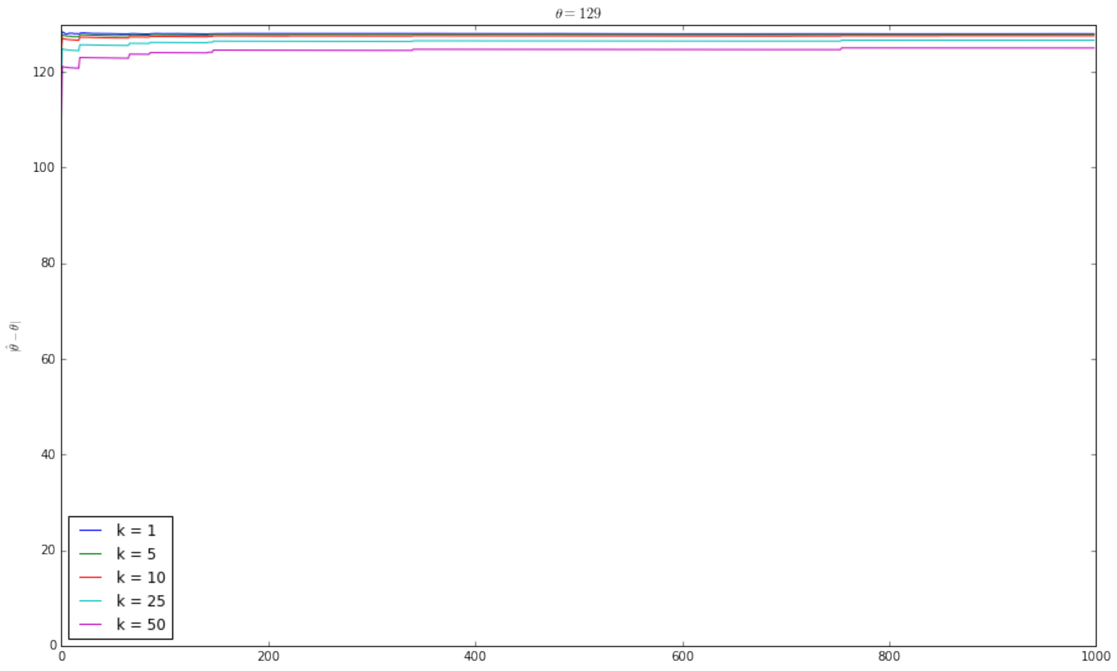


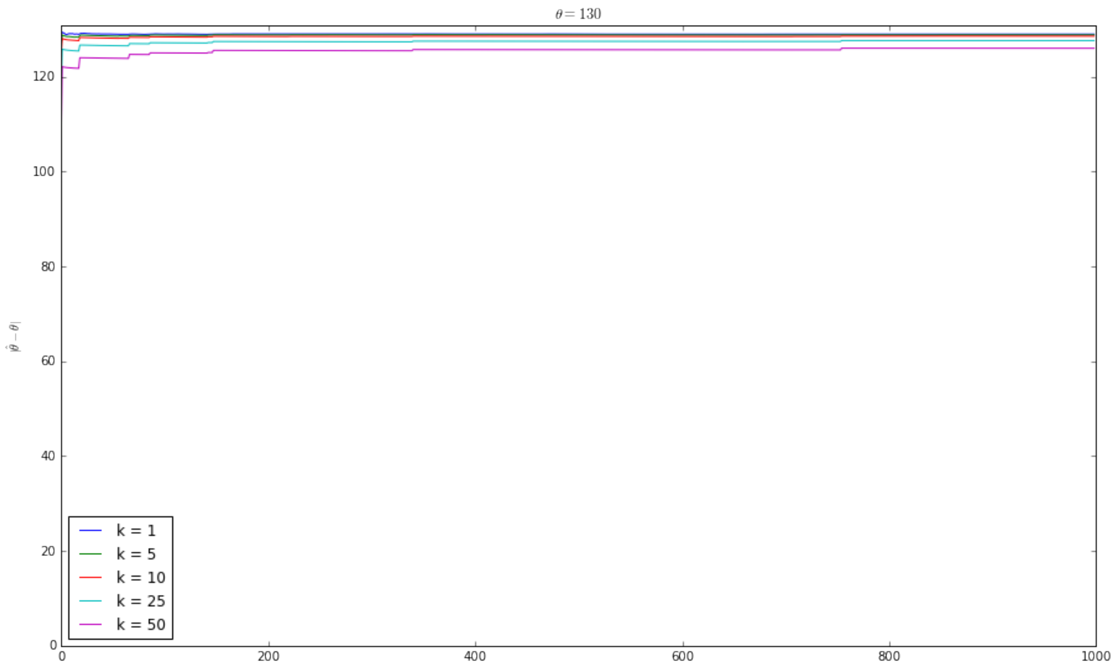
$\theta = 126$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
200
400
600
800
1000



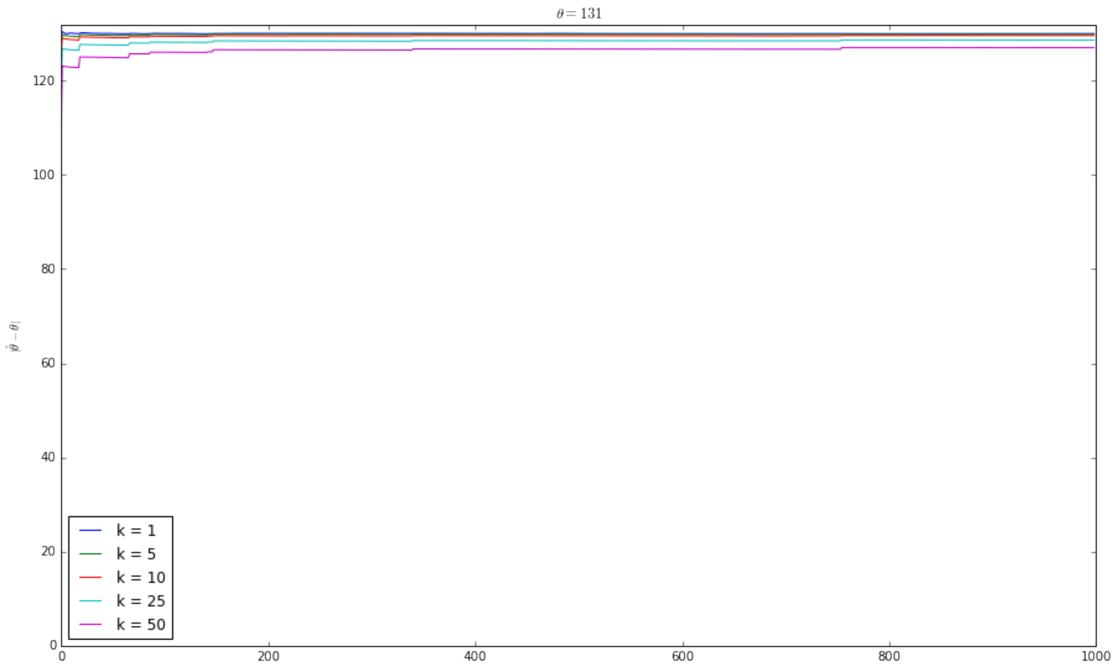
$\theta = 127$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
200
400
600
800
1000


$\theta = 128$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

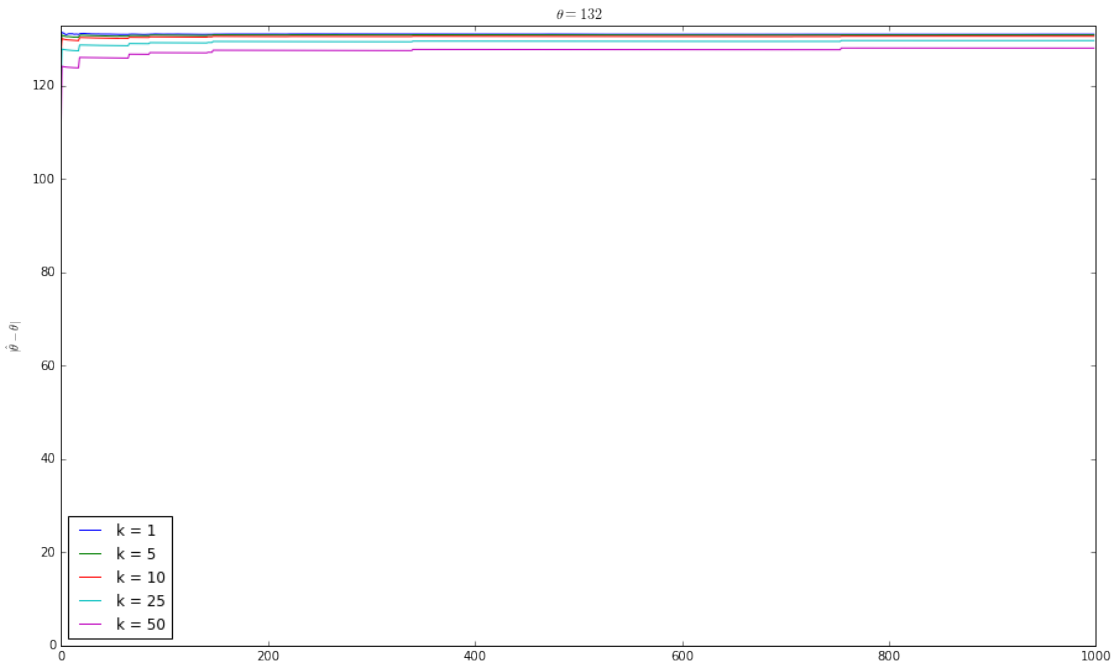

$\theta = 129$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

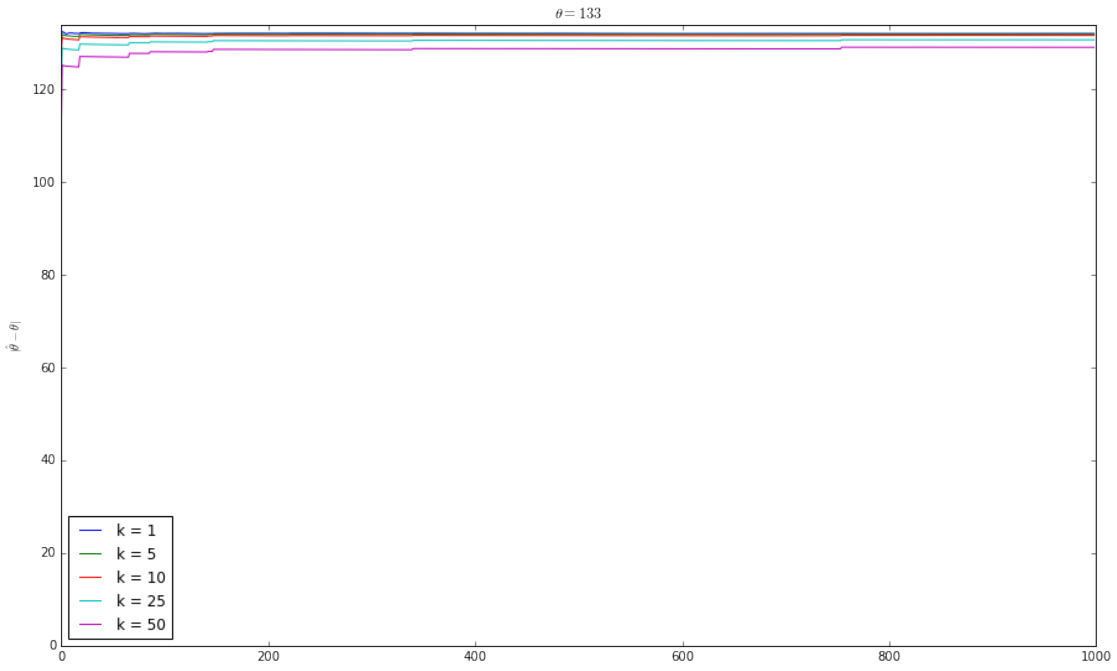


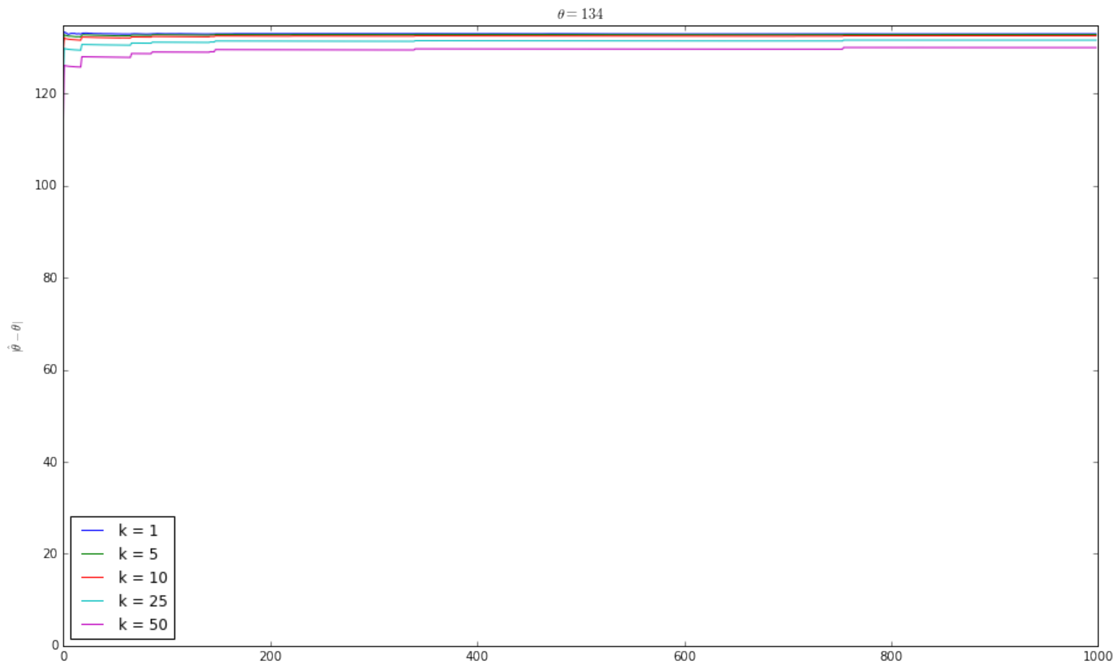
$\theta = 130$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



$\theta = 131$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 132$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 133$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 134$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
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100
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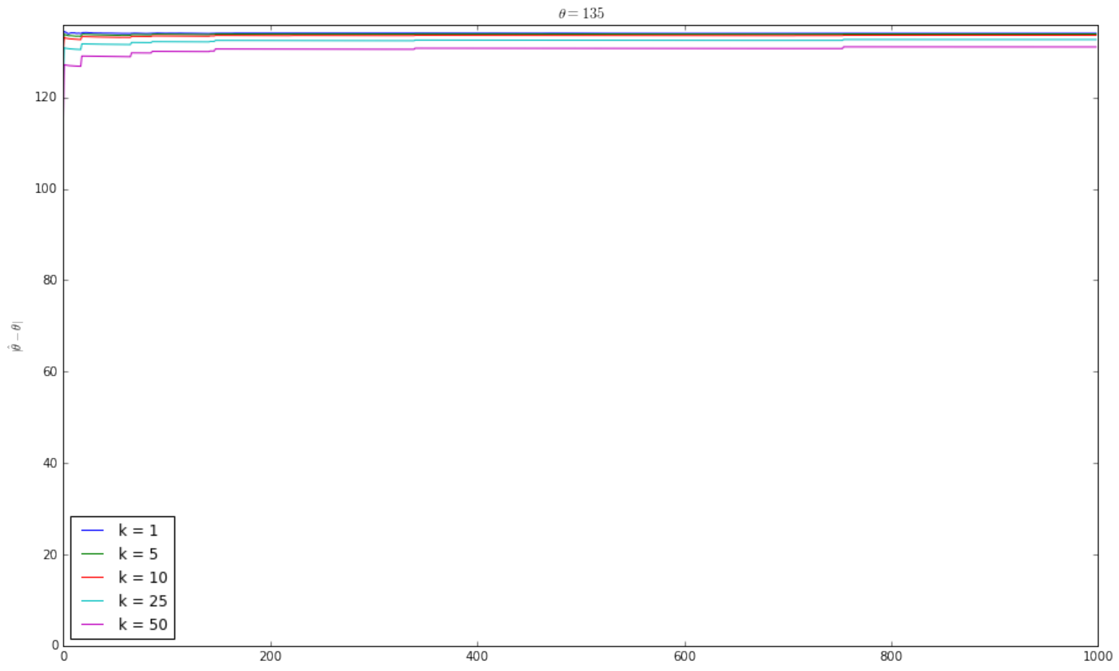
0
200
400
600
800
1000


$\theta = 135$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
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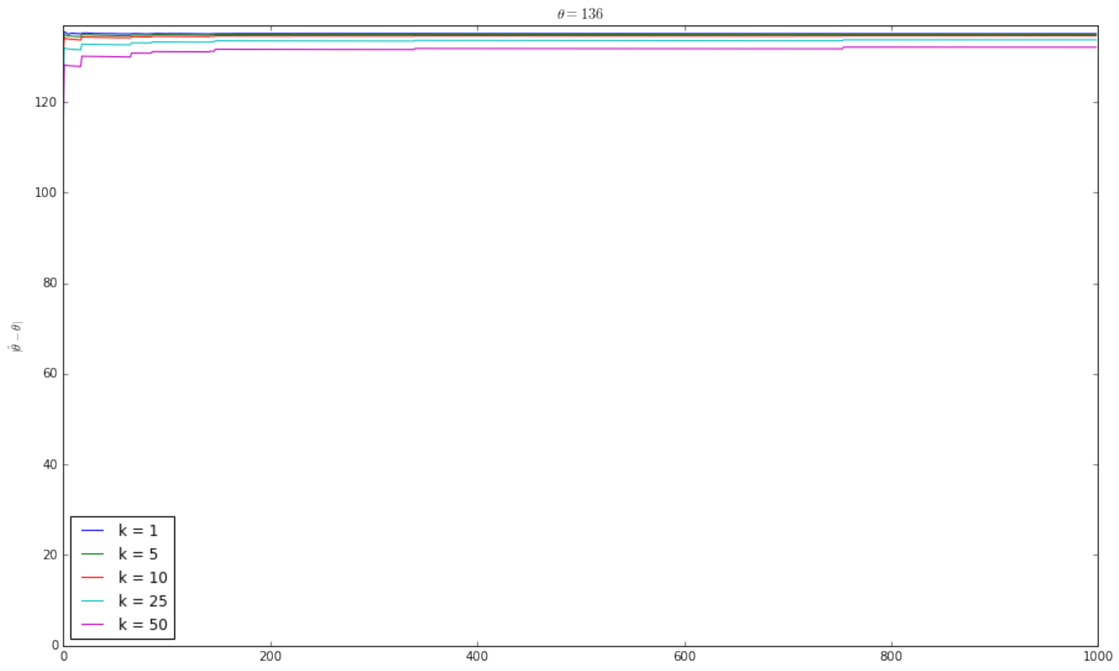
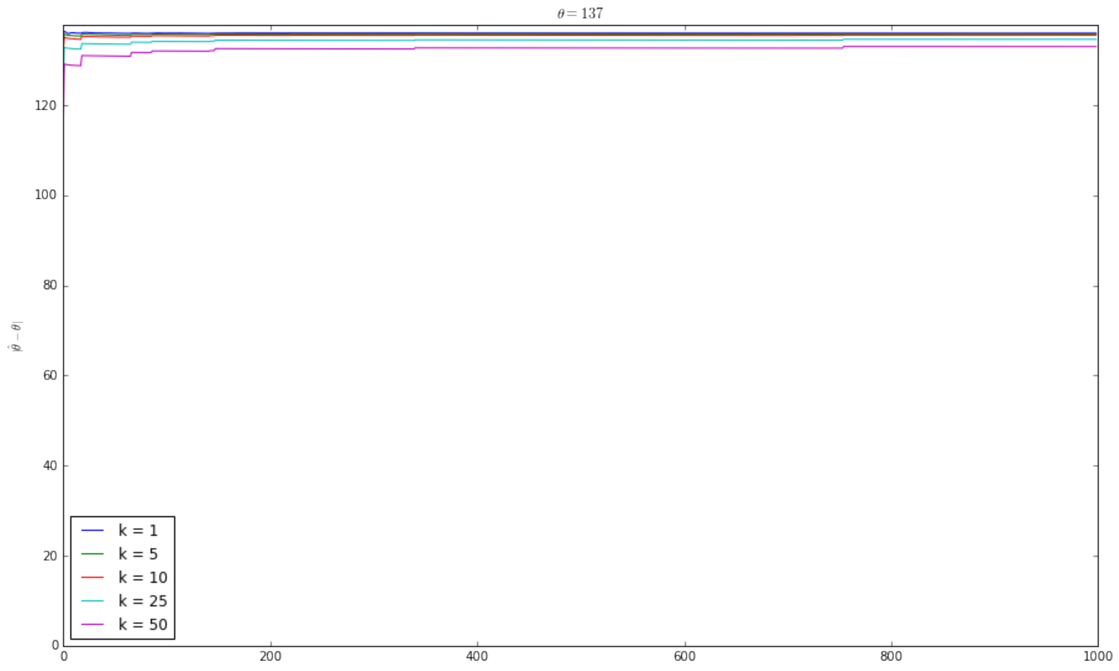
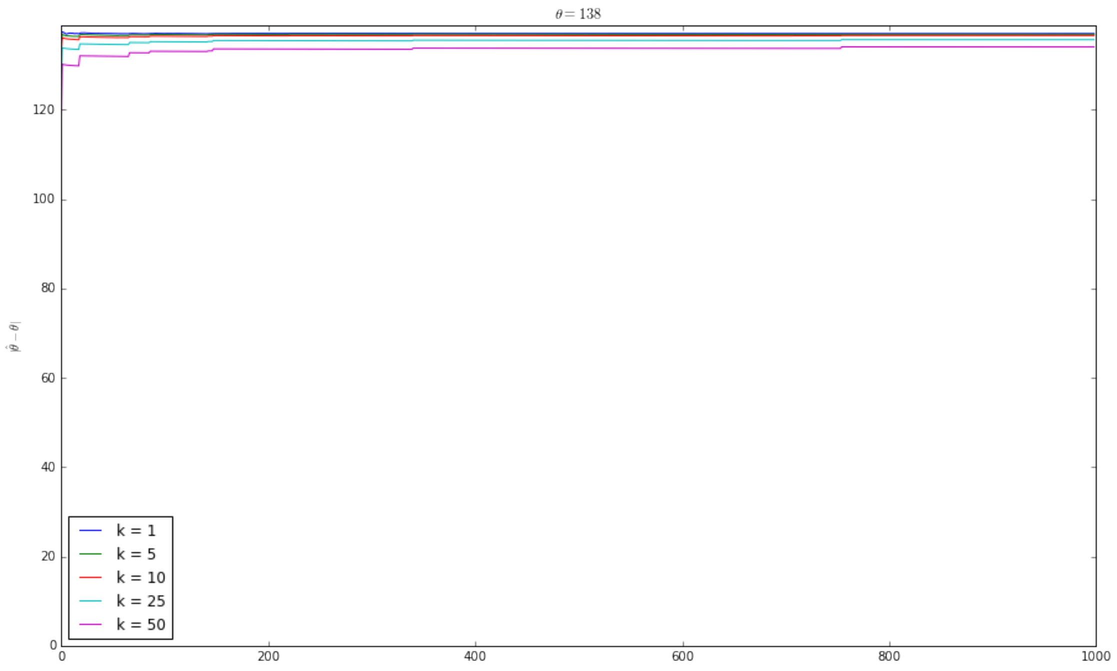
0
200
400
600
800
1000


$\theta = 136$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 137$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 138$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
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100
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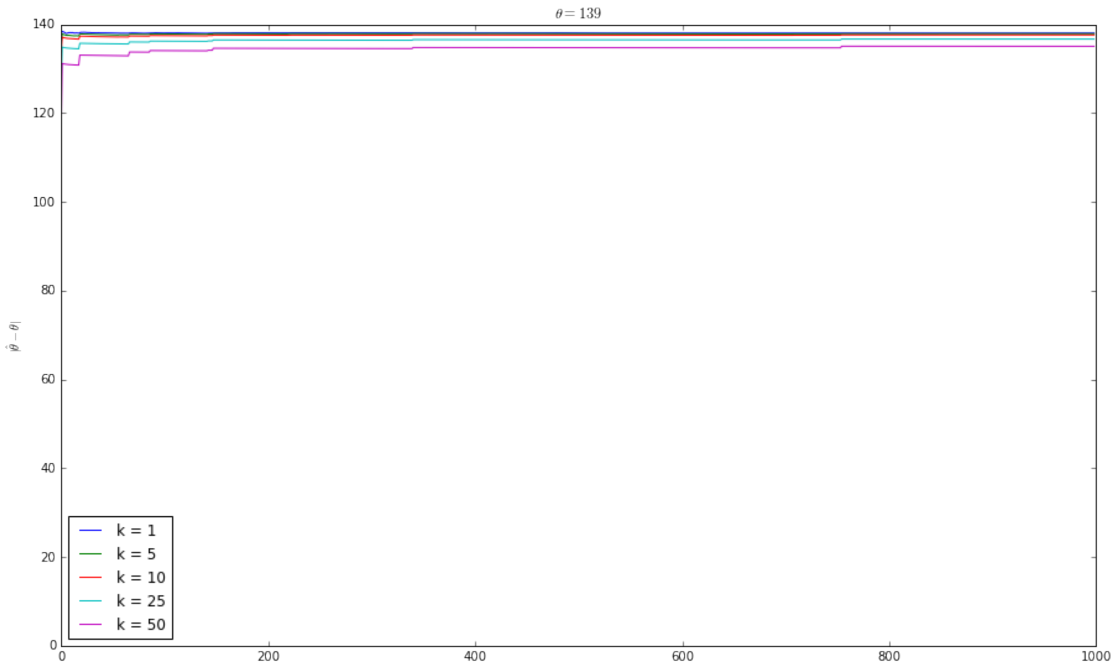
0
200
400
600
800
1000


$\theta = 139$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
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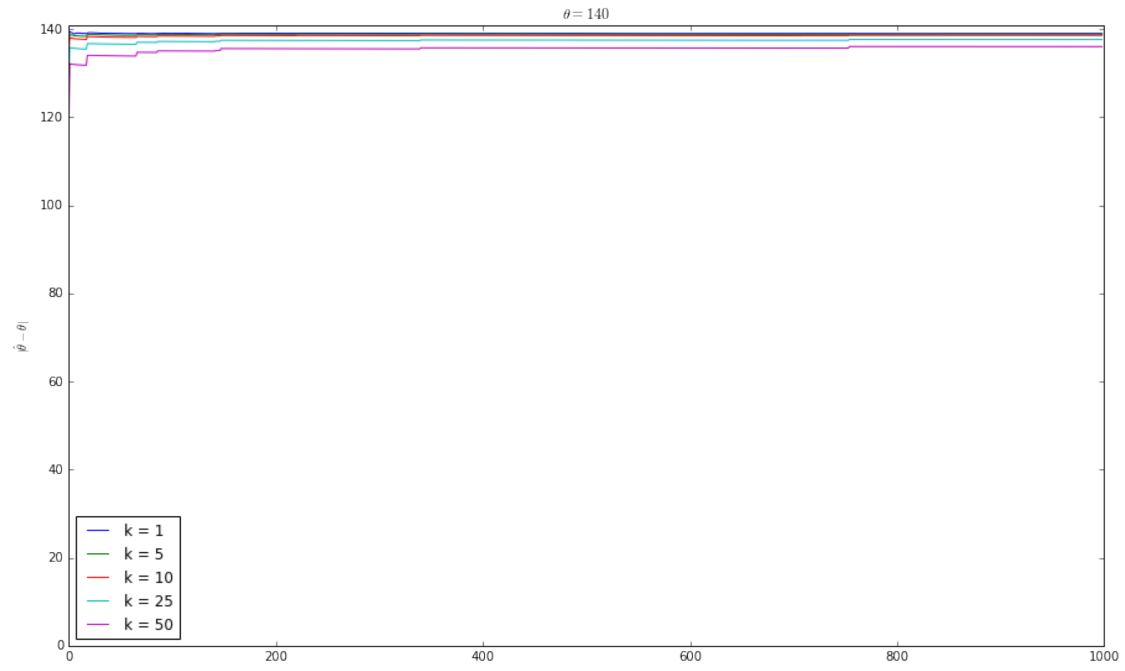
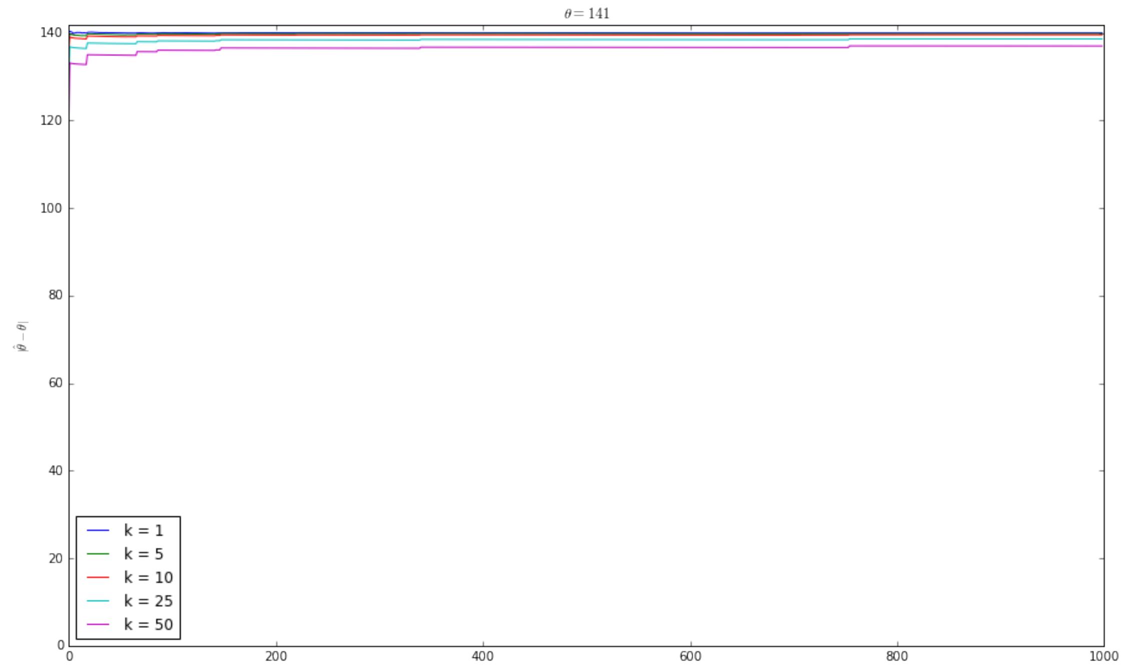
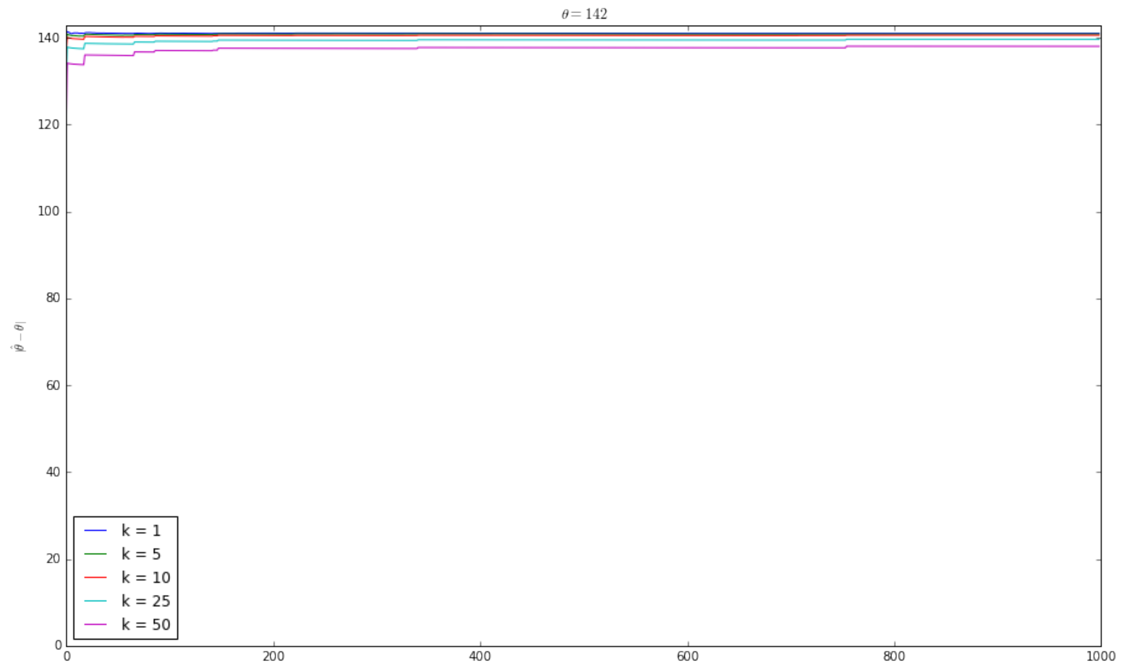
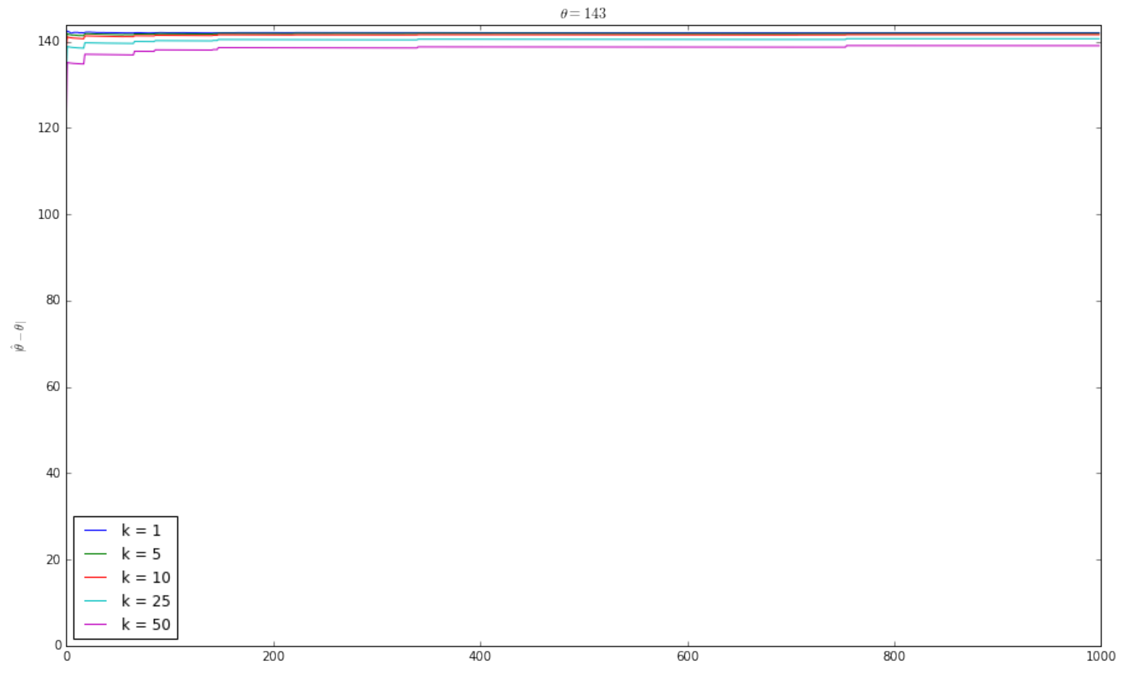
0
200
400
600
800
1000

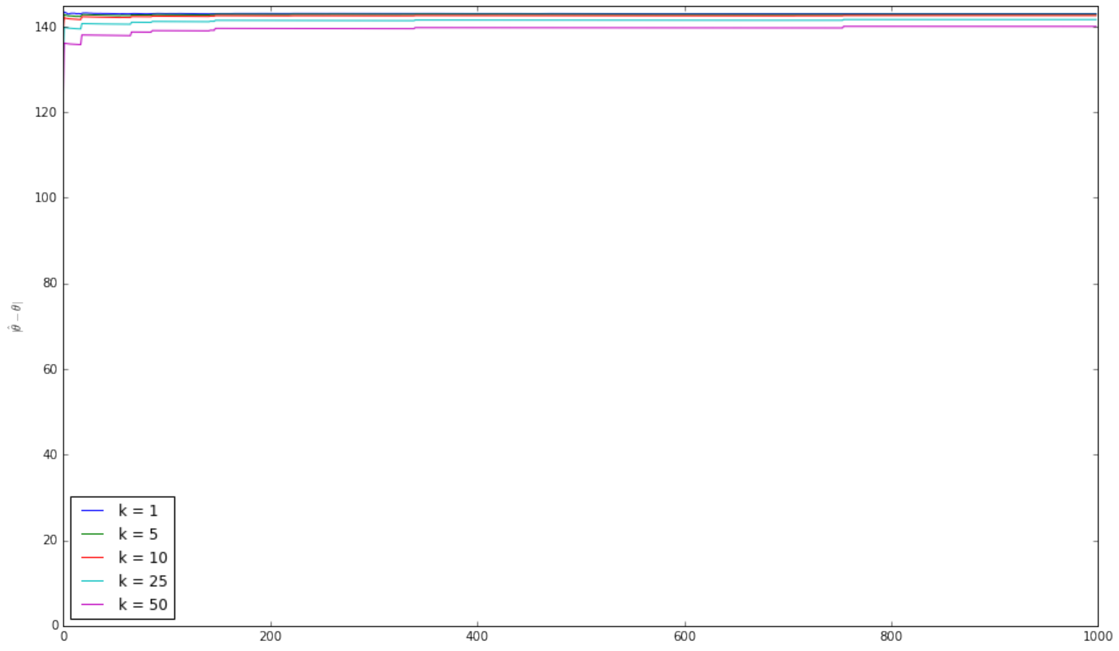

$\theta = 140$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
140
0
200
400
600
800
1000


$\theta = 141$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50
0
20
40
60
80
100
120
140
0
200
400
600
800
1000

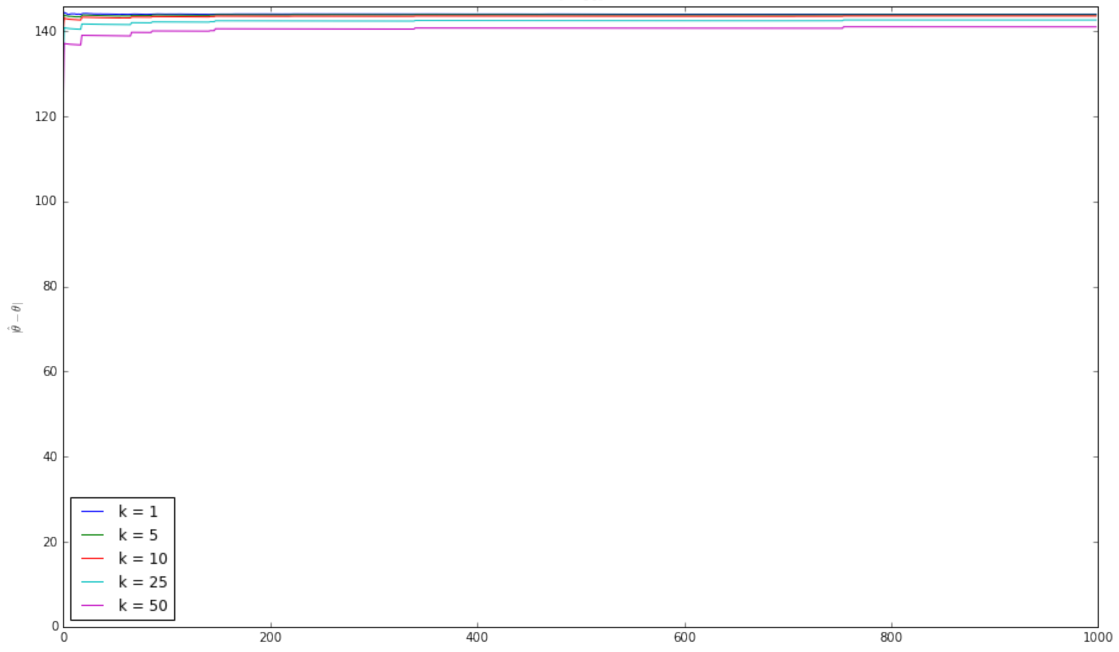

$\theta = 142$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50


$\theta = 143$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

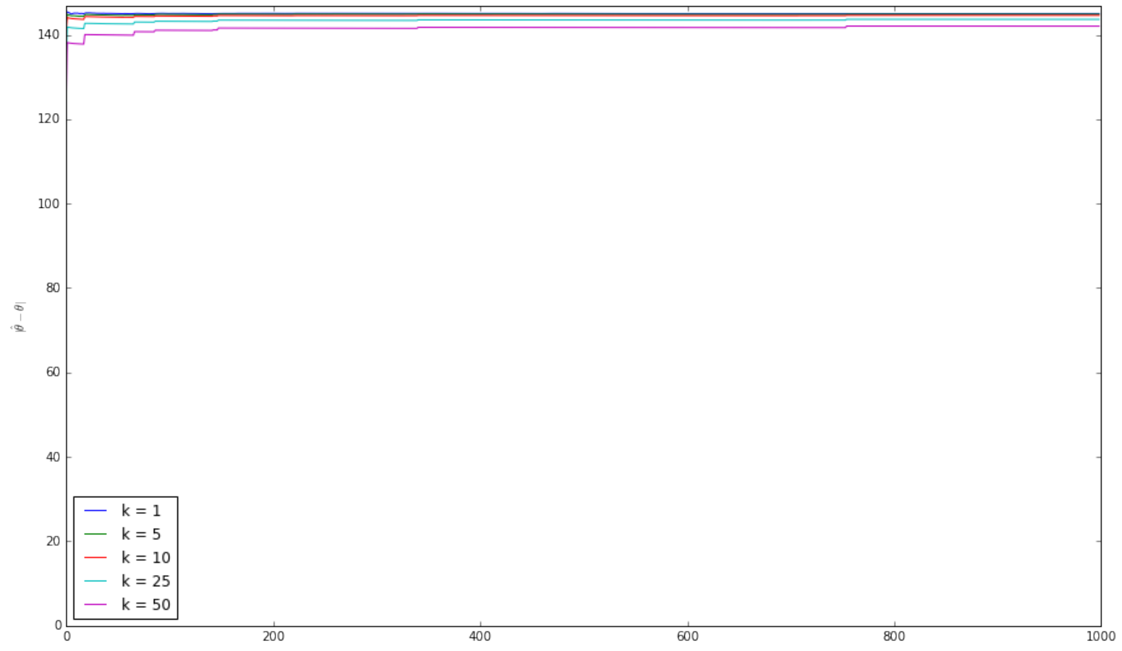
$\theta = 144$



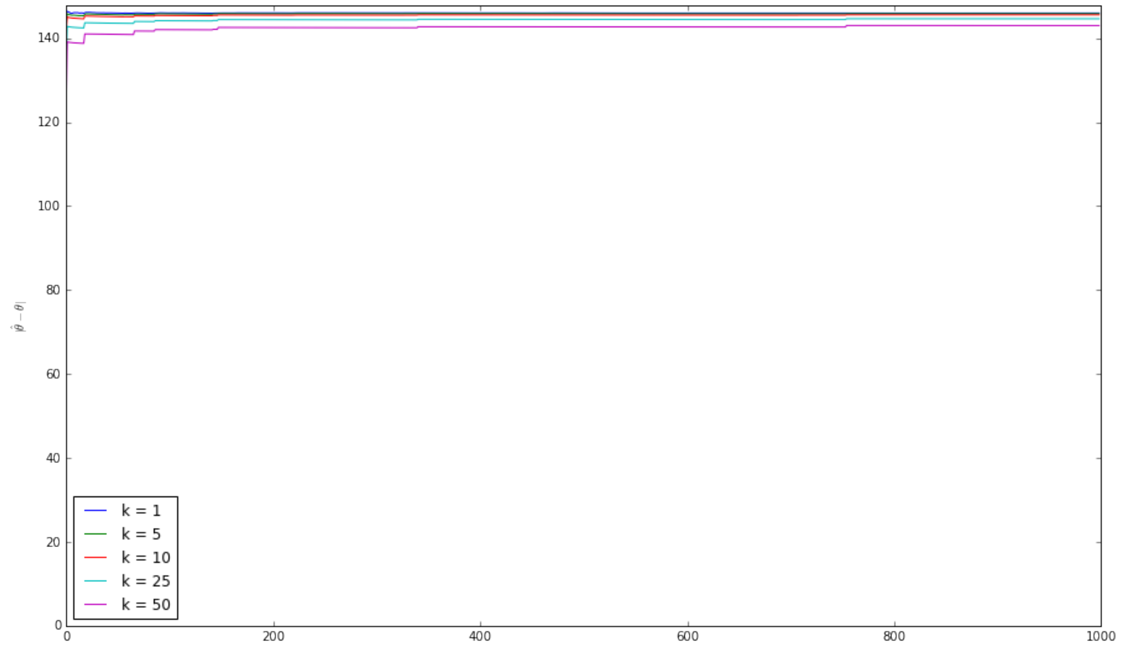
$\theta = 145$

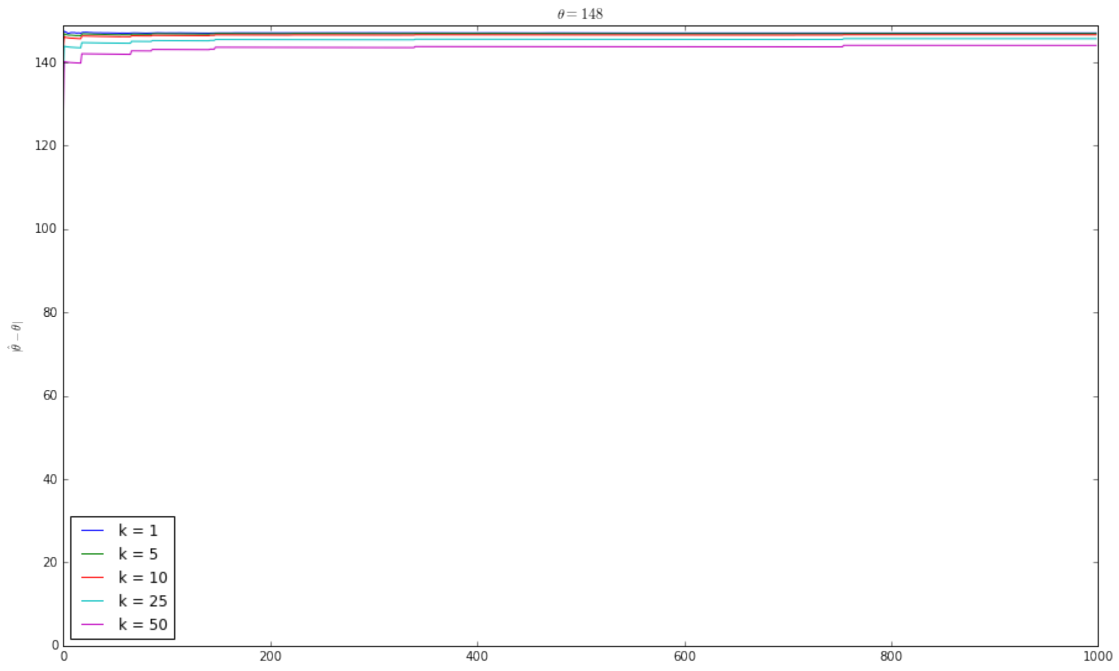


$\theta = 146$

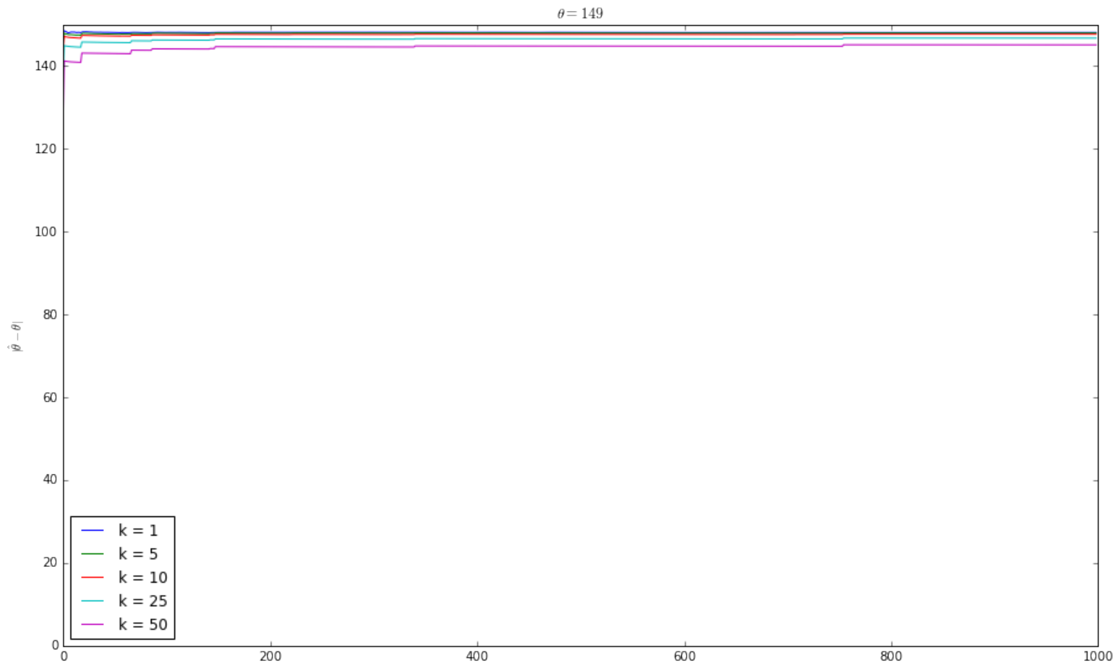


$\theta = 147$





$\theta = 148$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50



$\theta = 149$
$|\hat{\theta} - \theta|$
k = 1
k = 5
k = 10
k = 25
k = 50

```
In [ ]:
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