Physics 514 Computational Physics, Fall 2020

Homework 4: Percolation

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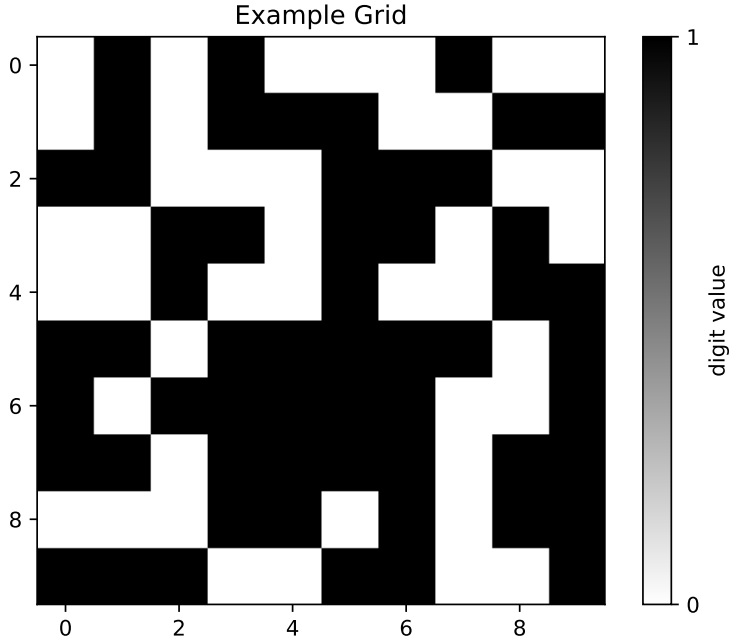
1 Problem 1

Code 1: Initialize the Lattice

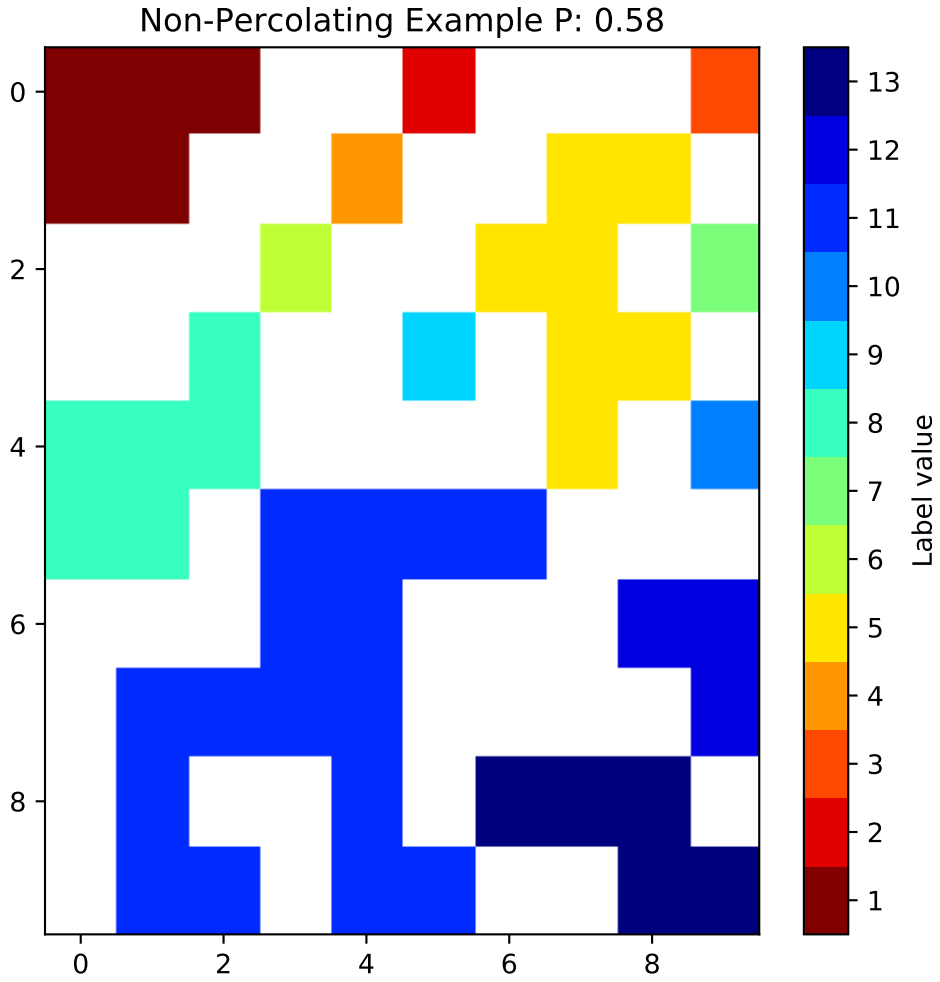
```
def init_square_lattice (L, p):
        grid = np.random.random([L, L])
        grid = np.ceil(grid - (1.0 - p))
        return grid
```

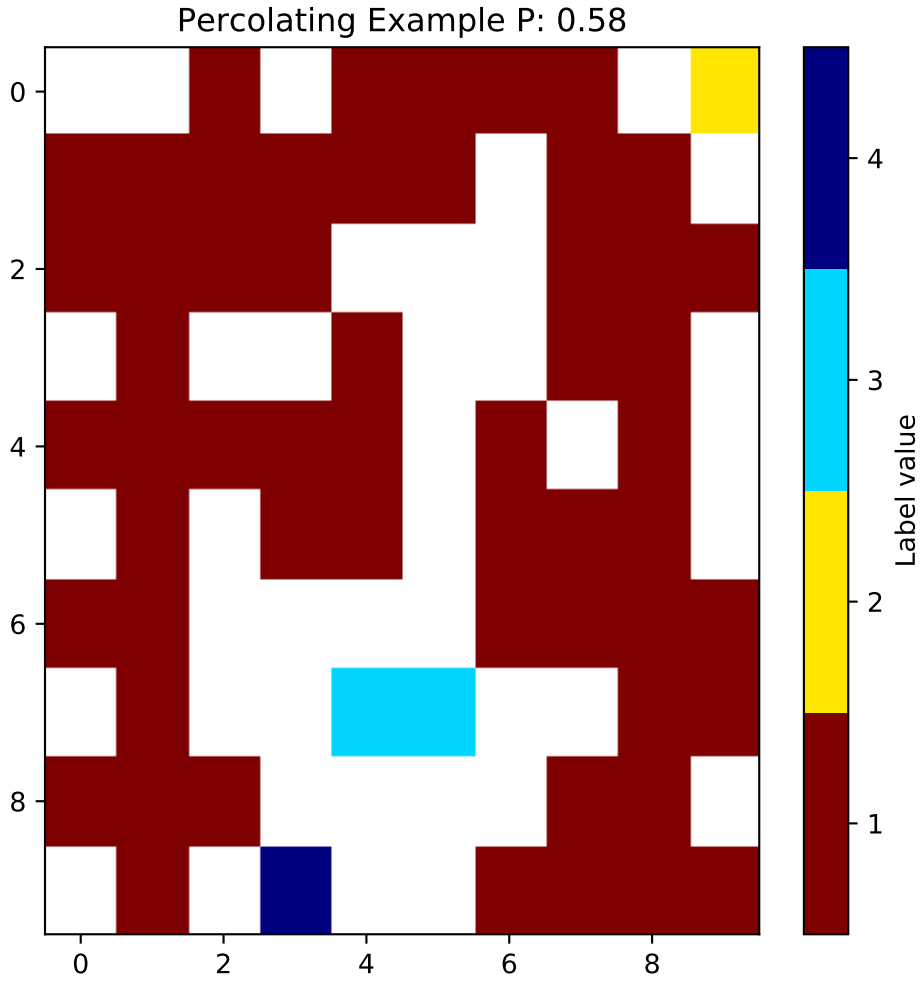
The code randomized $N \times N$ matrix containing numbers from 0 to 1. Subtracting $(1-p)$ from the whole matrix will make $(1-p)/p$ smaller than 0, and the rest of them will be greater than 0. After using the ceil function, the one smaller than 0 will be round to 0, and the ones greater than 0 will be round to 1.



2 Problem 2

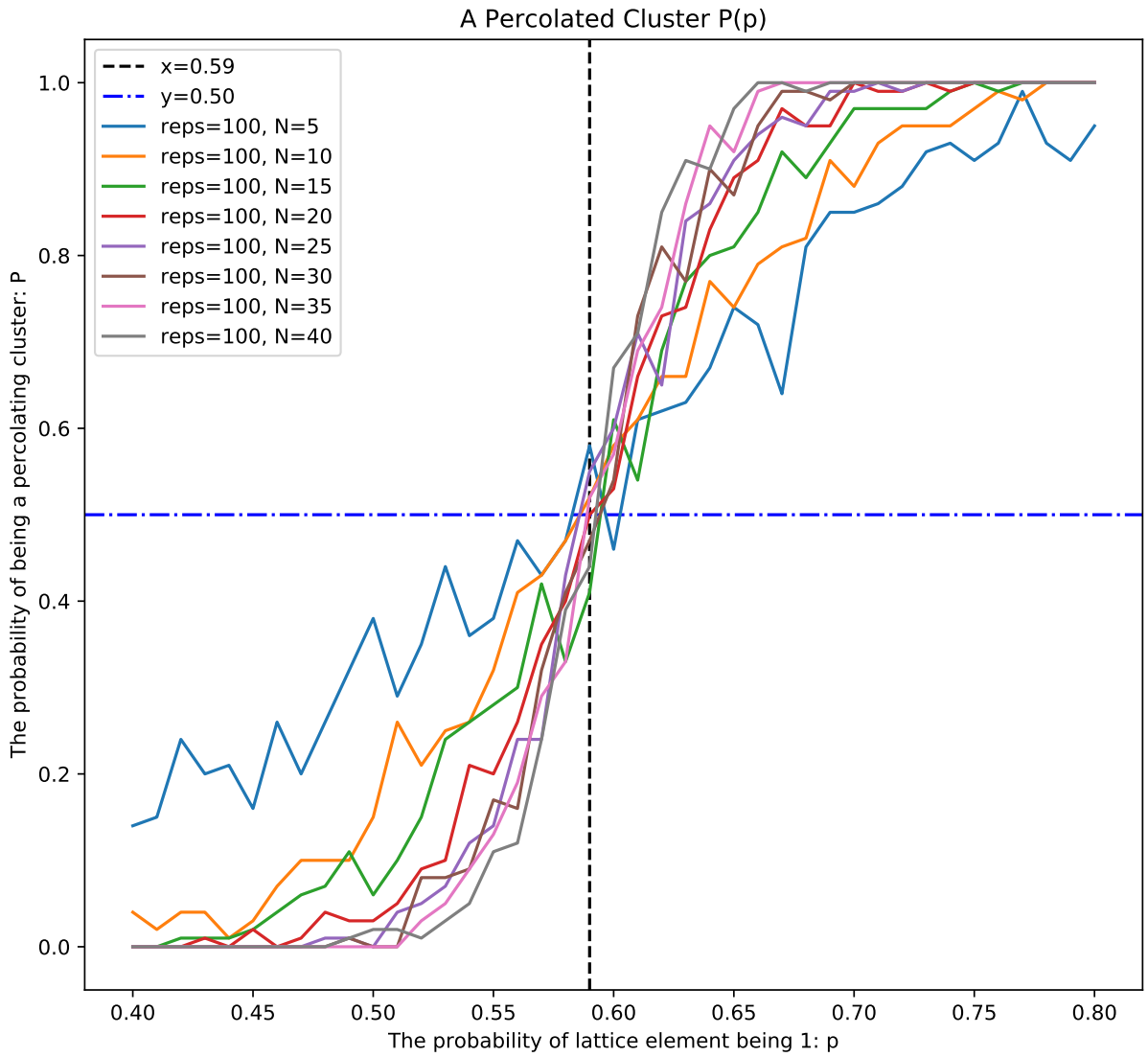
The function ”hoshen_kopelman_label” returns the labelled matrix and the number of clusters in the matrix. And the function ”problem02” will generate two plots(percolating and non-percolating) where the p is 0.58.

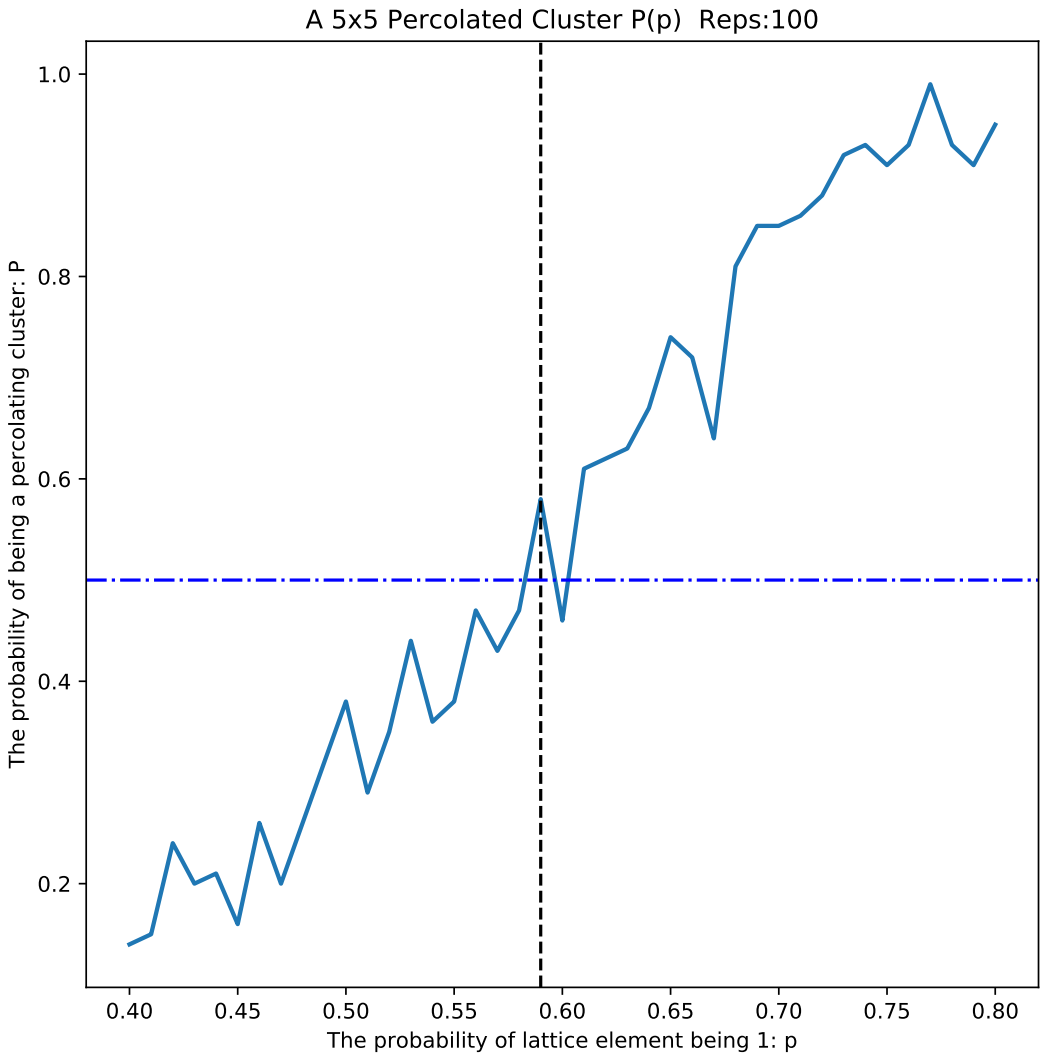


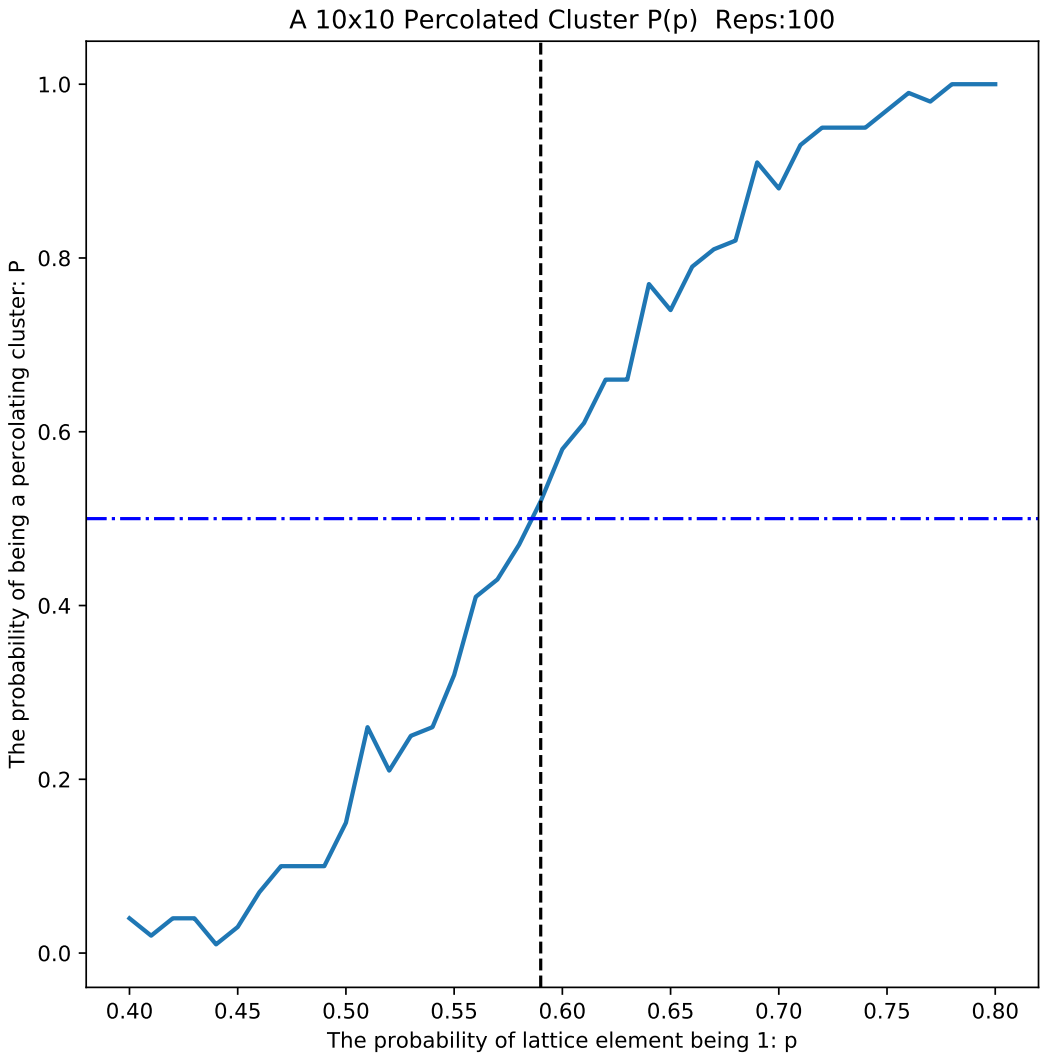


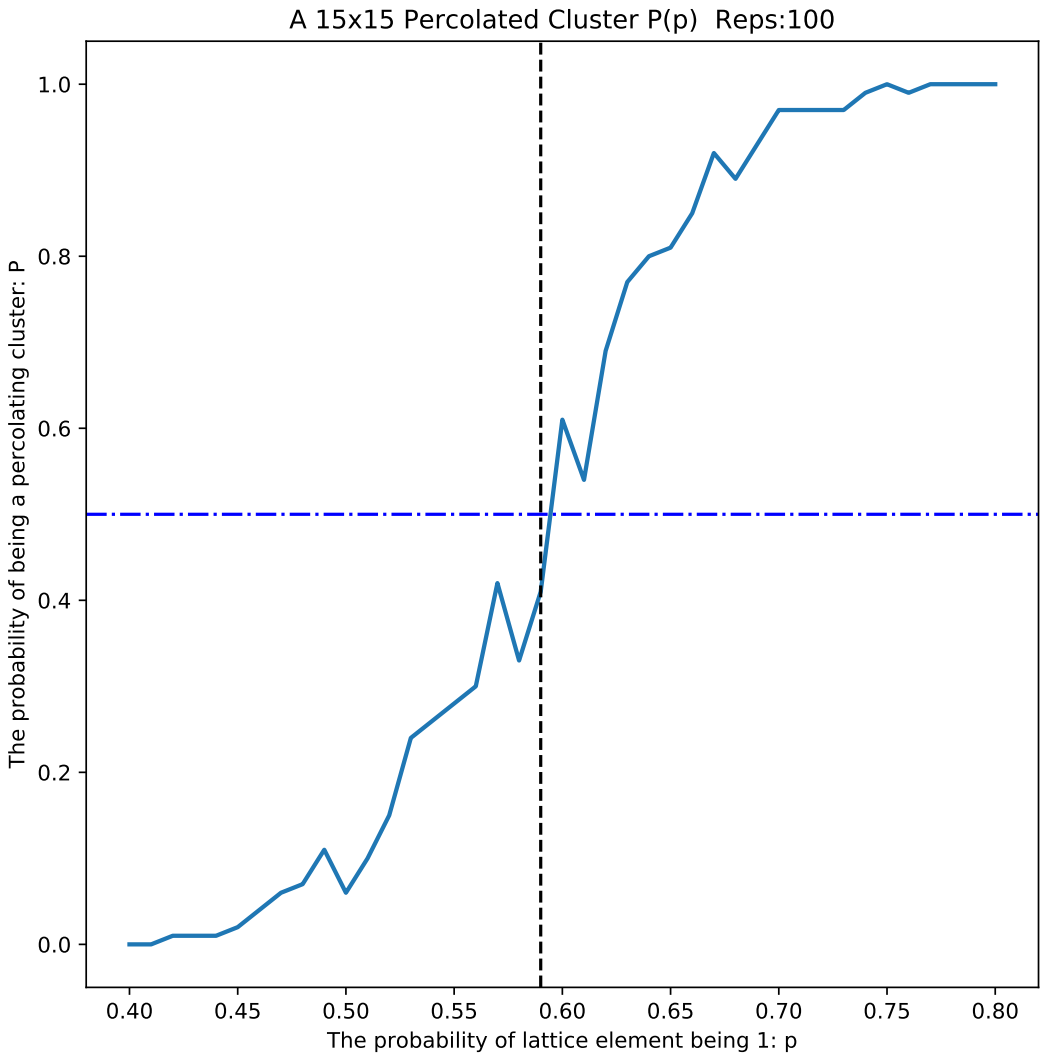
3 Problem 3

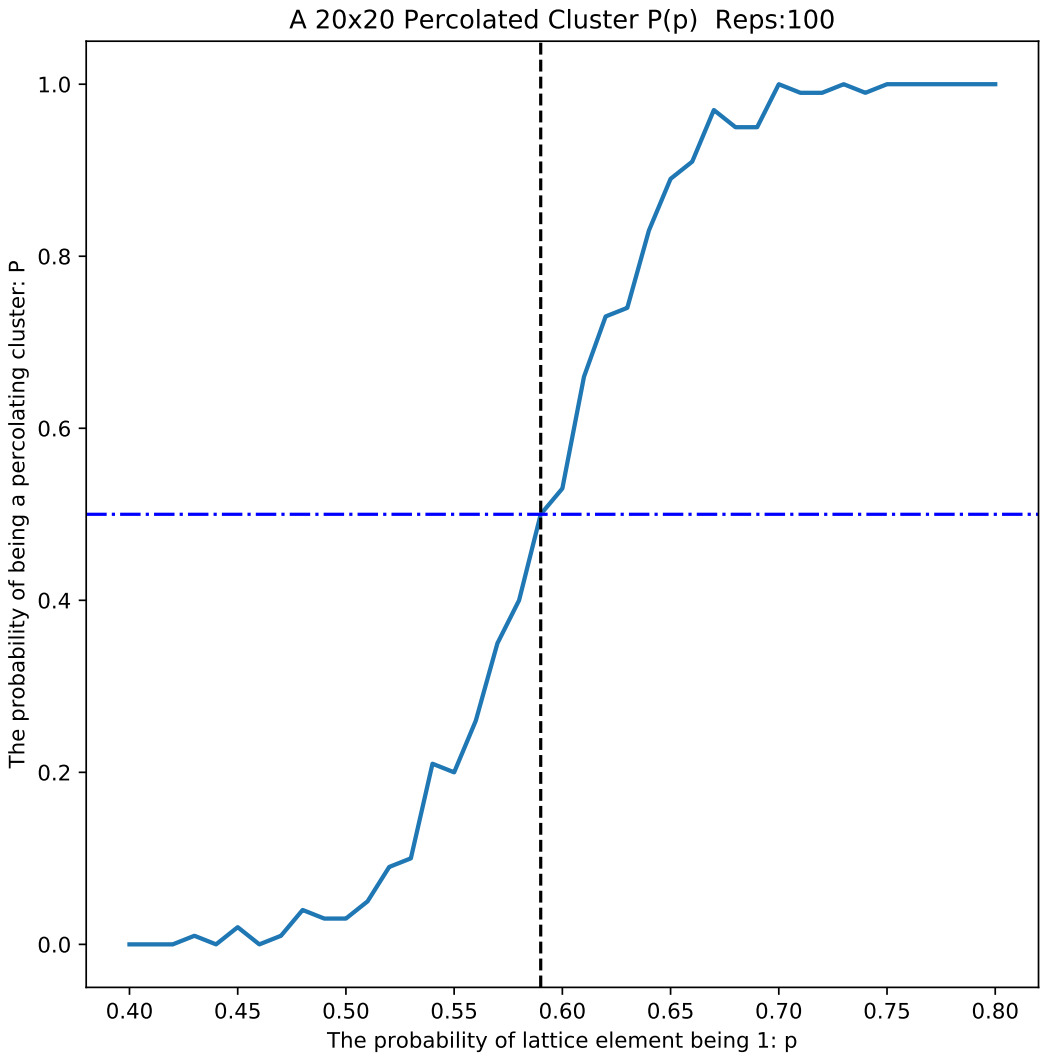
The function "Problem03" will generate the .dat files for cases where lattice lengths are 5, 10, 15, 20, 25, 30, 35, 40 if setting the recalculate as "True" (default is "False"). In order to see the actual trends, I set the number of repetitions to be 100. The 100 repetitions will take a relatively long time, you could either set the number of repetitions smaller keep the "recaculate" as "False". In the later case, you will need the .dat files in the same directory. The function will draw using the .dat files. And from the plot, clearly we can see around $p = 0.59$, we could have around $1/2$ getting the percolating cluster.

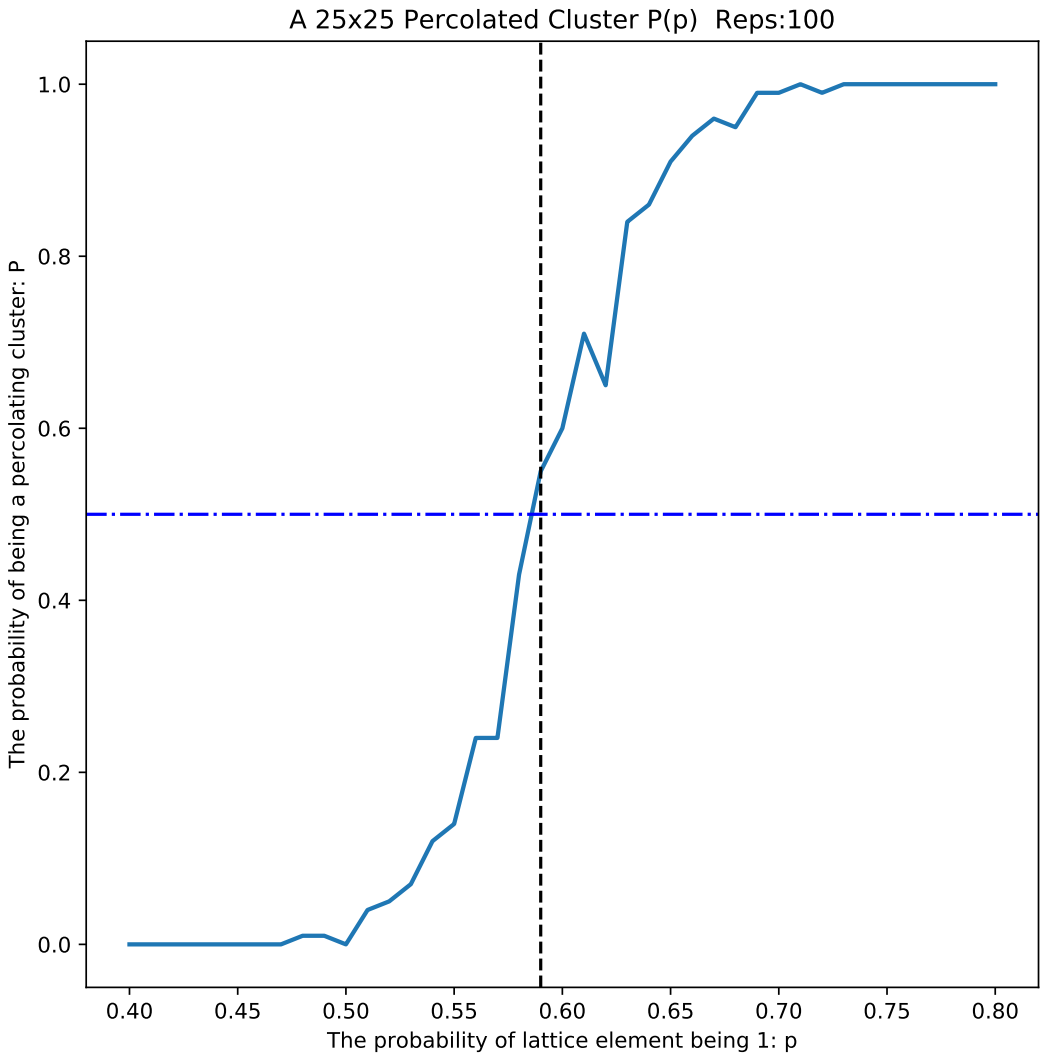

A Percolated Cluster P(p)
x=0.59
y=0.50
reps=100, N=5
reps=100, N=10
reps=100, N=15
reps=100, N=20
reps=100, N=25
reps=100, N=30
reps=100, N=35
reps=100, N=40
The probability of being a percolating cluster: P
The probability of lattice element being 1: p
0.0
0.2
0.4
0.6
0.8
1.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80

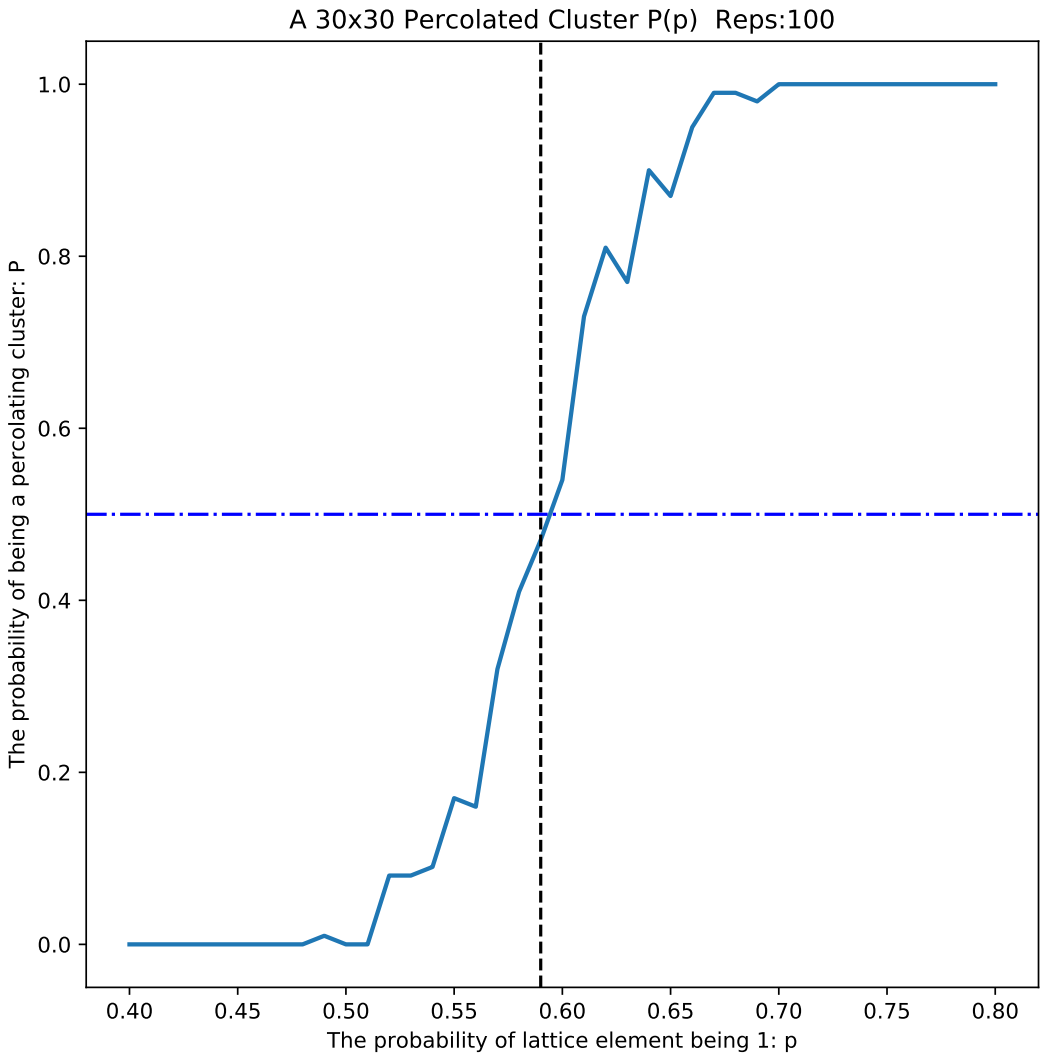

A 5x5 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p

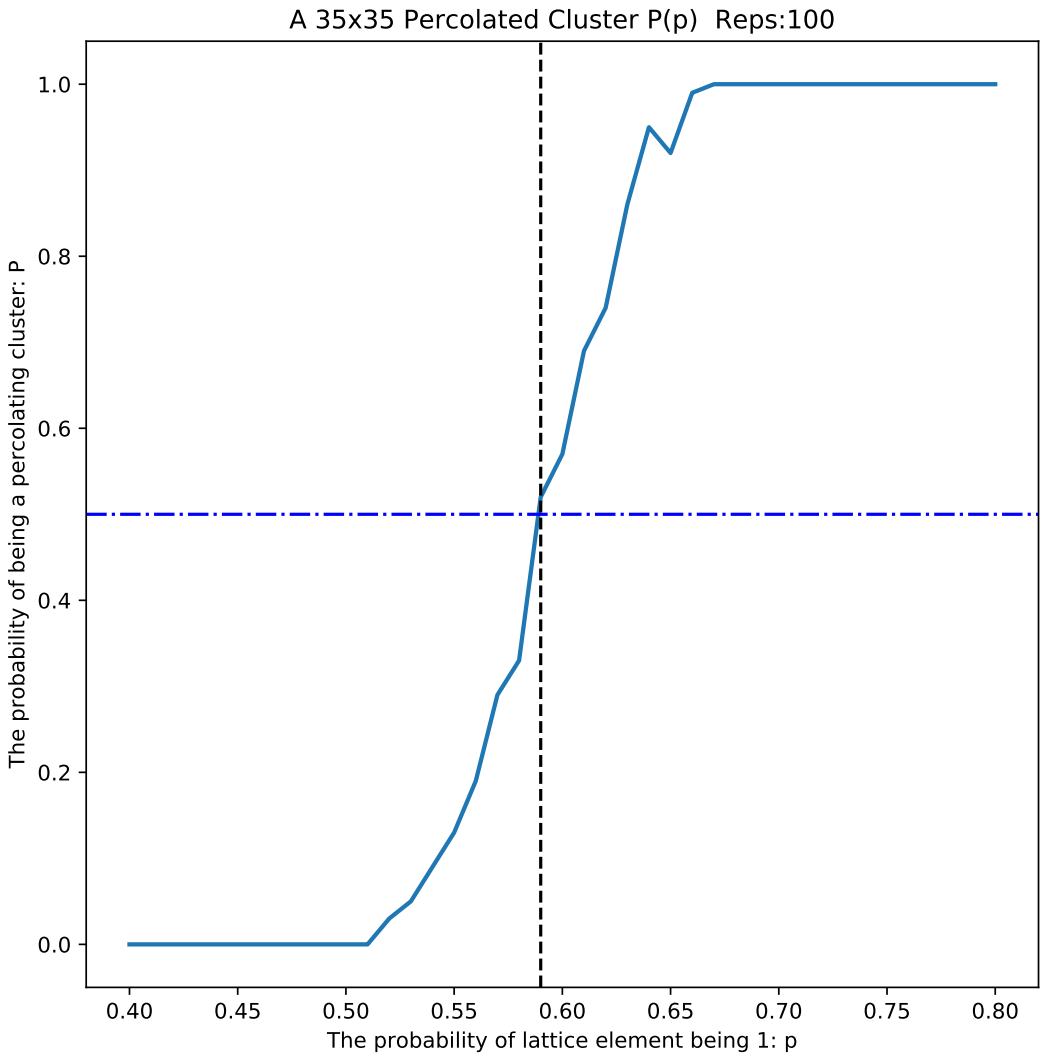

A 10x10 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p

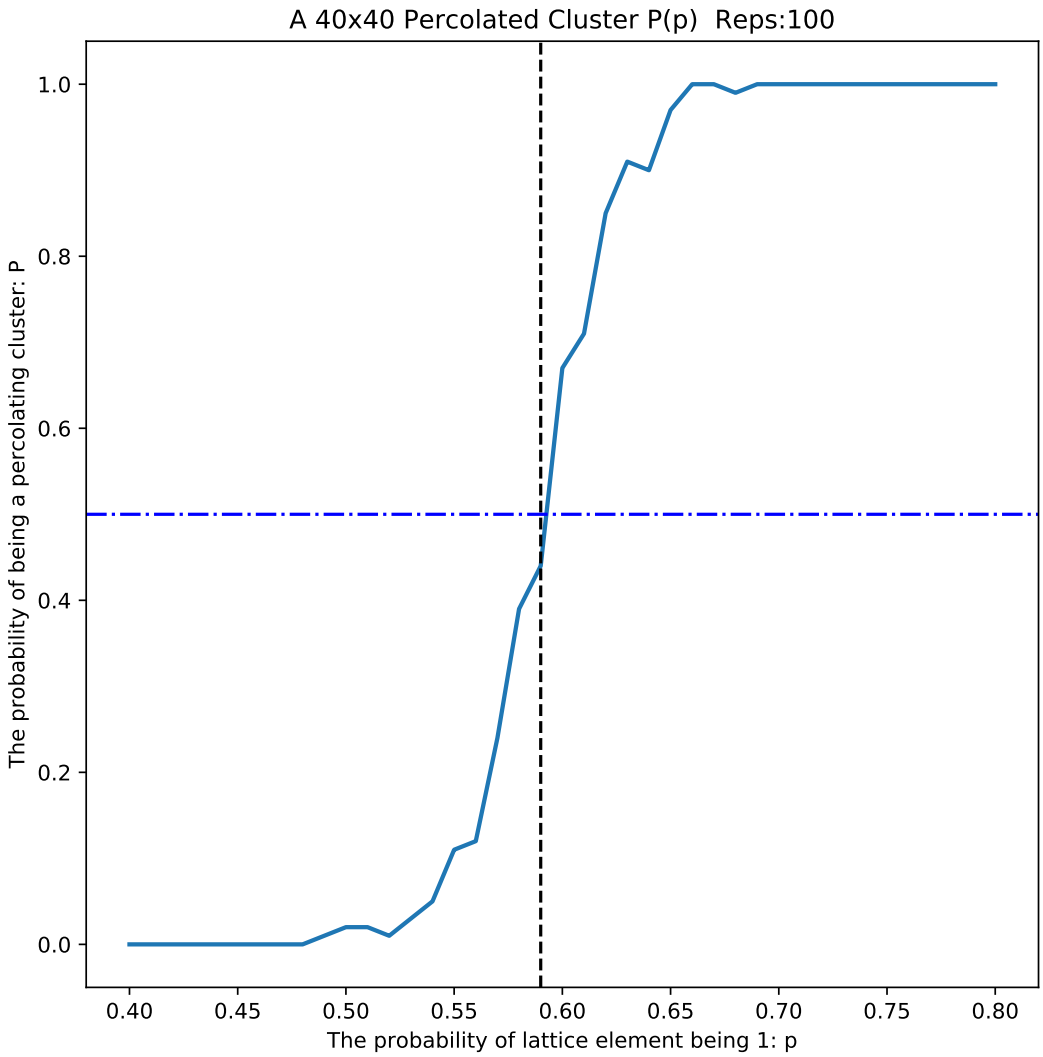

A 15x15 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p


A 20x20 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p


A 25x25 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p


A 30x30 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p


A 35x35 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p


A 40x40 Percolated Cluster P(p) Reps:100
The probability of being a percolating cluster: P
1.0
0.8
0.6
0.4
0.2
0.0
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
0.80
The probability of lattice element being 1: p