GMDL, HW #1

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Exercise 3:

Temp	ZTemp
1	121.23293134406595
1.5	40.922799092745386
2	27.048782764334526

Exercise 4:

Temp	ZTemp
1	365645.7491357704
1.5	10565.42198351426
2	2674.518123060087

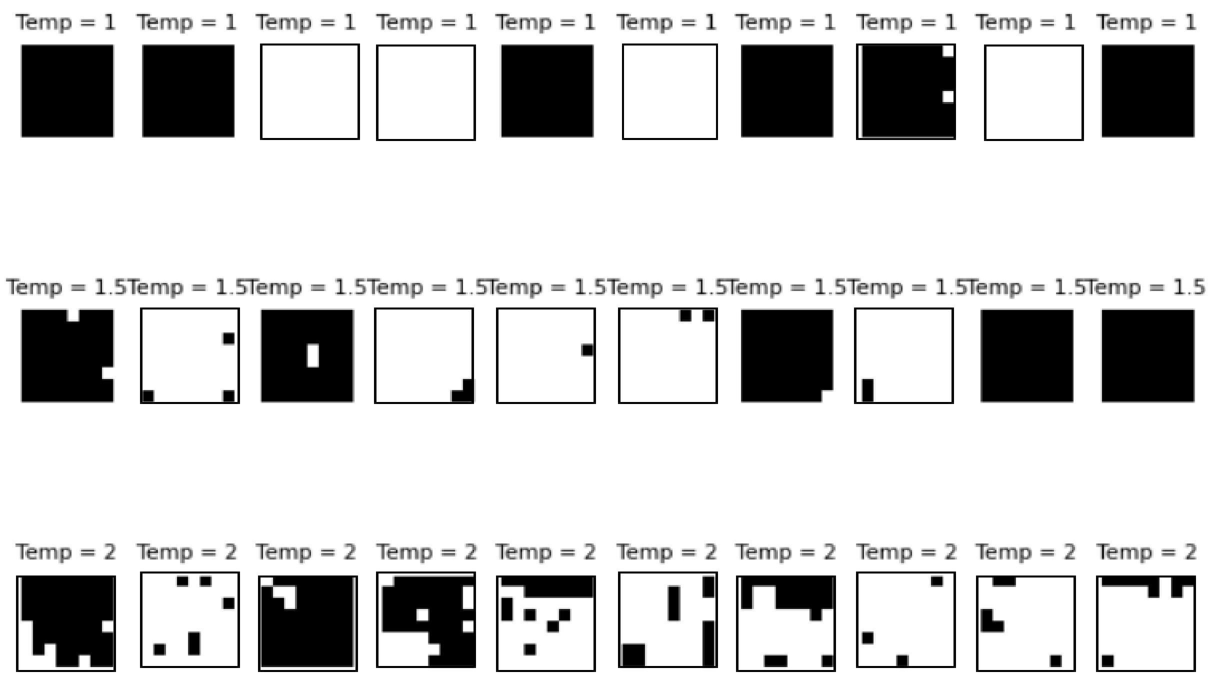
Exercise 5: for 2X2 Lattice

Temp	ZTemp
1	121.23293134406595
1.5	40.922799092745386
2	27.048782764334526

Exercise 6: for 3X3 Lattice

Temp	ZTemp
1	365645.7491357704
1.5	10565.421983514265
2	2674.518123060087

Exercise 7:



<u>Problem 1:</u>

The most likely programming bug is that the student encountered is related to integer division in Python 2. When dividing two integers in Python 2, the result is an integer, which means that any fractional part of the result is truncated. For example, 3/2 in Python 2 would evaluate to 1, whereas in Python 3 it would evaluate to 1.5.

When Temp is set to 2, this ratio would be less than 1.0 for many pairs, which would cause 1/Temp = ½, which is interpreted as 0 due to the integer division. The effect of this bug is that all the probabilities are the same in the samples of each pixel in the image and therefore as we learned in class we obtain the uniform distribution.

Exercise 8:

Temp	$E(X_{(1,1)}X_{(2,2)})$	$E(X_{(1,1)}X_{(8,8)})$
1	0.958	0.904
1.5	0.77	0.542
2	0.494	0.058

Problem 2:

It can be seen that when the temperature is lower, then the chance that $X_{(1,1)} = X_{(2,2)}$ increases (and similarly for $X_{(1,1)} = X_{(8,8)}$). This is because, as we learned in class, as the temperature -> 0, all values of points in the lattice will be the same.

In addition, it can be seen that the chance that X (2,2) = X (1,1) is greater than the chance that X (8,8) = X (1,1) because as the distance between 2 points in the lattice increases, the dependence between them decreases. Therefore we can conclude, accordingly:

$E(X_{(1,1)}X_{(2,2)}) \geq E(X_{(1,1)}X_{(8,8)})$

Exercise 9:

Method 1 Results:

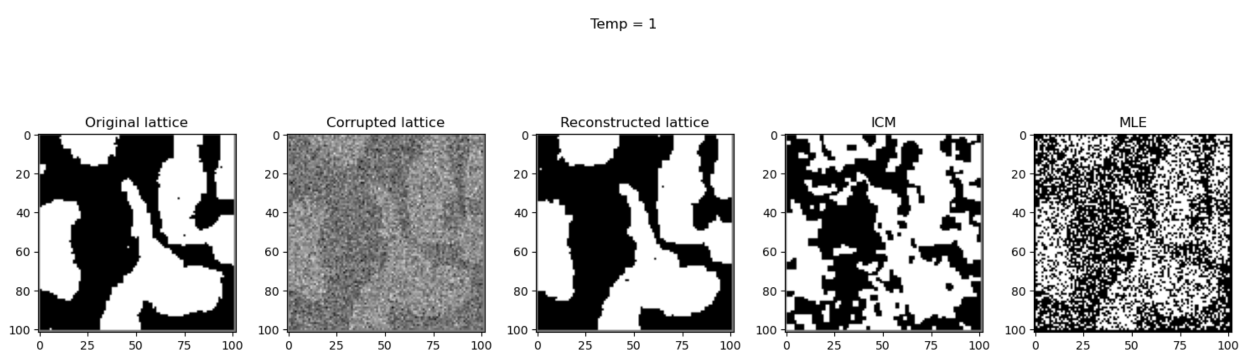
Temp	$E(X_{(1,1)}X_{(2,2)})$	$E(X_{(1,1)}X_{(8,8)})$
1	0.934	0.52
1.5	0.724	0.314
2	0.546	0.158

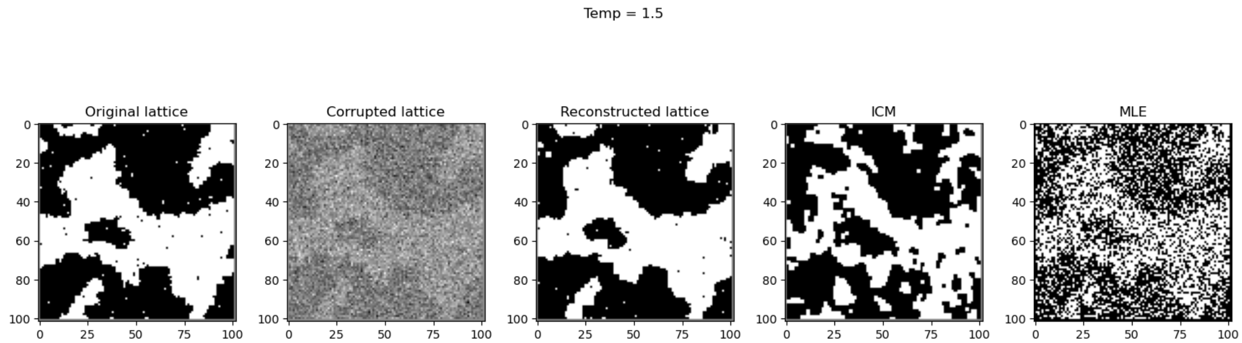
Method 2 Results:

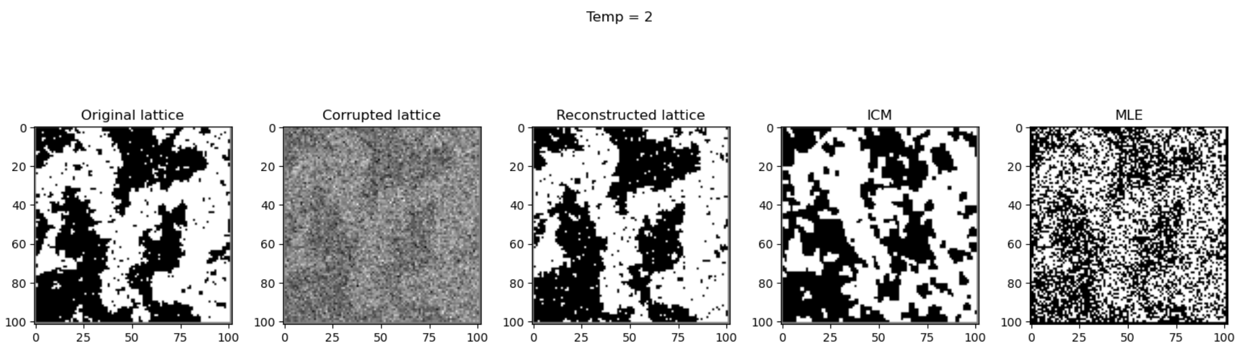
Temp	$E(X_{(1,1)}X_{(2,2)})$	$E(X_{(1,1)}X_{(8,8)})$
1	0.951	0.902
1.5	0.758	0.544
2	0.497	0.108

<u>Problem 3:</u>
As we can see in our results, method 2 better resembles the distribution which we portray in exercise 8.
That is what we expected, because in the class we saw that in Gibbs Sampling:
$p(x^{[t]}, y^{[t]}, z^{[t]}) \rightarrow (as\ t \rightarrow \infty)\ p(x, y, z)$
In method 2 we make only one random initialization and iterate 25,000 sweeps, which is a much larger number of iterations (or sweeps) than the 25 sweeps we made in method 1 for each random initialization of the 10,000.

Exercise 10:




Temp = 1.5
Original lattice
Corrupted lattice
Reconstructed lattice
ICM
MLE


Temp = 2
Original lattice
Corrupted lattice
Reconstructed lattice
ICM
MLE