Due Friday October 16th

1. **python:**

   (a) Bit operations: Explain the results of the following expressions. (Of course, you should confirm your calculations by running the expressions in python.)

   (i) `20 >> 2`

   (ii) `17 << 2`

   (iii) `20 | 17`

   (iv) `20 & 17`

   (b) Find out what an anonymous function (lambda expression) is. Rewrite the following function definition

```
def func1 (x,y):
    if y<0:
        return x**3
    else:
        return x**3 - x*y
```

   in a single line of code, using a lambda expression.

   (c) Using 'map' and a lambda expression, Write a one-line code to produce a list containing the integers $1, 4, 9, 16, \ldots, 400$.

   The first argument of map should be a lambda expression, and the second argument should be something like range(20).

2. **The command line:**

   (a) Explain what the unix/linux/bash command

```
cat file*.txt > newfile.txt
```

   does. Hint: look up 'input/output redirection'. For the meaning of the star (*), look up 'globbing' or 'wildcard'.

   (b) From the unix/linux command line, how would you terminate a process?

3. **Probability distribution of transformed variable:**

Consider the random variate X which is uniformly distributed between 0 and 1, i.e., its probability distribution is

$$P_X(x) = \begin{cases} 1 & \text{for } x \in [0,1] \\ 0 & \text{for } x \notin [0,1]. \end{cases}$$

(a) Show that the variable $Y = \sqrt{e^X - 1}$ has the distribution

$$P_Y(y) = \begin{cases} \dfrac{2y}{y^2+1} & \text{for } y \in [0, \sqrt{e-1}] \\ 0 & \text{for } y \notin [0, \sqrt{e-1}]. \end{cases}$$

(Note how I am careful to specify the support. Please always specify the support if at all relevant.)

(b) Drawing many values of X from the distribution $P_X(x)$, calculate the corresponding Y values and plot a normalized histogram of Y values obtained.

Plot the probability distribution function $P_Y(y)$ on the same plot, to demonstrate that Y is indeed distributed as claimed above.

4. **Phase transitions:**

(a) The 2D Ising model on a square lattice has a phase transition at a certain temperature, $T = T_c$, known as the critical temperature. How does the system behave differently, above this temperature versus below this temperature?

(b) Define the critical exponent for the specific heat and for the correlation length. Sketch a plot of either of these quantities against the temperature.