

## APPLIED MATH 9

### Computational Problem Set 1 for Zero Sum Games

1. Consider a matlab test for the Law of Large Numbers. In matlab,  $y = \text{binornd}(100, 0.2, 1, 10000)$ ; generates an array  $y$  of ten thousand random numbers with the binomial distribution. Each element of the array is independent from all the others. Each binomial random variable can be interpreted as the number of heads obtained when a coin is tossed a certain number of times. Here 100 stands for number of times the coin is tossed 0.2 is the probability of heads. 10000 stands for the number of binomial random variables we generate.  $y$  is the vector of all these random variables. Each component of  $y$  has a value that lies between 0 and 100.

Compute the mean of the first  $k$  samples, where  $k$  ranges from 1 to 10,000:

```
for k = 1 : 10000, Ey(k) = mean(y(1 : k)); end;
```

plot your results (plot(Ey)).

Repeat the same thing with  $y(2 : \text{end}) = y(1)$ .

Compute the ratio of the number of element with  $y = 20$  over total number of samples:

```
for k = 1 : 10000, P(k) = sum(y(1 : k) == 20)/k; end;
```

plot your results.

Compute the variance:

```
for k = 1 : 10000, Var(k) = mean((y(1 : k) - Ey(k)).^2); end;
```

plot your results. You can check your results with matlab function  $\text{var}(y(1 : k))$ , it uses  $k - 1$  instead of  $k$  for normalization.

2. Each matlab command has a help document. By typing "help hist" to find out how to draw a histogram, and draw the histogram of  $y$ . A histogram is just a plot showing how many elements are inside a certain interval.

3. Compute the volume spanned by  $\mathbf{a}$ ,  $\mathbf{b}$ ,  $\mathbf{c}$ , where

$$\mathbf{a} = (3, 2, 1), \mathbf{b} = (0, 2, 1), \mathbf{c} = (1, 2, 3)$$

Thus you must compute the determinant of matrix

$$\begin{pmatrix} 3 & 2 & 1 \\ 0 & 2 & 1 \\ 1 & 2 & 3 \end{pmatrix}.$$