

# Probability and Primes

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## Tools/Review

```
RandomInteger[100]
```

```
81
```

```
RandomInteger[100, 10]
```

```
{48, 48, 96, 54, 10, 100, 35, 23, 94, 61}
```

```
Range[40]
```

```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20,  
21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40}
```

```
PrimeQ[67]
```

```
True
```

```
EvenQ[67]
```

```
False
```

```
Map[f, {1, 2, 3}]
```

```
{f[1], f[2], f[3]}
```

```
tflist = Map[EvenQ, Range[40]]
```

```
{False, True, False, True, False, True, False, True, False, True, False, True, False, True,  
False, True, False, True, False, True, False, True, False, True, False, True, False,  
True, False, True, False, True, False, True, False, True, False, True}
```

```
Count[tflist, False]
```

```
20
```

```
Mean[{3, 4, 5, 6, 7}]
```

```
5
```

Reminder: Making fractions into decimals

```
N[7 / 8]
```

```
0.875
```

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## Putting tools together

Counting number of 5's in a list of 200 randomly chosen numbers less than 10.

```

Count[RandomInteger[10, 200], 5]
18

runs = Table[Count[RandomInteger[10, 200], 5], {8}]
{15, 24, 16, 15, 21, 17, 26, 20}

N[Mean[runs]]
19.25

N[Mean[runs] / 200]
0.08875

N[1 / 10]
0.1

```

Note: This (above) is a mistake....but one I will leave in during the instruction. It will make for a good check of understanding later...see below.

```

trials = 200;
runs = Table[Count[RandomInteger[10, trials], 5], {8}];
N[Mean[runs] / 200]
0.08875

```

Using Table and Module, we can run the experiment as many times as we want.

```

Table[
  trials = 200;
  runs = Table[Count[RandomInteger[10, trials], 5], {8}];
  N[Mean[runs] / 200],
{100}]
{0.08125, 0.09, 0.091875, 0.09, 0.096875, 0.079375, 0.088125, 0.093125, 0.08, 0.0925,
0.091875, 0.08625, 0.08375, 0.09625, 0.103125, 0.08, 0.1075, 0.0875, 0.09625,
0.081875, 0.095625, 0.103125, 0.089375, 0.0825, 0.089375, 0.085, 0.080625, 0.091875,
0.10375, 0.08875, 0.083125, 0.096875, 0.093125, 0.098125, 0.103125, 0.099375,
0.09125, 0.10375, 0.091875, 0.08875, 0.094375, 0.086875, 0.081875, 0.10125, 0.083125,
0.099375, 0.096875, 0.104375, 0.089375, 0.095625, 0.09875, 0.11, 0.09375, 0.099375,
0.110625, 0.08625, 0.09, 0.086875, 0.098125, 0.086875, 0.108125, 0.109375, 0.10125,
0.0925, 0.083125, 0.089375, 0.095, 0.09375, 0.09, 0.076875, 0.085, 0.09, 0.08125,
0.085, 0.094375, 0.095625, 0.08625, 0.079375, 0.116875, 0.084375, 0.07625, 0.099375,
0.083125, 0.095, 0.09875, 0.101875, 0.080625, 0.085625, 0.088125, 0.089375,
0.08625, 0.0925, 0.10125, 0.08875, 0.088125, 0.08, 0.075, 0.10875, 0.08, 0.093125}

```

Finding the average of all of the experiments. This is related to the Central Limit Theorem in Statistics.

```
Mean[
  Table[
    trials = 200;
    runs = Table[Count[RandomInteger[10, trials], 5], {8}];
    N[Mean[runs] / 200],
    {100}
  ]

0.0909813
```

No matter how many times I do this it lingers around 0.09 and doesn't get to 0.1. This is because `RandomInteger` chooses values between 0 and the number rather than 1. So, in this example, the actual probability is  $1/11$ .

```
RandomInteger[10, 20]

{2, 1, 5, 9, 10, 0, 0, 0, 6, 5, 3, 8, 1, 8, 5, 3, 10, 0, 5, 7}

N[1 / 11]

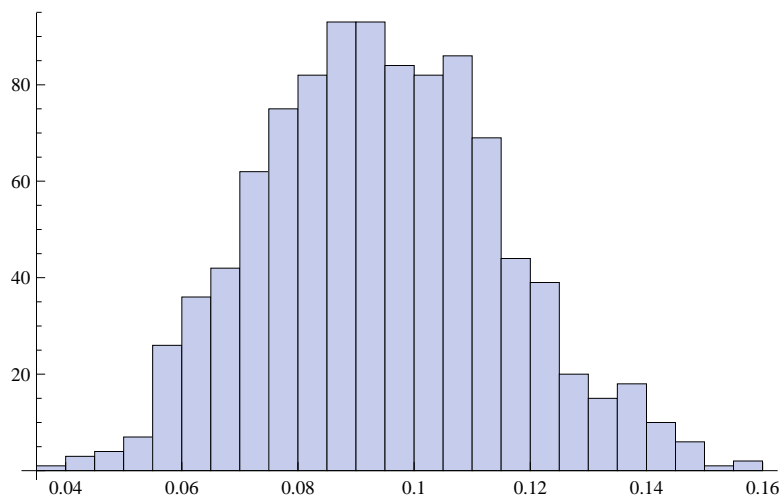
0.0909091
```

## ■ Graphing (maybe include)

To make a Histogram, we have to open the "package" first. This only has to be done once, unless the kernel is quit.

```
Needs["Histograms`"]

trials = 200;
runs = Table[Count[RandomInteger[10, trials], 5] / trials, {1000}];
Histogram[runs]
```



## Task

### ■ Part I

Answer the following using experimental and actual probabilities. Show your code and explain your conclusions in a few sentences.

When randomly selecting a number between 0 and 100, what is the probability of choosing a prime number?

### ■ Part II

Try to organize your code into a short program that will let you run several calculations with one evaluation. Then repeat Part I to find the probability of choosing a prime between (a) 0 and 500 and (b) 0 and 1000.

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