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### MTH 209 Lab 02 ###

# Question 1 #

repeats = 1e4

U  = runif(repeats, min = 0, max = 1)

# let X ~ Bernoulli (1/2) then p = q = 1/2

for(i in 1: repeats) {

    if (U[i] <1/2){

      X[i] = 0

    }

    else{

      X[i] = 1

    }

)

X

mean (X)

var(X)


# sample mean: 0.52

# sample variance: 0.249

# population mean: 0.5

# population variance: 0.25



# poission(4)

lambda = 4

n_samples = 1e4


gen_poisson = function(lambda) {
```

```
  U = runif(1)
  F = 0
  k = 0
  while (F < U) {
    F = F + (lambda^k * exp(-lambda) / factorial(k))
    k = k + 1
  }
  return(k - 1)
}

poisson_samples = replicate(n_samples, gen_poisson(lambda))
mean(gen_poisson(lambda))
var(gen_poisson(lambda))

# Sample Mean: 4.012
# Sample Variance: 3.973456
# Theoretical Mean: 4
# Theoretical Variance: 4

# binomial(10,1/3)
n = 10
p = 1/3
factorial = function(x) {
  if (x == 0) return(1)
  prod(1:x)
}

binom_coeff = function(n, k) {
```

```
  factorial(n) / (factorial(k) * factorial(n - k))
}

gen_binomial = function(n, p) {
  U = runif(1)
  F = 0
  k = 0
  while (F < U) {
    F = F + binom_coeff(n, k) * (p^k) * ((1 - p)^(n - k))
    k = k + 1
  }
  return(k - 1)
}

binomial_samples = replicate(n_samples, gen_binomial(n, p))
mean(gen_binomial(n, p))
var(gen_binomial(n, p))

# Sample Mean: 3.3152
# Sample Variance: 2.223904
# Theoretical Mean: 3.333333
# Theoretical Variance: 2.222222
```