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4/21/18

Code:

```
#Null Hypothesis: System works 50% of the time

import random
import matplotlib.pyplot as plt
import numpy as np

trial_num = 18
success_prob = 0.5
repeat_count = 100

#list to keep track of outcomes in a run
trial = [0]
trial = trial * trial_num

#list to keep track of success frequency
trial_sum = [0]
trial_sum = trial_sum * (trial_num + 1)

for k in range(repeat_count):
```

```
    #run bernoulli trials
    for i in range(trial_num):
        r = random.uniform(0,1)

        if r < success_prob:   #success
            trial[i] = 1
        else:                          #failure
            trial[i] = 0

    s = sum(trial)
    trial_sum[s] += 1

#create bar chart
hor_axis = np.arange(len(trial_sum))
plt.bar(hor_axis, trial_sum, align='center', alpha=0.5)
plt.xticks(hor_axis)
plt.xlabel('Number of Successes')
plt.ylabel('Frequency of Success')
plt.title('Binomial Distribution - Type II')
plt.show()

sig_level = 0.05
min_val = 100
crit_val = 0
prob_sum = 0

for x in range(len(trial_sum),0,-1):
```

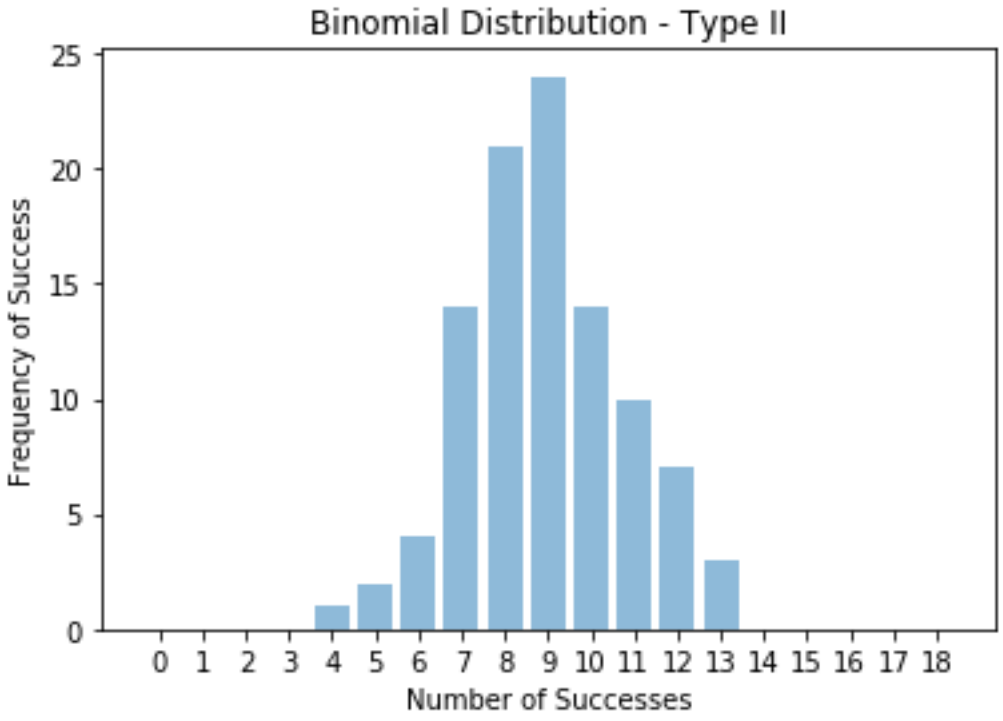
```
    #find probability for each x-value
    index = x-1
    prob = trial_sum[index] / repeat_count
    print("P({ X =",index,"}) =", format(prob,".2f"))

    #find critical value
    prob_sum += prob
    diff = abs(prob_sum - sig_level)
    if diff < min_val:
      min_val = diff
      crit_val = index

#Expected Critical Value: 13
print("Critical Value is", crit_val)



#Alt Hypothesis: System works more than 50% of the time

import random
import matplotlib.pyplot as plt
import numpy as np

trial_num = 18
```

```
crit_val = 13 #value based on result in Proj 4 Part 1
repeat_count = 100

start = 0.55
end = 1.00
increment = 0.05

prob_values = [0]
prob_values = prob_values * 10

power_vals = [0]
power_vals = power_vals * 10

for success_prob in np.arange(start,end+increment,increment):
    prob_values[int((success_prob - start)/increment)] = success_prob

    #list to keep track of outcomes in a run
    trial = [0]
    trial = trial * trial_num

    #list to keep track of success frequency
    trial_sum = [0]
    trial_sum = trial_sum * (trial_num + 1)

    for k in range(repeat_count):
        #run bernoulli trials
        for i in range(trial_num):
            r = random.uniform(0,1)
```

```
        if r < success_prob:   #success
            trial[i] = 1
        else:                          #failure
            trial[i] = 0

    s = sum(trial)
    trial_sum[s] += 1

print("Probability of Success:",success_prob)

#create bar chart
hor_axis = np.arange(len(trial_sum))
plt.bar(hor_axis, trial_sum, align='center', alpha=0.5)
plt.xticks(hor_axis)
plt.xlabel('Number of Successes')
plt.ylabel('Frequency of Success')
plt.title('Binomial Distribution - Type II')
plt.show()

prob_sum = 0
for z in range(crit_val):
    #find probability for each x-value
    prob = trial_sum[z] / repeat_count
    print("P({ X =",z,"}) =", format(prob,".2f"))
    prob_sum += prob

print("Beta value:",format(prob_sum,".2f"))
```

```
    power = 1 - prob_sum
    print("Power value:",format(power,".2f"))
    power_vals[int((success_prob - start)/increment)] = power
    print(" ")

plt.plot(prob_values, power_vals)
plt.title('The Power of the Test')
plt.xlabel('Success Probabilities')
plt.ylabel('Power Levels')
plt.show()
```

Output:



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P({ X = 12 }) = 0.07

P({ X = 11 }) = 0.10

P({ X = 10 }) = 0.14

P({ X = 9 }) = 0.24

P({ X = 8 }) = 0.21

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P({ X = 6 }) = 0.04

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P({ X = 4 }) = 0.01

P({ X = 3 }) = 0.00

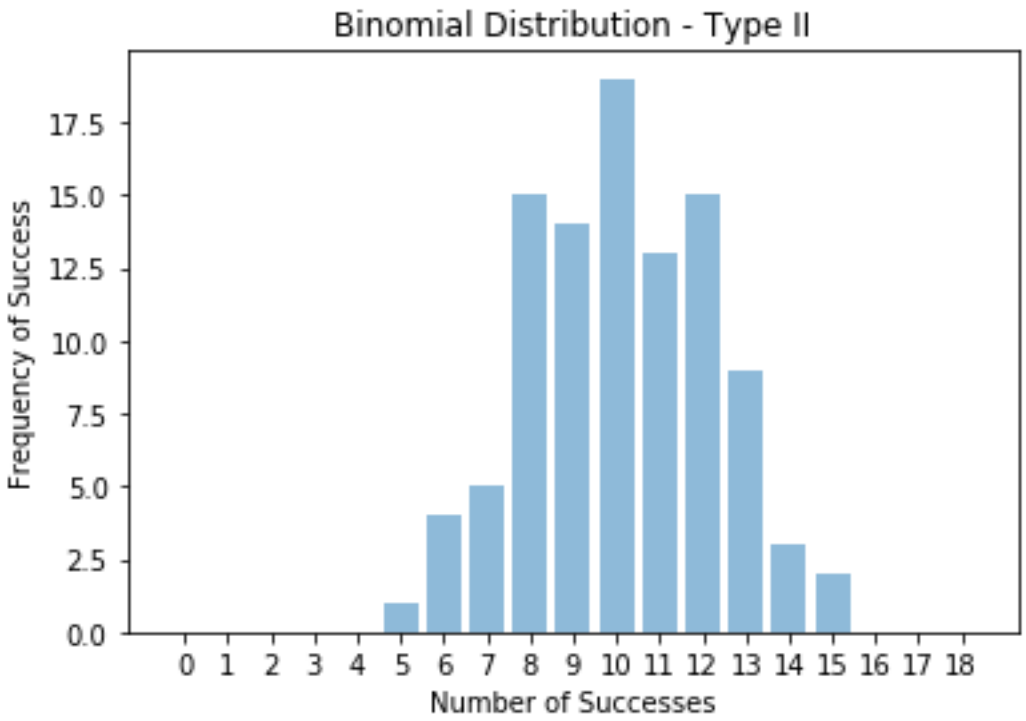
P({ X = 2 }) = 0.00

P({ X = 1 }) = 0.00

P({ X = 0 }) = 0.00

Critical Value is 13

Probability of Success: 0.55



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P({ X = 7 }) = 0.05

P({ X = 8 }) = 0.15

P({ X = 9 }) = 0.14

P({ X = 10 }) = 0.19

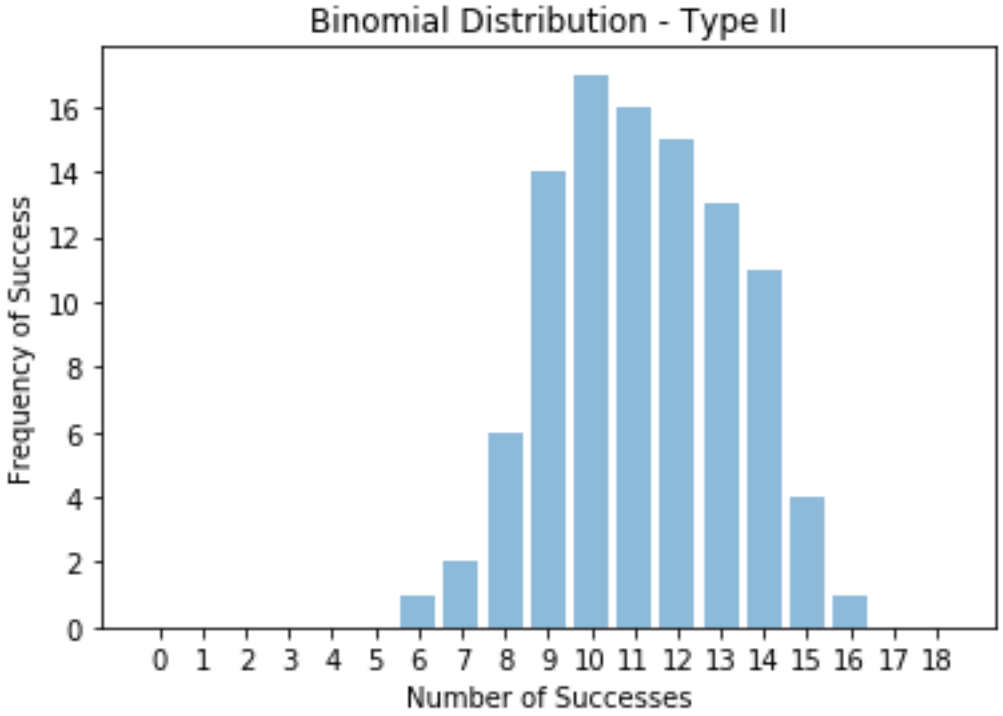
P({ X = 11 }) = 0.13

P({ X = 12 }) = 0.15

Beta value: 0.86

Power value: 0.14

Probability of Success: 0.6



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P({ X = 9 }) = 0.14

P({ X = 10 }) = 0.17

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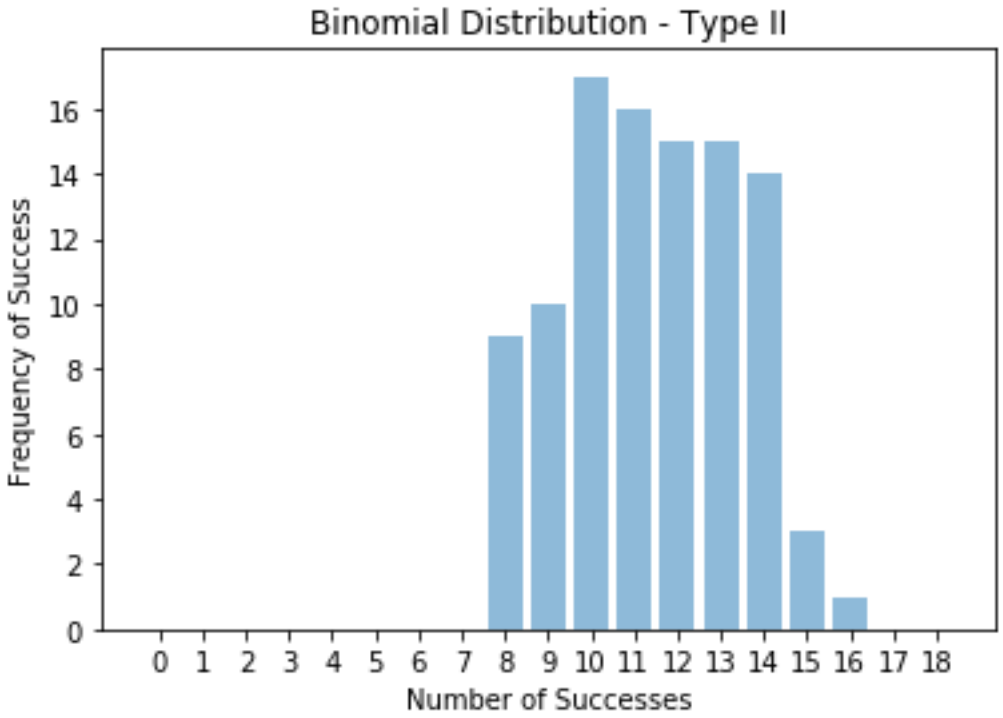
P({ X = 12 }) = 0.15

Beta value: 0.71

Power value: 0.29

Probability of Success: 0.65



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P({ X = 6 }) = 0.00

P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.09

P({ X = 9 }) = 0.10

P({ X = 10 }) = 0.17

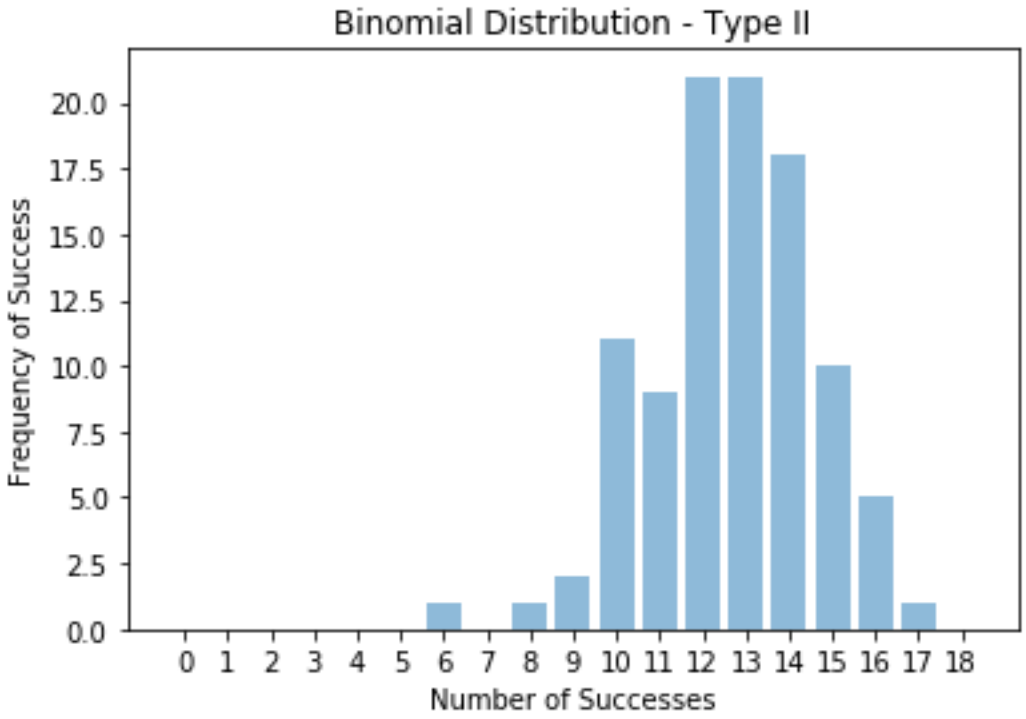
P({ X = 11 }) = 0.16

P({ X = 12 }) = 0.15

Beta value: 0.67

Power value: 0.33

Probability of Success: 0.7



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P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.01

P({ X = 9 }) = 0.02

P({ X = 10 }) = 0.11

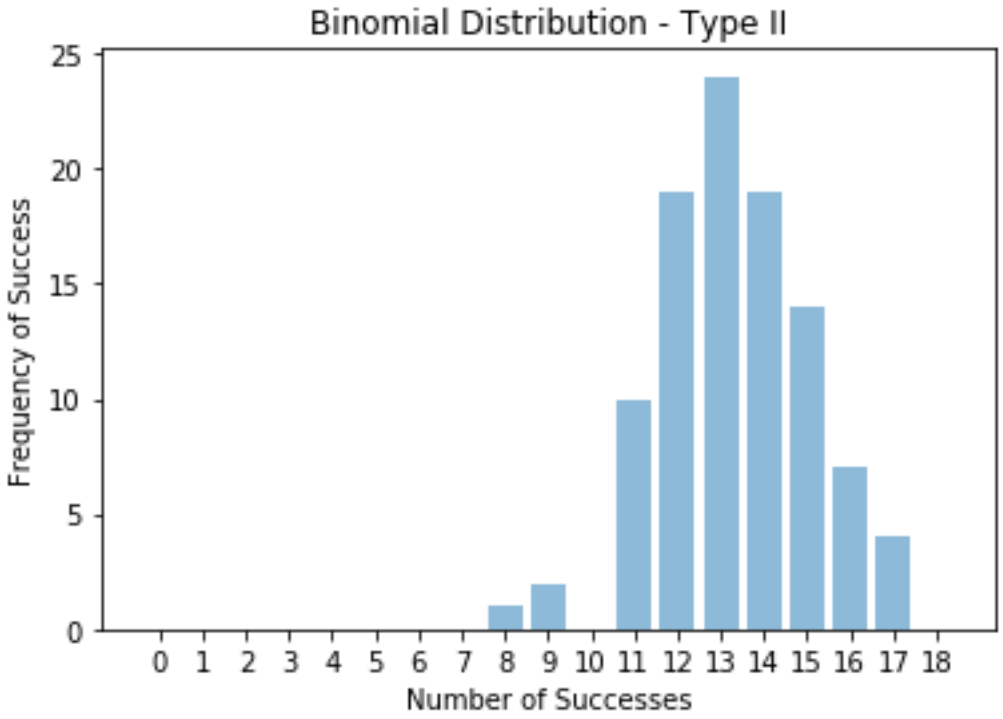
P({ X = 11 }) = 0.09

P({ X = 12 }) = 0.21

Beta value: 0.45

Power value: 0.55

Probability of Success: 0.75



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P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.01

P({ X = 9 }) = 0.02

P({ X = 10 }) = 0.00

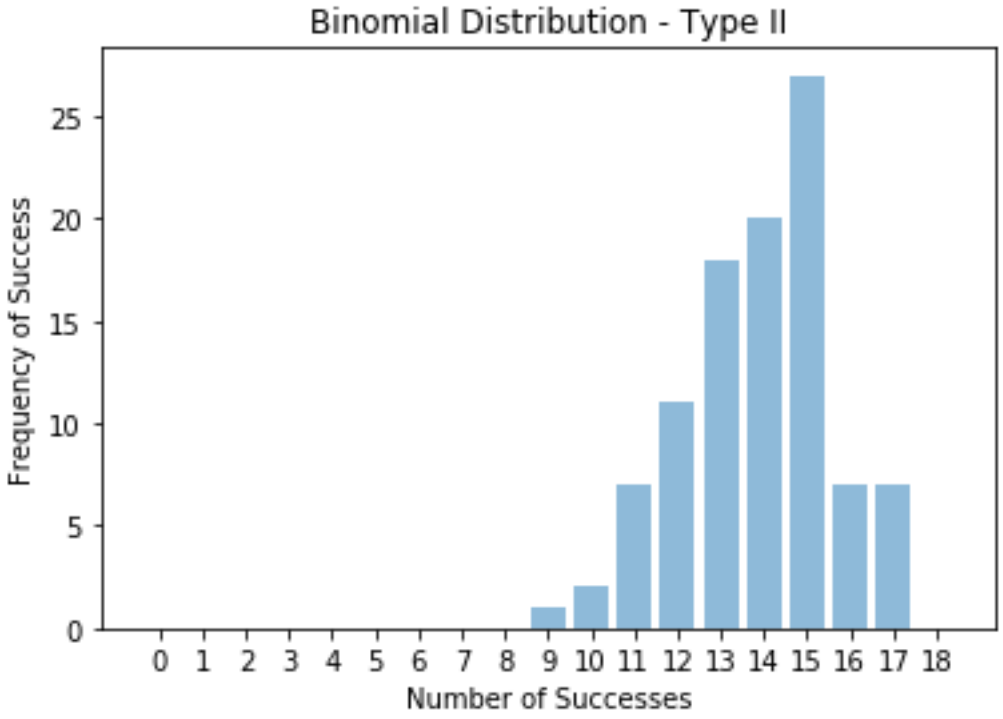
P({ X = 11 }) = 0.10

P({ X = 12 }) = 0.19

Beta value: 0.32

Power value: 0.68

Probability of Success: 0.8



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P({ X = 6 }) = 0.00

P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.00

P({ X = 9 }) = 0.01

P({ X = 10 }) = 0.02

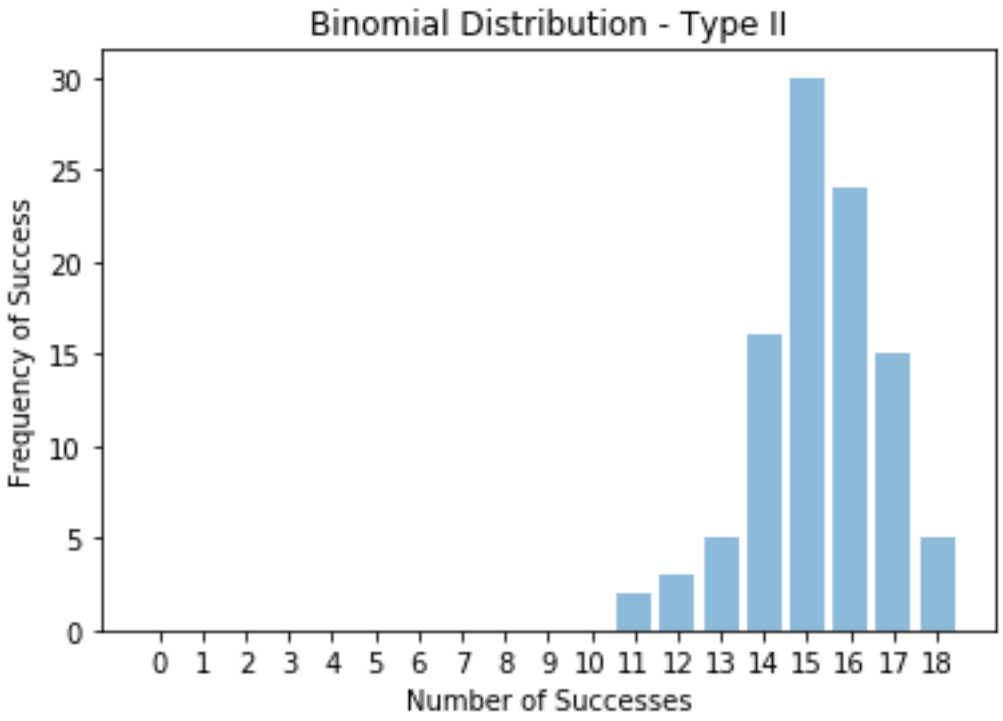
P({ X = 11 }) = 0.07

P({ X = 12 }) = 0.11

Beta value: 0.21

Power value: 0.79

Probability of Success: 0.85



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P({ X = 9 }) = 0.00

P({ X = 10 }) = 0.00

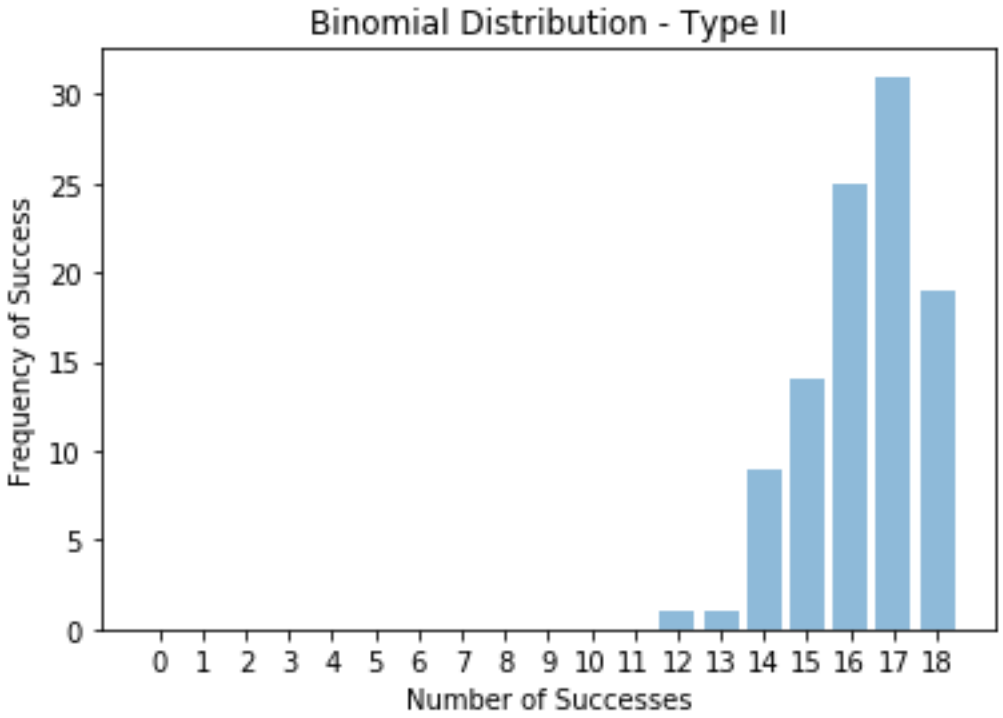
P({ X = 11 }) = 0.02

P({ X = 12 }) = 0.03

Beta value: 0.05

Power value: 0.95

Probability of Success: 0.9



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P({ X = 6 }) = 0.00

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P({ X = 8 }) = 0.00

P({ X = 9 }) = 0.00

P({ X = 10 }) = 0.00

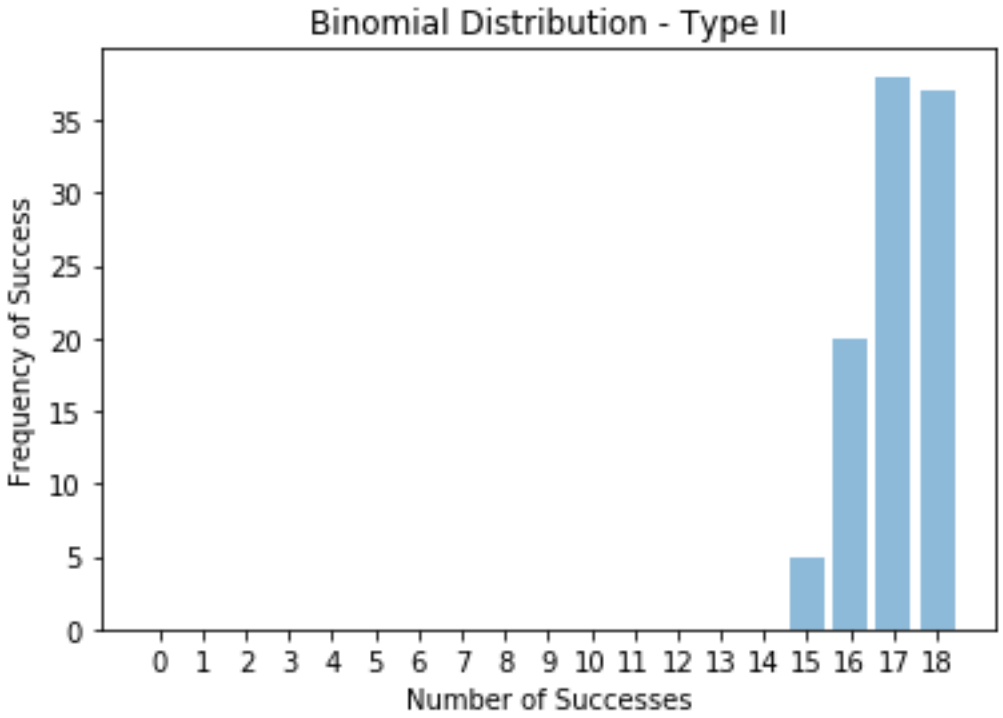
P({ X = 11 }) = 0.00

P({ X = 12 }) = 0.01

Beta value: 0.01

Power value: 0.99

Probability of Success: 0.95



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P({ X = 6 }) = 0.00

P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.00

P({ X = 9 }) = 0.00

P({ X = 10 }) = 0.00

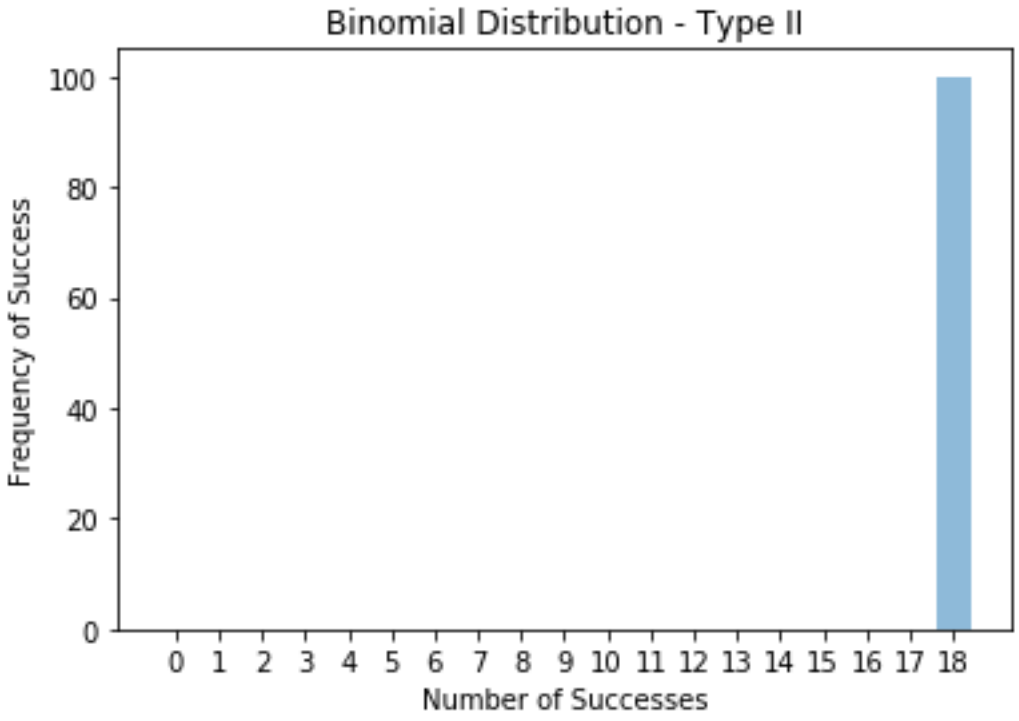
P({ X = 11 }) = 0.00

P({ X = 12 }) = 0.00

Beta value: 0.00

Power value: 1.00

Probability of Success: 1.0



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P({ X = 7 }) = 0.00

P({ X = 8 }) = 0.00

P({ X = 9 }) = 0.00

P({ X = 10 }) = 0.00

P({ X = 11 }) = 0.00

P({ X = 12 }) = 0.00

Beta value: 0.00

Power value: 1.00