CN_sheet_6_katja

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1 Problem Set 6: Stochastic Theory of Spike Production

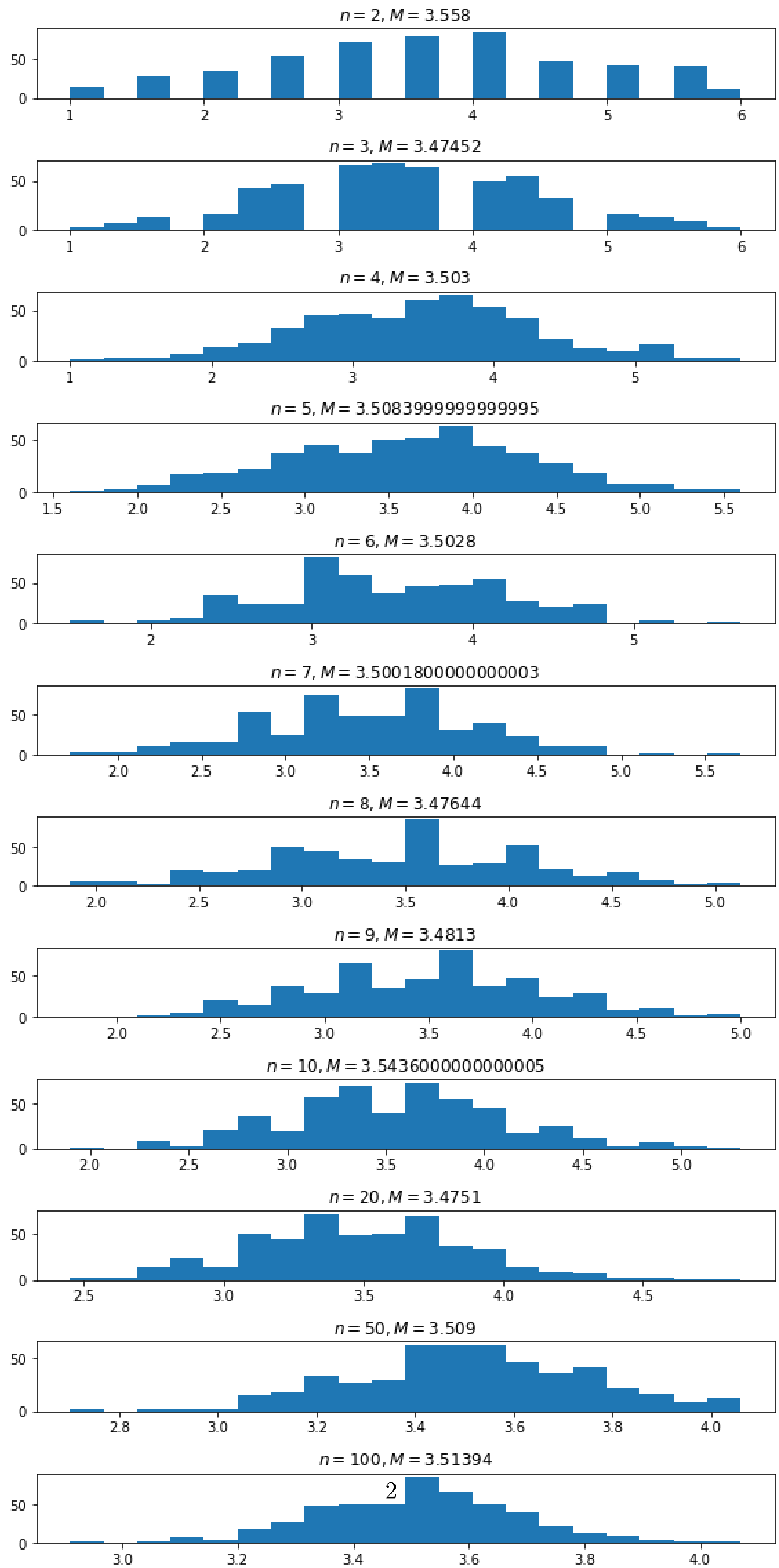
[1]:
```
import numpy as np
from matplotlib import pyplot as plt
```

1.1 Problem 1: Rolling a dice

[41]:
```
n = np.concatenate((np.arange(2, 10+1), np.array([20, 50, 100])))
rep = 500

fig, ax = plt.subplots(len(n), figsize=(8,16))

dice_means = np.zeros((rep, len(n)))
for i in range(len(n)):
    dice_results = np.zeros((rep, n[i]))
    for j in range(rep):
        for k in range(n[i]):
            dice_results[j, k] = np.random.randint(6) + 1
    dice_mean = np.mean(dice_results, axis = 1)
    ax[i].hist(dice_mean, bins = 20)
    ax[i].set_title('$n = {}, M = {}$'.format(n[i], np.mean(np.round(dice_mean,␣
↪2))))
    dice_means[:, i] = dice_mean
plt.tight_layout()
```


$n = 2, M = 3.558$
$n = 3, M = 3.47452$
$n = 4, M = 3.503$
$n = 5, M = 3.5083999999999995$
$n = 6, M = 3.5028$
$n = 7, M = 3.5001800000000003$
$n = 8, M = 3.47644$
$n = 9, M = 3.4813$
$n = 10, M = 3.5436000000000005$
$n = 20, M = 3.4751$
$n = 50, M = 3.509$
$n = 100, M = 3.51394$

With increasing nuber of dice, the mean dice throw fluctuates less and less around the expected value of 3.5 (with the mean value of the sampled distributions more accurately reflecting the true mean) and therefore the distribution of the man dice throw becomes more and more narrow and approaches a normal distribution with the variance given by the standard error of the mean $\frac{\sigma^2}{n}$.

1.2 Problem 3: The diffusion approximation

Incoming excitatory and inhibitory jumps can replaced by a Guassian white noise diffusion term because in a network there will be many different inputs coming in roughly at the same time and therefore sum up to an average input that is approximately normally distributed. According to the CLT, this only holds when (1) the inputs are independently distributed (which in a network could be problematic) and (2) the inputs have finite variance (which I would say should be fine because physiology limits the variance of the inputs).