Concepts Covered:

Binomial Distribution

Problem statement

80% of all the visitors to Lavista Museum end up buying souvenirs from the souvenir shop at the Museum. On the coming Sunday, if a random sample of 10 visitors is picked:

- 1. Find the probability that every visitor will end up buying from the souvenir shop
- 2. Find the probability that a maximum of 7 visitors will buy souvenirs from the souvenir shop

Let's check first whether we satisfy the assumptions of the binomial distribution.

- There are only two possible outcomes (success or failure) for each trial. A visitor will buy souvenirs from the souvenir shop or not (yes or no).
- Number of trials (n) is fixed - There are 10 visitors in the sample.
- Each trial is independent of the other trials - It is reasonable to assume that the buying activity of visitors is independent.
- The probability of success (p) is the same for each trial - The probability of success for each visitor is 0.8.

Continuous Uniform Distribution

Problem statement

IT industry records the amount of time a software engineer needs to fix a bug in the initial phase of software development in 'debugging.csv'.

Let

X = Time needed to fix bugs

X is a continuous random variable. Let's see the distribution of X and answer the below questions.

1. Find the probability that a randomly selected software debugging requires less than three hours
2. Find the probability that a randomly selected software debugging requires more than two hours
3. Find the 50th percentile of the software debugging time

Reading the Data into the Dataframe

```
debugging = pd.read_csv("debugging.csv")
debugging.head()
```

	Bug ID	Time Taken to fix the bug
0	12986	2.42
1	12987	2.03
2	12988	2.74
3	12989	3.21
4	12990	3.40

Normal Distribution

Problem statement

A testing agency wants to analyze the complexity of SAT Exam 2020. They have collected the SAT scores of 1000 students in "sat_score.csv". Let's answer some of the questions that will help to decide the complexity of SAT exam 2020.

1. Calculate the probability that a student will score less than 800 in SAT exam
2. Calculate the probability that a student will score more than 1300 in SAT exam
3. Calculate the minimum marks a student must score in order to secure 90th percentile
4. Calculate the minimum marks a student must score in order to be in the top 5%

Reading the Data into the Dataframe

```
sat_score = pd.read_csv("sat_score.csv")
sat_score.head()
```

	student_id	score
0	1	1018
1	2	1218
2	3	611
3	4	723
4	5	541

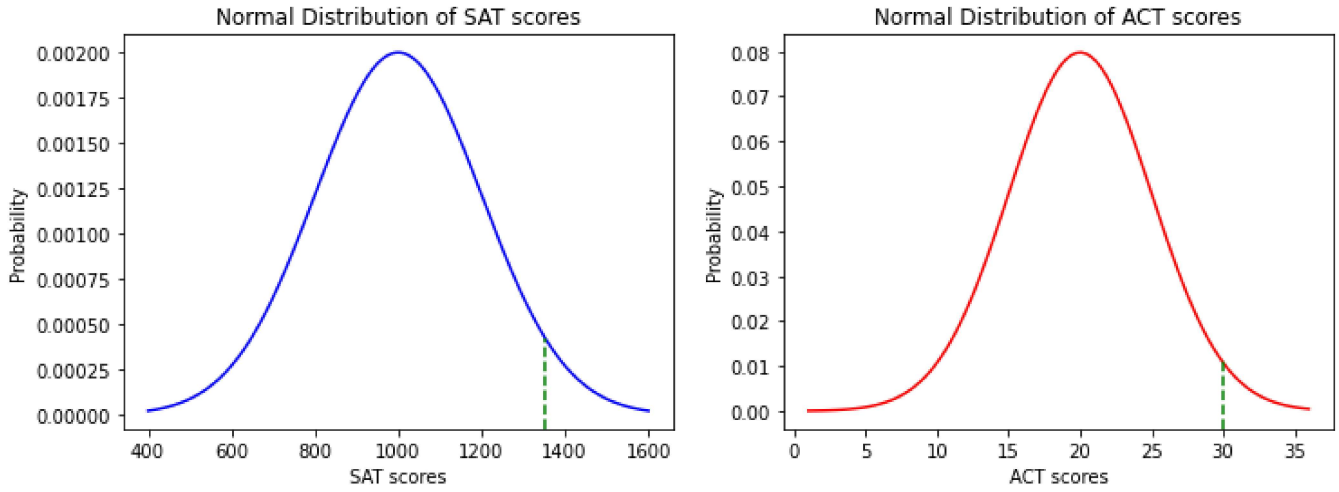
Standardization of Normal Variables

Suppose we know that the SAT scores are normally distributed with mean 1000 and standard deviation 200 and ACT scores are normally distributed with mean 20 and standard deviation 5.

A college provides admission only on the basis of SAT and ACT scores. The college admin decides to give the top performer fellowship to the student who has performed the best among all applicants. The highest score received from applicants who appeared for SAT is 1350 and the highest score received from applicants who appeared for ACT is 30.

Help the college to choose the best candidate for the fellowship!

```
# plot the two distribution for SAT and ACT scores
from scipy.stats import norm
fig, (ax1, ax2) = plt.subplots(1,2, figsize = (12,4))
x = np.linspace(400, 1600, 1000)
ax1.plot(x, norm.pdf(x, loc = 1000, scale = 200), color = 'b')
ax1.set_title('Normal Distribution of SAT scores')
ax1.set_xlabel('SAT scores')
ax1.set_ylabel('Probability')
ax1.axvline(1350, ymax = 0.23, linestyle = '--', color = 'green')
x1 = np.linspace(1, 36, 100)
ax2.plot(x1, norm.pdf(x1, loc = 20, scale = 5), color = 'r')
ax2.set_title('Normal Distribution of ACT scores')
ax2.set_xlabel('ACT scores')
ax2.set_ylabel('Probability')
ax2.axvline(30, ymax = 0.18, linestyle = '--', color = 'green')
plt.show()
```



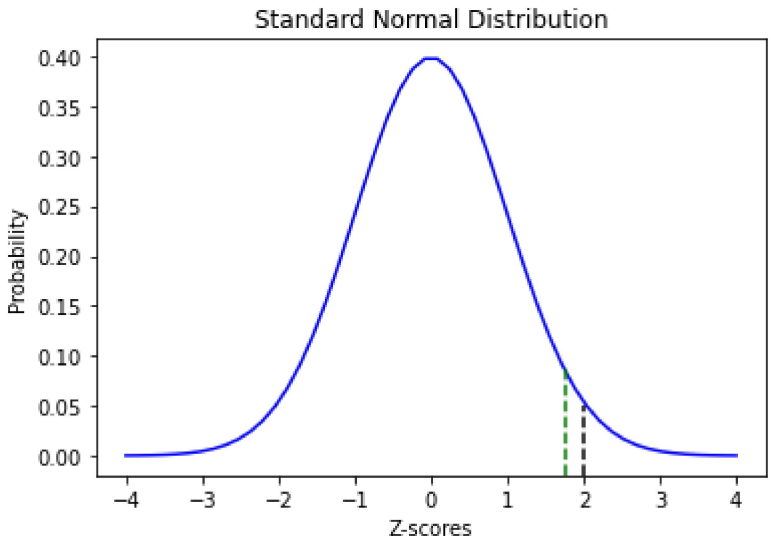
In the above plot, the blue curve represents the distribution of SAT scores and the red curve represents the distribution of ACT scores. The highest scores of the applicants in SAT and ACT exams are dotted with green lines in the respective distributions. However, it is difficult for us to compare the raw highest scores in the above plot. Thus, we need to standardize the two scores and compare their Z-scores.

```
# find the Z-score of highest scorer in SAT among all the applicants
top_sat = (1350 - 1000) / 200
print('The Z-score of highest scorer in SAT among all the applicants', top_sat)
# find the Z-score of highest scorer in ACT among all the applicants
top_act = (30 - 20) / 5
print('The Z-score of highest scorer in ACT among all the applicants', top_act)
```

```
The Z-score of highest scorer in SAT among all the applicants 1.75
The Z-score of highest scorer in ACT among all the applicants 2.0
```

Let's plot the standard normal distribution and visualize the above standardized scores.

```
# plot the standard normal distribution
# and visualize the standardized scores
# We are plotting the distributions here to better visualize the calculations.
fig, ax = plt.subplots()
x = np.linspace(-4,4,50)
ax.plot(x, norm.pdf(x, loc = 0, scale = 1), color = 'b')
ax.set_title('Standard Normal Distribution')
ax.set_xlabel('Z-scores')
ax.set_ylabel('Probability')
ax.axvline(top_sat, ymax = 0.25, linestyle = '--', color = 'green')
ax.axvline(top_act, ymax = 0.16, linestyle = '--', color = 'black')
plt.show()
```



In the above plot, the green line represents the standardized highest SAT score of the applicants which is 1.75 standard deviations above the mean and the black line represents the standardized highest ACT score of the applicants which is 2 standard deviations above the mean.

This means that among the applicants, the highest scorer in ACT performed better than the highest scorer in SAT.

Thus, the top performer fellowship should be given to the applicant who has scored highest in ACT.