Law of large numbers

Formula

- The law suggests that as the number of trials increase, the sample average gets closer to it's expected value.
- Let X be a discrete random variable. The formula is given as

$$\mathbb{E}[X] = \sum_{i=1}^{n} x_i P(x_i)$$

where the first term represents a value and the latter its probability.

Example calculation

- For example, let's call X the obtained number when rolling a six sided dice. Therefore, its expected value is

$$\mathbb{E}[X] = \frac{1}{6}(1 + 2 + 3 + 4 + 5 + 6) = 3.5$$

Simulation

In [1]:

```
import random
import matplotlib.pyplot as plt
```

In [2]:

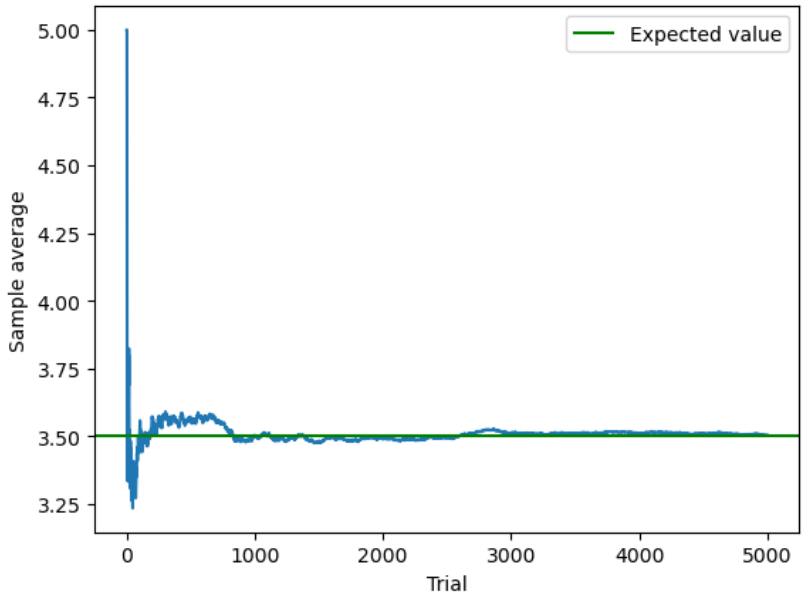
```
# Create lists to store the samples and their averages
samples = []
averages = []
```

In [3]:

```
# Number of simulations
num_simulations = 5000

# Sides on the dice
num_sides = 6

# Simulate the rolls
for i in range(num_simulations):
    roll = random.randint(1, num_sides)
    samples.append(roll)

for i in range(num_simulations):
    sample = samples[0:i+1]
    averages.append(sum(sample)/len(sample))
```

In [4]:

```
plt.plot(averages)
plt.ylabel('Sample average')
plt.xlabel('Trial')
plt.axhline(y = 3.5, color = 'g', label = "Expected value")
plt.legend()

plt.show()
```



- It can clearly be seen that the sample average tends to get closer to the expected value of X.