PLD 9

Bernoulli Distribution

AFRICAN LEADERSHIP UNIVERSITY

TODAY'S AGENDA

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8. Python with Numpy

THE TEAM

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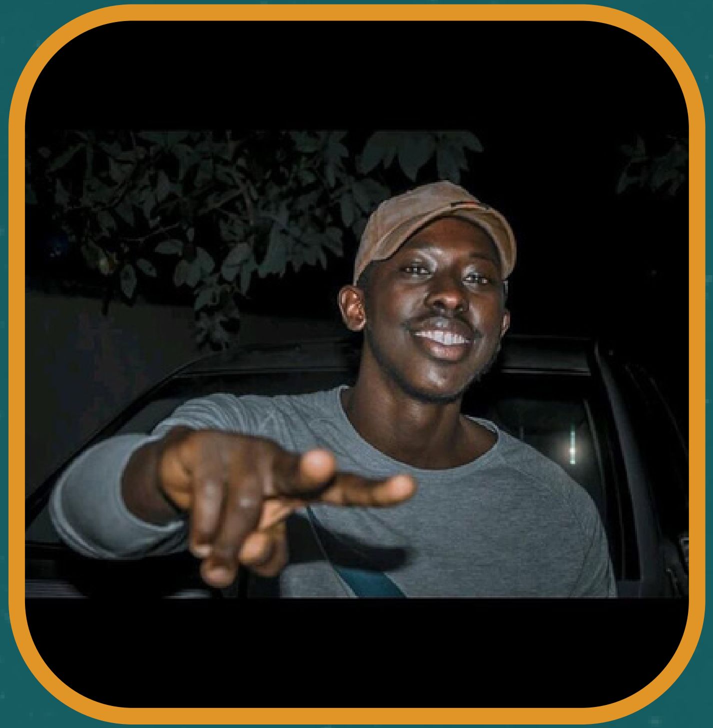

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INTRODUCTION

According to Sinharay (2010), The Bernoulli distribution is the most basic discrete distribution. A variable that follows the distribution can take one of two possible values, 1 (usually called a success) or 0 (failure), where the probability of success is p, $0 < p < 1$. An example of a Bernoulli random variable (that is a variable that follows the Bernoulli distribution) is the outcome of a coin toss, where the outcome is either a head (success) or a tail (failure) and the probability of a head is a number between 0 and 1.

Bernoulli Distribution formula

The Bernoulli distribution uses the following notation:

- p = the probability of success.
- q = the probability of failure ($1 - p$).

The probability of success and failure must sum to 1 because each trial must always end with a success or failure: $p + q = 1$. Therefore, using simple algebra, the probability of failure (q) equals $1 - p$.

A Probability Mass Function (PMF) describes the distribution of outcomes for a discrete probability function like the Bernoulli distribution. Typically, the outcomes are denoted as $k = 1$ for a success and $k = 0$ for a failure.

The PMF below describes the probability of each outcome in the Bernoulli distribution:

$$f(k;p) = \begin{cases} p & \text{if } k = 1, \\ q = 1 - p & \text{if } k = 0. \end{cases}$$

EXAMPLE

A BASKETBALL PLAYER CAN SHOOT A BALL INTO THE BASKET WITH A PROBABILITY OF P = 0.6. WE WANT TO FIND THE PROBABILITY THAT HE MISSES THE SHOT.

SOLUTION:

1. DEFINE THE RANDOM VARIABLE XXX SUCH THAT X=1X = 1X=1 REPRESENTS A SUCCESSFUL SHOT (THE PLAYER MAKES THE BASKET), AND X=0 REPRESENTS A MISSED SHOT.
2. GIVEN THE PROBABILITY OF SUCCESS P(X=1) = P= 0.6 P(X = 1) = P = 0.6.
3. THE PROBABILITY OF FAILURE (MISSING THE SHOT) IS P(X = 0) = 1−P. SO, P(X = 0) = 1 − 0.6 = 0.4

THUS, THE PROBABILITY THAT THE PLAYER MISSES THE SHOT IS 0.4.

Example of the Bernoulli Distribution

Check the full code in this Github Repo:

Bernoulli_PLD9

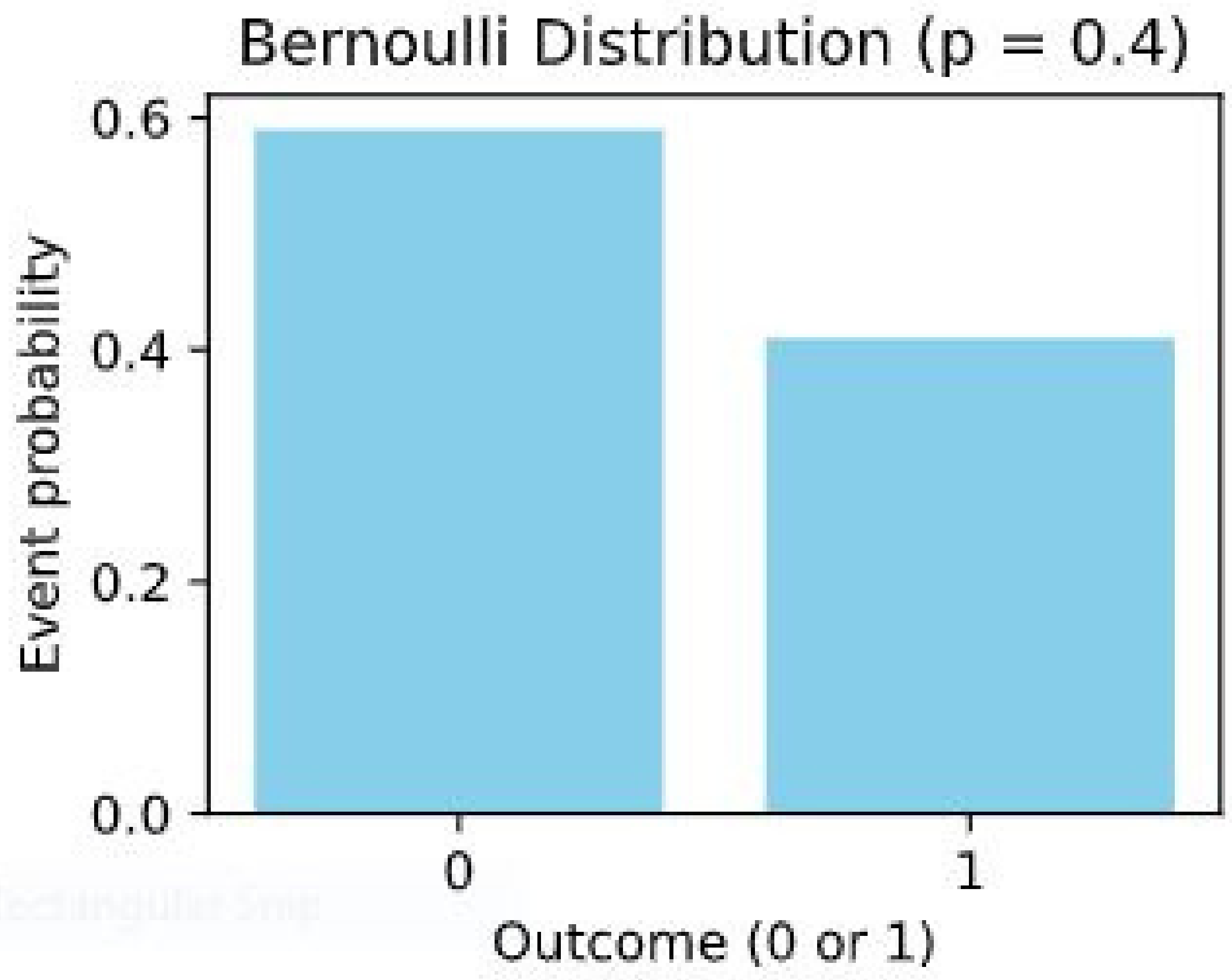
```
# Parameters
n_experiments = 100
p = 0.4

# Simulate Bernoulli trials
bernoulli_trials = np.random.binomial(1, p, n_experiments)  # n=1

# Count the occurrences of 0s and 1s
outcomes, counts = np.unique(bernoulli_trials, return_counts=True)

# Calculate the probabilities of each outcome
event_prob = counts / n_experiments

# Plot the results
plt.bar(outcomes, event_prob, color='skyblue')
plt.xlabel('Outcome (0 or 1)')
plt.ylabel('Event probability')
plt.title('Bernoulli Distribution (p = 0.4)')
plt.xticks([0, 1])
plt.show()
```



Python code example implemented with numpy only

```
# Set the probability of getting heads (success) for the Bernoulli distribution
p_heads = 0.5

# Simulate flipping a coin 1 time
# The size parameter determines the shape of the output array
coin_flips = np.random.binomial(n=1, p=p_heads, size=3)

# Map the results to 'Heads' or 'Tails'
results = np.where(coin_flips == 1, 'Heads', 'Tails')

print("Coin flips:", coin_flips)
print("Results:", results)
```

```
Coin flips: [0 1 1]
Results: ['Tails' 'Heads' 'Heads']
```

REFERENCES

Bernoulli Distribution - Definition, formula, graph, examples. (n.d.-b). Cuemath. https://www.cuemath.com/data/bernoulli-distribution/

Sinharay, S. (2010). Discrete probability distributions. In Elsevier eBooks (pp. 132–134). https://doi.org/10.1016/b978-0-08-044894-7.01721-8

THANK YOU!

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