

# PHSX815 Project 3 PR Input: Maximum Likelihood Estimation

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## Revisiting Urns

In this project, I will take random samples from an urn, which has an unknown distribution, and try to which urn someone selected from an ensemble of urns. Let's assume the urn contains 10000 marbles composed of 2 colors (White and Black).

Suppose we generate 3 urns, each with a different ratio of White to Black marbles. We can "blindfold" ourselves and have a friend shuffle the urns and hand us one of them.

Next, we take  $n$  samples of 1000 marbles each from each urn. We can then calculate the fraction of White(Black) to the total number of marbles drawn. We can then plot histograms of the White(Black) fractions for each urn, then calculate the likelihood and maximum likelihood for each urn.

Figure 1 is a histogram based on a sample run of 30 trials per urn which each urn containing 10000 marbles. As we can see, it seems we should be able to distinguish significantly Urn 3 from Urns 1 and 2. However, the maximum count for Urns 1 and 2 appear to have different maximum counts from each other, but only until later analysis will we be able to calculate the likelihood of drawing from which given  $n$  draws.

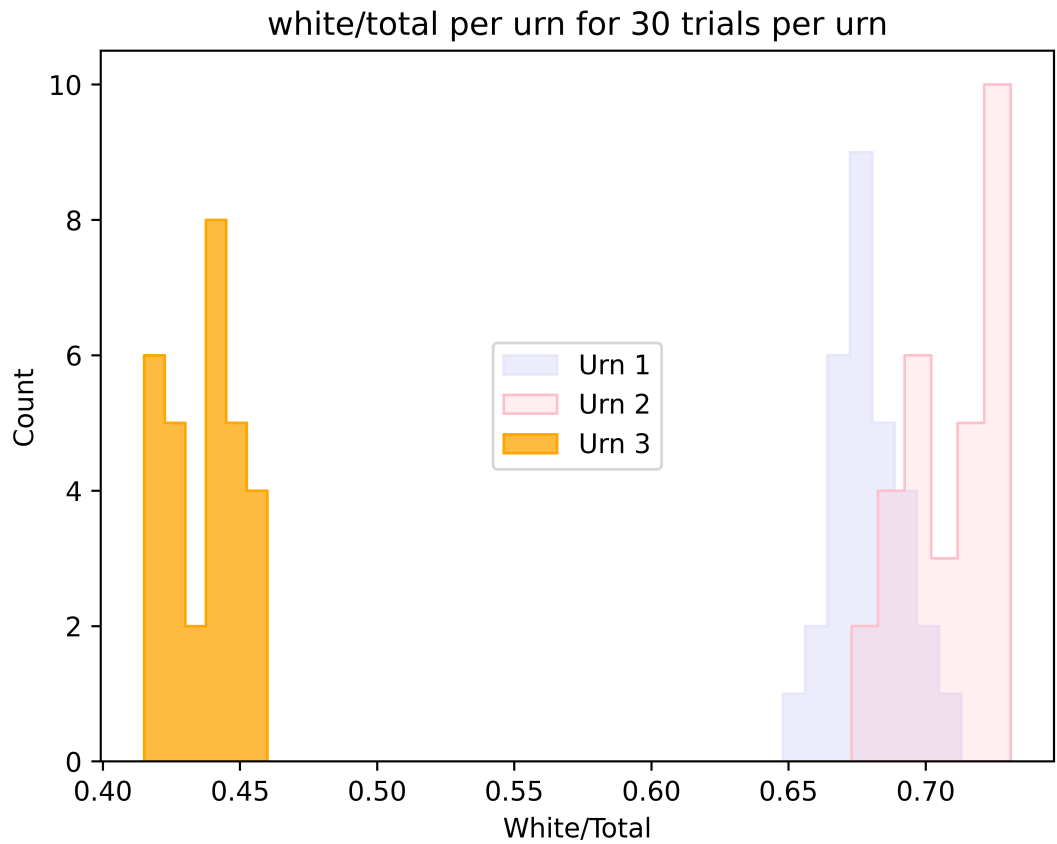


Figure 1: Distribution of White marble fractions for each urn

## Code

Below is a link to a Jupyter notebook with code snippets that will generate the urns and do the sampling. It is largely based on code from previous projects with some modification

[Jupyter notebook with some code snippets for Project 3](#)