

# Guessing Shoe Sizes

## Game Instructions

This game deals naturally with important concepts in statistical thinking and machine learning:

- loss functions
- streaming data
- exploration vs. exploitation
- diminishing returns
- inference and uncertainty
- latent variables

The goal of this game is to use “noisy measurements” to guess (“infer”) the true but hidden value of the shoe size of your opponent.

As so often in real life, you face an **explore/exploit** tradeoff, where (i) you pay a price to collect more data, but (ii) the risk of a bad guess also decreases.

The sequential rolling of dice can be looked upon as inference on streaming data which are very common in online marketing campaigns.

### Start of the game:

1. Team up in pairs; randomly assign
2. player A writes down his/her shoe size  $\mu$  as an integer number between 5 and 15 on a piece of paper and hides it from player B. Note that this number does not have to be your real shoe size.

### Version 1: Actual dice At each turn $n$ :

3. player A tosses a die (hidden from player B) and computes the **running average**  $\bar{x}_n$  in a (hidden) spreadsheet or notebook or paper ...
4. player B is told only the sum  $\mu + \bar{x}_n$  and now has two options:
  - continue the game to another round  $n + 1$  and hence reduce his/her potential win of  $100 - n$
  - end the game by proclaiming an educated guess  $\mu_0$  for  $\mu$ .

**0/1 Loss** If correct ( $\mu_0 = \mu$ ), player A wins  $100 - n$  points otherwise **nothing**

**Squared Loss** player A wins  $(100 - n) - 5(\mu_0 - \mu)^2$  points.

**Version 2: Software dice** player A and B now switch roles and start from scratch, but we replace the actual die with the python *numpy random* module.

Extra Challenge: Find the **optimal number of tosses** !

			True Shoe size	
toss	die	Running Sum	Running Avg	Reported Size
1				
2				
3				
4				
5				
6				
7				
8				
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