

Probability and Computing

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Why Randomness?

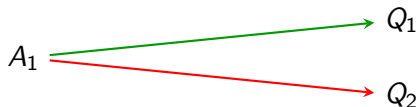
An **Adversarial** Game

YOU (A_1, A_2)

TESTER (Q_1, Q_2)

Deterministic Strategy

YOU submit A_1 , the TESTER gives Q_2



Why Randomness?

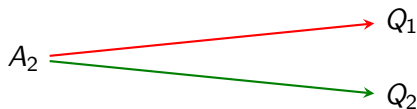
An **Adversarial** Game

YOU (A_1, A_2)

TESTER (Q_1, Q_2)

Deterministic Strategy

YOU submit A_2 , the TESTER gives Q_1



$$\Pr[\text{success}] = 0$$

Worst Case Behavior

Why Randomness?

An **Adversarial** Game

YOU (A_1, A_2)

TESTER (Q_1, Q_2)

Randomized Strategy

Choose randomly between A_1 and A_2

$(A_1, A_2) \longrightarrow (Q_1, Q_2)$

$$\Pr[\text{success}] = \frac{1}{2}$$

Expected Behavior

Randomness and Probability in Computing

Randomness: simpler and faster algorithms

Input $\rightarrow \{Algorithm\}_{randomness} \rightarrow \{Output\}_{randomness}$
(Expected Behavior)

Probability: The tool to understand and play with Randomness.

Course Contents

Based on Mitzenmacher M, Upfal E. [Probability and Computing: Randomized Algorithms and Probabilistic Analysis](#). Cambridge University Press; 2005.

First Half:

- 1 Events and Probability
- 2 Discrete Random Variables and Expectation
- 3 Moments and Deviations
- 4 Chernoff Bounds
- 5 Balls, Bins and Random Graphs
- 6 The Probabilistic Method
- 7 Markov Chains and Random Walks

Second Half:

- 1 Continuous Distributions and Poisson Process
- 2 Entropy, Randomness and Information
- 3 The Monte Carlo Method
- 4 Coupling of Markov Chains
- 5 Martingales
- 6 Pairwise Independence and Universal Hash Functions
- 7 Balanced Allocations

- ① Probability Space: Sample Space, Events and Probability Function
- ② Axioms of Probability
- ③ Monty Hall Problem