CIS 635 Knowledge Discovery & Data Mining

Basics of Probability

Standard vs AI solutions

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- Will it snow tomorrow? What are the chances?
- Who is going to win in the next NFL games between Texans vs Ravens?
- Translate the following into “French”:
  - *“English and French are two European languages; they have a lot in common; however they also possess a lot of differences, especially when we talk about conjugations, contractions and gender usages.”*

Standard vs AI solutions

- Difference between a regular/standard and an AI/ML algorithm
  - Regular/standard algorithms (Deterministic)
  - AI/ML algorithms (non deterministic, lives with uncertainty)
  - Probability theory is the branch of Math that talks about uncertainty.

Standard vs AI solutions

- Fill in the Gaps
    - I am very ……???…….

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    - It's already 7pm; I have been working since early morning, I am very ……???……

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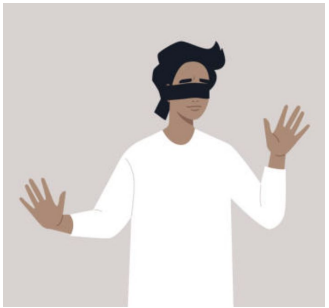
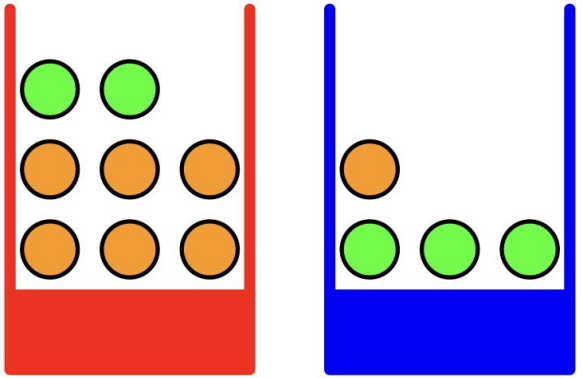
- Additional context can help us reduce uncertainty
- “**Probability**” is the branch of **Mathematics** which helps us quantify, measure, and explain uncertainty

Basics of Probability

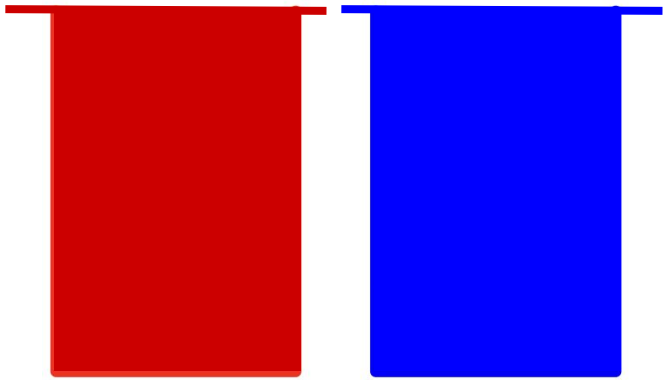
- There are some orange and green balls in a red and blue box
- Someone (blinded) picked up a ball and it found to be with color orange
- ***What is is probability that the ball came from the red box?***





Basics of Probability

- Let’s say, we have two boxes of mixed oranges and apples (as depicted in the right)



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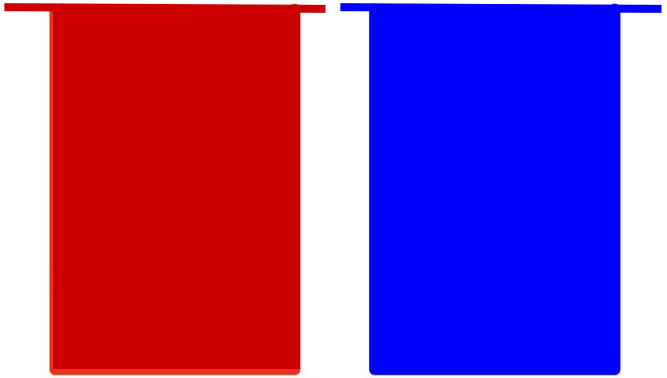

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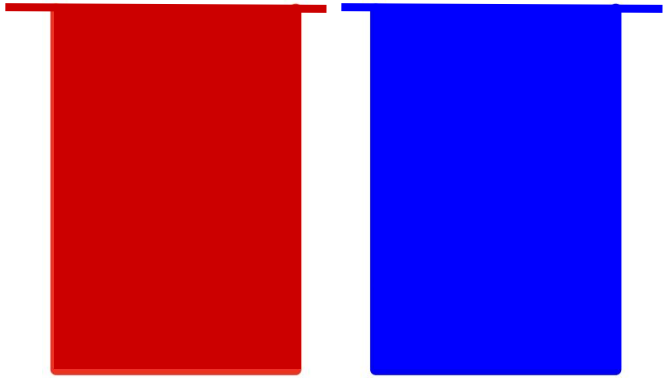
- If you don’t have any **Bias** (say color, or the location of the boxes, etc), assigning a 50%-50% preference is a reasonable assumption



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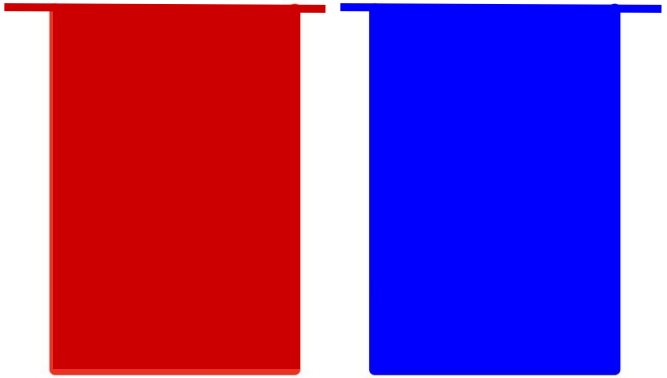
- This is generally known as **“Uniform distribution”** assumption



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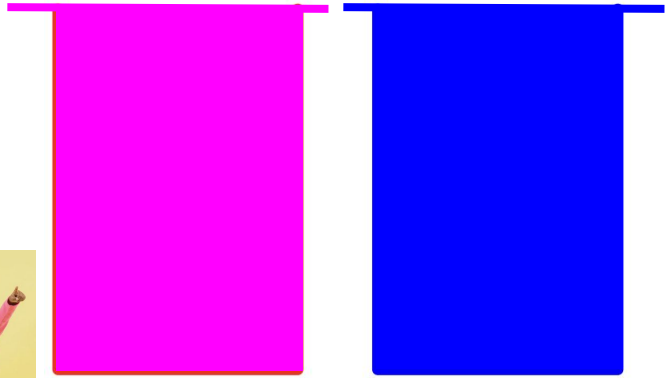
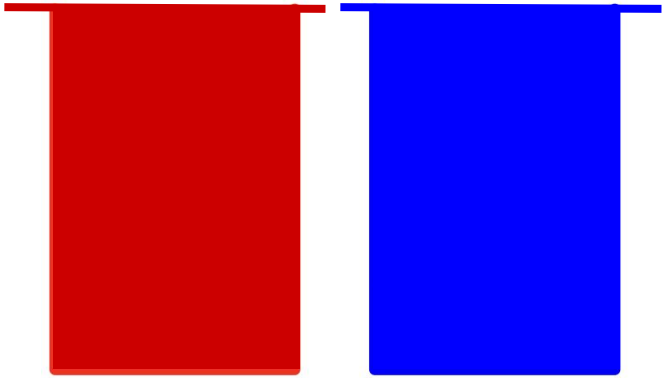
- **“Uniform distribution”** assumption is no more true…



What if ???

Basics of Probability

- Let's say, we have two boxes of mixed oranges and apples (as depicted in the right)
- For some unknown reason when some people were asked to choose a fruit from one these two (2) boxes, people preferred the **Blue box (60%)** and the **Red one (40%)** of the time.



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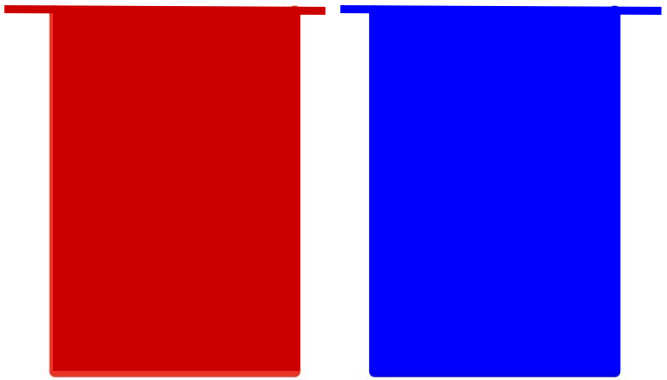
- For some unknown reason when some people were asked to choose a fruit from one these two (2) boxes, people preferred the Blue box (60%) and the red one (40%) of the time.
  - So we have Two **Random variables**:
    - Box (B), and
    - Fruit (F)
  - Probability of choosing the Red box is, **p(B=r) = 40/100 = 0.4**
  - Probability of choosing the Blue box is, **p(B=b) = 60/100 = 0.6**



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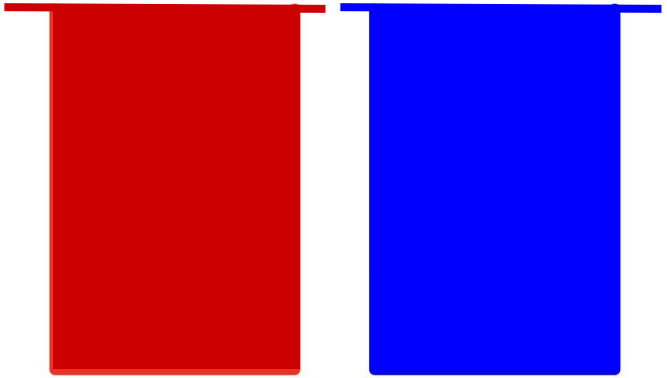
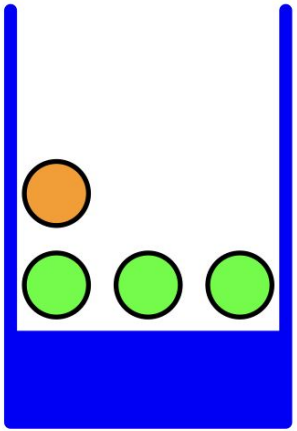
  - **p(B=r) + p(B=b) = 1 (Summation rule)**
    - *Two boxes are completely independent and disjoint*



Basics of Probability

Let's open the boxes, and explore the fruits inside, and explain the content in terms of probabilities.

- p(F=a|B=b) = ¾ = 0.75
- p(F=o|B=b)= ¼ = 0.25
- p(F=a|B=b) + p(F=o|B=b)=1



Basics of Probability

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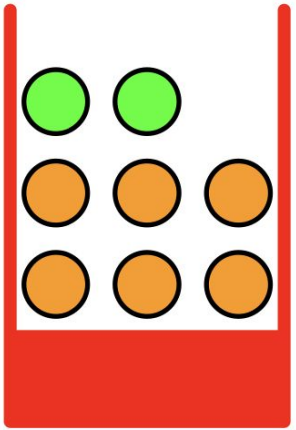
- p(F=a|B=r) = 2/8 = 0.25
- p(F=o|B=b)= 6/8 = 0.75
- p(F=a|B=r) + p(F=o|B=r)=1



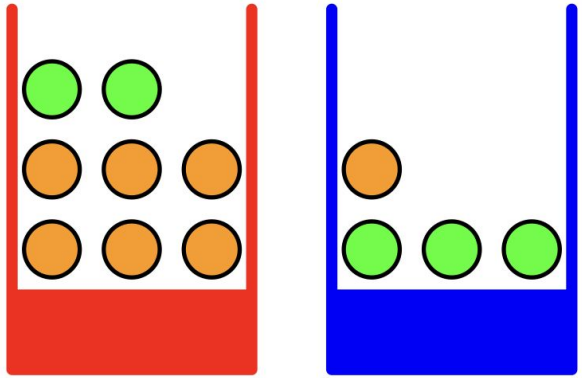
Basics of Probability

Let's open the boxes, and explore the fruits inside, and explain the content in terms of probabilities.

$$p(F=a) = p(F=a|B=r)\, p(B=r) + p(F=a|B=b)p(B=b)$$

$$= 0.25*0.4 + 0.75*0.6$$

$$= 0.55$$

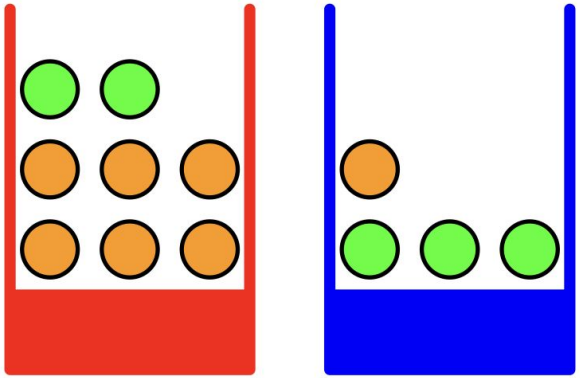


Basics of Probability

$$p(B = r|F = o) = \frac{p(F = o|B = r)p(B = r)}{p(F = o)}$$

$$= \frac{3}{4} \times \frac{4}{10} \times \frac{20}{9} = \frac{2}{3}.$$

Bayes' rule/theorem



What we have learned

- Differences between Standard vs AI solutions
- Uncertainty is attached to AI solutions
- Probability theory is to a tool to explain and manipulate Uncertainty
- Some Basics of Probability theory
    - Summation Rule
    - Bayes Rule
- Our Probability journey starts here