Probability Cheat Sheet

1 Basic Probability Concepts

- **Experiment**: A process that leads to an outcome (e.g., rolling a die).
- **Sample Space (S)**: The set of all possible outcomes.
- Example: Rolling a die → S={1,2,3,4,5,6}S = \{1, 2, 3, 4, 5, 6\}S={1,2,3,4,5,6}
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- **Event (E)**: A subset of the sample space.
- Example: Rolling an even number → E={2,4,6}E = \{2, 4, 6\}E={2,4,6}
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Types of Events

- **Independent Events**: Events that do not affect each other.
- **Dependent Events**: Events where the outcome of one affects the other.
- **Mutually Exclusive Events**: Events that cannot happen together.
- Example: Rolling a 3 and rolling a 5 simultaneously → E1∩E2= E_1 \cap E_2 = \emptysetE1∩E2=
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- **Exhaustive Events**: Events that cover the entire sample space.

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2 Definition of Combinatorial Probability

- **Combinatorial Probability Formula**: P(E)=Number of Favorable OutcomesTotal Possible OutcomesP(E) = \frac{\text{Number of Favorable Outcomes}}{\text{Total Possible Outcomes}}P(E)=Total Possible OutcomesNumber of Favorable Outcomes

Permutations & Combinations

- **Permutation (Order Matters)**: P(n,r)=n!(n−r)!P(n, r) = \frac{n!}{(n-r)!}P(n,r)=(n−r)!n!
- **Combination (Order Doesn't Matter)**: C(n,r)=n!r!(n−r)!C(n, r) = \frac{n!}{r!(n-r)!}C(n,r)=r!(n−r)!n!

Example: In a deck of 52 cards, choosing 5:

- Ordered selection: **Permutation**
- Unordered selection: **Combination**

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3 Conditional Probability

- **Definition**: The probability of event A occurring given that event B has already occurred.
- **Formula**: P(A B)=P(A∩B)P(B)P(A | B) = \frac{P(A \cap B)}{P(B)}P(A B)=P(B)P(A∩B)
- P(A B)P(A | B)P(A B) = Probability of A given B
- P(A∩B)P(A \cap B)P(A∩B) = Probability of both A and B occurring
- P(B)P(B)P(B) = Probability of B occurring
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Example: Drawing a red card given the first card drawn was a red.

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4 Bayes' Theorem

- **Used for updating probabilities when new information is available**.
- **Formula**: P(A B)=P(B A)P(A)P(B)P(A | B) = \frac{P(B | A) P(A)}{P(B)}P(A B)=P(B)P(B A)P(A)
- P(A B)P(A | B)P(A B) = Probability of A given B
- P(B A)P(B | A)P(B A) = Probability of B given A
- P(A)P(A)P(A) = Prior probability of A
- P(B)P(B)P(B) = Total probability of B

- **Example**: A medical test is 95% accurate. If a patient tests positive, what is the probability they actually have the disease? → Use **Bayes' Theorem**.

Quick Reference Table

Concept	Formula
Probability	P(E)=Favorable OutcomesTotal OutcomesP(E) = \frac{\text{Favorable Outcomes}}{\text{Total Outcomes}}P(E)=Total OutcomesFavorable Outcomes
Complement Rule	P(A′)=1−P(A)P(A') = 1 - P(A)P(A′)=1−P(A)
Addition Rule	P(A B)=P(A)+P(B)−P(A∩B)P(A \cup B) = P(A) + P(B) - P(A \cap B)P(A B)=P(A)+P(B)−P(A∩B)
Conditional Probability	(P(A
Multiplication Rule	(P(A \cap B) = P(A
Bayes' Theorem	(P(A