

# Cheatsheet for Math Exercises

## Probability and Conditional Probability

| Notation      | Value  | Formula  |
|---------------|--|--|
| $P(A)$        | Probability of event A occurring.  | $P(A) = \frac{\text{Number of favorable outcomes for } A}{\text{Total number of possible outcomes}}$                           |
| $P(A \mid B)$ | Conditional probability of event A occurring, given that event B has occurred. | $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$   |
| $P(A \cap B)$ | Probability of both events A and B occurring.                                  | In general: $P(A \cap B) = P(A) \cdot P(B \mid A)$<br>If A and B are independent events, then: $P(A \cap B) = P(A) \cdot P(B)$ |
| $P(A \cup B)$ | Probability that event A or event B (or both) occur.                           | $P(A \cup B) = P(A) + P(B) - P(A \cap B)$  |

## Information Theory

| Notation   | Value  | Formula  |
|------------|--|--|
| $I(A)$     | Information content or self-information of an event A.   | $I(A) = -\log_2 P(A)$ [bits]   |
| $H(X)$     | Entropy, which measures the average amount of information (or uncertainty) in a random variable X. | $H(X) = -\sum_{x \in X} P(x) \log_2 P(x)$ [bits]   |
| $H_{\max}$ | Maximum possible entropy (when all outcomes are equally likely).                                   | $H_{\max} = \log_2  \mathcal{X} $<br>  $\mathcal{X}$   is the number of possible outcomes in the set $\mathcal{X}$ |
| $R(X)$     | Redundancy, which measures the portion of duplicative information within a message.                | $R(X) = 1 - \frac{H(X)}{\log_2  X }$<br>In terms of maximum entropy: $R = \frac{H_{\max} - H}{H_{\max}}$           |

## Combinatorics

|                     | without repetition          | with repetition  |
|---------------------|-----------------------------|--|
| <b>Permutations</b> | $P_n = n!$                  | $P_n^{k_1, k_2, \dots, k_r} = \frac{n!}{k_1! \cdot k_2! \cdot \dots \cdot k_r!}$ |
| <b>Variations</b>   | $V_n^k = \frac{n!}{(n-k)!}$ | $\overline{V}_n^k = n^k$   |
| <b>Combinations</b> | $C_n^k = \binom{n}{k}$      | $\overline{C}_n^k = \binom{n+k-1}{k}$  |

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