Cheatsheet for Math Exercises

Probability and Conditional Probability

Notation	Value	Formula
$$P(A)$$	Probability of event A occuring.	$$P(A) = \frac{\text{Number of favorable outcomes for } A}{\text{Total number of possible outcomes}}$$
$$P(A \mid B)$$	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: $$P(A \cap B) = P(A) \cdot P(B \mid A)$$ 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.	$$I(A) = -\log_2 P(A) = \log_2 \frac{1}{P(A)} \text{ [bits]}$$
$$H(X)$$	Entropy, which measures the average amount of information (or uncertainty) in a random variable X.	$$H(X) = -\sum_{x \in X} P(x) \log_2 P(x) = \sum_{x \in X} P(x) \log_2 \frac{1}{P(x)} \text{ [bits]}$$
$$H_{max}$$	Maximum possible entropy (when all outcomes are equally likely).	$$H_{\text{max}} = \log_2 \|\mathcal{X}\|$$ $$\|\mathcal{X}\| \text{ is the number of possible outcomes in the set } \mathcal{X}$$
$$R(X)$$	Redundancy, which measures the portion of duplicative information within a message.	$$R = \frac{H_{\text{max}} - H}{H_{\text{max}}}$$

Combinatorics

	without repetition	with repetition
Permutations number of all possible arrangements of n elements	$$P_n = n!$$	$$P_n^{k_1, k_2,...k_r} = \frac{n!}{k_1! \cdot k_2! \cdot ... \cdot k_r!}$$
Variations the number of all possible arrangements of any k elements from n elements	$$V_n^k=\frac{n!}{(n-k)!}$$	$$\overline{V}_n^k=n^k$$

	without repetition	**with repetition**
Combinations number of ways to choose k items from n items, regardless of order	$$C_n^k=\binom{n}{k}=\frac{n!}{k! \cdot (n - k)!}$$	$$\overline{C}_n^k=\binom{n+k-1}{k}$$

What formula to use?

		Repetition	
		Not possible	*Possible*
Order	*Matters*	$$V_n^k$$ (variation without repetition)	$$\overline{V}_n^k$$ (variation with repetition)
	Doesn't matter	$$C_n^k$$ (combination without repetition)	$$\overline{C}_n^k$$ (combination with repetition)