
Probability Theory

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Abstract

1 Notes of Probability Theory mainly from the book *Introduction to Probability*
2 *Theory by Hoel, Port, Stone.*

3 1 Probability Spaces

4 2 Discrete Random Variables

5 3 Expectation of Discrete Random Variables

- 6 • Let n be the number of trials and $N_n(x_i)$ be the number of times you observed x_i , then for
7 large n

$$f(x_i) = \frac{N_n(x_i)}{n}.$$

- 8 • A random variable X has *finite* expectation if and only if

$$\sum_{i=0}^{i=\infty} |x_i| f(x_i) < \infty,$$

9 then the expectation is

$$EX = \sum_{i=0}^{i=\infty} x_i f(x_i).$$

10 Otherwise EX is undefined.

- 11 • Quick Expectations to remember: Binomial - np , Poisson - λ , Geometric - $\frac{1-p}{p}$.
12 • Expectation of a function (if it is finite):

$$E\phi(X) = \sum_x \phi(x)f(x)$$

- 13 • Properties

14 $E(c_1X_1 + c_2X_2 + \dots) = c_1EX_1 + c_2EX_2 + \dots$

15 $|EX| \leq E|X|$

16 $X \leq Y \implies EX \leq EY$

17 If $P(|X| \leq M) = 1$ then $EX \leq M$

18 if X and Y are independent, $E(XY) = (EX)(EY)$. The converse is not true.

19 if X is a non negative, integer valued random variable, X has a finite expectation if
20 and only if $\sum_{x=0}^{x=\infty} P(X \geq x)$ converges. Then $EX = \sum_{x=0}^{x=\infty} P(X \geq x)$.

21 **References**

22 References follow the acknowledgments. Use unnumbered first-level heading for the references. Any
23 choice of citation style is acceptable as long as you are consistent. It is permissible to reduce the font
24 size to small (9 point) when listing the references. **Remember that you can use more than eight**
25 **pages as long as the additional pages contain *only* cited references.**

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