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1

Definition

A *random variable* is a measurable map from a probability space to a measurable space.

A *real-valued random variable* is a measurable map between the probability space and the set of real numbers with its topological sigma algebra.

Notation

Let $(X, \mathcal{A}, \mathbf{P})$ be a probability space. Let (Y, \mathcal{B}) a measurable space. Then a random variable is a measurable function $f : X \rightarrow Y$.

Some authors denote real-valued random variables by upper case Latin letters: for example, X, Y, Z . In this case, the base probability space is denoted by Ω , a mnemonic for “outcomes.” Let $(\Omega, \mathcal{A}, \mathbf{P})$ be a probability space. Let $X : \Omega \rightarrow \mathbf{R}$ be measurable. Then X is a real-valued random variable.

Some authors use notation for the probability of certain common sets. Let $A \in \mathcal{B}(\mathbf{R})$. Let $\mathbf{P}(X \in A)$ denote $\mathbf{P}(X^{-1}(A))$. These are equivalent to

$$\mathbf{P}(\{\omega \in \Omega \mid X(\omega) \in A\}).$$

¹Future editions will include this.

Next, let $Y : \Omega \rightarrow R$ a measurable function and let $B \in \mathcal{B}(R)$. Similar to the above, let $\mathbf{P}(X \in A, Y \in B)$ denote $\mathbf{P}(X^{-1}(A) \cap Y^{-1}(B))$. These are equivalent to

$$\mathbf{P}(\{\omega \in \Omega \mid X(\omega) \in A \text{ and } Y(\omega) \in B\}).$$

