18.600: Lecture 17

Continuous random variables

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Outline

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Expectation and variance of continuous random variables

Measurable sets and a famous paradox

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- Probability of any single point is zero.
- Define **cumulative distribution function** $F(a) = F_X(a) := P\{X < a\} = P\{X \leq a\} = \int_{-\infty}^{a} f(x)dx$.

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- We say that X is **uniformly distributed on the interval** $[0,2]$.

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- This formula is often useful for calculations.

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- What if B is the set of all rational numbers?
- How do we mathematically define the volume of an arbitrary set B?

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- Thus $[0,1) = \cup \tau_r(A)$ as r ranges over rationals in $[0,1)$.
- If $P(A) = 0$, then $P(S) = \sum_r P(\tau_r(A)) = 0$. If $P(A) > 0$ then $P(S) = \sum_r P(\tau_r(A)) = \infty$. Contradicts $P(S) = 1$ axiom.

Three ways to get around this

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- In practice, sets we care about (e.g., countable unions of points and intervals) tend to be measurable.

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- Riemann integration is a mathematically rigorous theory. It's just not as robust as Lebesgue integration.