Lecture Notes in Measure Theory

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June 2022

Introduction

This is a set of lecture notes which I took for reviewing stuff that I typed after taking class from Professor *insert name here*. All the typos and errors are of mine. I like to take notes in LaTeXas it motivates me to drag my ass to class. The pictures that make here will be hand drawn and I will appreciate it if someone who is knowledgeable in Tikz will help me digitizing my rough hand-drawn pictures.

Contents

1 Lecture 1 - 9th August 2022 - Basic Definitions

1.1 Algebras and Sigma-algebras

Definition 1.1.1 (Algebra)**.** Let X be any arbitrary set. A collection $\mathcal{A} \subseteq \mathscr{P}(X)$ is called an algebra if

1. $X \in \mathcal{A}$
2. $\forall A \in \mathcal{A}$, $X \setminus A \in \mathcal{A}$
3. $\forall \mathcal{F} \subseteq \mathcal{A} \, (\mathcal{F} \text{ finite } \Rightarrow \bigcup \mathcal{F} \in \mathcal{A})$
4. $\forall \mathcal{F} \subseteq \mathcal{A} \, (\mathcal{F} \text{ finite } \Rightarrow \bigcap \mathcal{F} \in \mathcal{A})$

Definition 1.1.2 (σ -Algebra)**.** Let X be any arbitrary set. A collection $\mathcal{A} \subseteq \mathscr{P}(X)$ is called an *algebra* if

1. $X \in \mathcal{A}$
2. $\forall A \in \mathcal{A}$, $X \setminus A \in \mathcal{A}$
3. $\forall \{A_i\}_{i \in \mathbb{N}} \subseteq \mathcal{A}$, $\bigcup_{i \in \mathbb{N}} A_i \in \mathcal{A}$
4. $\forall \{A_i\}_{i \in \mathbb{N}} \subseteq \mathcal{A}$, ($\mathcal{F}$ finite $\Rightarrow \bigcap_{i \in \mathbb{N}} A_i \in \mathcal{A}$)

Example 1.1.3 (Some families of sets that are algebras or σ-algebras , and some that are not)**.** Here's a list of examples:

1. Let X be any set. Let $\mathcal{A} = \mathcal{P}(X)$. Then $\mathcal{A}$ is a σ-algebra on X.
2. Let X be any set. Let $\mathcal{A}$ be the collection of all subsets A of X such that A or A^c is countable. Then $\mathcal{A}$ is σ-algebra.

Proposition 1.1.4. *Let X be any set. The intersection of an arbitrary nonempty collection of σ-algebras on X is a σ-algebra on X.*

1.2 Measures

Example 1.2.1.

2 Lecture 2

2.1 Lebesgue Integral