

MM5023

Lecture 1

Logistic:

Schedule: Mondays- Thursday 9-11, with TA session 11-12.

There might be small variation soon look at the official schedule

Who: Sofia Tirabassi tirabassi@math.su.se

Book: Grimaldi's Introduction to discrete and combinatorial mathematics

Bonus points:

Lecture notes:

Exam: January ~~2024~~ You have to be here!

Course Plan:

- Review and counting (inclusion/exclusion)
- Rook polynomial
- Generating functions
- Graph theory (coloring, Hamilton paths, tree, weighted trees, optimization, max flow min cut)
- Finite geometry and Latin squares

Today:

- Review: set functions equivalence relations
- Review: principles of counting (counting using functions)
- Pigeon holes principle and generalized pigeon hole principle.

What is a set?

Set Notation

A set is a collection of elements.

Example

$$\begin{aligned} P &= \{\text{red, yellow, blue}\} \\ &= \{\text{primary colors}\} \\ &= \{c \mid c \text{ is a primary color}\} \end{aligned}$$

$$\text{blue} \in P \quad \text{purple} \notin P$$

The symbol \emptyset denotes the set with no element, aka **the empty set**.

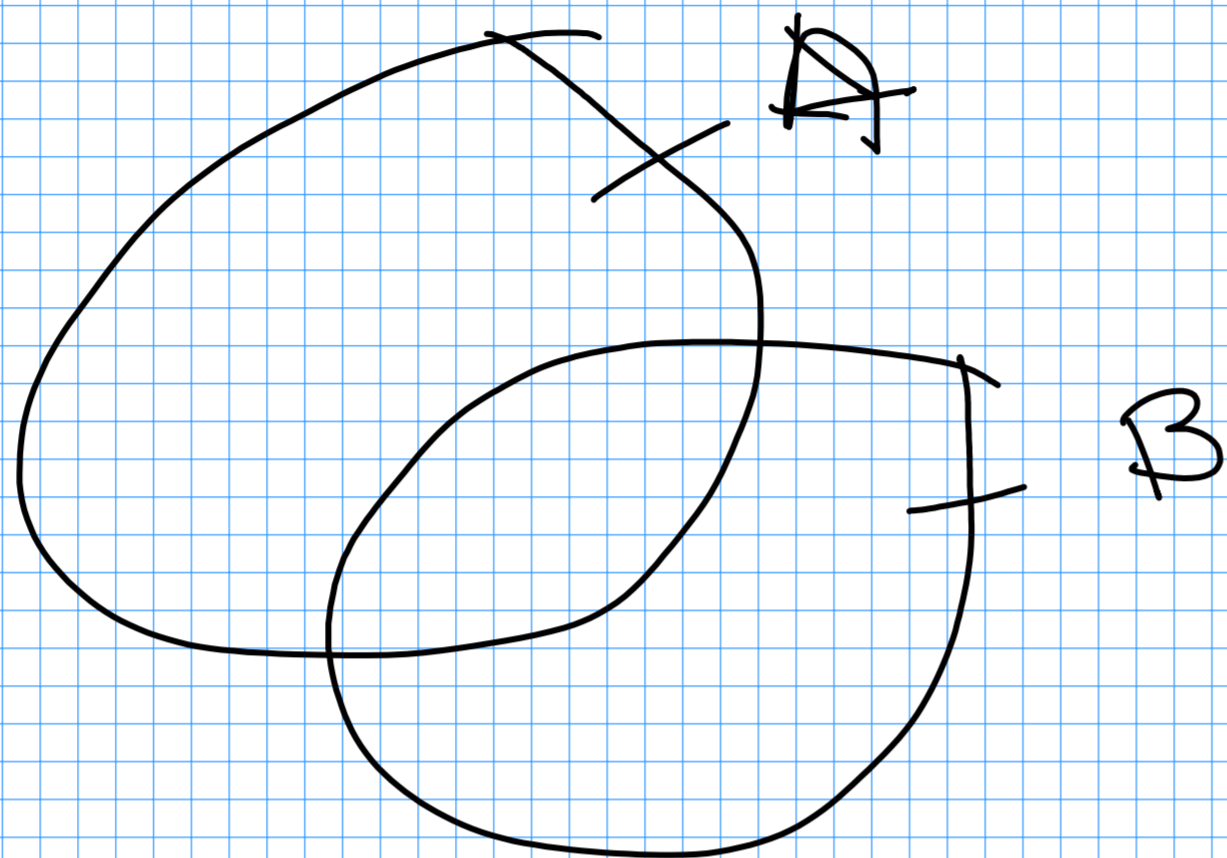
Operations on sets

In order to leave barbers alone we are always going to assume that all our subsets are subsets of a universe set.



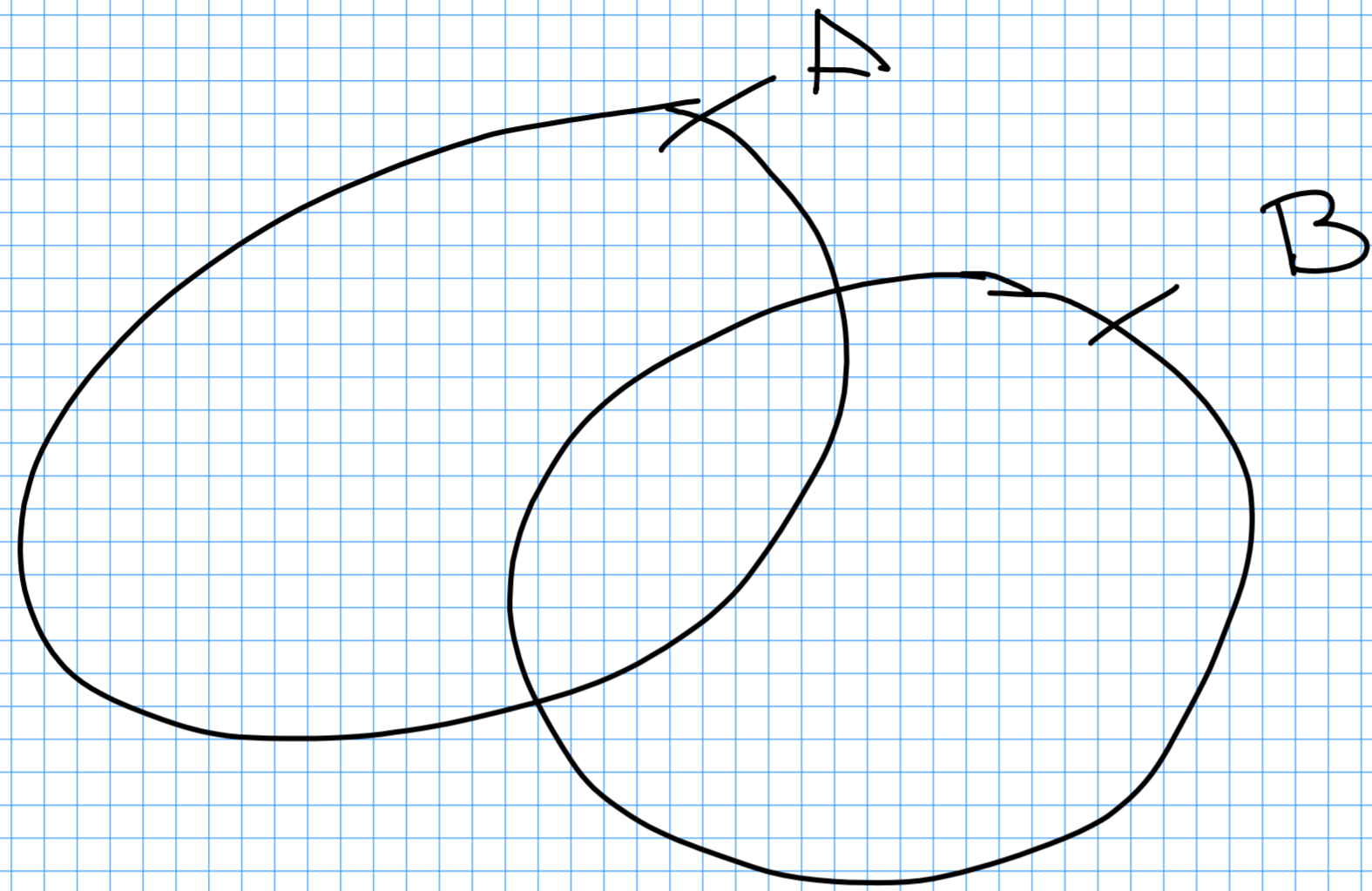
The Union of two sets

$$A \cup B = \{x \in U \mid x \in A \text{ or } x \in B\}$$



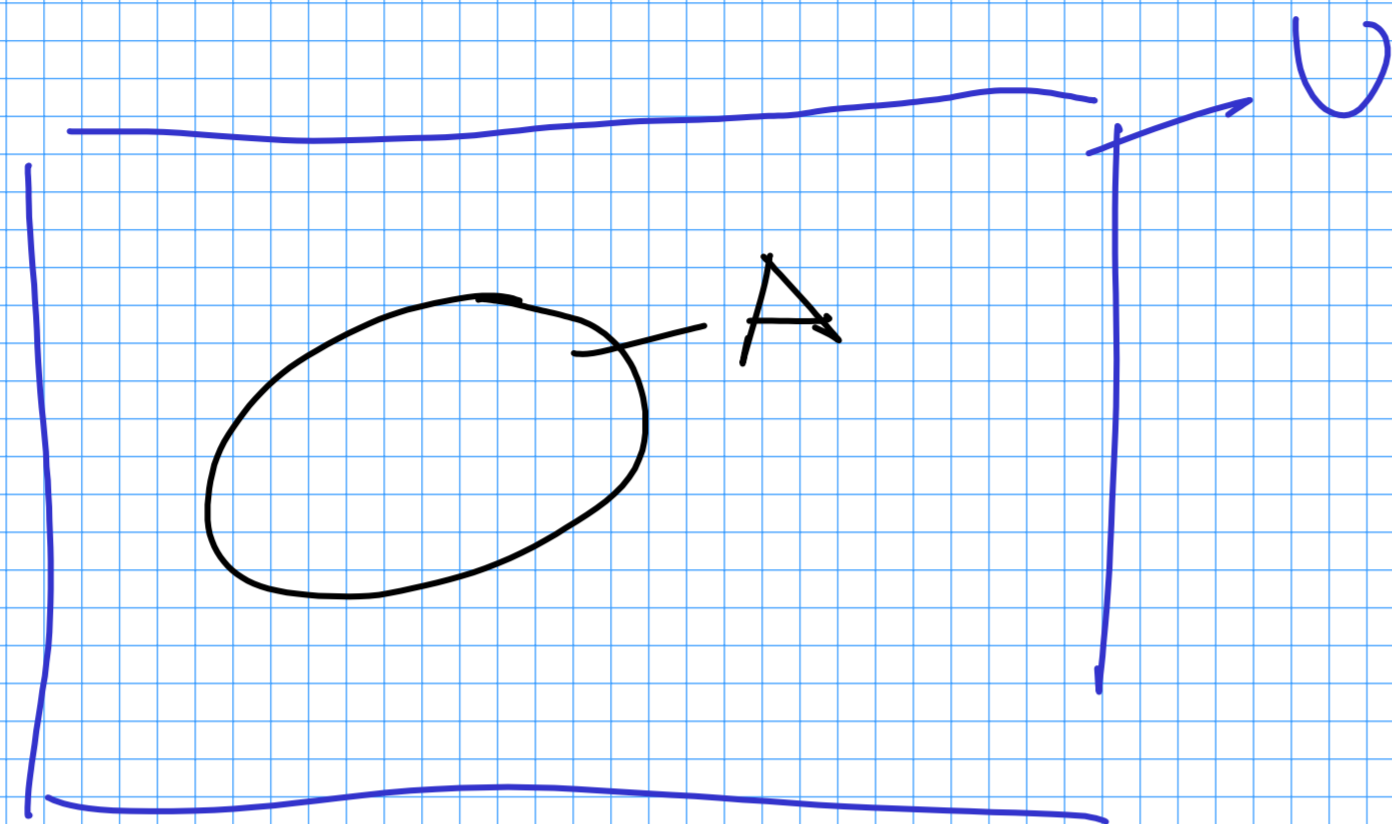
Exclusion

$$A \setminus B = \{x \in U \mid x \in A \text{ and } x \notin B\}$$



Complementary:

$$CA := A' := \{x \in U / x \notin A\}$$



Disjoint Union



Cartesian product



What is a function $f: A \rightarrow B$



Relations



A function can be

1) injective $x_1 \neq x_2 \Rightarrow f(x_1) \neq f(x_2)$ (1-1)

2) surjective Every $y \in B$ can be written as $f(x)$ with $x \in A$ (onto)

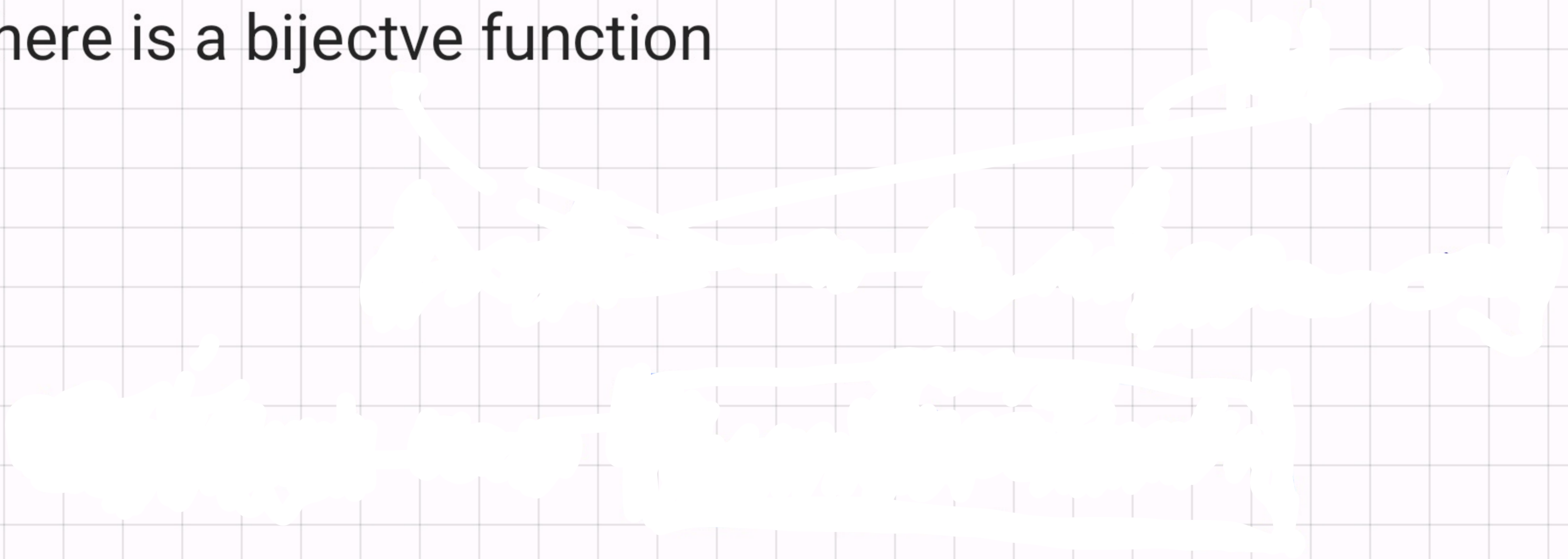
3) bijective if it is both

Example:

Formal definition of function

Counting

Def: Let n be a natural number. We say that a set A has size n if there is a bijective function



Rule of Product

Rule of sum

Permutations & Combinations

Pigeon hole principle

Generalized Pigeon Hole Principle

Example:

At a party 5 teams play a series of 1-1 games. There are two rules

- None can play twice against the same adversary
- One cannot play against their teammates.

At the end Aragon asks how many games has everyone played and get different answers.

How many games has Bilbo (Aragon's team mate) has played?