# Lecture 6

CSE 331

Sep 9, 2024

# 2nd T/F poll up

Actions ▾

## 2nd T/F poll

Is the following statement **true** or **false**:

In every Stable Matching problem instance where a man $m$ and woman $w$ have each other as their least preferred partner, the following is true. There is no stable matching for the instance where $(m, w)$ are matched.

(Note by a stable matching problem instance, we mean both the set of men and women as well as all the $2n$ preference lists.)

○ True

○ False

Please select one option

Submit

You have **not yet** voted.

Revoting is **not allowed**. Select your vote and click submit to register your vote.

Your name will **not be visible to anyone**.

# We're not mind readers

# If you need it, ask for help

# NEVER apologize
## for asking a question!!!

# Make sure you can run HW0 code

## Make sure you can run HW 0 template on your machine

If you did not submit HW 0 Q3, please make sure you have the setup on your computer so that you can run the HW 0 Q3 template code (in whichever language you prefer). If you need it, **please go to an OH on Monday or Tuesday** in case you cannot get things to setup and need help.

Note that the autolab page has instructions on how to setup the template code in ItelliJ (so only for java). The page also has a video on how to run the C++ template code from command line on a VM (in case you are using that option).

Also see @14 if you are using C++.

Please note that **starting Wednesdays, the office hours will give preference to questions specifically about HW 1 and not questions on setup** (like making sure you have your IDE/compiler ready to go).

homework0    autolab    office_hours

Edit    good note | 0      Updated 37 seconds ago by Atri Rudra

# Register your project groups

**Deadline: Friday, Sep 20, 11:59pm**

Project Overview

Group signup form

## Forming groups

You form groups of size **exactly three (3)** for the project. Below are the various logistics:

- You have two choices in forming your group:
  1. You can form your group on your own: i.e. you can submit the list of EXACTLY three (3) group members in your group.

</> **Note**

Note that if you pick th[...]annot submit as a group of size two. If

Also, if you form a gro[...]

> If you miss this deadline then you will get a ZERO on the ENTIRE project

  2. You can submit *just your name*, and you will be assigned a random group *among all students who take this second option*. However, **note that if you pick this option, you could end up in a group of size** 2. There will be at most two groups of size 2.

</> **Potential risk**

Note that if you pick the option of being assigned a random group, you take on the risk that a assigned group might not "pull their weight." We unfortunately cannot help with such aspects of group dynamics. (Of course if a group member is being abusive, please do let Atri know.) Please note that a group member who does not do much work will get penalized on the individual component of the project grade.

- **Submitting your group composition**
  Use this Google form ⧉ to submit your group composition (the form will allow you to pick one of the two options above).

- You need to fill in the form for group composition by **11:59pm on Friday, September 20**.

# HW 1 gets released this Tue

| Mon, Sep 9 | Gale Shapley algorithm ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 1.1]<br>*Reading Assignment:* Pigeonhole principle<br>*Reading Assignment:* Asymptotic notation care package |
|---|---|---|
| Tue, Sep 10 | | **(HW 1 out)** |
| Wed, Sep 11 | Gale Shapley algorithm outputs a stable matching ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 1.1]<br>*Reading Assignment:* Proof details of GS termination |
| Fri, Sep 13 | Efficient algorithms ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 1.1] *Reading Assignment:* Worst-case runtime analysis notes<br>*Reading Assignment:* [KT, Sec 1.1, 2.1, 2.2, 2.4] |
| Mon, Sep 16 | Runtime Analysis of Gale-Shapley algorithm ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 2.3] |
| Tue, Sep 17 | | **(HW 2 out, HW 1 in)** |
| Wed, Sep 18 | Graph Basics ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 2.3, 3.1] |
| Fri, Sep 20 | Computing Connected Component ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 3.2] **(Project Team Composition Due)**<br>*Reading Assignment:* Care package on trees<br>*Reading Assignment:* BFS by examples |
| Mon, Sep 23 | Breadth First Search ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 3.2] |
| Tue, Sep 24 | | **(HW 3 out, HW 2 in)** |
| Wed, Sep 25 | Explore algorithm ▶F23 ▶F22 ▶F21 ▶F19 ▶F118 ▶F17 $x^2$ | [KT, Sec 3.3] |
| Fri, Sep 27 | Runtime Analysis of BFS algorithm ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 3.3, 3.6]<br>*Reading Assignment:* [KT, Sec 3.3, 3.4, 3.5, 3.6]<br>*Reading Assignment:* Care package on topological ordering |
| Mon, Sep 30 | More graph stuff ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 3.3, 3.6] **(Quiz 1)**<br>**(Group Registration on Autolab due)** |
| Tue, Oct 1 | | **(HW 3 in)** |
| Wed, Oct 2 | Interval Scheduling Problem ▶F23 ▶F22 ▶F21 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 4.1]<br>**(Project out)**<br>*Reading Assignment:* [KT, Sec 4.1, 4.2] |
| Fri, Oct 4 | Greedy Algorithm for Interval Scheduling ▶F23 ▶F22 ▶F19 ▶F18 ▶F17 $x^2$ | [KT, Sec 4.4]<br>*Reading Assignment:* Care package on minimizing maximum lateness |
| Mon, Oct 7 | **Mid-term exam: I** | |
| Wed, Oct 9 | **Mid-term exam: II** | |

# Reading Assignment - I

Actions ▾

## Reading Assignment: Asymptotic Analysis

As one of the changes made in F19, we will assume that y'all are familiar with asymptotic analysis and not spend reviewing it in any detail during the lectures. In case you are not that comfortable with asymptotic analysis and/or want to review the material, please read through the asymptotic analysis care package:

http://www-student.cse.buffalo.edu/~atri/cse331/support/care-package/asymptotics/index.html

We will need this either the middle of lecture on Wednesday or in the Friday lecture.

lectures

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# Reading Assignment - II

## Reading Assignment: Pigeonhole principle

Another reading assignment for this week (here is the other one: @57). Please go through this support page on **pigeonhole principle**--

http://www-student.cse.buffalo.edu/~atri/cse331/support/pigeon/index.html

It's actually a very simple result that turns out to be surprisingly powerful. We'll use this in one of this week's (most likely the Wed) lecture.

lectures

Edit  good note | 0
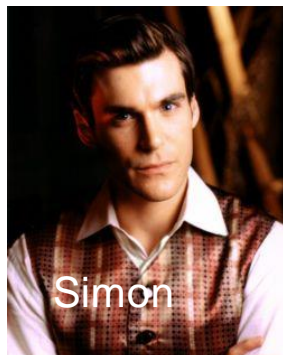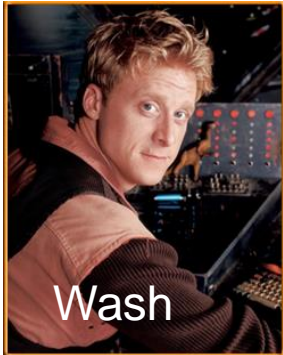
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# (Perfect) Matching

A matching $S \subseteq W \times M$ satisfies the following properties:

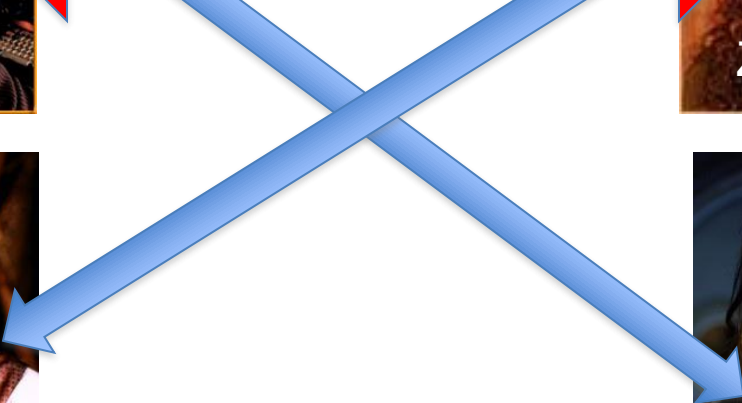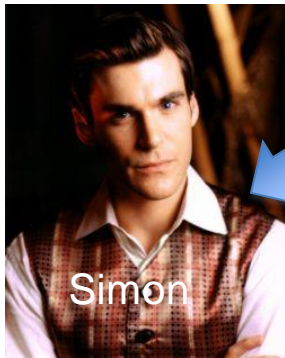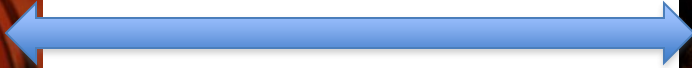S is a **set** of pairs (w,m) where w in W and m in M

(1) For every woman w in W, exist *at most* one m such that (w,m) in S
<span style="color:orange">exactly</span>

(2) For every man m in M, exist *at most* one w such that (w,m) in S
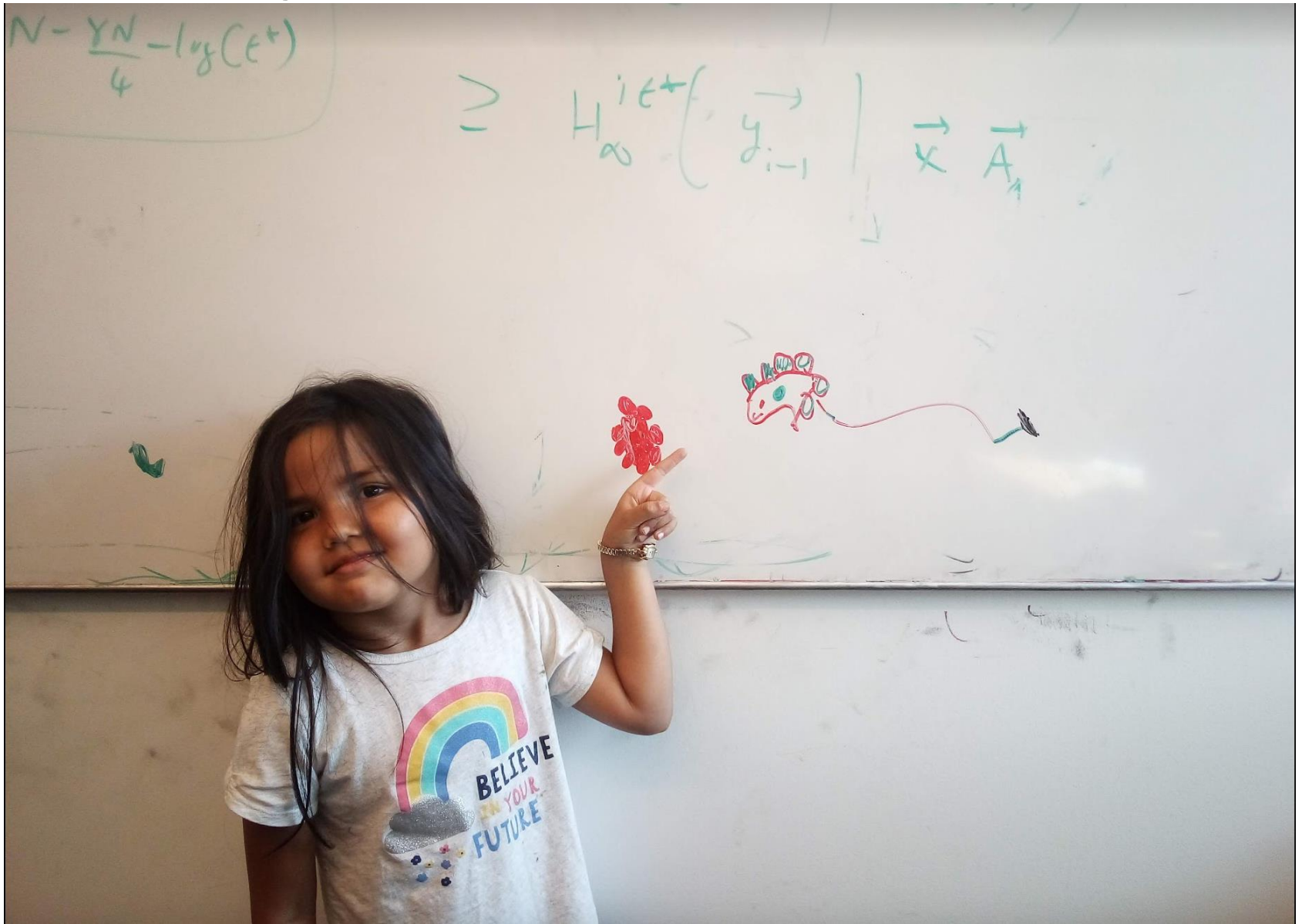<span style="color:orange">exactly</span>

Perfect matching

# Preferences

# Instability
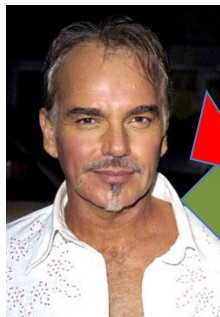
# Questions/Comments?

# A stable matching



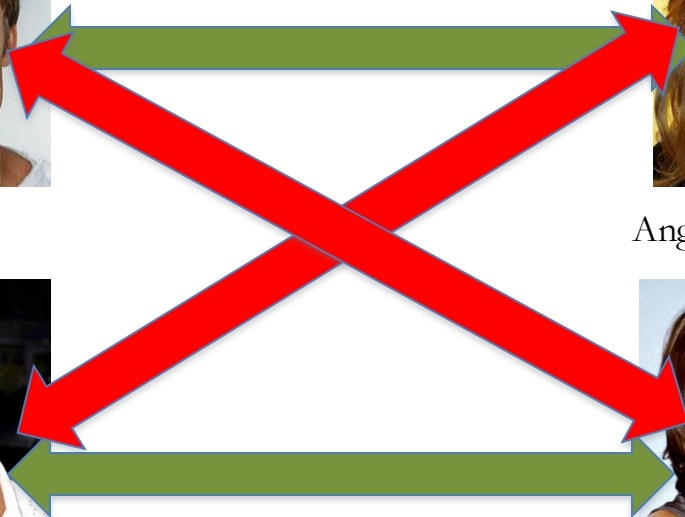Even though BBT and JA are not very happy

Brad Pitt

Angelina Jolie

Billy Bob Thornton

Jennifer Aniston

# Two stable matchings



Brad Pitt

Angelina Jolie
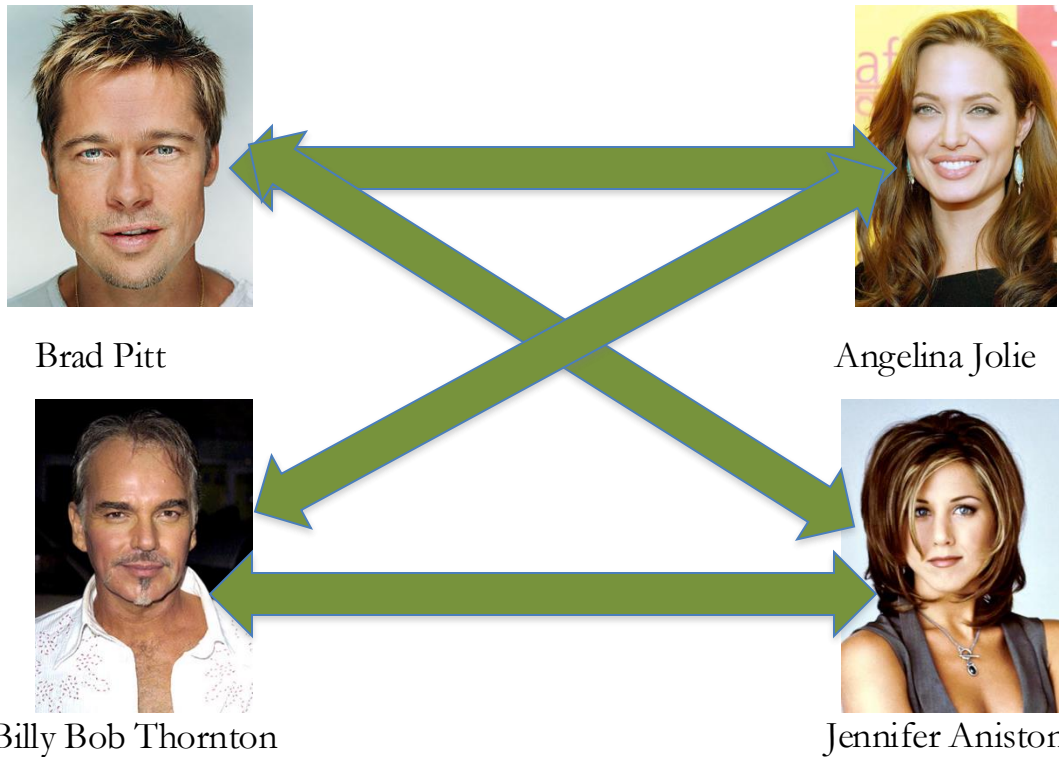
Billy Bob Thornton

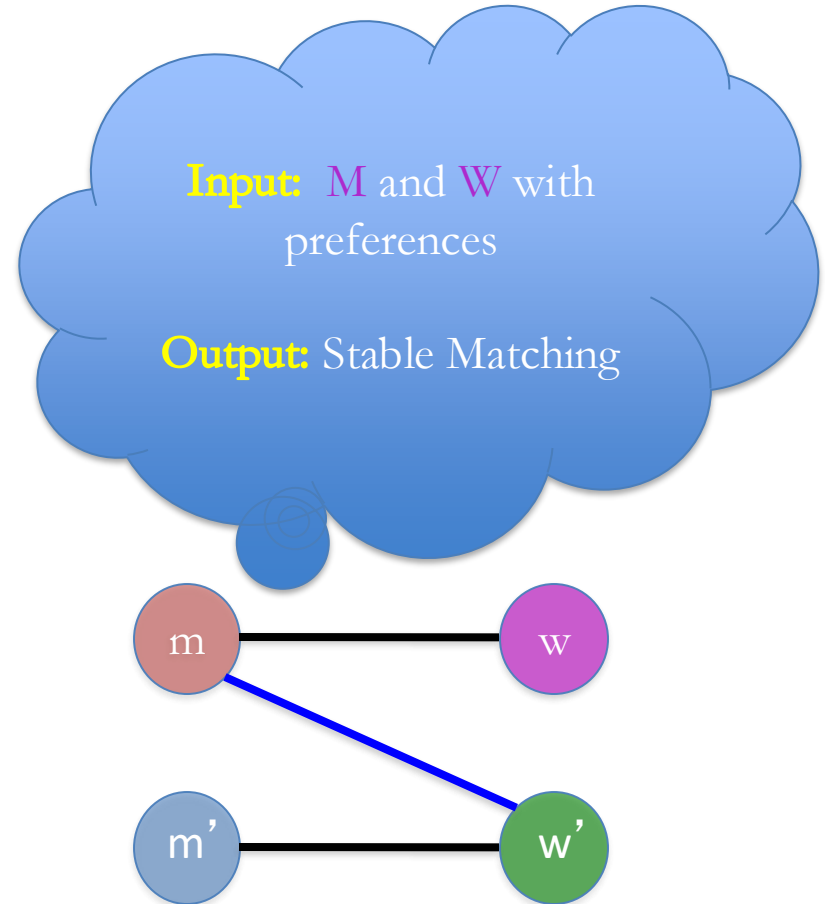Jennifer Aniston

# Stable Matching problem

Set of men M and women W

Preferences (ranking of potential spouses)
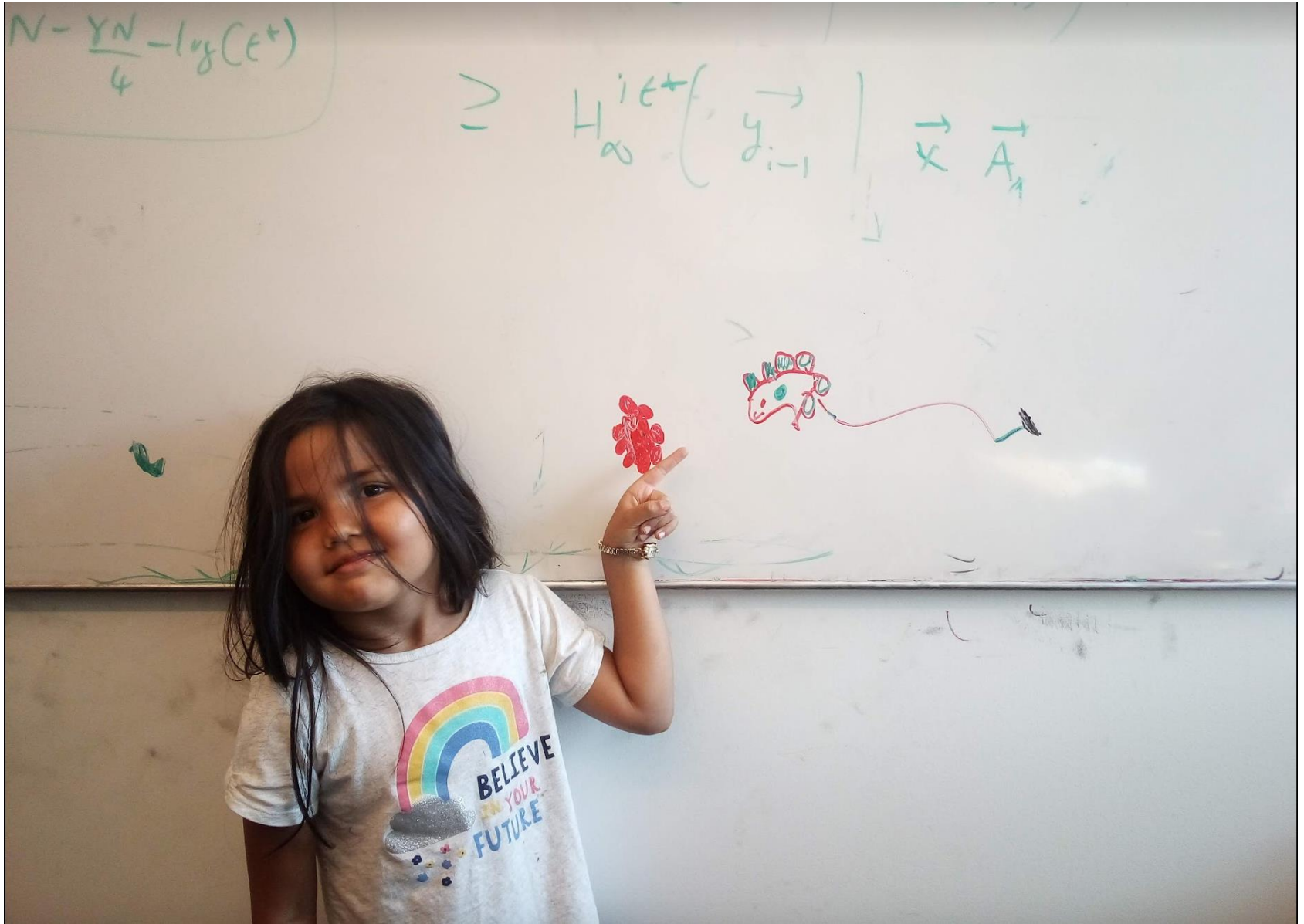
Matching (no polyandry/gamy in M X W)

Perfect Matching (everyone gets married)

Instablity

Stable matching = perfect matching+ no instablity

Input: M and W with preferences

Output: Stable Matching

# Questions/Comments?

# Two Questions

Does a stable marriage always exist?

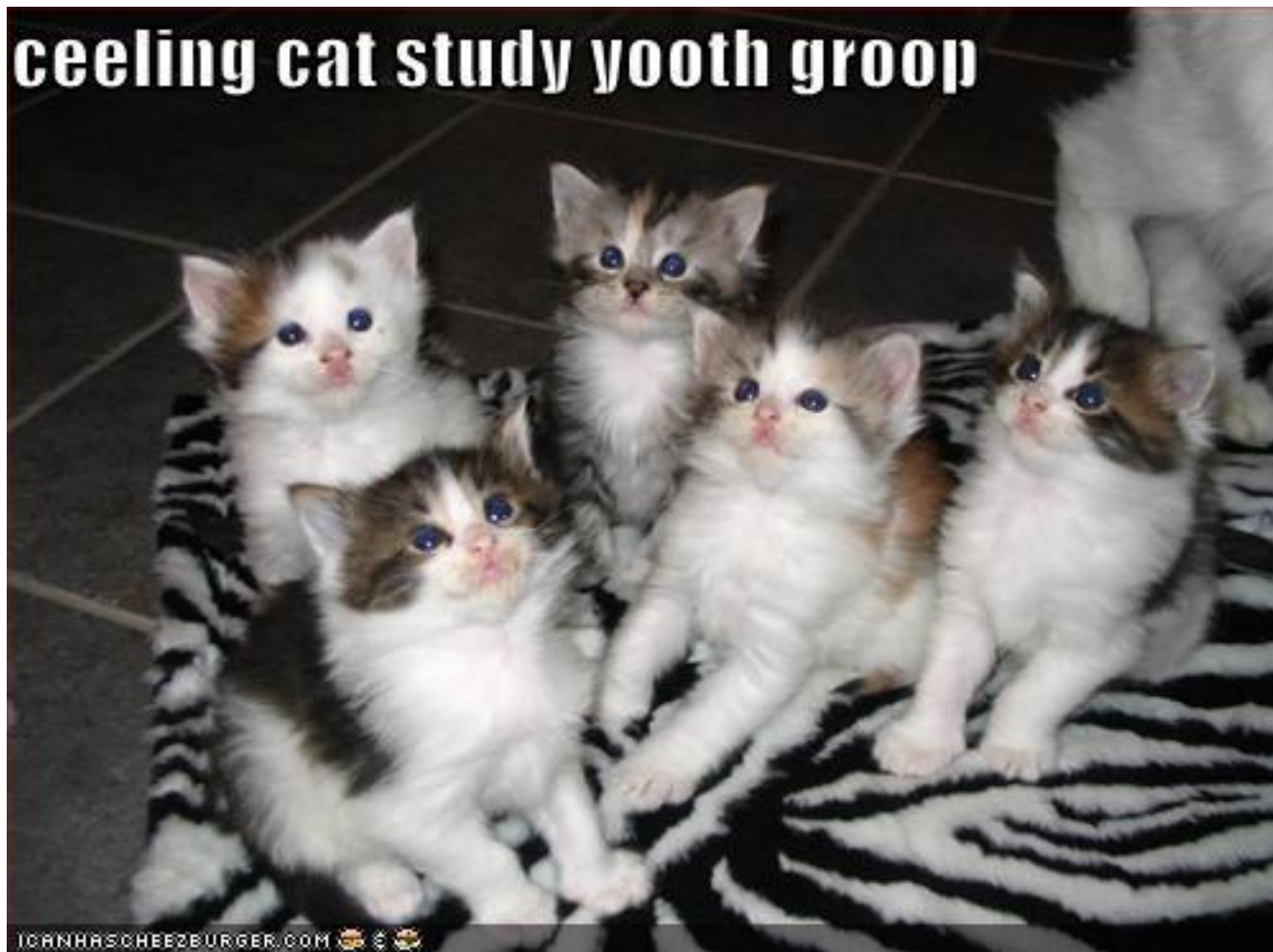If one exists, how quickly can we compute one?

# Rest of today's lecture

Naïve algorithm

Gale Shapley algorithm

# Questions/Comments?

# Discuss: Naïve algorithm!

# The naïve algorithm

Go through all possible perfect matchings $S$
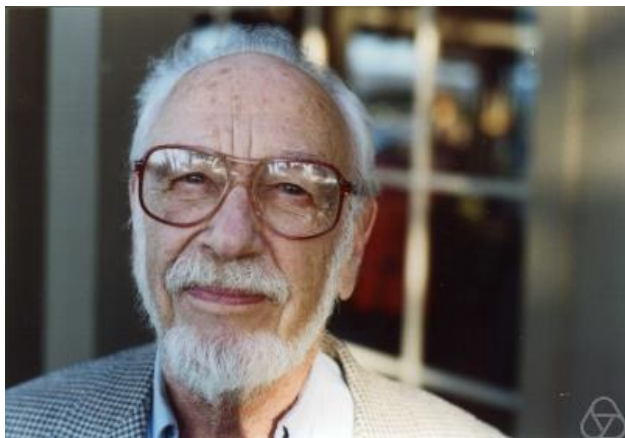
If $S$ is a stable matching

then Stop

n! matchings

Else move to the next perfect matching
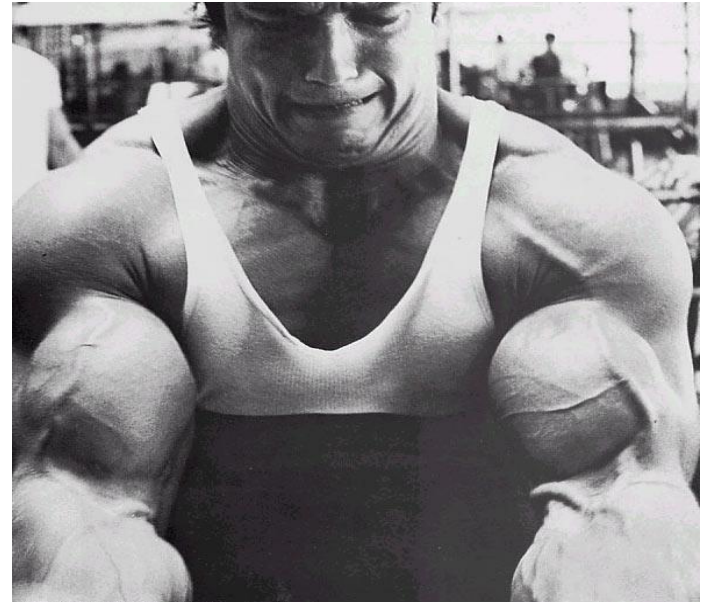
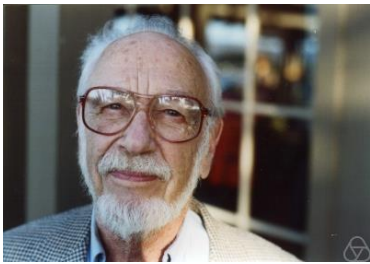# Gale-Shapley Algorithm



David Gale

Lloyd Shapley

O(n²) algorithm

# Moral of the story…



\>

# Questions/Comments?

# Rest of today's agenda

Gale Shapley (GS) algorithm

Run of GS algorithm on an instance

Prove correctness of the GS algorithm

# Back to the board…