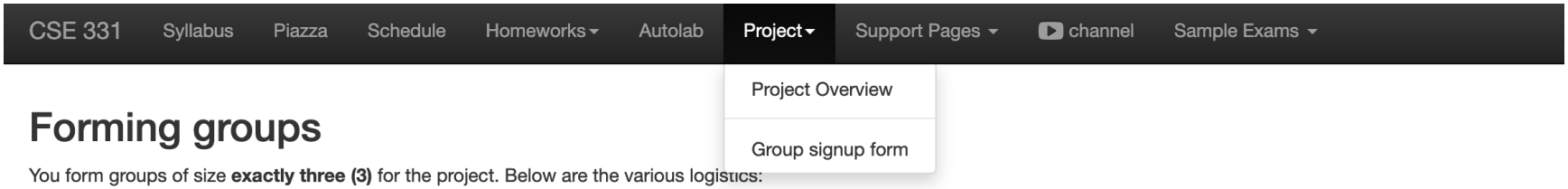
Lecture 9

CSE 331

Sep 16, 2024

Register your project groups

Deadline: Friday, Sep 20, 11:59pm



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… …nnot 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

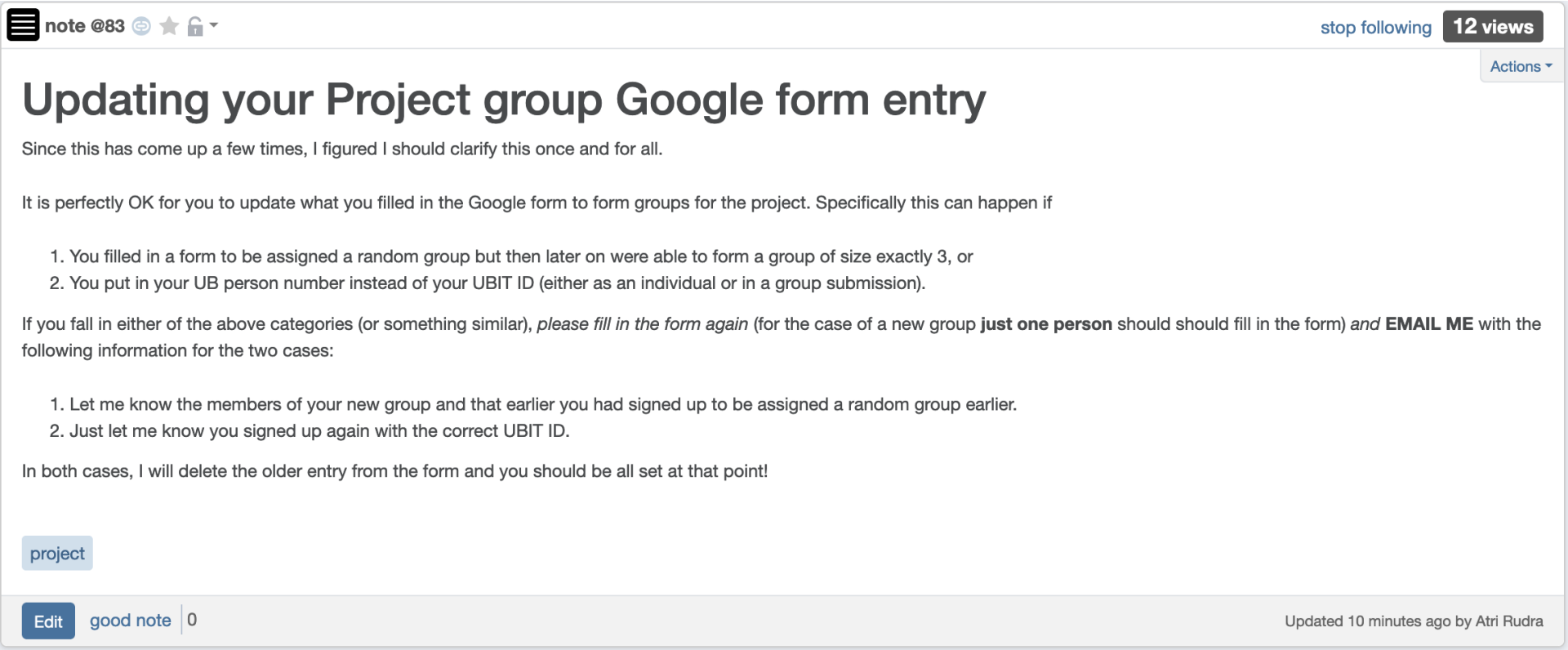
  2. You can submit *just your name*, and you will be assigned a random group *among all students who take this second option.* However, **note that if you pick this option, you could end up in a group of size** 2. There will be at most two groups of size 2.

> **</> 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.

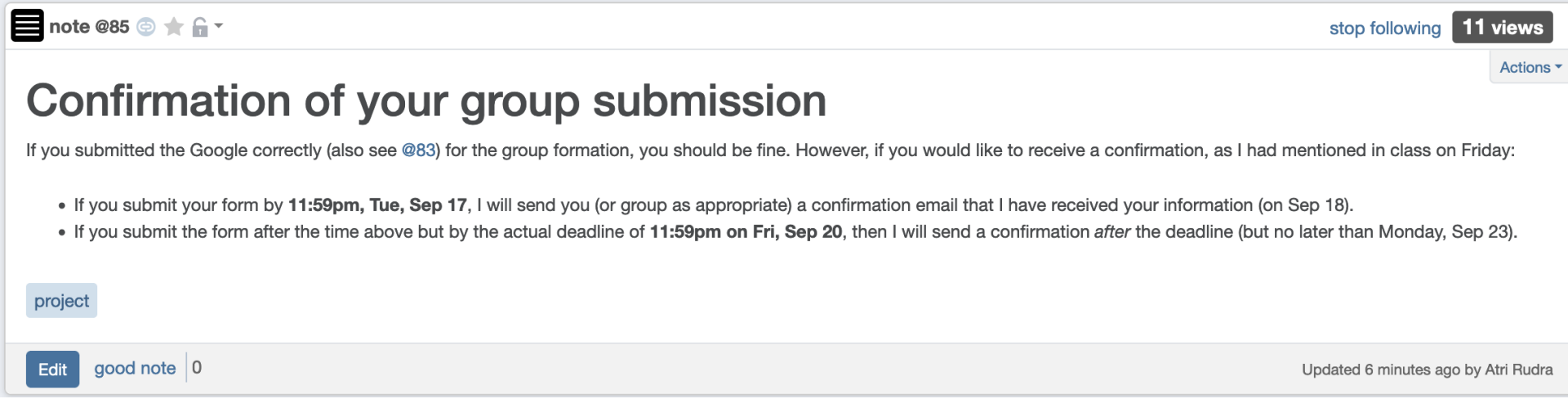
- **Submitting your group composition**
  Use this Google form to submit your group composition (the form will allow you to pick one of the two options above).

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

Updating your Google form entry



Confirmation of your group



Submission requirements

Submission

> **! Submit part (a) and (b) separately**
>
> You need to submit **two (2) PDF** files to Autolab: one for part `(a)` and one for part `(b)`. While you can assume part `(a)` as a given for part `(b)`, to get credit for part `(a)` you have to submit your solution for part `(a)` separately from part `(b)`.
>
> **Make sure you submit the correct PDF to the correct submission link on Autolab. If you do not (e.g. if you submit Q1(a) PDF to Q1(b) or even Q2(a) or Q2(b)), then you will lose ALL points.**
>
> We recommend that you typeset your solution but we will accept scans of handwritten solution-- you have to make sure that the scan is legible.

> **! PDF only please**
>
> **If Autolab cannot display your file, (irrespective of the reason) then you will get a zero (0) on the entire question.**
>
> Autolab might not be able to display files in formats other than PDF (e.g. Word cannot be displayed). **Note that Autolab will "accept" your submission even if you submit non-PDF file, so it is YOUR responsibility to make sure you submit in the correct format.**
>
> Also the file size has to be **at most 3MB**.

Grading Guidelines

We will follow the usual grading guidelines for non-programming questions. Here is a high level grading rubric specific to part `(a)` of this problem:

1. `Proof idea`: `10` points.

and here is the high level grading rubric for part `(b)`:

1. `Proof/Algorithm idea`: `20` points for
   - *If your answer is yes*: the idea behind the algorithm that for any input, computes a pair of stable schedules.
   - *If your answer is no*: a counterexample idea explaining the insight behind why you think the property does not hold.
2. `Proof/Algorithm details`: `20` points for
   - *If your answer is yes*: details of the algorithm that for any input, computes a pair of stable schedules *and* an argument as to why your algorithm will always output a pair of stable schedules for every input.
   - *If your answer is no*: a complete description of a counterexample *and* a complete proof for why the given counter example does not have any stable schedule.

> **! Note**
>
> **If you do not have separated out and labeled proof/algorithm idea and proof/algorithm details for part `(b)`, you will get a zero (0) irrespective of the technical correctness of your solution.**

You need to confirm that you followed the requirements

Homework 1, Question 1(a)

Collaboration

You can collaborate on this question with up to two (2) more CSE 331 students. However, you cannot work with someone else outside of your group for the other questions on HW 1.

Submit part (a) and (b) separately for Q1

You need to submit **two (2) PDF** files for Q1 to Autolab: one for part `(a)` and one for part `(b)`. While you can assume part `(a)` as a given for part `(b)`, to get credit for part `(a)` you have to submit your solution for part `(a)` separately from part `(b)`.

Make sure you submit the correct PDF to the correct submission link on Autolab. If you do not (e.g. if you submit your Q1(a) PDF to Q1(b) or any of Q2(a) or Q2(b)), then you will lose ALL points.

We recommend that you typeset your solution but we will accept scans of handwritten solution-- you have to make sure that the scan is legible.

PDF only please

By clicking the check mark below, you confirm that you have read and understood the instructions in HW 1 (as well as the CSE 331 homework policies). **Note that not following the instructions could result you getting a ZERO (0) on the entire problem *even if your actual solution is technically correct*** (*After clicking this check-box you cannot later claim that you missed reading an instruction.*)

☐ You confirm that you have read and understood the instructions in HW 1 (as well as the CSE 331 homework policies)

Sources and Collaborators

By clicking the check mark below, you confirm that you have listed your source(s) in your submitted PDF. (If you did not use any sources say *none*. Not stating your source(s) explicitly will **result in loss of all points**.)

☐ You confirm that you have explicitly stated your source(s) in your submission

By clicking the check mark below, you confirm that you have listed your collaborator(s) in your submitted PDF. (If you did not collaborate with anyone say *none* for collaborators. Not stating your collaborator(s) explicitly will **result in loss of all points**.)

☐ You confirm that you have explicitly stated your collaborator(s) in your submission

Review the HW policy doc!

CSE 331 | Syllabus | Piazza | Schedule | Homeworks | Autolab | Project | Support Pages | channel | Sample Exams

- HW 0
- Soln 0
- HW 1
- Allowed Sources
- Homework Policies

CSE 331 ework Policies

Fall 2024

This page contains policies, suggestions and explanations of things related to CSE 331 homeworks. Please note that not following some of these policies can lead to a **letter grade reduction or an F** in the course and not following some could lead to you getting a zero on your homework submission.

Please Note

It is **your responsibility** to make sure you read and understand the contents of this document. If you have any questions, please contact the instructor. Or better yet, make a post on Piazza.

Overview

On this page, you can find more details on:

1. Source and Collaboration policy (or how not to get an F in this course);
2. Preparing your homework submissions (or how not to get a zero on a question);
3. Grading details (or what to expect on how your homework submissions will be graded);
4. Other helpful tips (or how to do better on the homeworks and in the course).

Source and Collaboration policy

HW 1 (pre)post-mortem

note @71 stop following 1 view

Actions

(Advance view of) post-mortem on Homework 1

The post below is from Fall 2019 that I posted *after* HW1 was due but I figured I should post it a bit earlier this time in case it is helpful to some of you as y'all work on your HW 1 submissions.

Of course this would depend pretty much on you as an individual but here are some questions, **in no particular order**, for y'all to ponder on (with some of our comments in *italics*):

- **Did you start early enough?**
  - *We recommend that you start working on the homework on Wednesday immediately after the homework is handed out itself. And distribute your hours over the week rather than wait to start till Monday (or gasp! Tuesday).*
- **Did you go to the recitations AND read the recitation notes?**
  - *Both of them help you a lot towards answering Q1(a) and Q2(a) so they are highly recommended.*
- **Did you work on the questions in correct order?**
  - *We have the current order based on what we think is most beneficial to you. In particular, we want y'all to focus more on the proof based questions, which is why they come before the programming question. But perhaps a different order would work better for you?*
- **Did you get help when you got stuck?**
  - *If you were stuck at a problem for a long time did you ask for help on piazza? Did you go to one of the office hours?*
- **Did you work on all the problems alone?**
  - *While working on all the problem by yourself will be good for you in the long run (since you are developing your proofs/algorithms skills), in the interest of time we recommend that you at least collaborate on Q2 (b).*
- **(If you submitted HW 0), did you get enough feedback?**
  - *(This is going to be true for all homeworks so extrapolate this advice for future homeworks.) If you lost points, did you understand* why *you lost points? if not, did you go talk with the TA who graded your submission to ask why?*
    - *If you did understand why you lost points, did you figure out how you could have changed your thought process (and hence your solution) to get a level 0? If not, did you talk with a TA to get their thoughts on how* they *would change your solution to make it correct?*

Feedback on Q1(a) and Q2(a)

note @80 stop following 51 views

Actions

Couple of clarifications

I mentioned these in answers to some private posts so am re-stating these here for everyone:

Comment 1

For feedback on proof ideas, we ask that y'all come to OH to get feedback-- we won't be doing this over piazza. In other words, when we said that you can come and show your Q1(a) and Q2(a) answers and get feedback on whether they are correct are not, the offer is *only valid if you come to an office hour and ask it in person*.

Comment 2

Also anything you claim in your submission *has* to be argued. As I mentioned in class this past week–

- Always better to give more details than less
- If you think a claim is "obvious" add in a one line proof. If you cannot give a one line proof, then your claim is not obvious.
    - For proof details the bar for what is considered a valid argument is higher: so more details are needed for proof details.

homework1

Edit good note 0 Updated 1 day ago by Atri Rudra

If you need it, ask for help

Advice from TAs

CSE 331 Advice from TAs

Where students who took CSE 331 and became TAs share their experiences of how to fully utilize the class to your advantage. (And no, Atri did not pay them to say these things.)

Under Construction

This is a living document that will get updated over time. However, all the advice below is valid and you should pay attention to them!

The class is structured to your advantage

Utilize the before, during and after aspects of the course to their fullest.

Do the assigned readings before coming to class and if you get time even watch lecture videos from previous years. Atri will give you plenty of time during lecture to ask questions about the readings or the lecture itself. And of course get the most out of the assignments (Explained further below).

The assignments are separated into different parts for your convenience.

Questions 1 and 2

For Q1 and Q2, think of the algorithm and proof ideas as things that go inside a header (`.h`) file. They are the high level overview of how you are approaching the problem; you don't have to be very technical here. For example, listing out all the steps in your algorithm, what proof technique are you using, what property of the algorithm are you induction on, etc.

Questions/Comments?

Gale-Shapley Algorithm

Intially all men and women are free

While there exists a free woman who can propose

Let w be such a woman and m be the best man she has not proposed to

w proposes to m

If m is free

(w,m) get engaged

Else (w',m) are engaged

If m prefers w' to w

w remains free

Else

(w,m) get engaged and w' is free

Output the engaged pairs as the final output

The Lemmas

Lemma 0: The GS algorithm has at most n^2 iterations

Lemma 1: S is a perfect matching

Lemma 2: S has no instability

Questions?

Question from end of Friday class

What is the size of an SMP input?

There are $2n$ preference lists

How many entries does each list have? n

Total size = $2n \times n = 2n^2 = \Theta(n^2)$

Questions?

Extensions

Fairness of the GS algorithm

Different executions of the GS algorithm

Main Steps in Algorithm Design

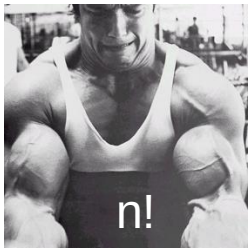
Problem Statement

Problem Definition

Algorithm

"Implementation"

Analysis



Correctness Analysis

Definition of Efficiency

An algorithm is efficient if, when implemented, it runs quickly on real instances

Implemented where?

Platform independent definition

What are real instances?

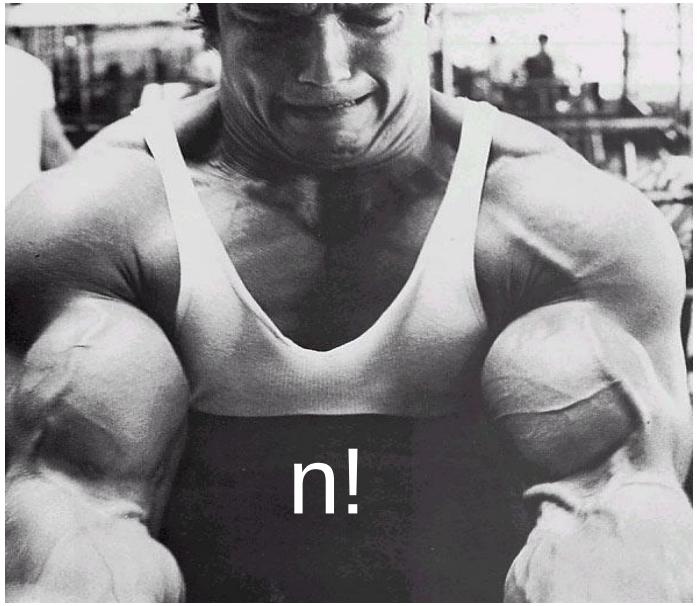
Worst-case Inputs

Efficient in terms of what?

$N = 2n^2$ for SMP

Input size N

Definition-II



Analytically better than brute force

How much better? By a factor of 2?

Definition-III

Should scale with input size

If N increases by a constant factor,
so should the measure

Polynomial running time

At most $c \cdot N^d$ steps ($c>0$, $d>0$ absolute constants)

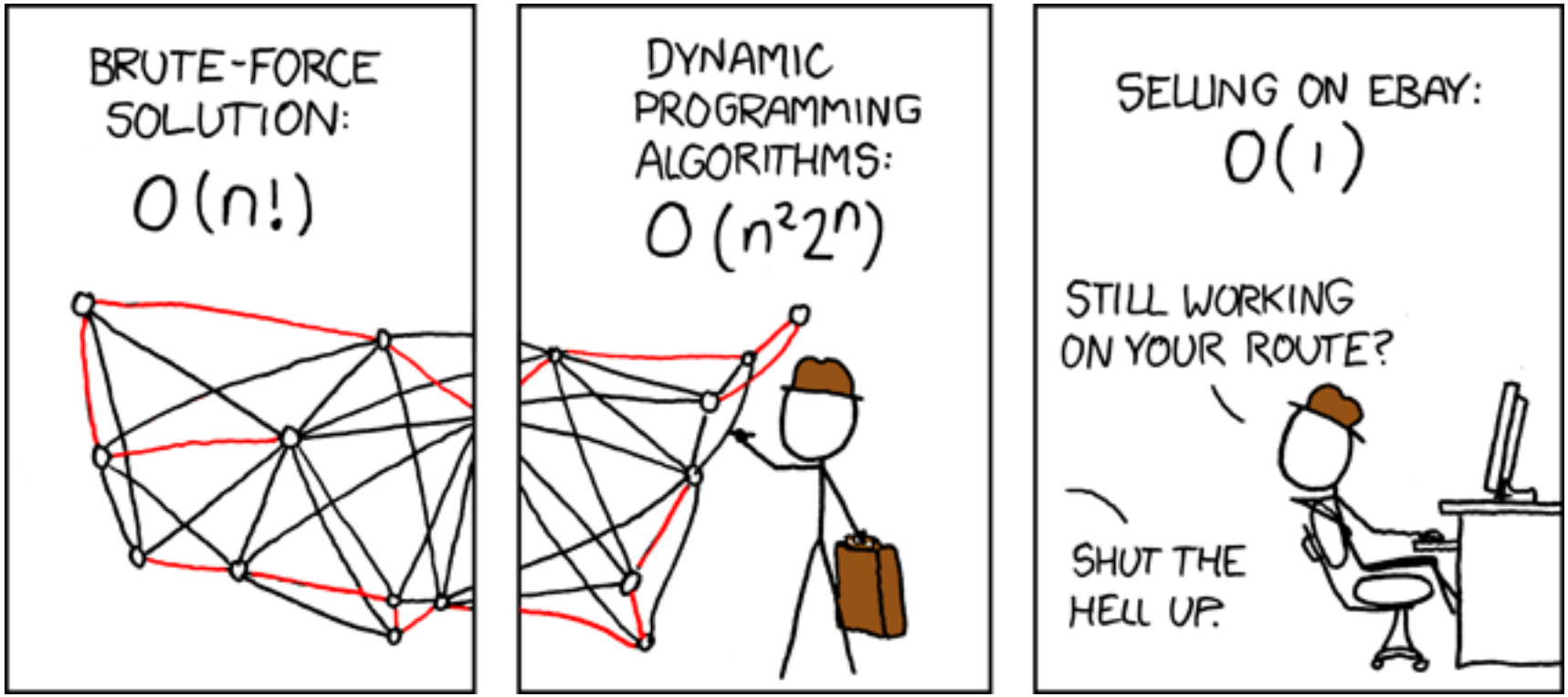
Step: "primitive computational step"

More on polynomial time

Problem centric tractability

Can talk about problems that are not efficient!

Asymptotic Analysis



Travelling Salesman Problem

(http://xkcd.com/399/)

Reading Assignment for today

note @57

stop following 1 view

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

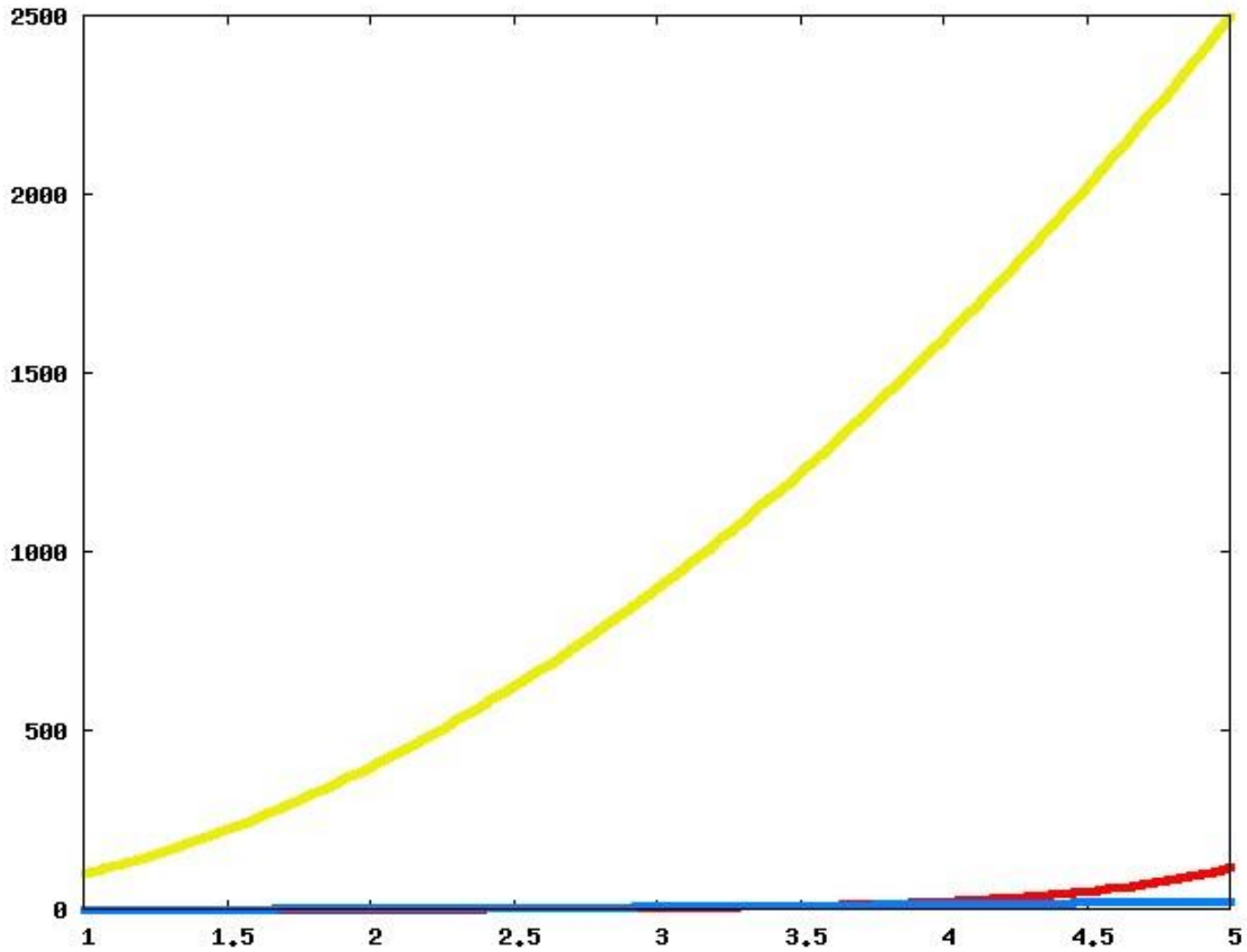
We will need this either the middle of lecture on Wednesday or in the Friday lecture.

lectures

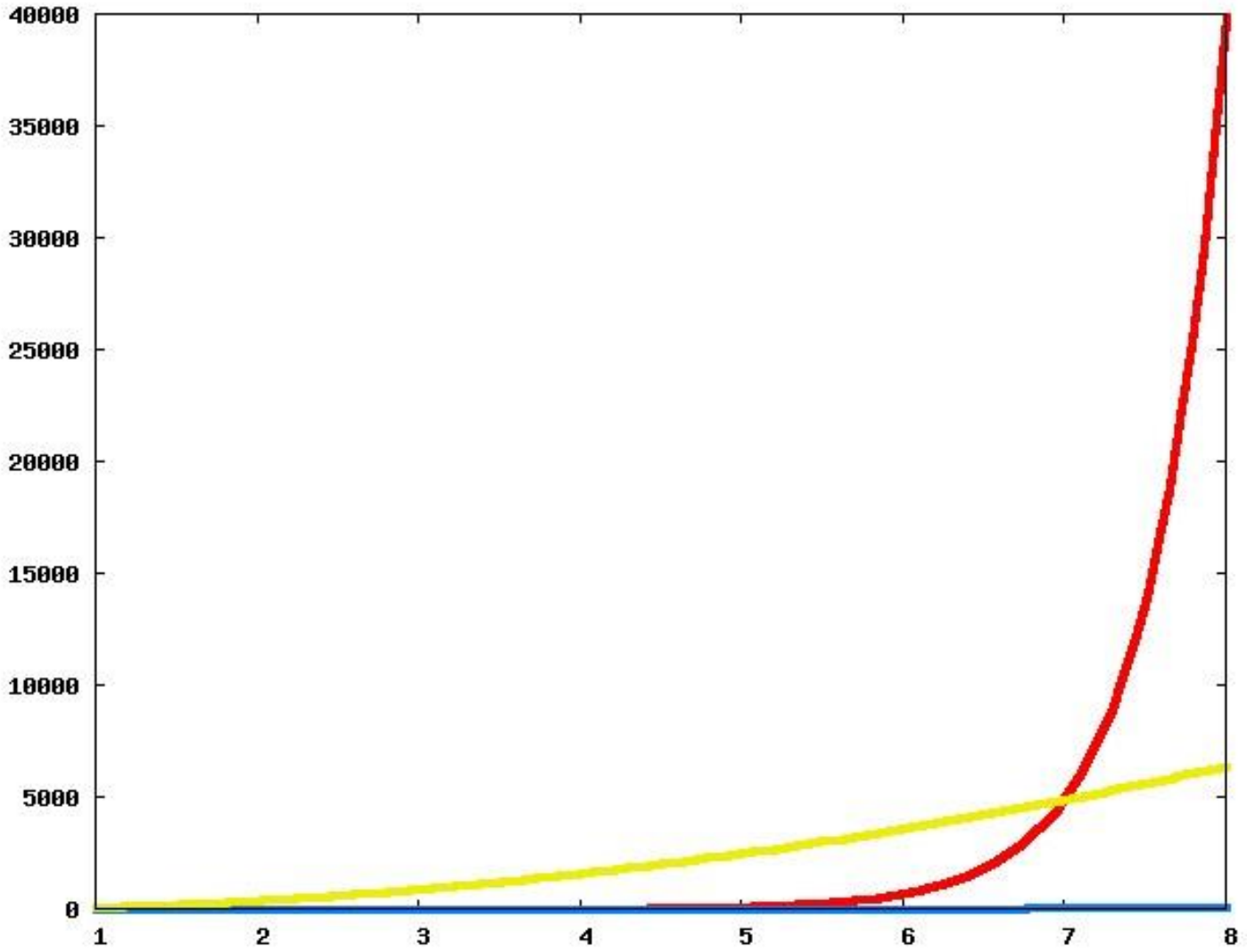
Edit good note 0

Updated 1 minute ago by Atri Rudra

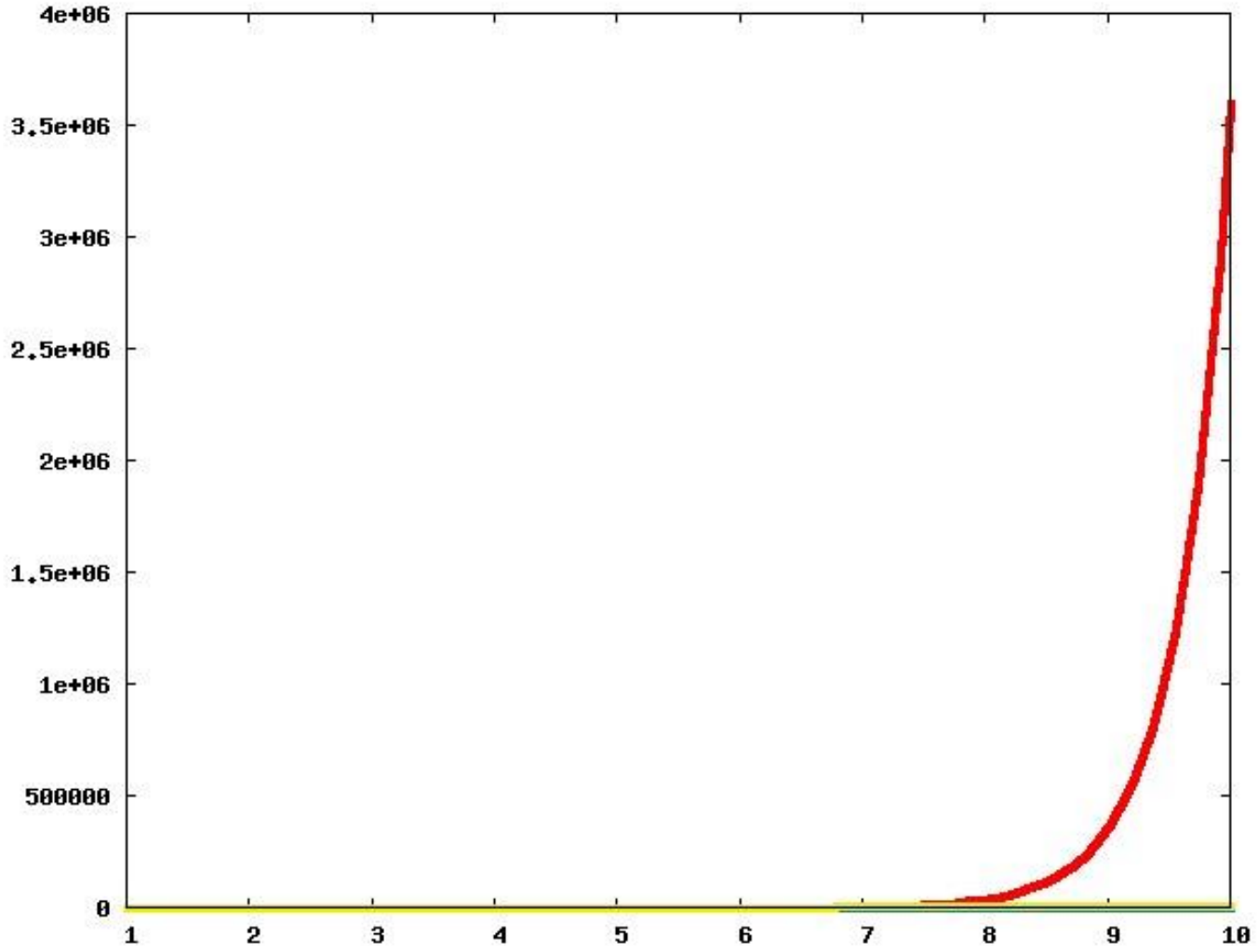
Which one is better?



Now?



And now?

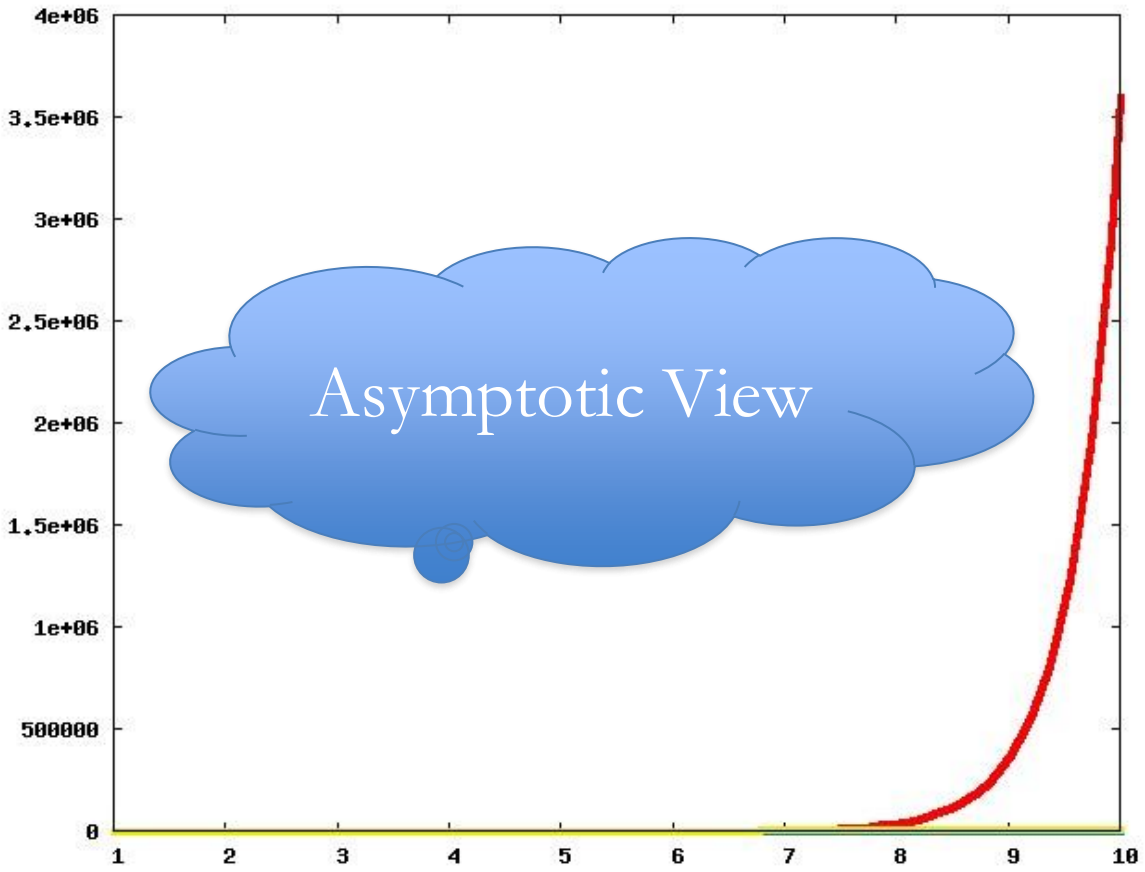


The actual run times

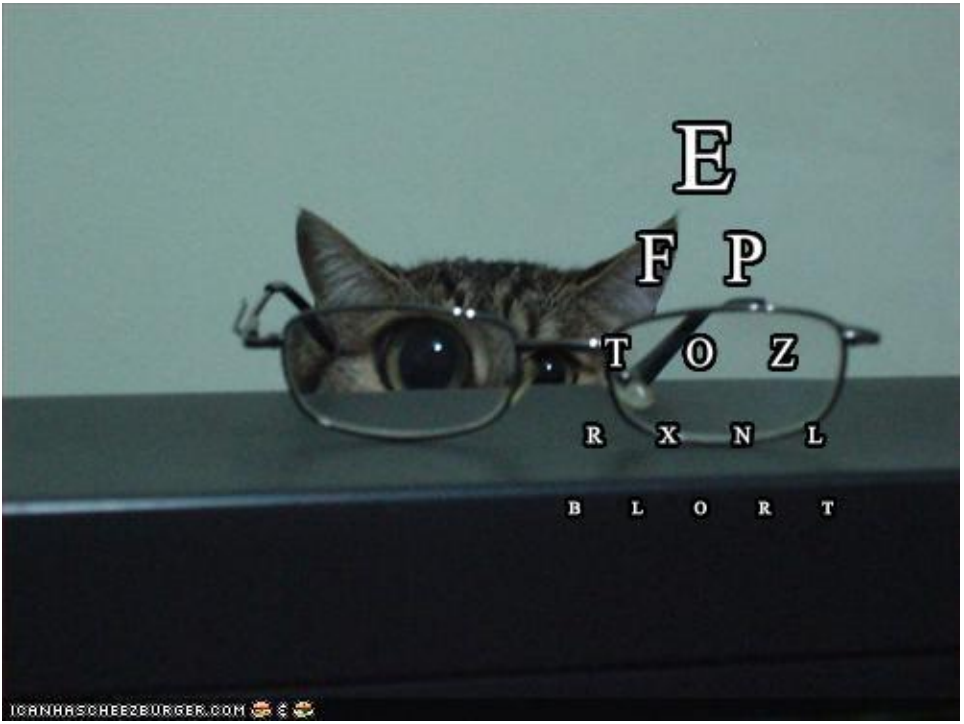
n!

$100n^2$

n^2



Asymptotic Notation

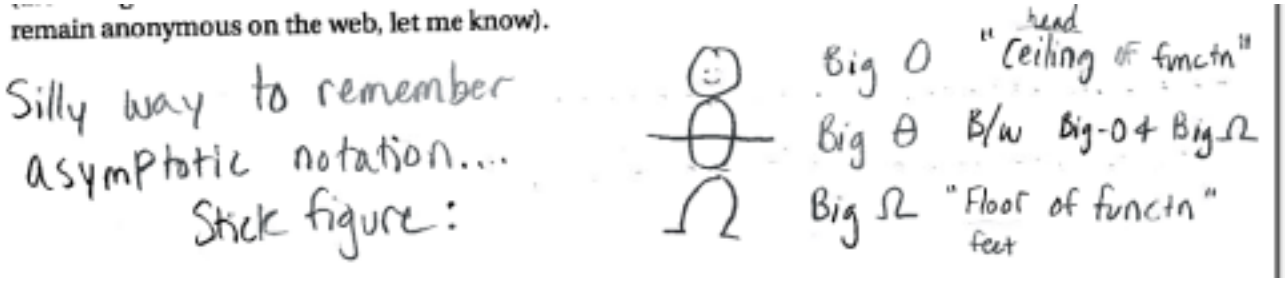


$\leq$ is O with glasses

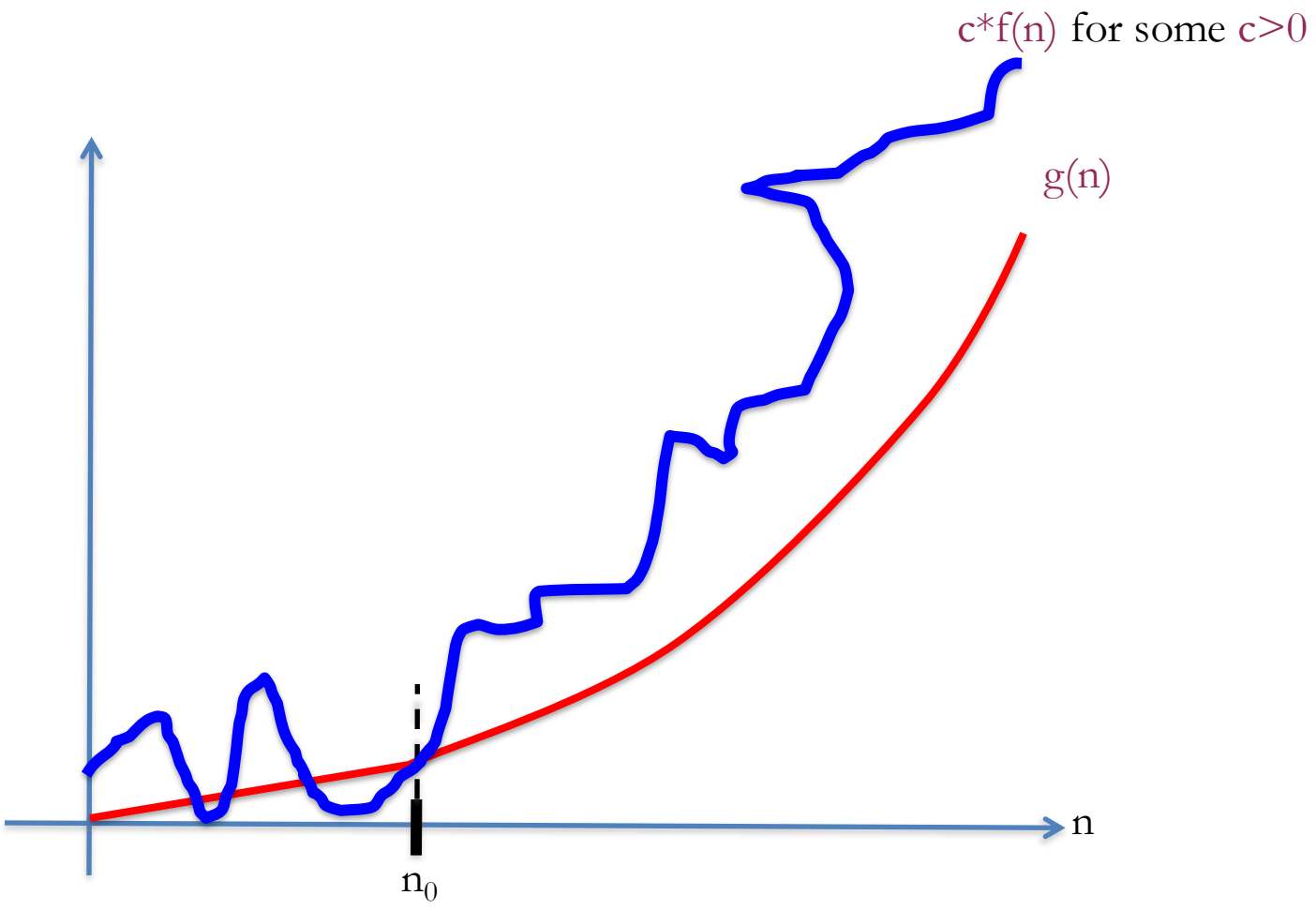
$\geq$ is Ω with glasses

$=$ is Θ with glasses

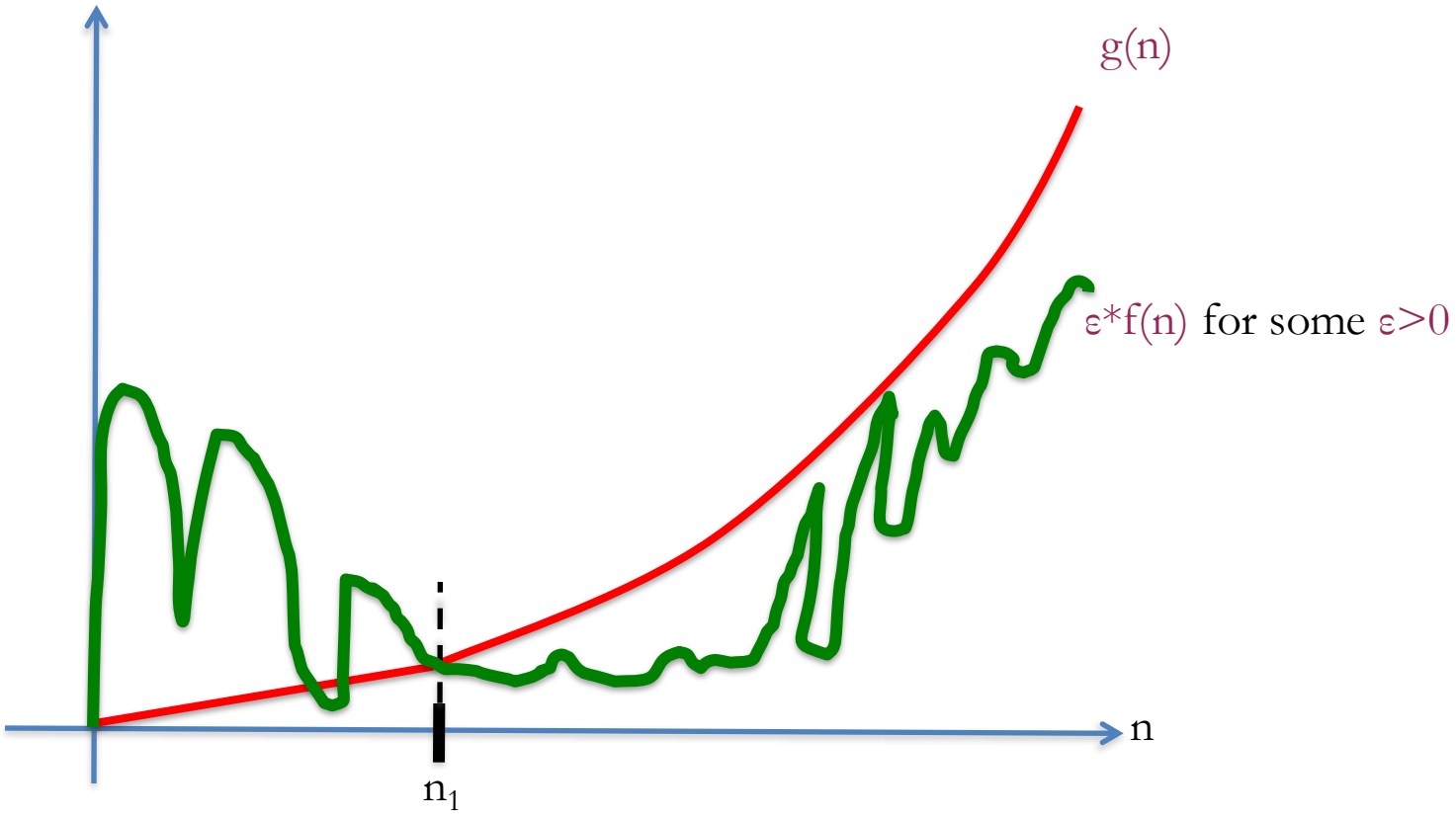
Another view



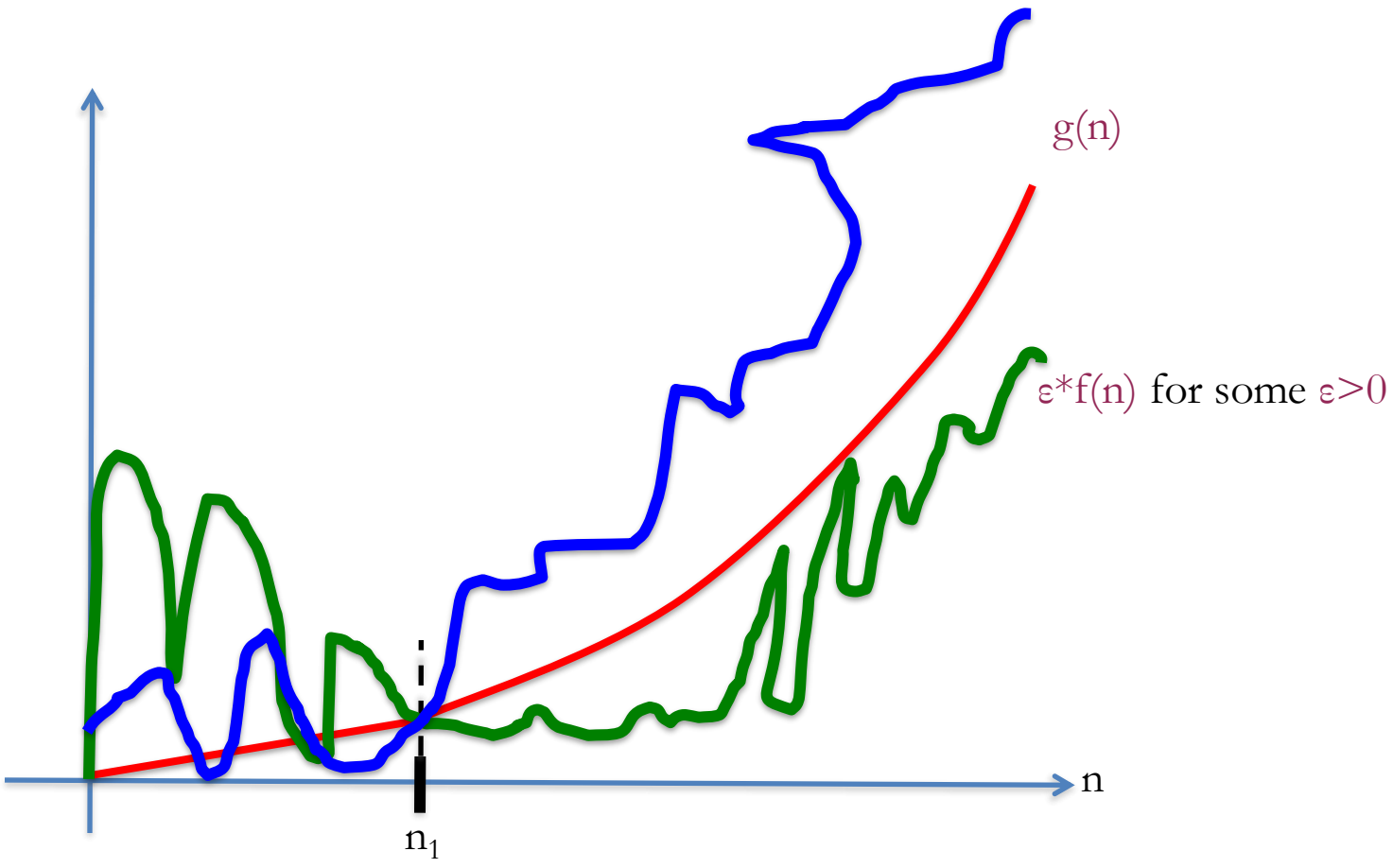
g(n) is O(f(n))



g(n) is Ω(f(n))



g(n) is Θ(f(n))



Properties of O (and Ω)

Transitive

g is O(f) and f is O(h) then
g is O(h)

Step 1 // O(n) time
Step 2 // O(n) time

Additive

g is O(h) and f is O(h) then
g+f is O(h)

Overall:
O(n) time

Multiplicative

g is $O(h_1)$ and f is $O(h_2)$ then
g*f is $O(h_1 * h_2)$

Overall:
$O(n^2)$ time

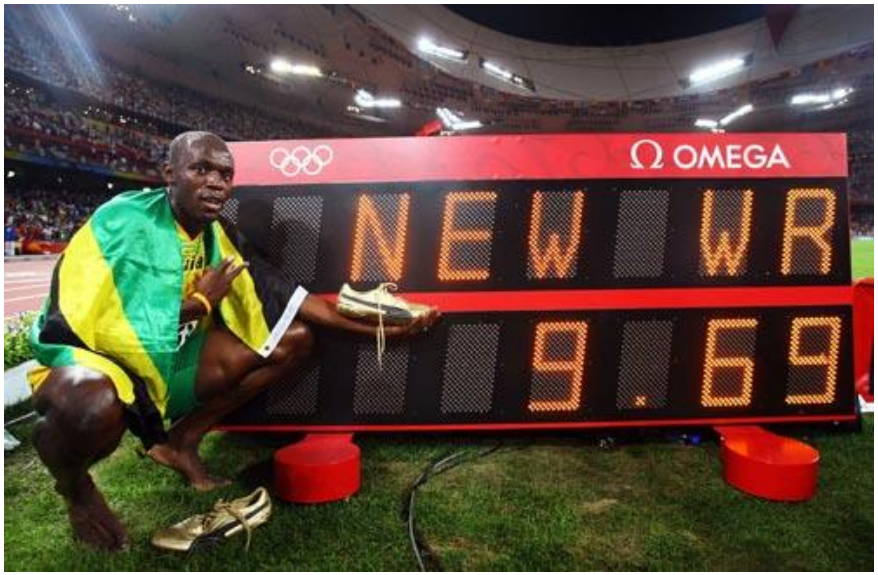
While (loop condition) // $O(n^2)$ iterations
Stuff happens // O(1) time

Questions?

Rest of today's agenda

$O(n^2)$ implementation of the Gale-Shapley algorithm

Some practice with run time analysis



Another Reading Assignment

CSE 331 Support Pages

Analyzing the worst-case runtime of an algorithm

Some notes on strategies to prove Big-Oh and Big-Omega bounds on runtime of an algorithm.

The setup

Let $\mathcal{A}$ be the algorithm we are trying to analyze. Then we will define $T(N)$ to be the worst-case run-time of $\mathcal{A}$ over all inputs of size N. Slightly more formally, let $t_{\mathcal{A}}(\mathbf{x})$ be the number of steps taken by the algorithm $\mathcal{A}$ on input $\mathbf{x}$. Then

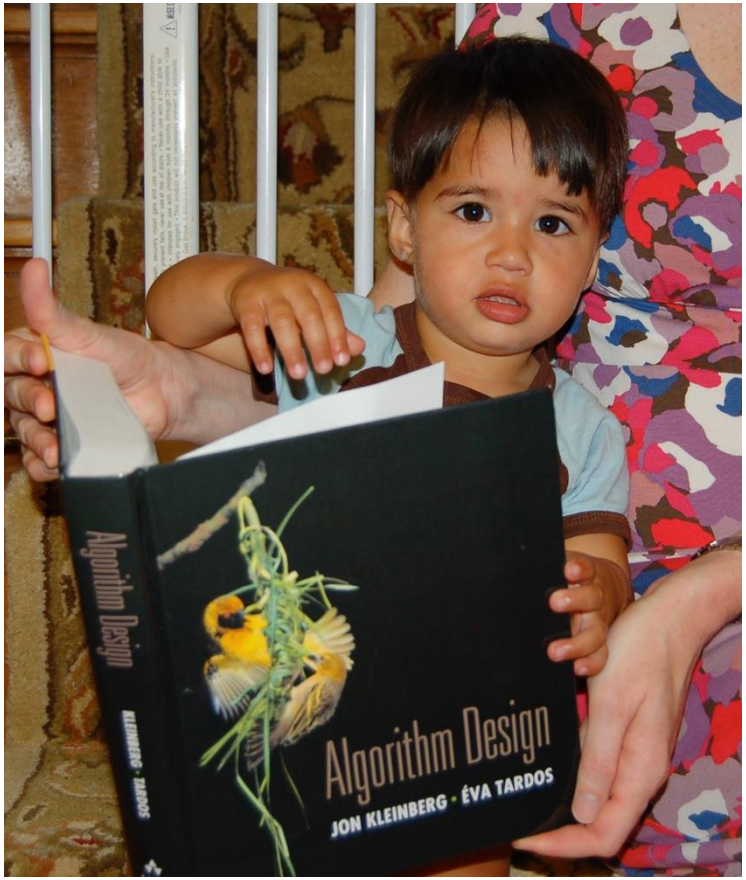
$$T(N) = \max_{\mathbf{x}:\mathbf{x} \text{ is of size } N} t_{\mathcal{A}}(\mathbf{x}).$$

In this note, we present two useful strategies to prove statements like $T(N)$ is $O(g(N))$ or $T(N)$ is $\Omega(h(N))$. Then we will analyze the run time of a very simple algorithm.

Preliminaries

We now collect two properties of asymptotic notation that we will need in this note (we saw these in class today).

Reading Assignments



Sections 1.1, 1.2, 2.1, 2.2 and 2.4 in [KT]

Gale-Shapley Algorithm

Intially all men and women are free

While there exists a free woman who can propose

At most n^2 iterations

Let w be such a woman and m be the best man she has not proposed to

w proposes to m

If m is free

(w,m) get engaged

Else (w',m) are engaged

If m prefers w' to w

w remains free

Else

(w,m) get engaged and w' is free

O(1) time implementation

Output the engaged pairs as the final output

Implementation Steps

(0) How to represent the input?

(1) How do we find a free woman w?

(2) How would w pick her best unproposed man m?

(3) How do we know who m is engaged to?

(4) How do we decide if m prefers w' to w?

Overall running time

Init(1-4)

n^2 X (Query/Update(1-4))

Questions?

Rest on the board…