Algorithm Design and Analysis

Introduction & multiplication

How was your break!?

Today: Huashui Algorithm

The Big Questions

- Who are we?
- Why are we here?
- What is going on?

Who are we?

We are ...

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  - Writing
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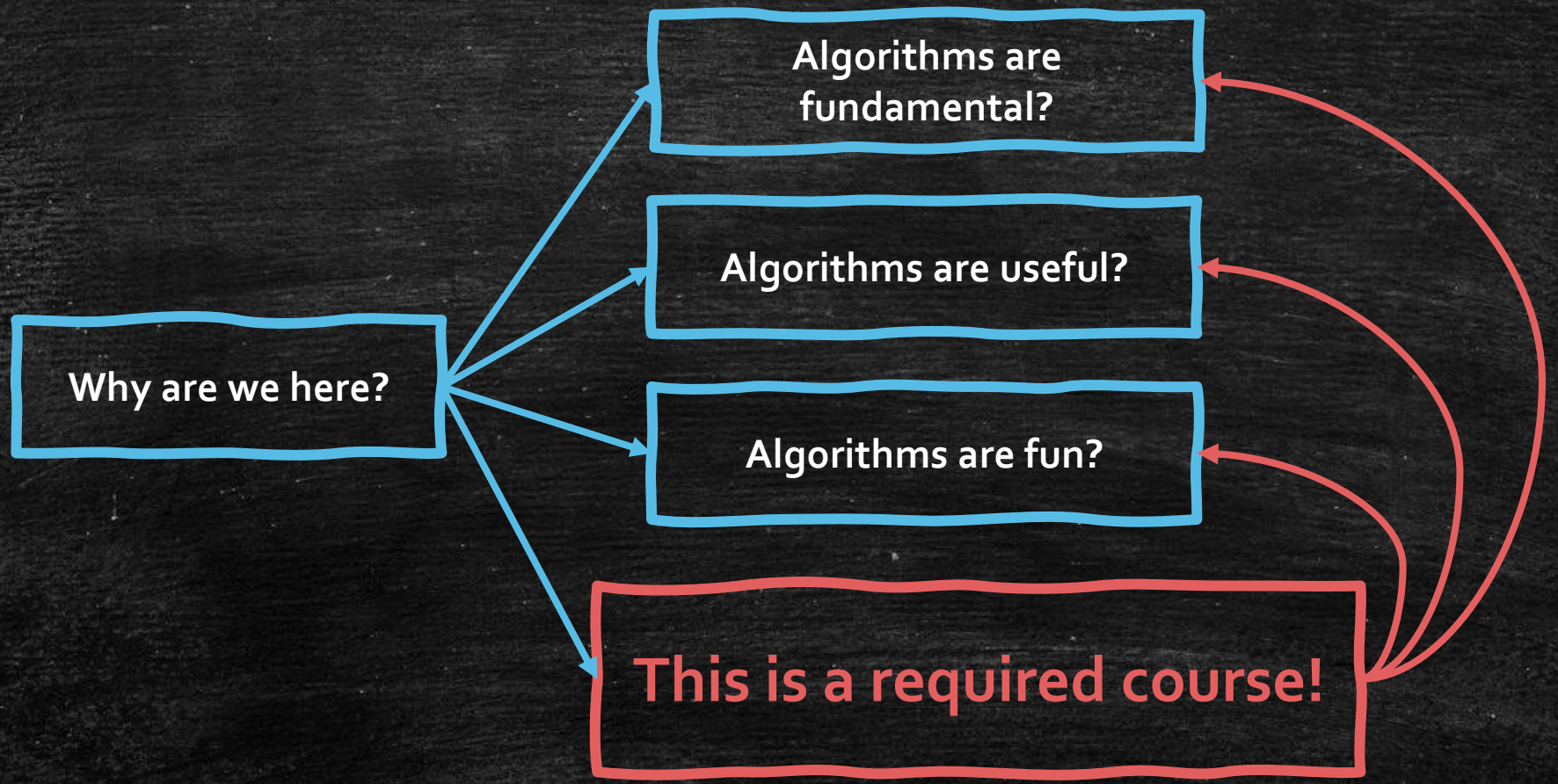
    - 金佳绒
    - 刘盼凤
  - Programming
    - 杨宗翰

Why are we here?

Algorithm!


Why are we here?
Algorithms are fundamental?
Algorithms are useful?
Algorithms are fun?
This is a required course!

What is going on?

Course goals

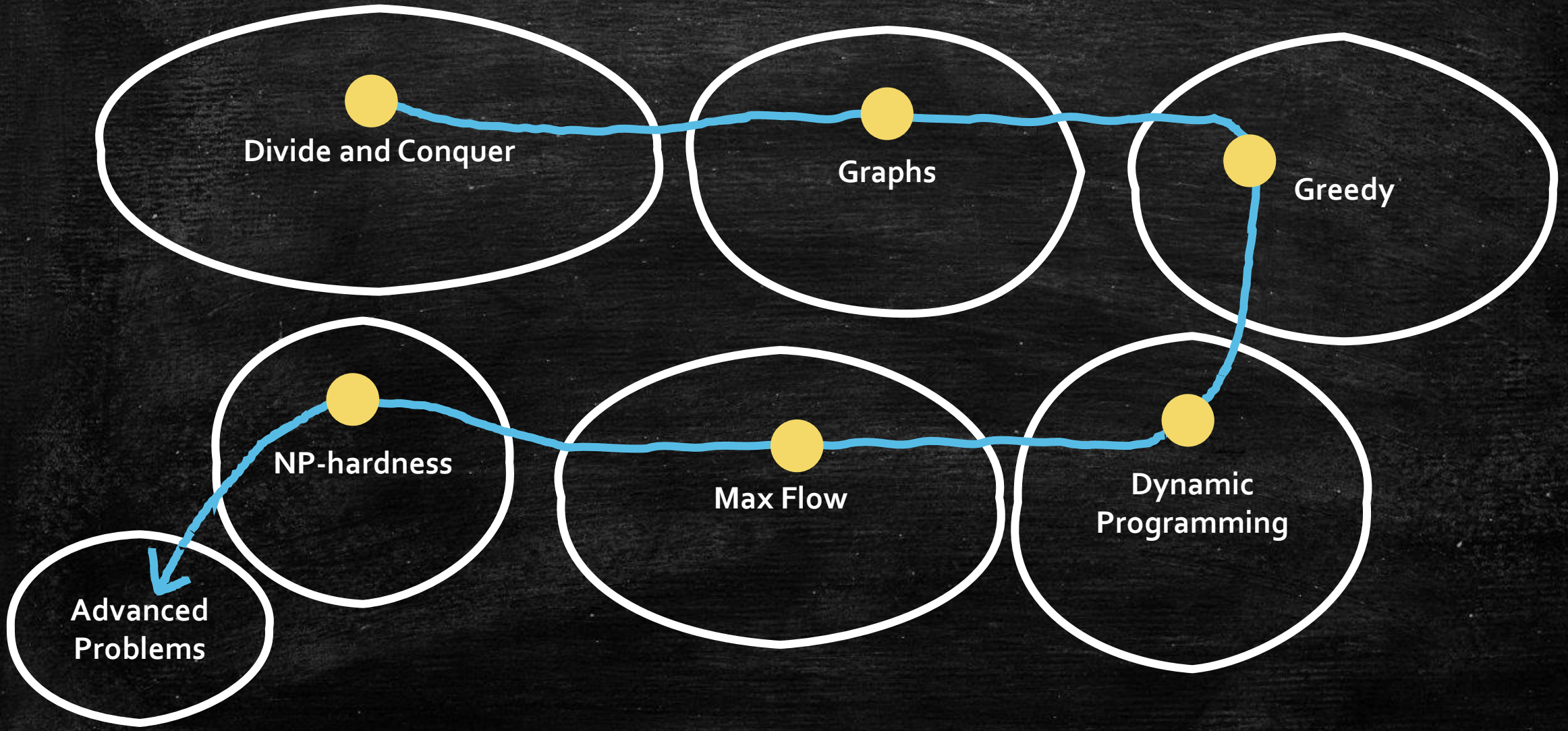
- The **design** and **analysis** of algorithms
- After this course, you will
  - Think **analytically** about algorithms
  - Clearly **communicate** your algorithmic idea
  - Equip with an **algorithmic toolkit**

  - Use them **correctly**

Most Important Thing

Raise Questions, Discussion

Roadmap


Divide and Conquer
Graphs
Greedy
NP-hardness
Max Flow
Dynamic Programming
Advanced Problems

How to evaluate algorithms?

Guide questions

- Does the algorithm **work**?
- Is it **fast**?
- Can I do **better**?

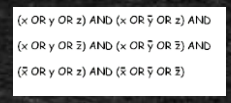
How to think in most of this course?

- Does the algorithm **work**?
  - Optimal or correct answer
  - **Exact Algorithms**
- Is it **fast**?
  - Time complexity
  - Worst case
- Can I do **better**?
  - More efficient
  - Better time complexity

Aside the course.

- What if the problem is so hard to get the solution?
  - Np-hard problems: take too long time
  - Online problems: not enough information

Included in advanced topics



SAT Problem

Online Matching

- What if a more efficient algorithm is not better?
  - More efficient → make private data public
  - More efficient → focus on the majority population

Data Privacy


Fairness

- What if you can not control player's behavior?
  - Auction
  - Public resource allocation


Auction


Public Resources

Advanced Topic

- Approximation Algorithms
  - Sometimes, we can not have both **efficiency** and **exactness,** unless **P=NP**.
  - Design Approximation Algorithms in Polynomial Time.
  - How to evaluate?
  - Algorithm A achieve Approximation Ratio Γ.
    - Minimizing Problem
    - For **all** inputs σ, $A(\sigma) \leq \Gamma \cdot OPT(\sigma)$.
    - A is a Γ −approximate algorithm.
    - Exact Algorithm: $\Gamma = 1$.

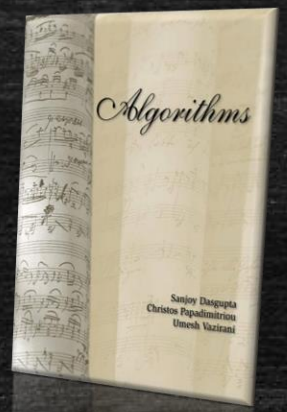
Advanced Topic

- Online Algorithm
  - Sometimes, we can not have **exactness,** if we are making **online decision,** even we have super computational power.
  - Example: Ski-rental
    - Rent: $1
    - Buy: $10
    - Buy or rent?
  - How to evaluate?
  - Algorithm A achieve Competitive Ratio Γ.
    - For **all** input sequences σ, $A(\sigma) \leq \Gamma \cdot OPT(\sigma)$.
    - A is a Γ −competitive algorithm.

About the course?

References (optional)

- **Algorithms by Dasgupta, Papadimitriou, Vazirani**



Homework

- Homework: $\mathbf{70\%}$
  - 5 programming + 6 writing homework: $\mathbf{55\%}$
  - 1 midterm (in-class): $\mathbf{15\%}$
- 1 final exam: $\mathbf{30\%}$
- We encourage **discussion**, but please try them on your **own** before discussion, and conclude them on your **own** after discussion.

Talk to us and each other!

- You can discuss with us at office hours.
  - Question: I do not know how to do it? ✖
  - Question: This is my approach, but I am stuck here…
- Office hours
  - Any time on wechat
  - Regular Office Hour: TBD
- Wechat group
  - Check **CANVAS**

Policy: Writing

- We encourage discussion on homework, but you should **write down** your solution **on your own**.
- You must **cite** all collaborators, as well as all sources used (e.g., online materials).
- Late policy
  - Within 3 days: **50%** of your score
  - Out of 3 days: **0%**
  - Special Issue

Plagiarism Policy of Programming

- We have **NO TOLERANCE** on it
- Unless instructed, **you can not submit copied code from any source**
  - Protecting your solution from copying is **your responsibility**
  - If you help others debugging, **do not submit using your own account**
- If the anti-cheating result is confident enough, you will have:
  - For the first time, **NO credit on that homework**
  - Otherwise, **NO credit on that homework** and **ALL upsolving disabled**
  - Trying to avoid anti-cheating by tampering code will count **twice**
  - **We will review code with you before making decision**
- We will do our best to fulfill our declaration here.

Feedback

- ~~It's my **first course**~~, so please tell me
  - The **pace** of the lecture
  - The **difficulty** of the homework
  - The **tpyos** in the sldies