Chapter 0.

Course Plan

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Goal
Lower bounds for dynamic problems based on various conjectures.
Fine-grained Complexity & Static Problems

The real world and hard problems

I’ve got data. I want to solve this algorithmic problem but I’m stuck!

I’m sorry, this problem is NP-hard. A fast algorithm for it would resolve a hard problem in CS/math.

Ok, thanks. I feel better that none of my attempts worked. I’ll use some heuristics.

The real world and easy problems

I’ve got data. I want to solve this algorithmic problem but I’m stuck!

Great news! Your problem is in P. Here’s an $O(n^2)$ time algorithm!

But my data size $n$ is huge! Don’t you have a faster algorithm?

Uhm, I don’t know… This is already theoretically fast… For some reason I can’t come up with a faster algorithm for it right now…

I want to analyze this **evolving data** but I’m stuck.

There is a lower bound of \( \Omega(\log^2 n) \) in cell-probe

But \( O(\log^5 n) \) will be good enough

Sorry, we don’t know how to prove big cell-probe lower bounds, and there is no such thing like NP-hardness ...
Rough Plan

1. Introduction to dynamic algorithms
   – Update & Query Time
   – Incremental/Decremental Algorithms
   – Amortization & Empty-start assumption
   – Randomization & Oblivious-adversary assumption
2. Lower bounds based on the OMv conjecture
3. Other conjectures
   – SETH, OV, dynamic OV, BMM, 3SUM, APSP, Multiphase, etc.

Optional:
- Unconditional lower bounds
- Hardness of FPT-approximation (GapETH-, W[1]-hardness, etc.)
Questions?

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