Representations in Algorithm Design.

Social network. Friend recommendation

Alice's friends: Cathy, David.

Bob ... : Cathy

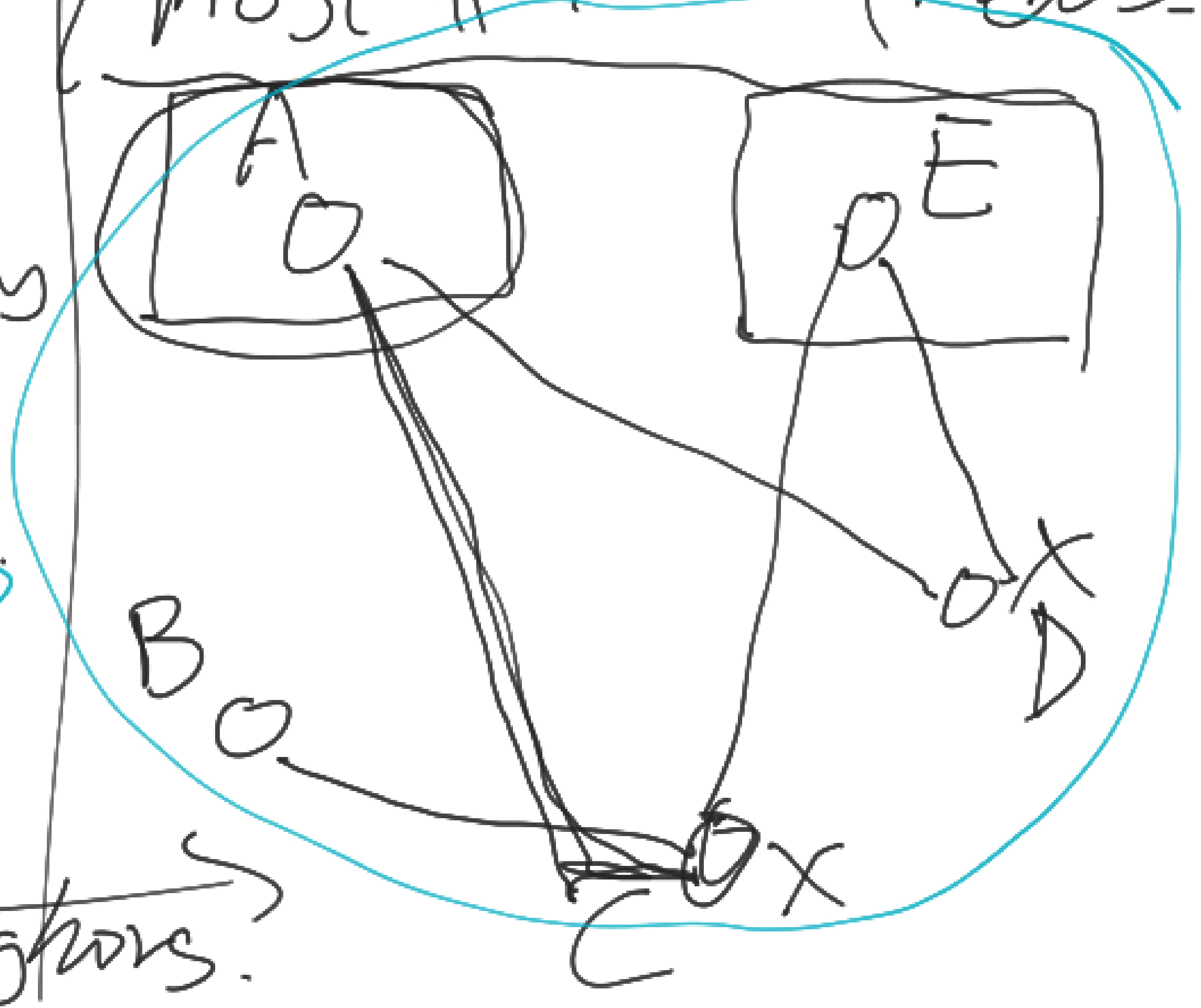
Cathy ... : Alice, Erica, Bob

David ... : Alice, Erica

Erica : Cathy, David

representation.

most # common friends



most common neighbors.

Representations

Graph representations

- Trees.
- expanders.
- Graph sparsification
- Decompositions: expander decomposition,

  low diameter.

  Short cycle

① what are useful representations

② what are properties?

③ How to algorithmically use these representations?

Matrix representation / Algebraic representation

Linear system solvers.

Laplacian solvers.

Tensor. $\Rightarrow$ matrix multiplication.

Combinatorial representations.

Dynamic programming.

Prerequisite: CS 401 / MCS 401.

No exam

Grading:

- Homework (two) 30%.
- Scribe notes 30%.
- Research project / paper presentation 30%
- Class participation 10%.

Algorithms:

- Approximate Algo:

  approximation ratio: $\alpha = \dfrac{\text{Solution by algo}}{\text{optimal solution}}$.

  for maximization problems. $\alpha \leq 1$

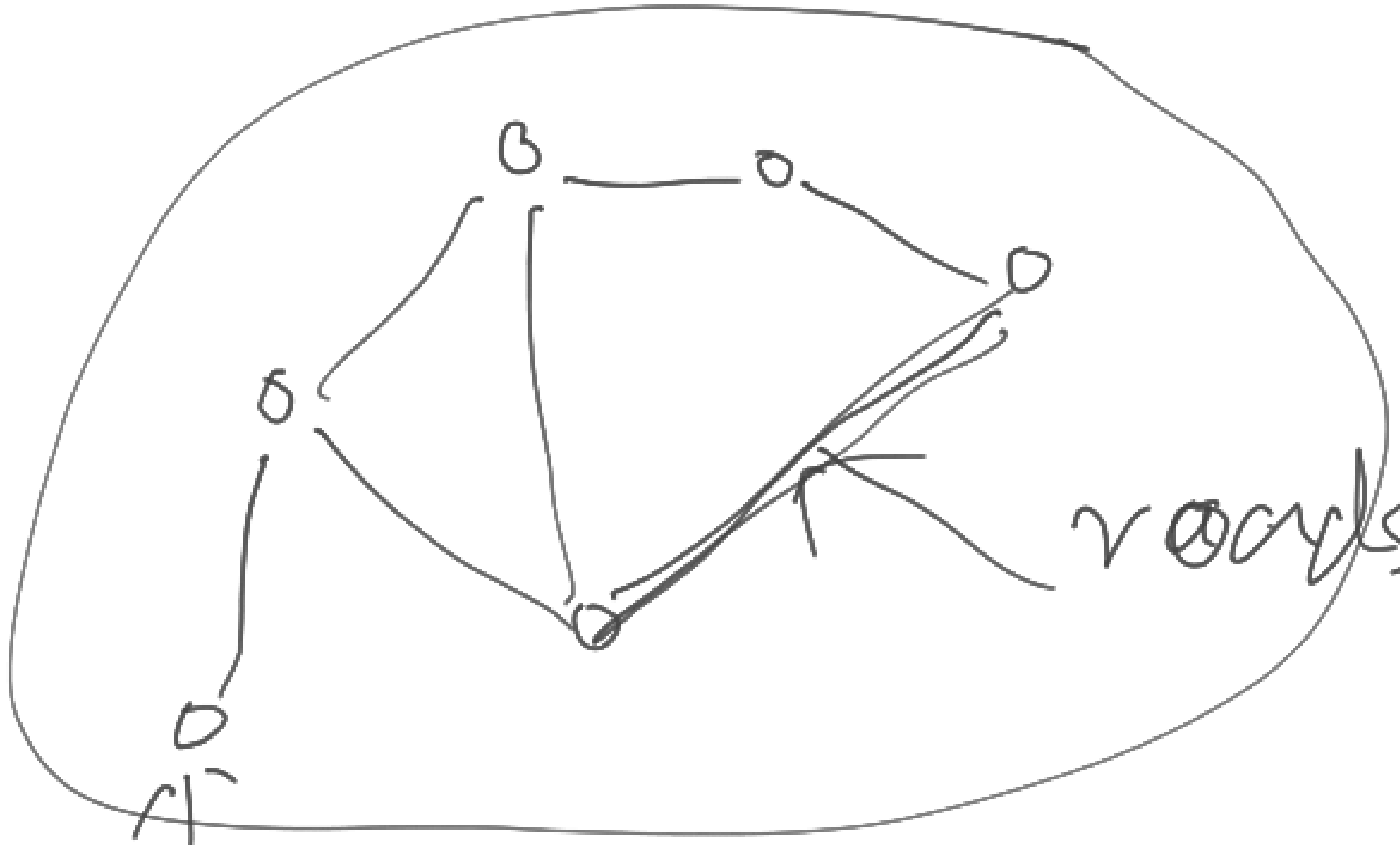
  goal: α as big as possible.

  minimization $\alpha \geq 1$

  goal: ~ " small ~ ~ -

- Dynamic Algorithm: input is changing.

  - maintain some property object.



roads: time need travel from one end to the other end,

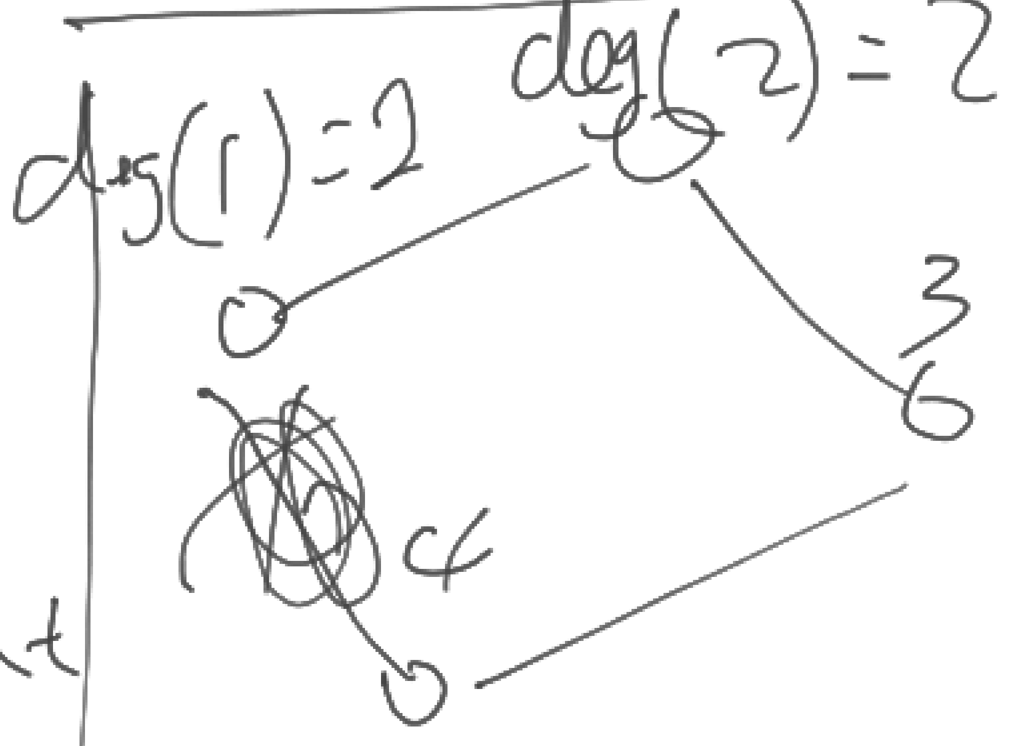
street intersections.

- Parallel Algo: use many computers to do computation together. (speed up).

Graph representations. (Trees)

(Vertices, edges).

- path: a sequence of vertices.
- Cycle: path with same start and end vertex
- Tree: is a graph without any cycle
- connected component:
- Degree: #edges.



(1, 2, 3, 4, 2)

vertex path

(1, 3, 2, 4).

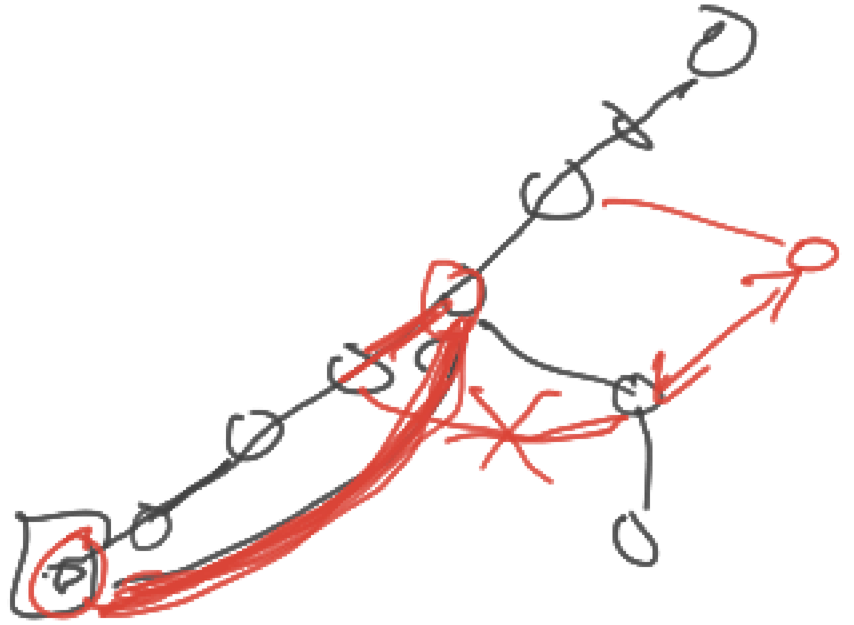
Tree ⟸ a special graph.

For each graph there can be different tree representations.

BFS } graph traversal | trees.

DFS

DFS.



BFS → spanning tree (tree using edges from input graph)

① shortest path
② edges between vertices in same or adjacent level

DFS

② No ~~ed~~ non-tree edge in same or adjacent level.

② Non-tree edges connects two vertices s.t one is the other's ancester.

back edges.

Claim: For every graph s.t every vertex is degree ≥ 3, the graph has a cycle of lenght at most $O(\log n)$ (graph has n vertices).

a cycle length n.

short cycle decomposition

HINT: BFS for graph.