Peeling Set Systems
Daniel Nakhimovich
PI: James Abello
Data to Collection of Sets

student1: course1,course2,...
student2: course5,course2,...
...

course1
course2
course3
course4

course1
course2
course4
course6
Sets to Region Graphs

course 1

course 2

course 3

course 4

course 4

course 5

course 6

course 7

course 4

course 5

course 8

course 9

course 6

course 8

course 10

course 1

1, 2, 3

4

5

9

6

7

8

10, 11
Sets to Region Graphs

- Venn Diagram
  - Regions: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

- Region Graph
  - Connections:
    - 1, 2, 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10, 11
  - Connections:
    - 1, 2, 3
    - 4
    - 5
    - 6
    - 7
    - 8
    - 9
    - 10, 11
Problem?

Vertices: 99
Edges: 408

Data from: Rutgers Masters Students’ Studyplans
Iterative Edge Core Decomposition

Fig. 3 (d) from: J. Abello, F. Quelroy, "Fixed Points of Degree Peeling", ASONAM 2013, Advances in Social Networks, IEEE/ACM International Conference, Niagara Falls, Canada, August 2013.
Iterative Edge Core Decomposition

Peel 1

Peel 2

Peel 4

Peel 5

Peel 11
Problem?

Vertices: 572
Edges: 5237

Peel 10

**k-connectivity**

- A graph is **connected** when there is a path between every pair of vertices.

- A **separating set** of a graph is a set of vertices that when removed from the graph cause the resulting induced sub-graph to be disconnected.

- A graph is **k-connected** if it has more than k vertices and does not have a separating set of less than k vertices.
k-connected component decomposition

Find the Minimum Separating Set
If found, split the graph along the Separating Set
If there is none then done

For each piece...
Demo
Minimum Separating Set

- Flow?
  - yes, but we need a transformation:

- Remark: this only gives us minimum separating set between 2 vertices, not overall.
  - O(VE)
Minimum Separating Set

- Approximations:
  1. Don’t check every pair of vertices, just check the pair of vertices furthest apart. (actually lets relax that to just far apart, O(V+E) vs O(V^3))
  2. Instead of finding min cut with flow algorithms on auxiliary graph, just compare a few minimum separating set candidates.

- Candidate Finding Procedure:
  1. Run a breadth first searches starting from each of those vertices furthest apart from each other. (O(V+E))
  2. Note that each depth level in the BFS trees is a valid separating set and thus a candidate.
  3. Find the intersection of the middle depth level of both BFS trees and if it is a valid separating set include it as a candidate. (O(V+E))
Next

1. Decompose more data
   - Dreams
   - Drugs
   - Wiki-Votes
   - etc.
2. Look for structures that arise
3. Find more minimum separating set candidates
Special Thanks

- Grant: Computer-Human Graph TeleDiscovery (IIS-1563971)
- Principal Investigator: James Abello
- Region Graph Visuals: Monica Bansal