Kia Cooperative Systems Summer High School Outreach

Introduction

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Program's objectives

Primary Objective: Expose High School Students to How Independent Research Is Carry out in University

Secondary Objective: Introduce High School Students to Graph Theory and its Application in Robot Motion Planning

The program consists of

- Introduction to Graph Theory
- Introduction to Python Programming
- Robot Motion Planning Using Visibility Graphs
- Multi-robot Leader-Follower (if time allows)
- Observing Research Meetings

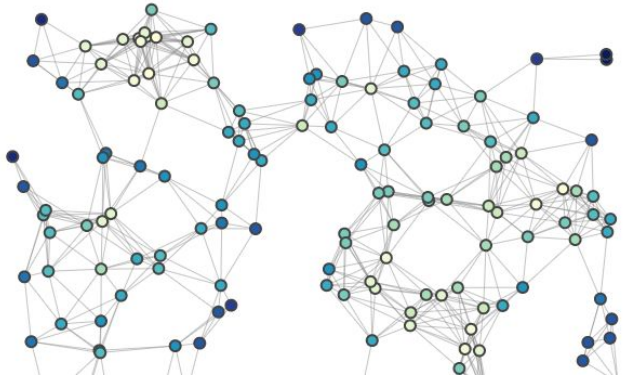
You are an independent research in this program!

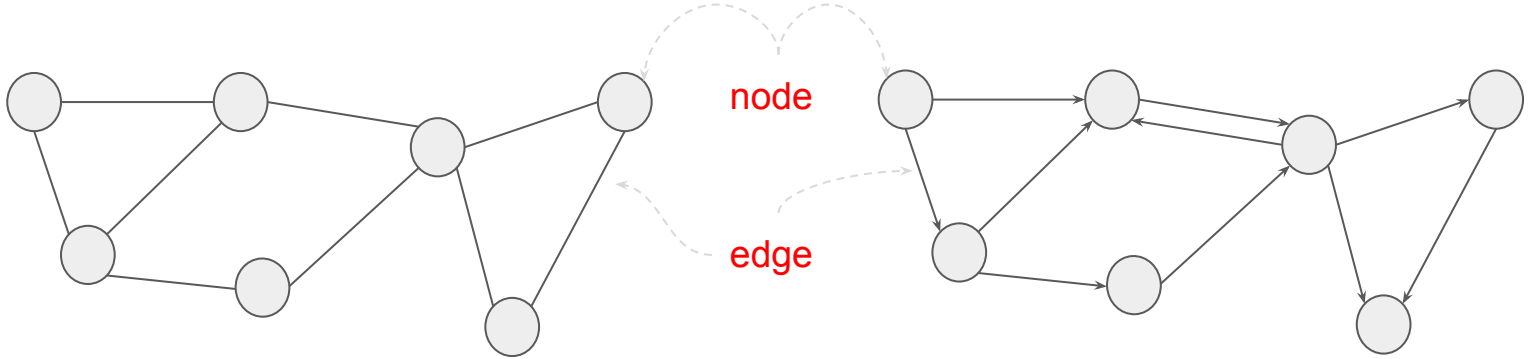
What is graph and why graphs are important in engineering and computer science?

These are not Graphs!

What is graph and why graphs are important in engineering and computer science?

Wikipedia's definition: In mathematics, **graph theory** is the study of *graphs*, which are mathematical structures used to model pairwise relations between objects. A graph in this context is made up of *vertices* (also called *nodes* or *points*) which are connected by *edges* (also called *links* or *lines*). A distinction is made between **undirected graphs**, where edges link two vertices symmetrically, and **directed graphs**, where edges link two vertices asymmetrically.





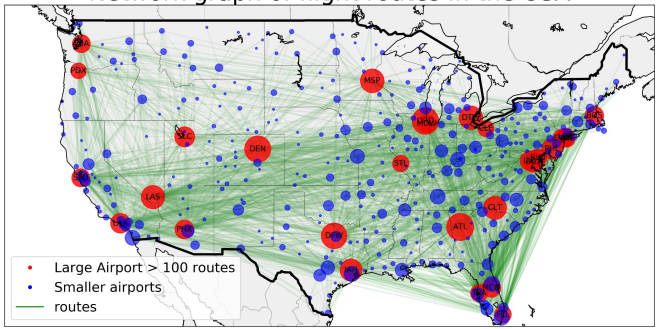
Undirected graph (think of Facebook)

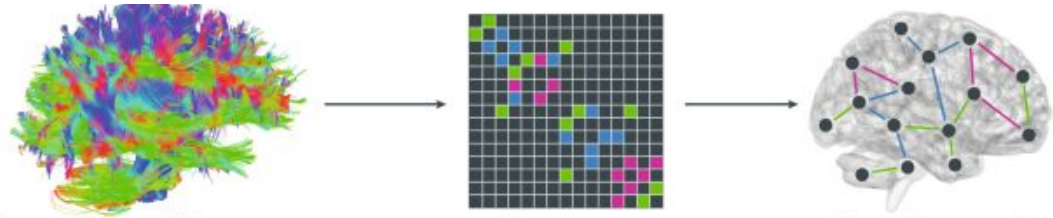
Directed graph (think of Twitter)

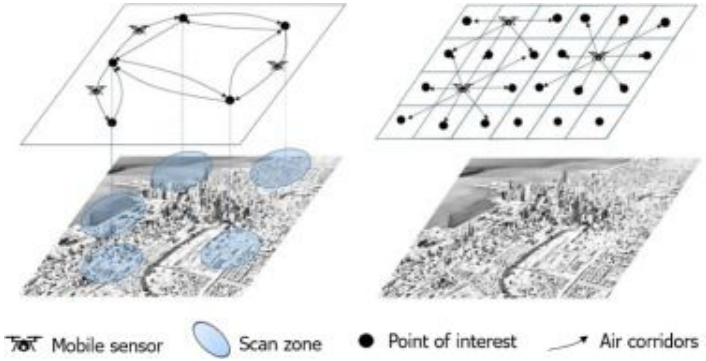
What is graph and why graphs are important in engineering and computer science?

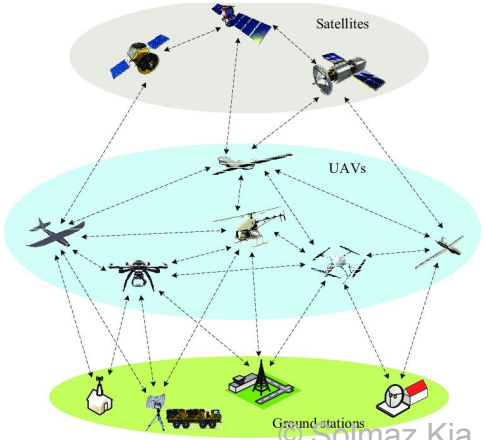
Application: Graphs are used to model pairwise relations between objects. Graphs provide natural abstractions for how information is shared between nodes(agents) in a network.

Network graph of flight routes in the USA



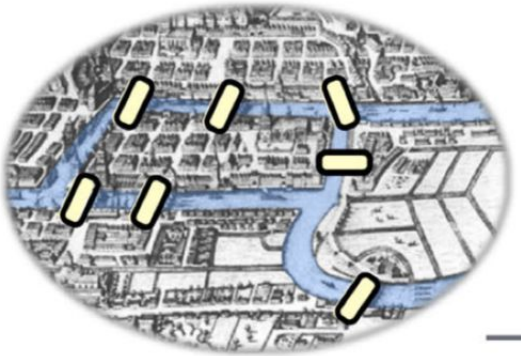






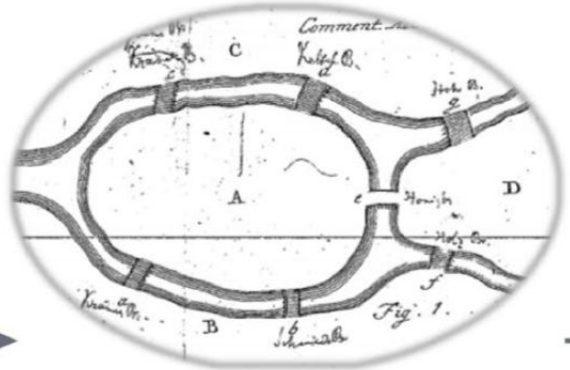
What is graph and why graphs are important in engineering and computer science?

History: Graphs have a history dating back to 1736, when Leonhard Euler solved the "Seven Bridges of Königsberg" problem. The problem asked whether it was possible to visit all four areas of a city connected by seven bridges, while only crossing each bridge once. It wasn't.



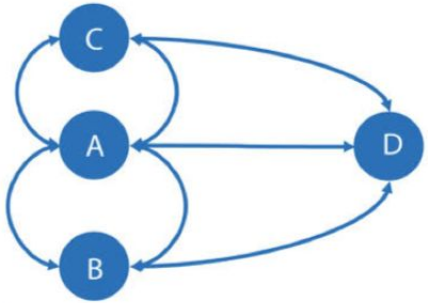
Walking the Bridges of Königsberg

4 Main areas of Königsberg with 7 Bridges. Can you cross each bridge only once and return to your starting point?



Euler's Insight

The only relevant data is the main areas and the bridges *connecting* them.

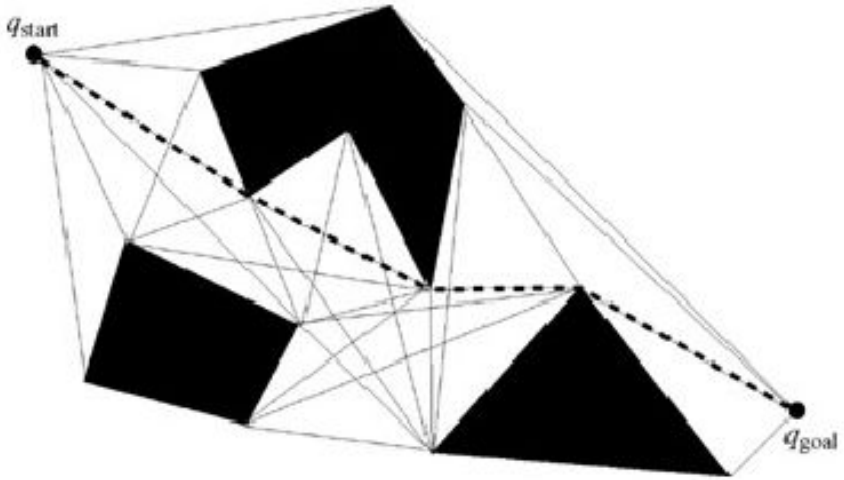


Origins of Graph Theory

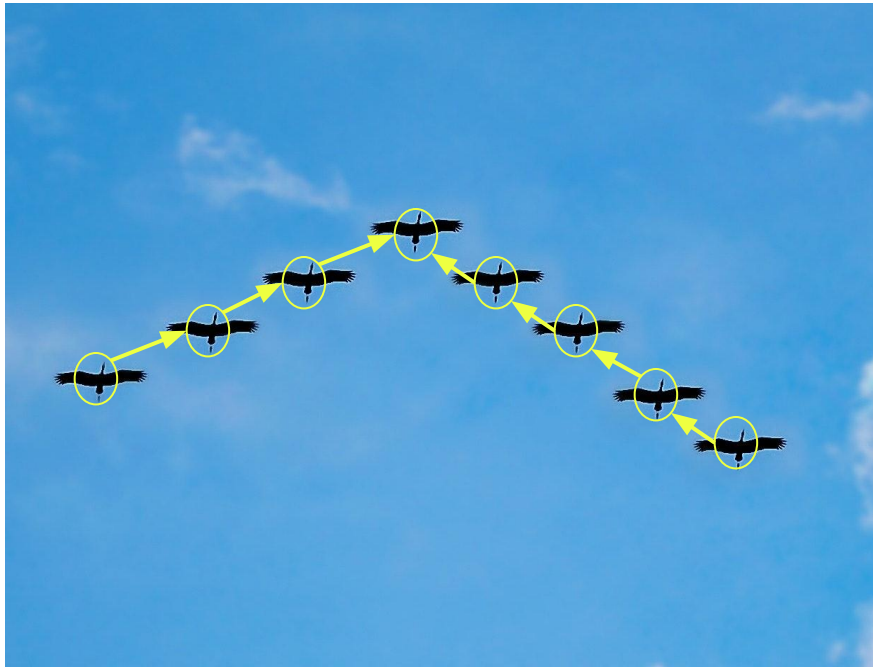
Euler abstracted the problem and created generalized rules based on nodes and relationships that apply to any connected system.

Motion planning using visibility graphs

Problem: Given a space with known obstacles, enable a robot to move from any start point to any goal point by taking the shortest obstacle-free possible path.

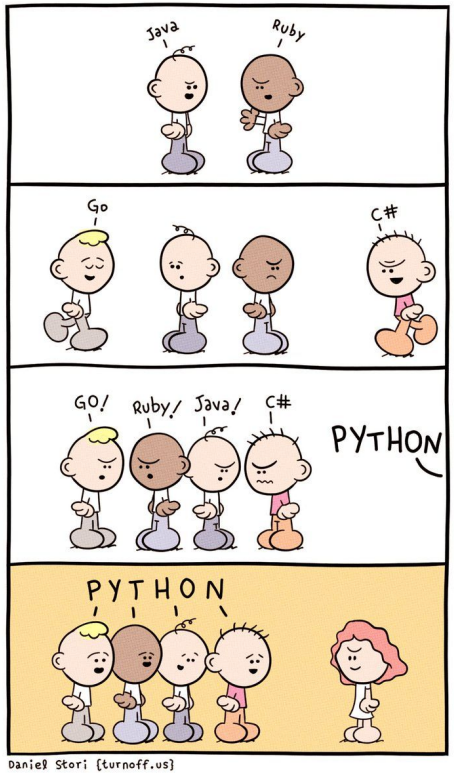


Multi-robot leader follower



Python programming

- A high level multipurpose programming language
- Popular libraries (numpy, scipy, matplotlib) has made it powerful environment for scientific computing
- Google Colab : cloud platform (IDE), we will be using



python + colab

https://colab.research.google.com/

Tutorial on python

- https://www.youtube.com/watch?v=rxSyXBq9zq0&list=PLlEgNdBJEO-nQkFDah-gm6UX7CI6rCdB-&ab_channel=TokyoEdtech
- https://www.youtube.com/watch?v=8ext9G7xspg&t=192s (Project based learning)
- https://python101.pythonlibrary.org/ (Free Textbook for Python Beginners)

Tutorial about using python in Google-colab

- https://www.youtube.com/watch?v=i-HnvsehuSw&ab_channel=ProgrammingKnowledge
- https://colab.research.google.com/github/cs231n/cs231n.github.io/blob/master/python-colab.ipynb

Python programming

Jul 2021	Jul 2020	Change	Programming Language	Ratings	Change
1	1		C	11.62%	-4.83%
2	2		Java	11.17%	-3.93%
3	3		Python	10.95%	+1.86%
4	4		C++	8.01%	+1.80%
5	5		C#	4.83%	-0.42%
6	6		Visual Basic	4.50%	-0.73%
7	7		JavaScript	2.71%	+0.23%
8	9	↑	PHP	2.58%	+0.68%
9	13	⇈	Assembly language	2.40%	+1.46%
10	11	↑	SQL	1.53%	+0.13%
11	20	⇈	Classic Visual Basic	1.39%	+0.73%
12	8	⇊	R	1.32%	-1.08%

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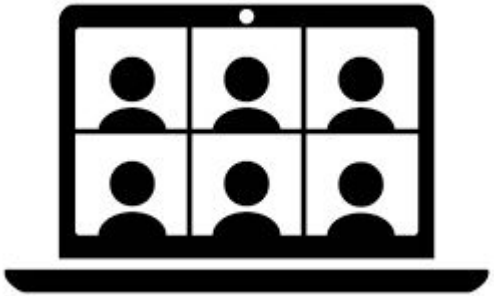
Schedule and timelines

Program Schedule

First week (July 7-9)
Tuesday July 6: 10-11am
Wednesday: 2:30-3:30pm
Friday: 11:30am-12:30



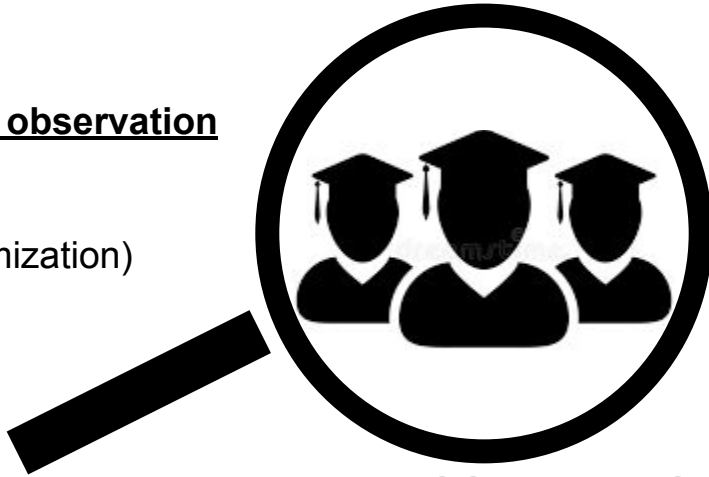
The remaining weeks
Mondays: 10-11am
Wednesdays: 10-11 am
Fridays: 11:30am-12:30 pm

Graduate student group meeting and individual advisor meeting observation

Graduate student group meeting: Fridays **10:30-11:30am**

Individual meetings (choose 1 starting second week):

- Noah: Wednesdays: 11:15-12:15 (privacy in networks and optimization)
- Doni: Wednesdays 1:30-2:30 (robot motion planning)
- Minwon: Tuesdays 2-3 (pedestrian localization)
- Changwei: Tuesday 3-4 (pedestrian localization)
- Navid: Tuesdays: 11:15-12:15 (motion planning, theoretical)



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