Kia Cooperative Systems
Summer High School Outreach
Introduction

PI: Solmaz Kia
Graduate Student: Donipolo Ghimire
Mechanical and Aerospace Engineering Department
University of California Irvine
Summer 2021
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!

© Solmaz Kia, UCI
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.
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.
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.
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

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

Tutorial on python

- https://www.youtube.com/watch?v=rXSyXBq9zq0&list=PLIEqNdbJEO-nQkFDah-qm6UX7CJ6rCdB&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
<table>
<thead>
<tr>
<th>Jul 2021</th>
<th>Jul 2020</th>
<th>Change</th>
<th>Programming Language</th>
<th>Ratings</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td>C</td>
<td>11.62%</td>
<td>-4.83%</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
<td>Java</td>
<td>11.17%</td>
<td>-3.93%</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
<td>Python</td>
<td>10.95%</td>
<td>+1.86%</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
<td>C++</td>
<td>8.01%</td>
<td>+1.80%</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td></td>
<td>C#</td>
<td>4.83%</td>
<td>-0.42%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td></td>
<td>Visual Basic</td>
<td>4.60%</td>
<td>-0.73%</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td></td>
<td>JavaScript</td>
<td>2.71%</td>
<td>+0.23%</td>
</tr>
<tr>
<td>8</td>
<td>9</td>
<td>↑</td>
<td>PHP</td>
<td>2.58%</td>
<td>+0.68%</td>
</tr>
<tr>
<td>9</td>
<td>13</td>
<td>↑</td>
<td>Assembly language</td>
<td>2.40%</td>
<td>+1.46%</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>↑</td>
<td>SQL</td>
<td>1.53%</td>
<td>+0.13%</td>
</tr>
<tr>
<td>11</td>
<td>20</td>
<td>↑</td>
<td>Classic Visual Basic</td>
<td>1.39%</td>
<td>+0.73%</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>↓</td>
<td>R</td>
<td>1.32%</td>
<td>-1.08%</td>
</tr>
</tbody>
</table>
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)