


Three small grey triangles pointing upwards, arranged horizontally.

# **Wildcat Integrated Mobility Solution (WIMS)**

ECE 579 Project, Team 6

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A large red triangle pointing upwards, located at the bottom center of the slide.



# Introduction

- The information age was heralded as an era that would be distinguished by faster, easier, and more informed human decisions.
- Instead, people began to experience “choice paralysis”.
- To make data useful, a good system must avoid placing the user in this uncomfortable situation.
  - Filter out noise.
  - Present limited options to the user.
- Google Maps?
  - Close, but not quite!



- WIMS analyzes all available possible routes at once.
  - Includes routes requiring change of vehicles.
  - Incorporates real-time traffic information.
    - Temporal and spatial.
- Features an AIPS to manage inventory of public transit bikes.
- Prototype developed limited in scope.
  - University of Arizona campus.
  - Three vehicles: walking, biking, CatTran.
- Scalable to any complex transportation network.
  - Consider downtown New York, international flights, etc.



# Engineering Requirements

- 1) The WIMS shall read database files that includes the information on locations and paths in the University of Arizona.
- 2) The WIMS shall accept updates to traffic and CatTran information.
- 3) The WIMS shall consolidate location, path, traffic and CatTran information to form a graph that represents the possible paths people may take to travel across various locations at campus.
- 4) The WIMS shall allow the user to specify two locations that correspond to locations on the map of the university.



# Requirements

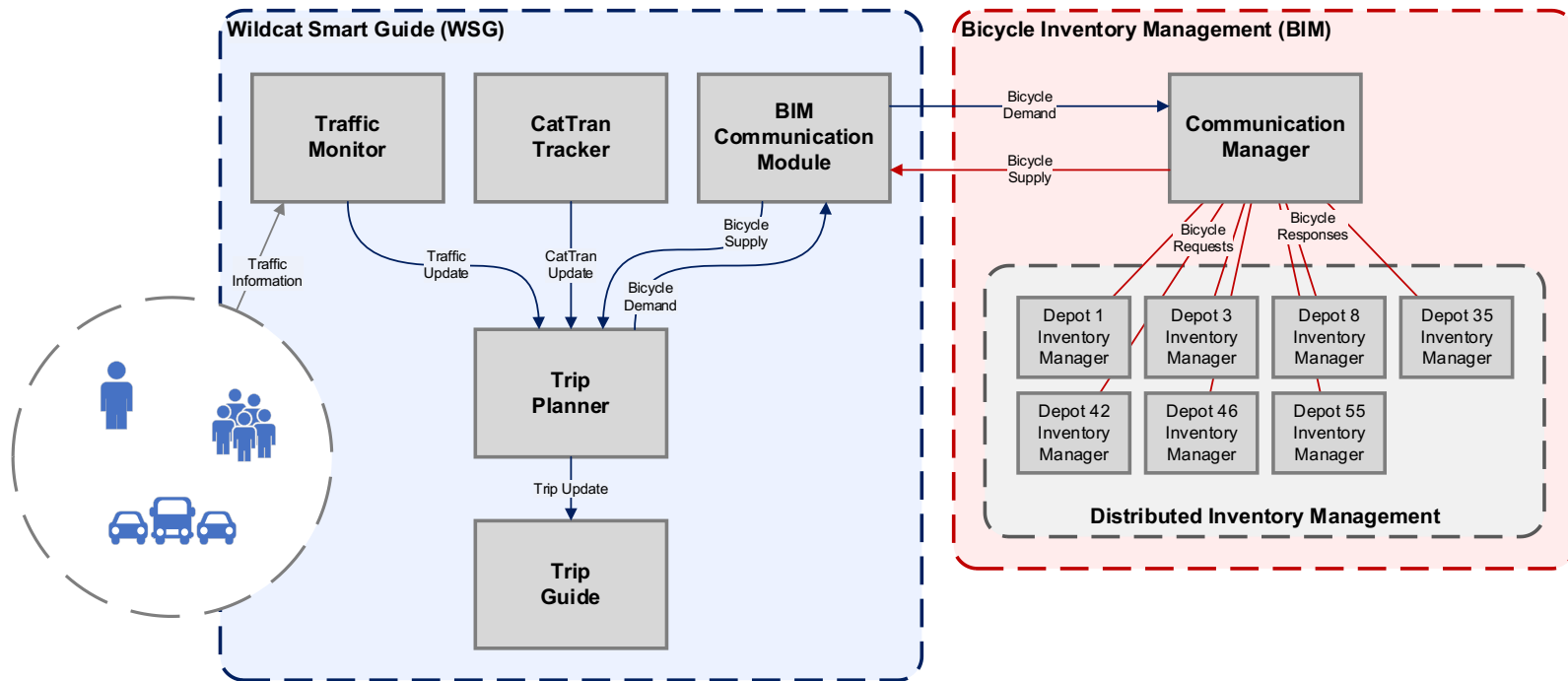
- 5) The WIMS shall allow the user to specify how to optimize the path search for. The parameters that can be specified are:
  - Minimize distance traveled
  - Minimize the time taken to travel between two locations
  - Minimize the time taken to travel between two locations while taking traffic and CatTran information into account
- 6) The WIMS shall use the inputs given by the user to conduct the optimal path search between the two locations entered by the user.



# Requirements

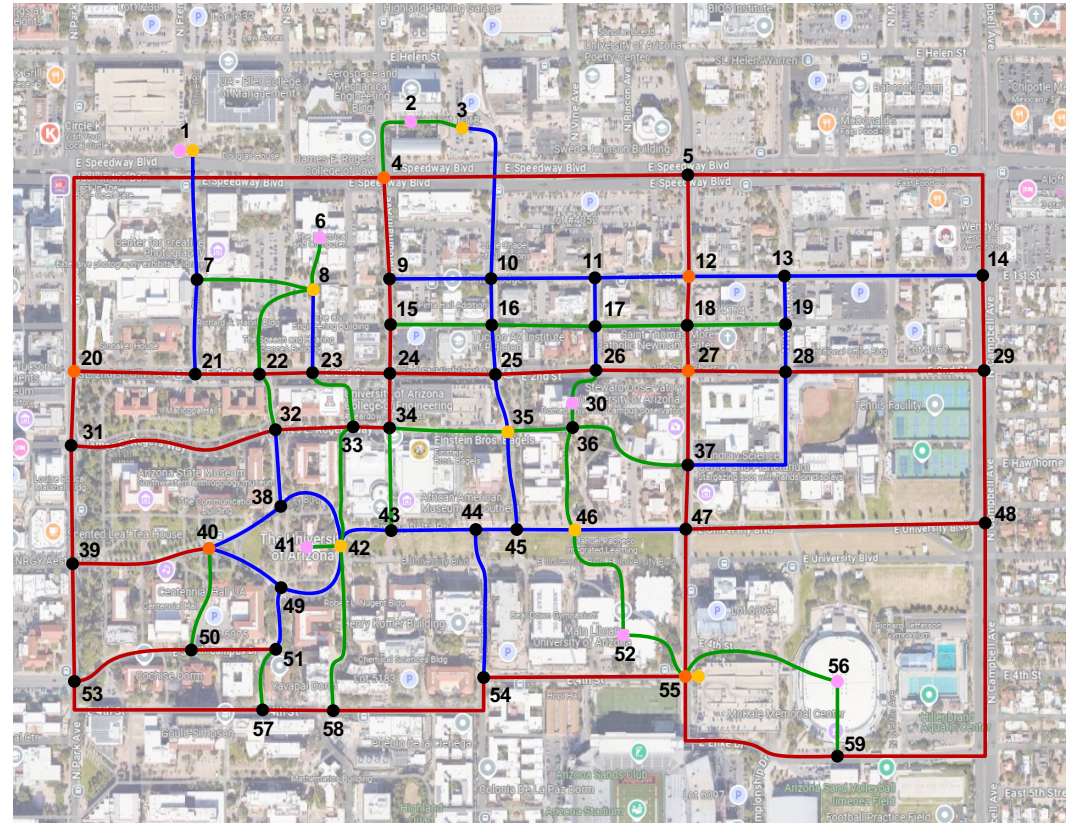
- 7) WIMS shall display the path found by the search algorithm. The display shall contain the following:
- The location IDs for the travel path
  - The order the locations are taken in the path
  - The mode of transportation used to arrive at the location.
  - The performance metric used to measure the optimality of the path.

# Engineering System Architecture



# Engineering Wildcat Smart Guide

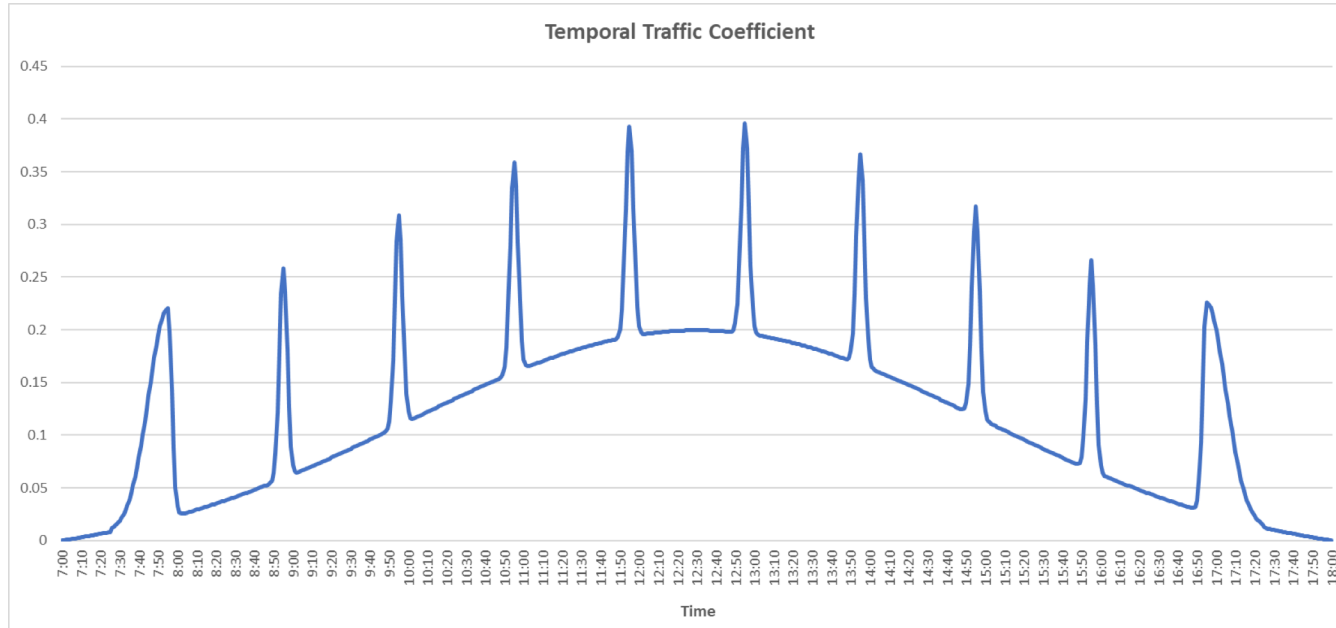
- 59 Locations
  - Destinations (Pink)
  - CatTran Stops (Orange)
  - Bicycle Depots (Yellow)
  - Intersections (Black)
- 97 Paths
  - Red
  - Blue
  - Green
- 3 Transportation Modes
  - Walking (5 km/h)
  - Bicycle (16 km/h)
  - CatTran (12 km/h)





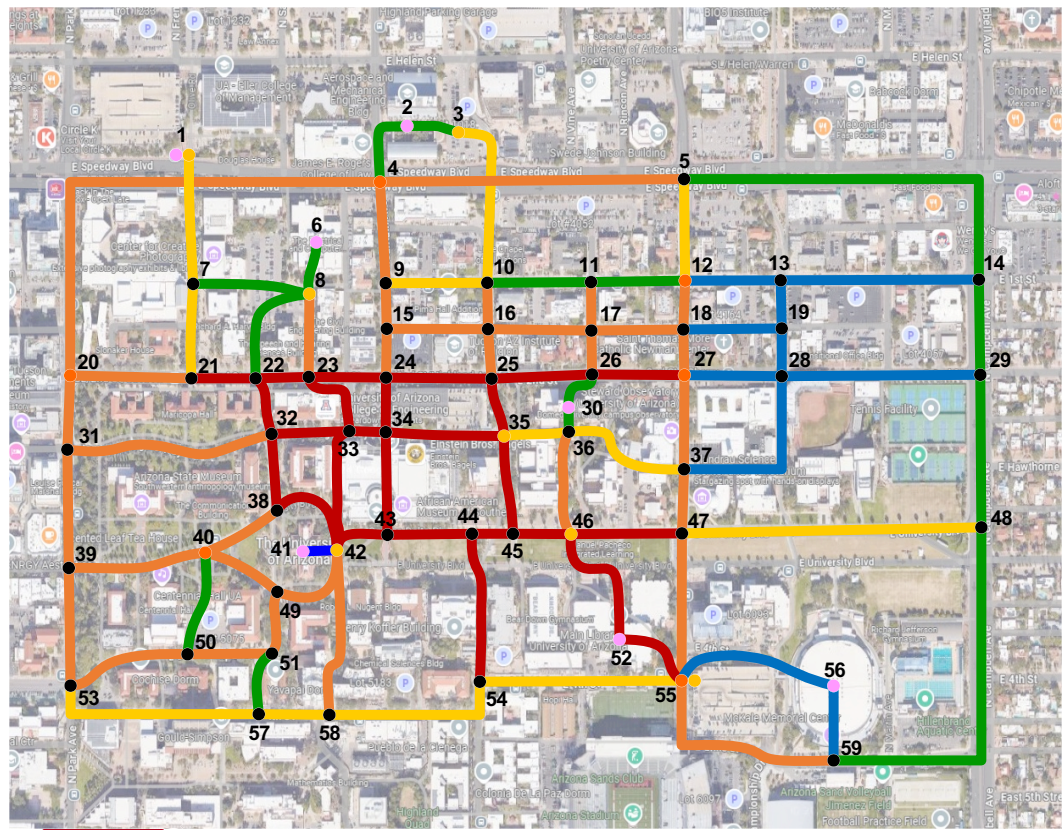
# Engineering Wildcat Smart Guide

- Temporal Traffic Simulation:



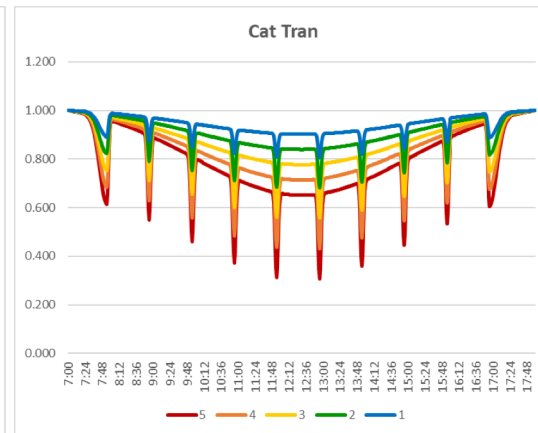
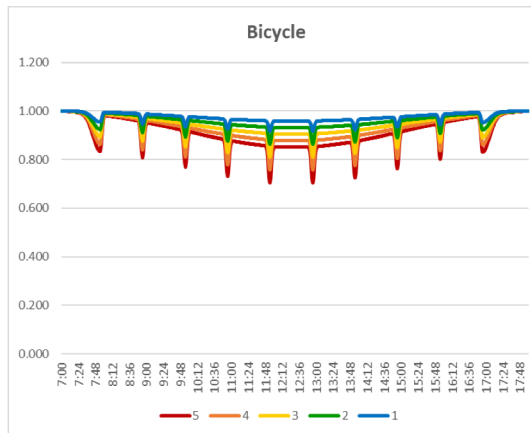
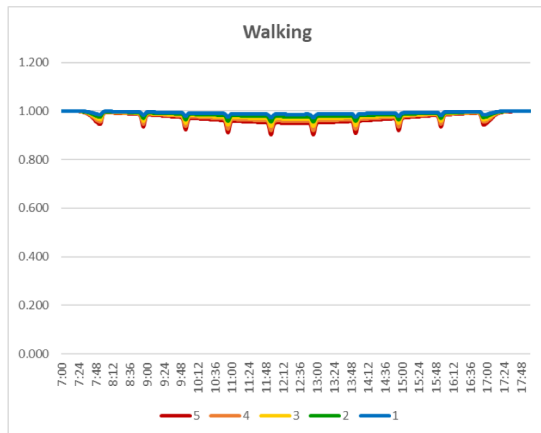
# Engineering Wildcat Smart Guide

- Spatial Traffic Simulation:
  - Rating 5 (Red) – The busiest
  - Rating 4 (Orange)
  - Rating 3 (Yellow)
  - Rating 2 (Green)
  - Rating 1 (Blue) – The least busy



# Engineering Wildcat Smart Guide

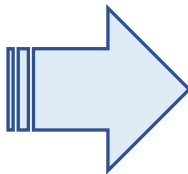
- Modal Traffic Simulation:



# Engineering **Wildcat Smart Guide**

- CatTran Simulation:

12	27	55	40	20	4
7:00	7:01	7:03	7:10	7:13	7:17
7:20	7:21	7:23	7:30	7:33	7:37
7:40	7:41	7:43	7:50	7:53	7:57
8:00	8:01	8:03	8:10	8:13	8:17
8:20	8:21	8:23	8:30	8:33	8:37
8:40	8:41	8:43	8:50	8:53	8:57
9:00	9:01	9:03	9:10	9:13	9:17
9:20	9:21	9:23	9:30	9:33	9:37
9:40	9:41	9:43	9:50	9:53	9:57
10:00	10:01	10:03	10:10	10:13	10:17
10:20	10:21	10:23	10:30	10:33	10:37
10:40	10:41	10:43	10:50	10:53	10:57
11:00	11:01	11:03	11:10	11:13	11:17
11:20	11:21	11:23	11:30	11:33	11:37
11:40	11:41	11:43	11:50	11:53	11:57
12:00	12:01	12:03	12:10	12:13	12:17
12:20	12:21	12:23	12:30	12:33	12:37
12:40	12:41	12:43	12:50	12:53	12:57
13:00	13:01	13:03	13:10	13:13	13:17
13:20	13:21	13:23	13:30	13:33	13:37
13:40	13:41	13:43	13:50	13:53	13:57
14:00	14:01	14:03	14:10	14:13	14:17
14:20	14:21	14:23	14:30	14:33	14:37
14:40	14:41	14:43	14:50	14:53	14:57
15:00	15:01	15:03	15:10	15:13	15:17



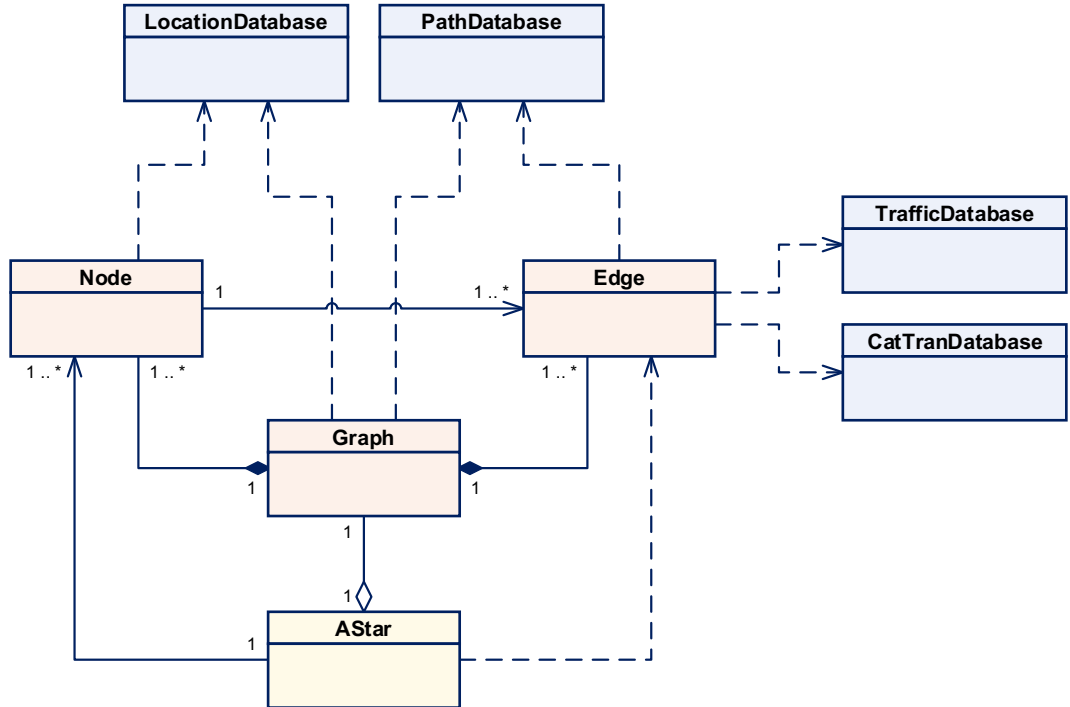
Time	12	27	55	40	20	4
7:00	0:00	0:01	0:03	0:10	0:13	0:17
7:01	0:19	0:00	0:02	0:09	0:12	0:16
7:02	0:18	0:19	0:01	0:08	0:11	0:15
7:03	0:17	0:18	0:00	0:07	0:10	0:14
7:04	0:16	0:17	0:19	0:06	0:09	0:13
7:05	0:15	0:16	0:18	0:05	0:08	0:12
7:06	0:14	0:15	0:17	0:04	0:07	0:11
7:07	0:13	0:14	0:16	0:03	0:06	0:10
7:08	0:12	0:13	0:15	0:02	0:05	0:09
7:09	0:11	0:12	0:14	0:01	0:04	0:08
7:10	0:10	0:11	0:13	0:00	0:03	0:07
7:11	0:09	0:10	0:12	0:19	0:02	0:06
7:12	0:08	0:09	0:11	0:18	0:01	0:05
7:13	0:07	0:08	0:10	0:17	0:00	0:04
7:14	0:06	0:07	0:09	0:16	0:19	0:03
7:15	0:05	0:06	0:08	0:15	0:18	0:02
7:16	0:04	0:05	0:07	0:14	0:17	0:01
7:17	0:03	0:04	0:06	0:13	0:16	0:00
7:18	0:02	0:03	0:05	0:12	0:15	0:19
7:19	0:01	0:02	0:04	0:11	0:14	0:18
7:20	0:00	0:01	0:03	0:10	0:13	0:17
7:21	0:19	0:00	0:02	0:10	0:12	0:16
7:22	0:18	0:19	0:01	0:09	0:11	0:15
7:23	0:17	0:18	0:00	0:08	0:10	0:14
7:24	0:16	0:17	0:19	0:07	0:09	0:13

# Wildcat Smart Guide

- WSG is implemented using the A\* algorithm
- Nodes: Location ID, Mode of Transportation
  - Keeps track of the arrival time
- Edges: Source ID, Location ID, Mode of Transportation
  - Cost takes real-time traffic information, CatTran schedule and Bicycle lock/unlock time into account
- Heuristic: Line-of-sight distance

# Wildcat Smart Guide

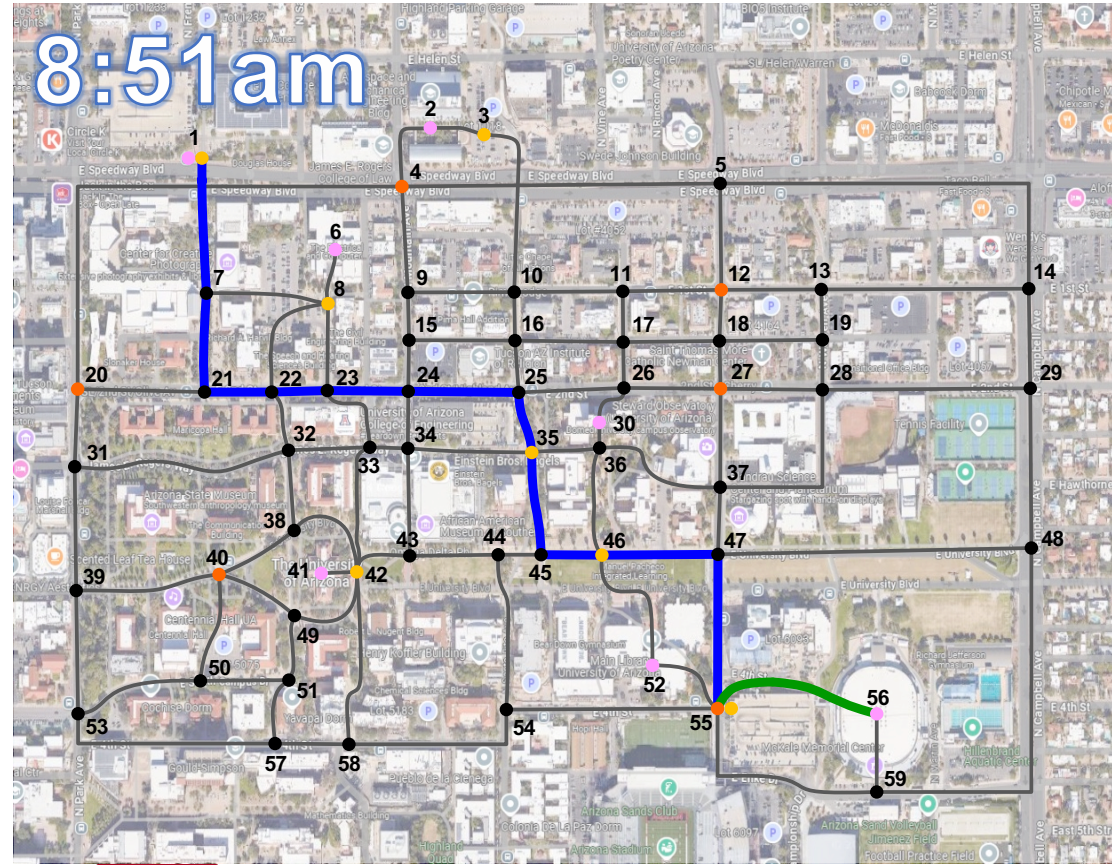
- UML Class Diagram:





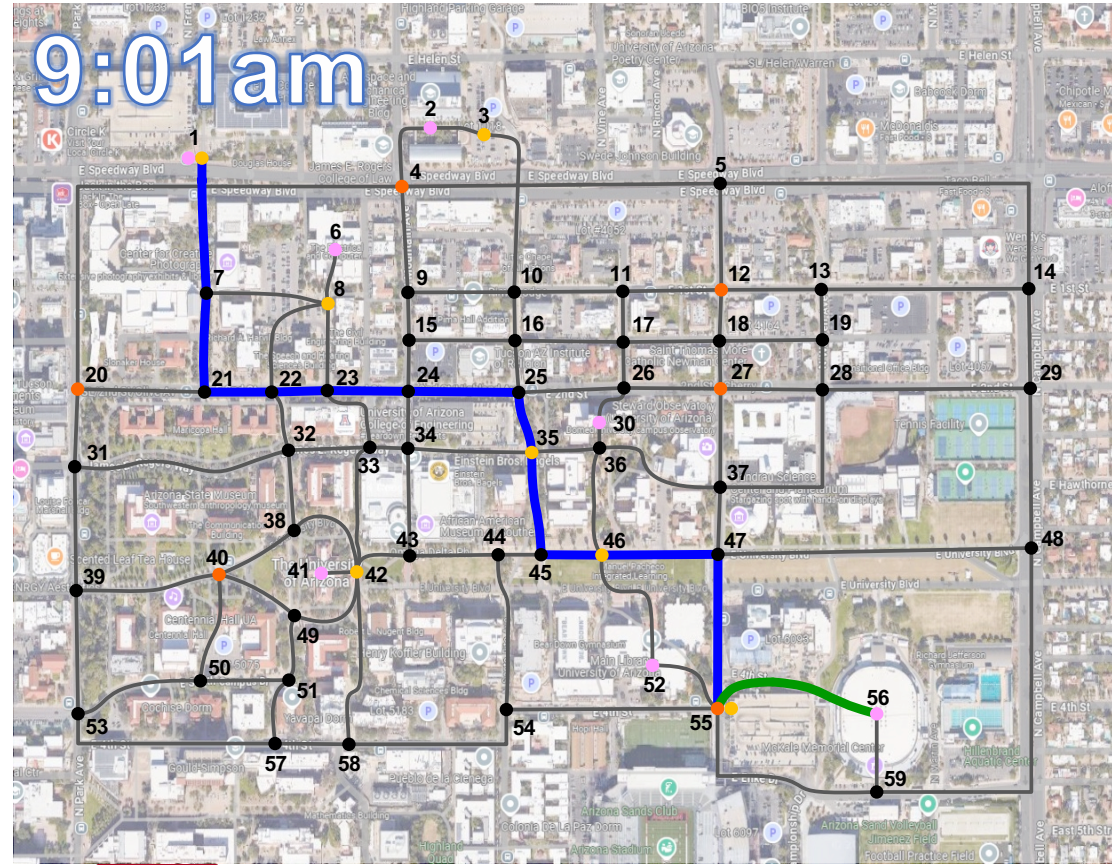
# Engineering Results

- Scenario 1:
  - Start: Park Ave Garage
  - End: McKale Center
- Elapsed Time:
  - 10 min 20 sec



# Engineering Results

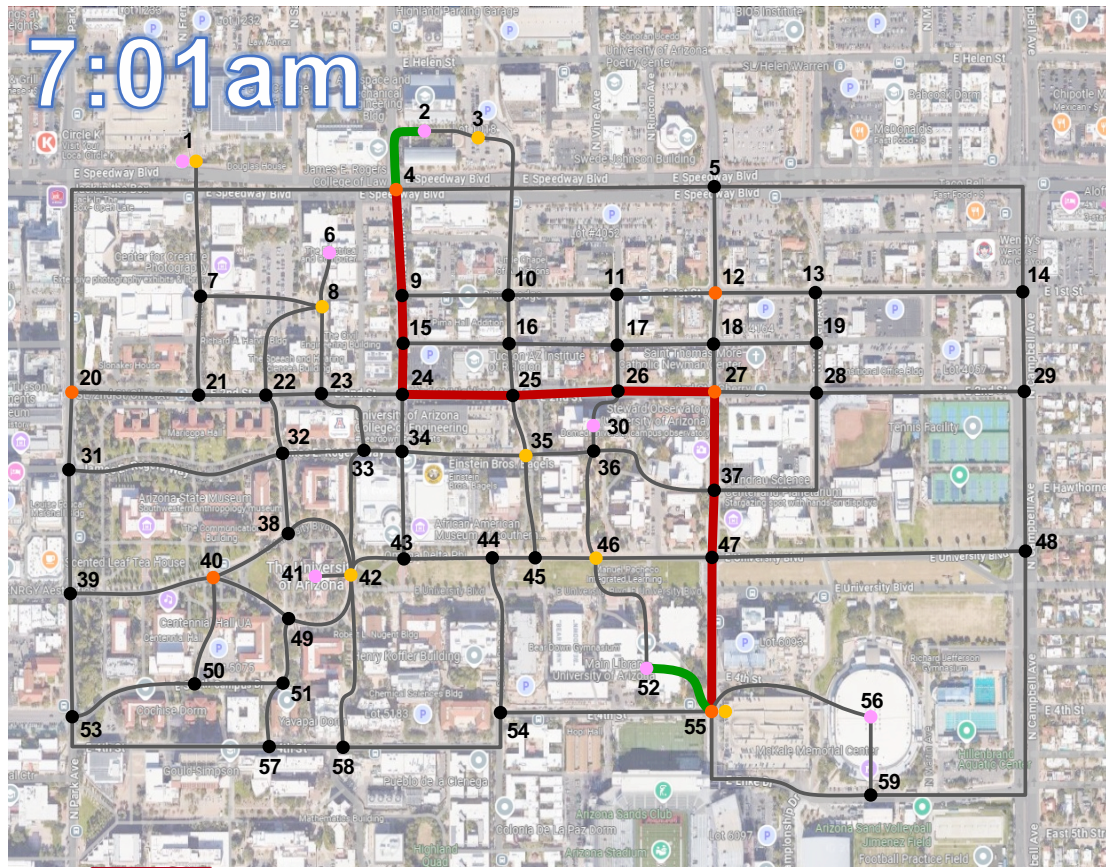
- Scenario 1:
  - Start: Park Ave Garage
  - End: McKale Center
- Elapsed Time:
  - 9 min 44 sec





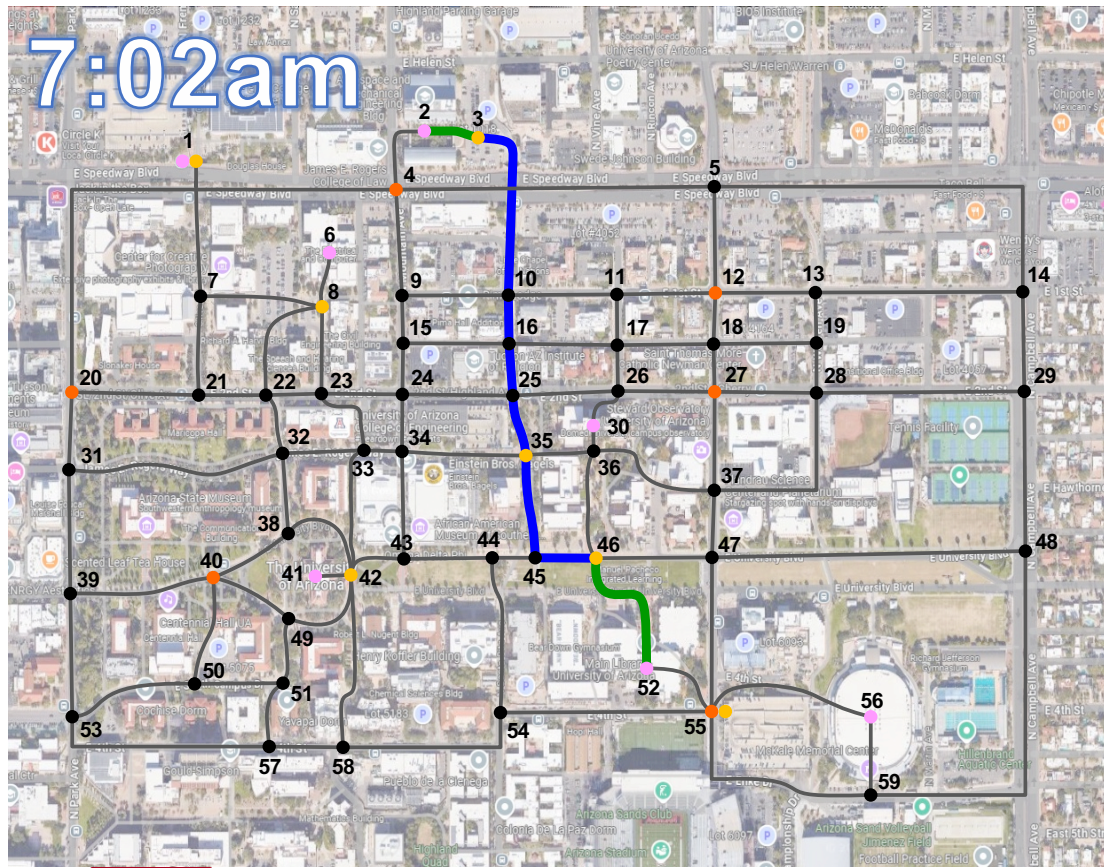
# Engineering Results

- Scenario 2:
  - Start: Main Library
  - End: AME Building
- CatTran: 20 km/h
- Elapsed Time:
  - 7 min 23 sec



# Engineering Results

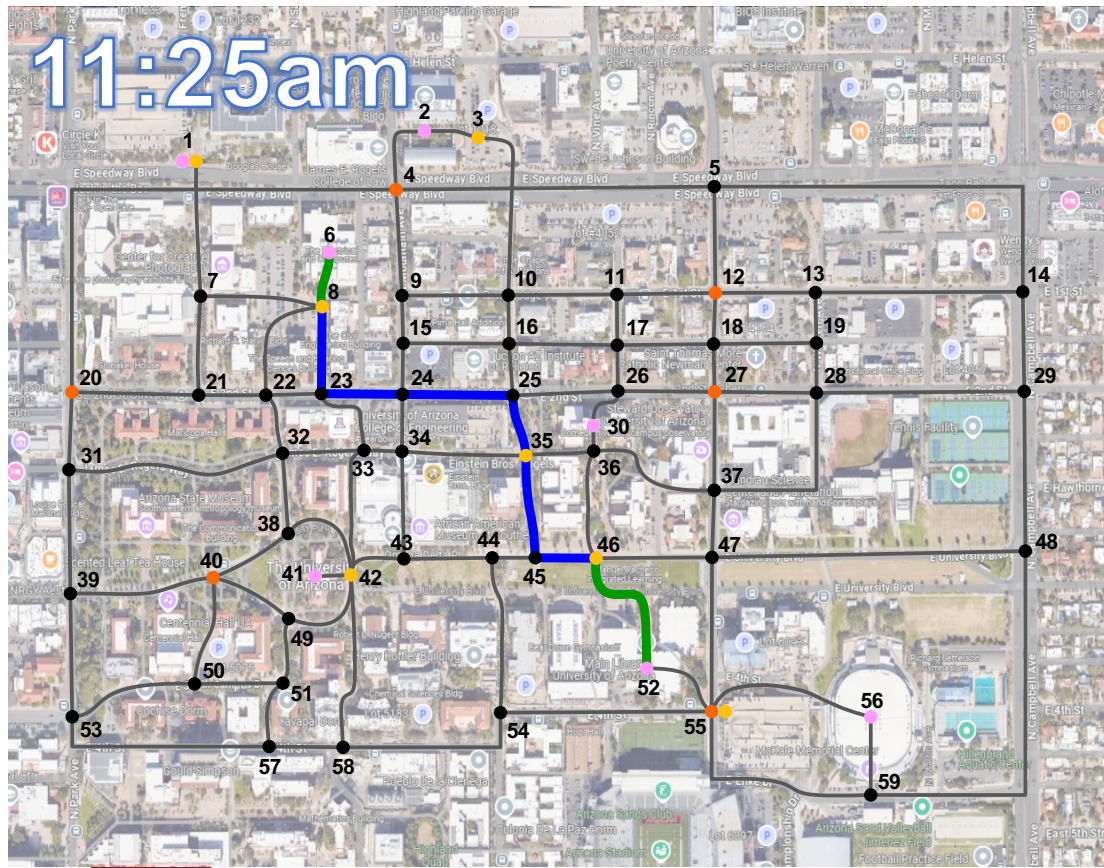
- Scenario 2:
  - Start: Main Library
  - End: AME Building
- CatTran: 20 km/h
- Elapsed Time:
  - 8 min 49 sec





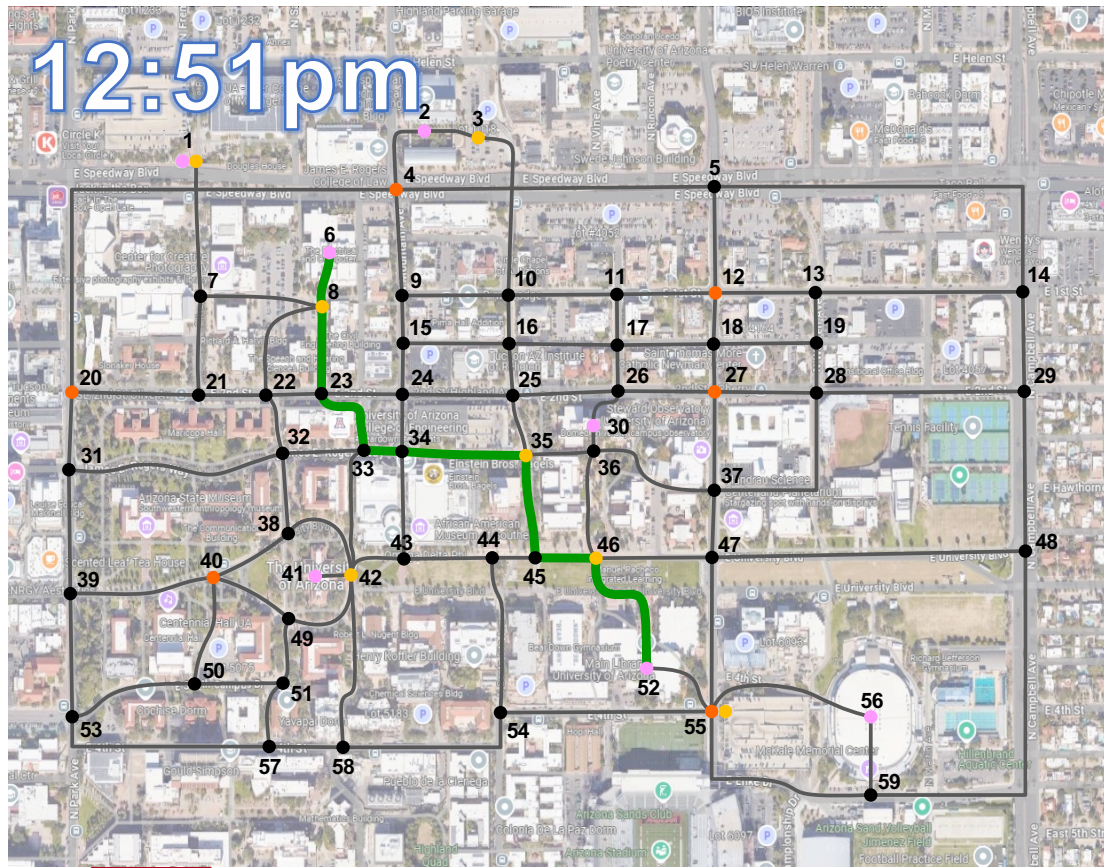
# Engineering Results

- Scenario 3:
  - Start: Main Library
  - End: ECE Building
- Bicycle:
  - 10 km/h
  - Modal Coeff: 0.3
- Elapsed Time:
  - 10 min 41 sec



# Engineering Results

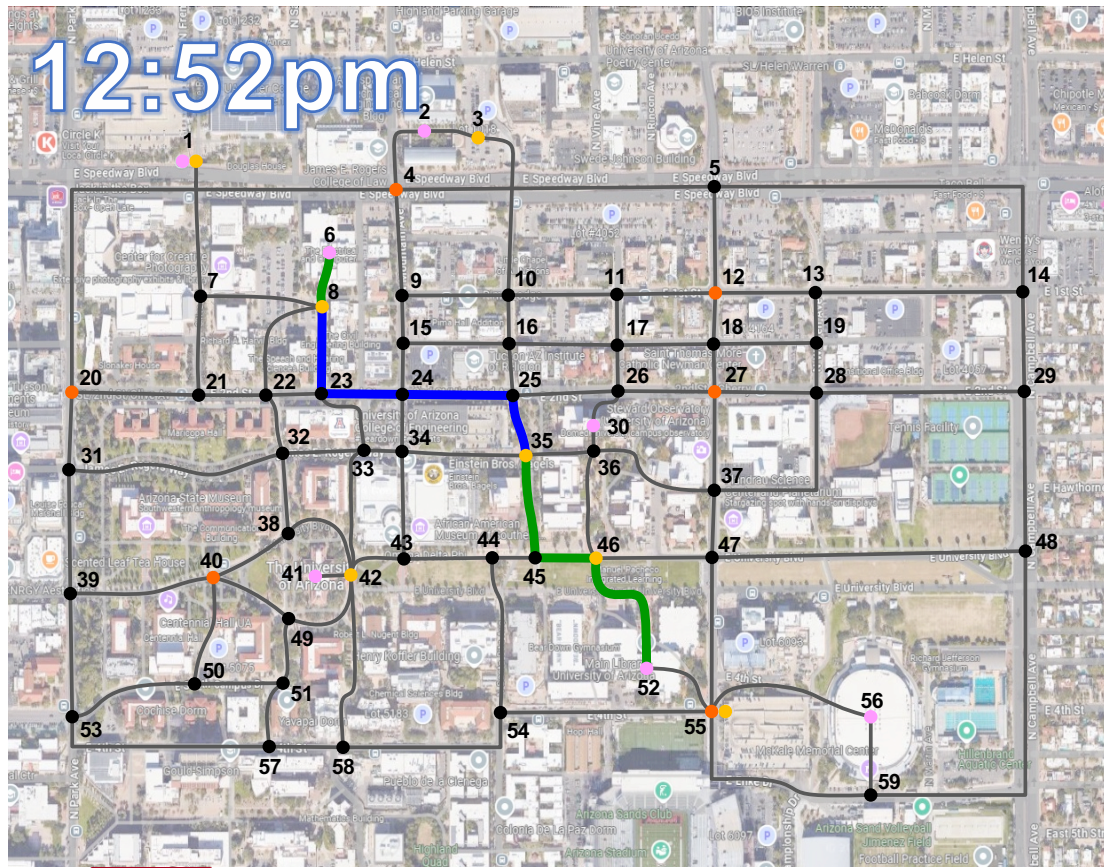
- Scenario 3:
  - Start: Main Library
  - End: ECE Building
- Bicycle:
  - 10 km/h
  - Modal Coeff: 0.3
- Elapsed Time:
  - 11 min 20 sec





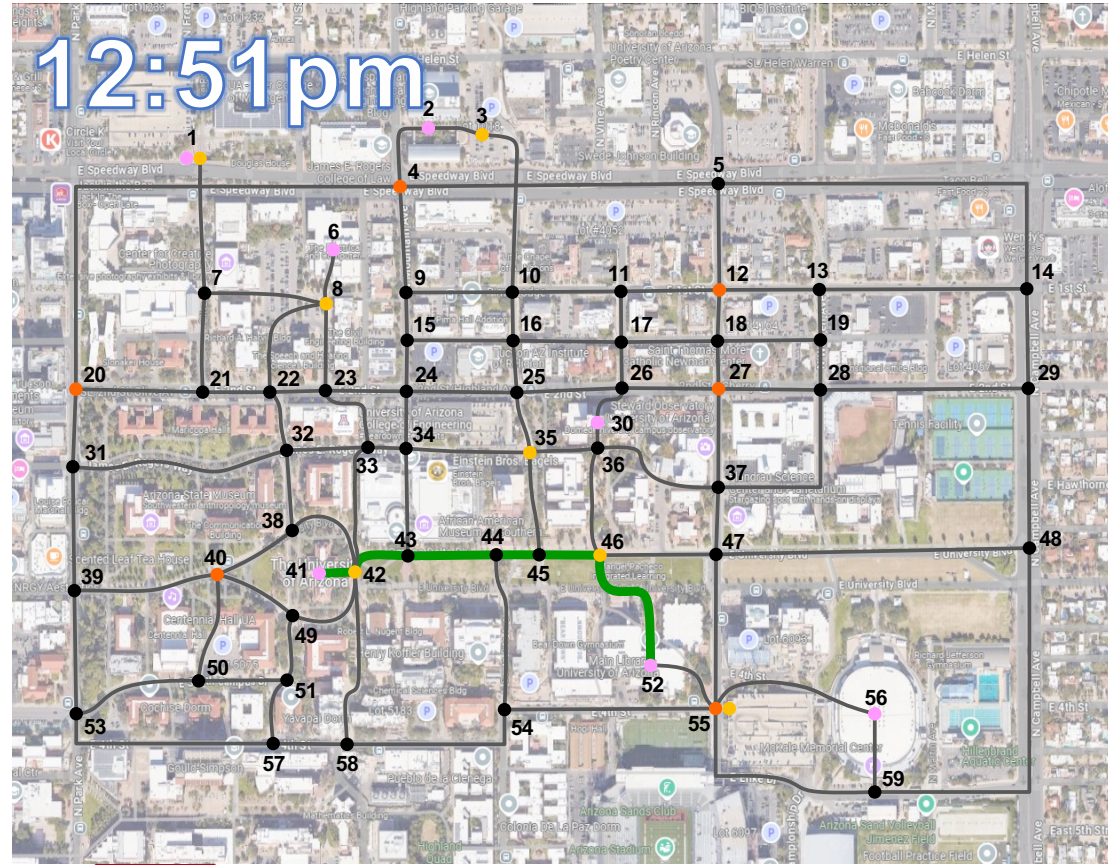
# Engineering Results

- Scenario 3:
  - Start: Main Library
  - End: ECE Building
- Bicycle:
  - 10 km/h
  - Modal Coeff: 0.3
- Elapsed Time:
  - 12 min 11 sec



# Engineering Results

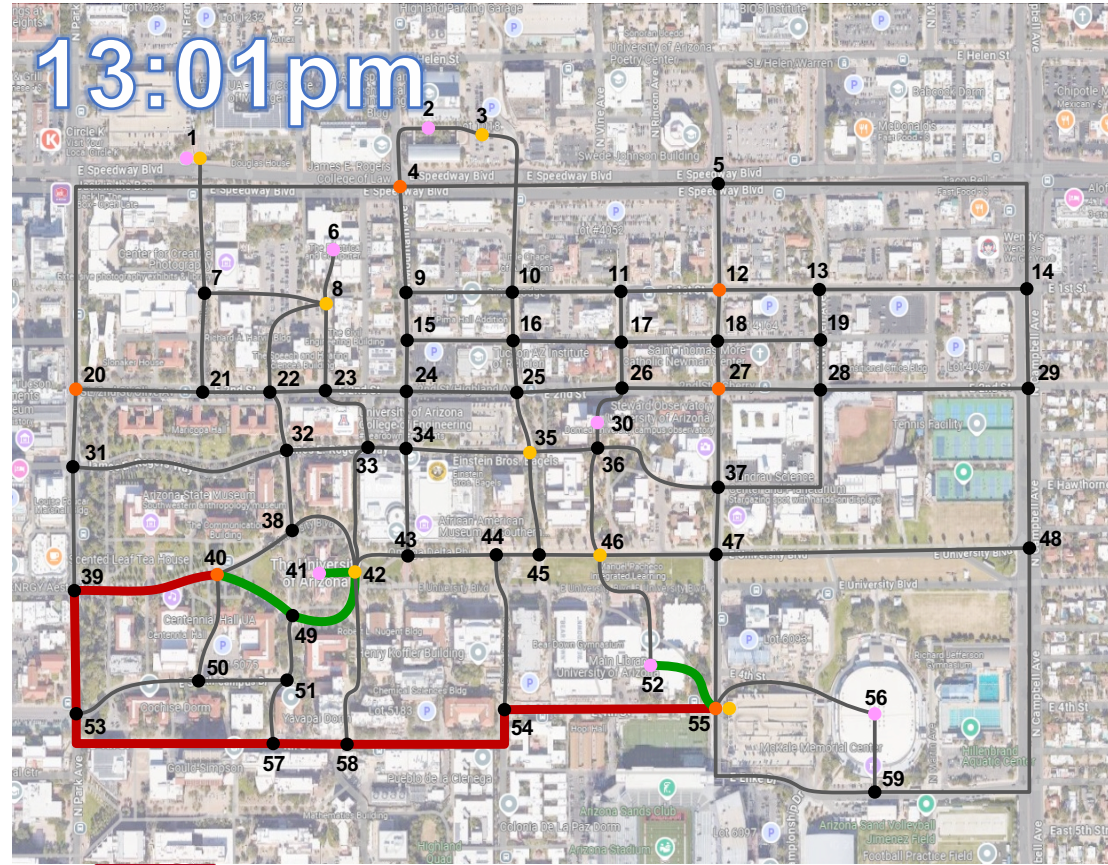
- Scenario 4:
  - Start: Main Library
  - End: Old Main
- Bicycle:
  - 10 km/h
  - Modal Coeff: 0.3
- CatTran:
  - 100 km/h
- Spatial Coeff
  - Rating 5: Hypersensitive
  - Other ratings: no effect
- Elapsed Time:
  - 7 min 30 sec





# Engineering Results

- Scenario 4:
  - Start: Main Library
  - End: Old Main
- Bicycle:
  - 10 km/h
  - Modal Coeff: 0.3
- CatTran:
  - 100 km/h
- Spatial Coeff
  - Rating 5: Hypersensitive
  - Other ratings: no effect
- Elapsed Time:
  - 5 min 56 sec



# Future Ideas

- Add different modes of transportation
- Expand to Tucson or another city like New York city
- Traffic load management: Central system that manages traffic for all users



**Back Up**



# Bicycle Inventory Management

- AIPS to manage bicycle inventories in bicycle depots
- Autonomous bicycles travel between bicycle depots
- The goal of BIM is so that bicycles are always available at bicycle depots to support WSG



# Bicycle Inventory Management

- Database:

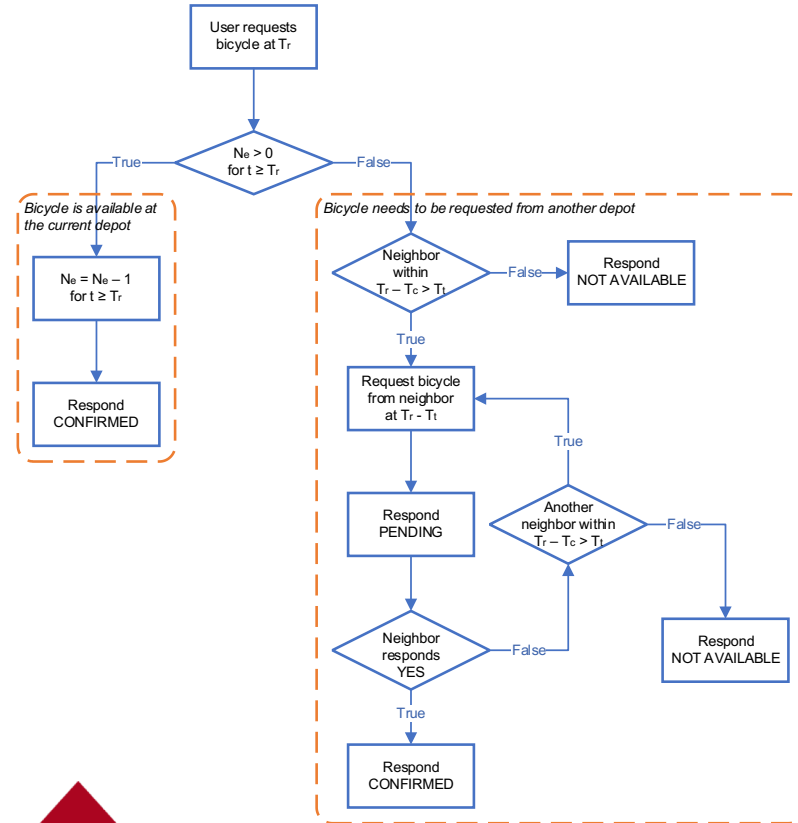
$$(N_e(t), N_a(t), t)$$

- Rules:

- 1) Receive a reservation for a bicycle.
- 2) Remove existing reservation.
- 3) Expect to receive a bicycle from another Bicycle Depot.
- 4) Send a bicycle to another Bicycle Depot.
- 5) Release a bicycle to the user.
- 6) Receive a bicycle returned from the user.

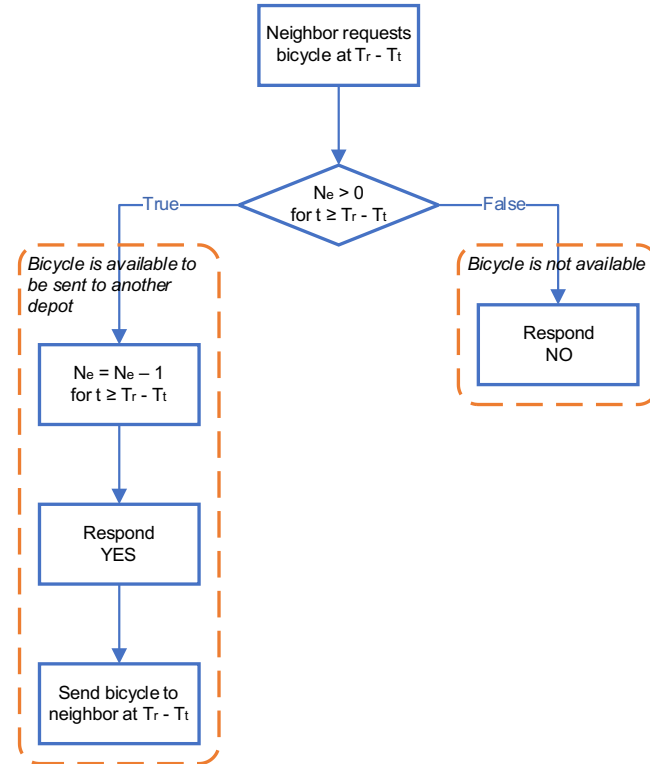
# Engineering Bicycle Inventory Management

- Control Strategy:
  - Handling user request



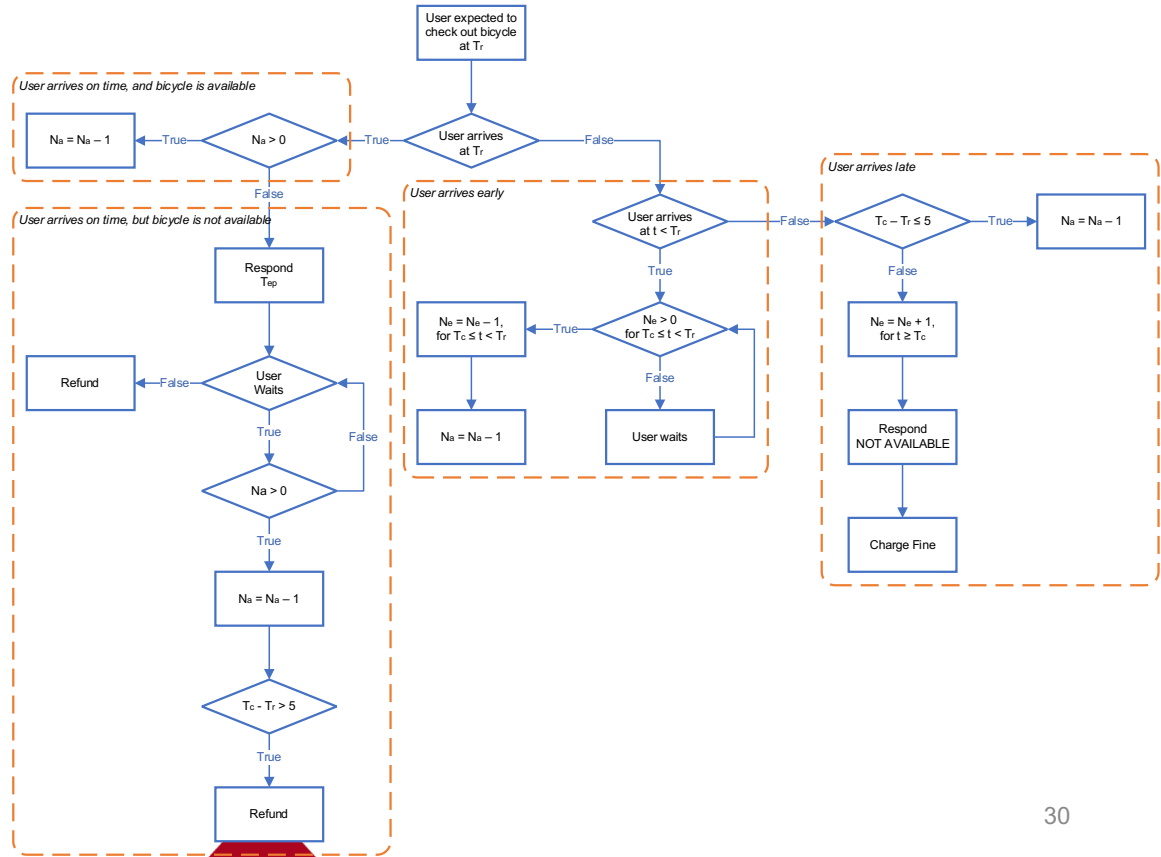
# Engineering Bicycle Inventory Management

- Control Strategy:
  - Handling neighbor request



# Engineering Bicycle Inventory Management

- Control Strategy:
  - Handling bicycle release





# Bicycle Inventory Management

- Control Strategy:
  - Handling bicycle return

