

A Wheelee Good Time: Safe Biking in Denver

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Motivation

- **Department of Transportation and Infrastructure's Denver Moves: Bicycles Program**
 - Adding 125 miles of bike lanes by 2024
 - Extending current bike paths
 - 60% of Denver residents are “interested but concerned” in bike commuting
- **Promoting Eco-friendly Transportation**
 - Denver announced e-bike grants
- **45% of Crashes Occur From Cars Veering into Rider**

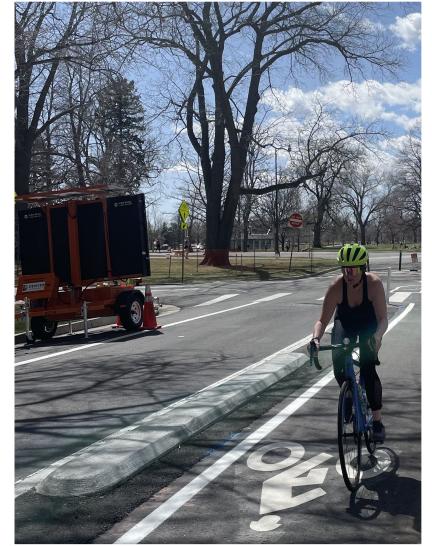
Types of Paths



Shared Use Path
(Shown: Cherry Creek Trail)

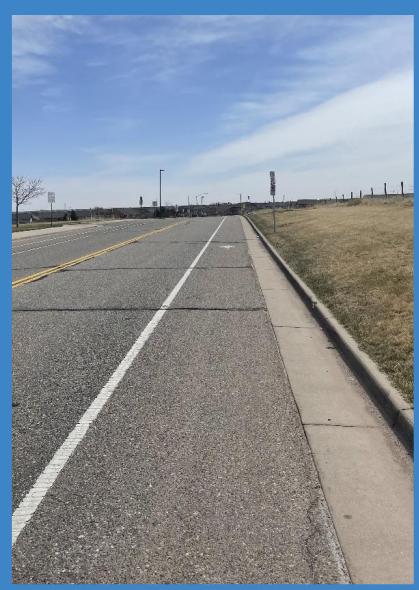


Neighborhood Bikeway
(Shown: Harvard Gulch)



Protected Bike Lane
(Shown: Marion St Pkwy)

Types of Paths



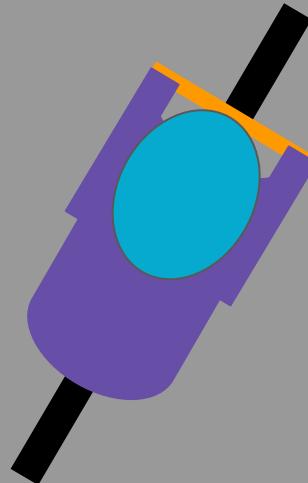
Unprotected Bike Lane (UBL)



Shared Road (SR)

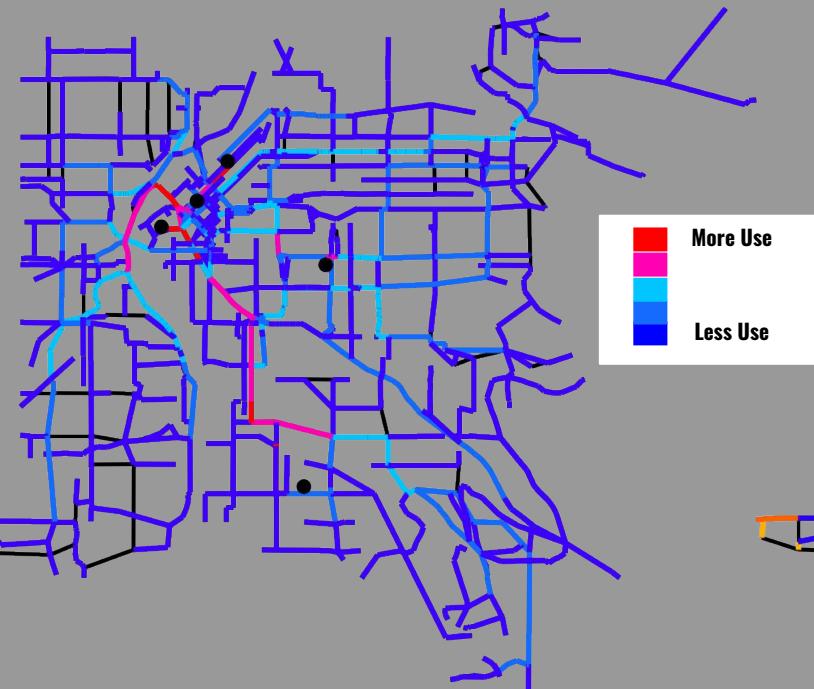
Shortest Path

- Compute shortest paths to 5 destinations
 - UCD, Union, 5 Points, DU, City Park
- Implementation in Python
 - Forward Star Representation
 - Label Correcting Algorithm
- Return distance labels and precedence list
 - Use precedence to plot paths

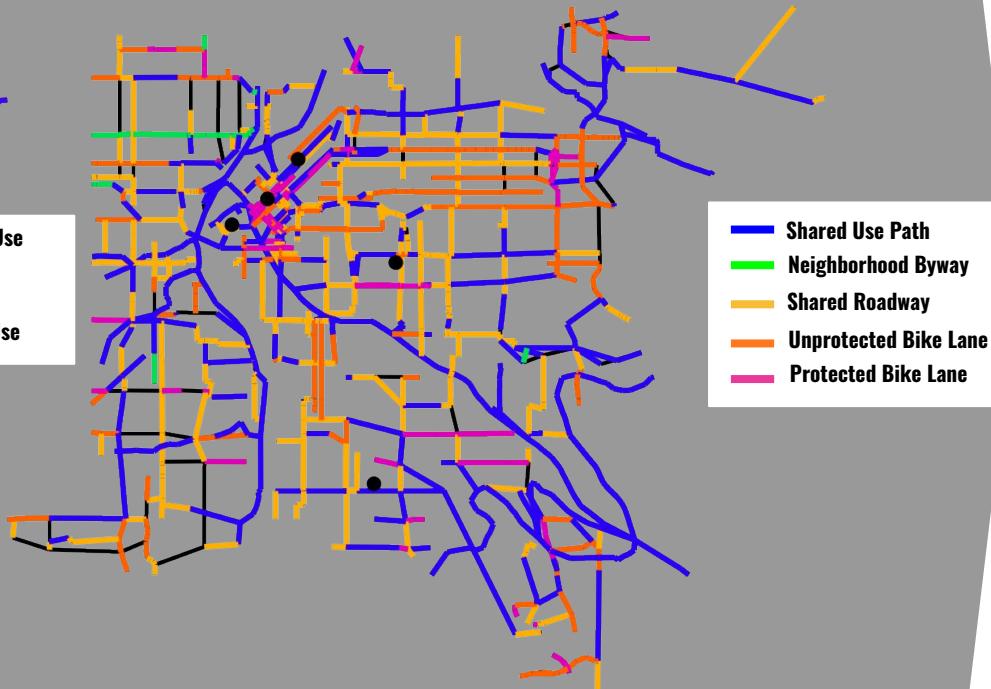


Shortest Paths

Frequency of Edges in Regular Shortest Paths

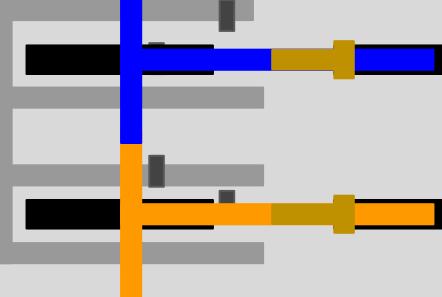


Types of Edges in Regular Shortest Paths



Safety-Constrained Shortest Path

- Assign safety value = $(\text{dist}) * (\text{safety factor})$ for each arc
- Compute shortest paths where total safety factor does not exceed 10 (Cautious) or 20 (Adventurous)
- Implementation in Python
 - Forward Star Representation
 - Dynamic Program
 - Return distance labels and precedence matrix



Safety Factor
Shared Path - 0
Nbhd Bikeway - 1
Protected BL - 2
Unprotected BL - 4
Shared Lane - 6

Values derived from a UBC paper on bicycling preferences

Cautious vs Adventurous Cyclist

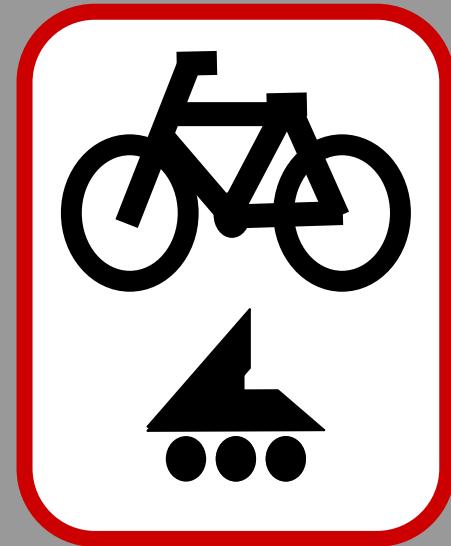
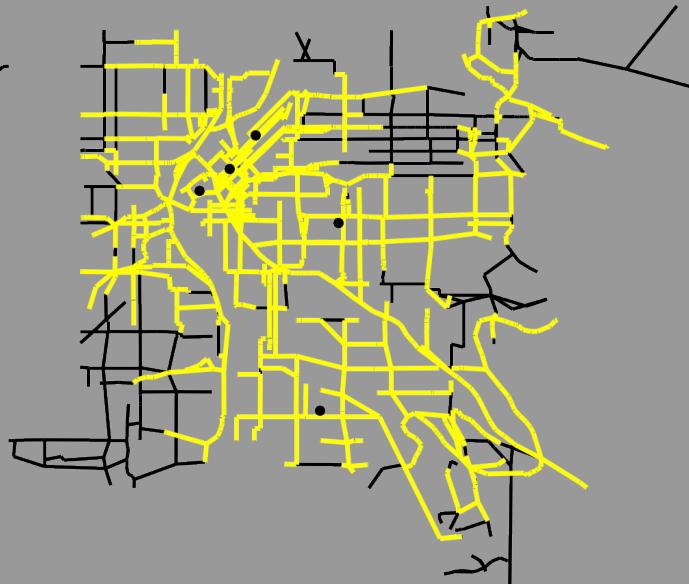
Cautious - little time on SR and UBL

Adventurous - more tolerance of SR and UBL

Cautious Tau Shortest Paths



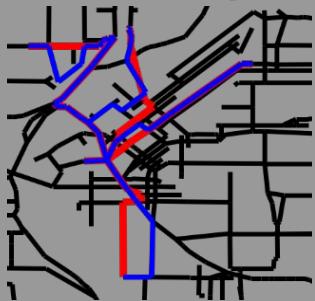
Adventurous Tau Shortest Paths



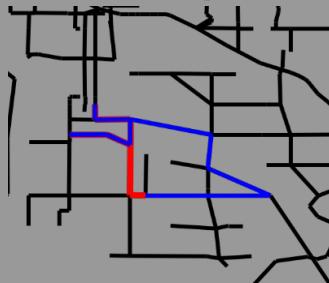
Cautious vs Regular Shortest Path

Most Significant Path Changes

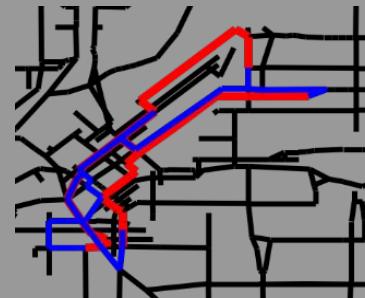
Auraria Campus



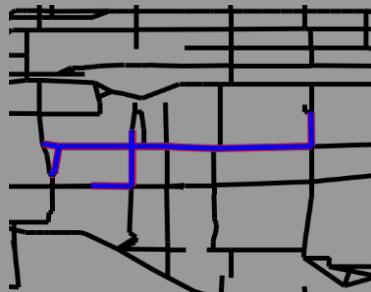
DU Campus



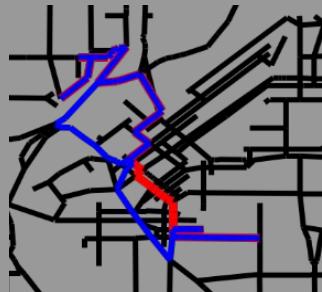
5 Points



City Park



Union Station





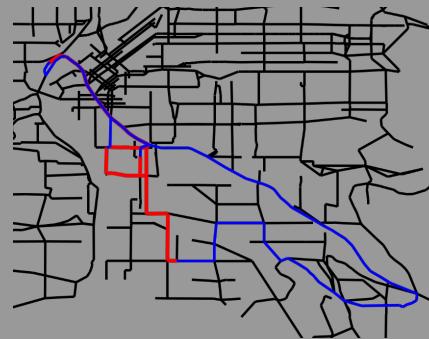
Adventurous vs Regular Shortest Path

- Regular Shortest Path
- Adventurous Shortest Path

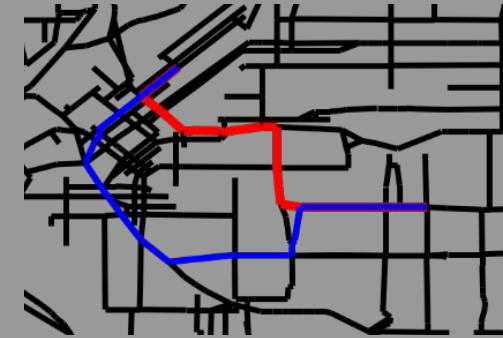
Auraria Campus



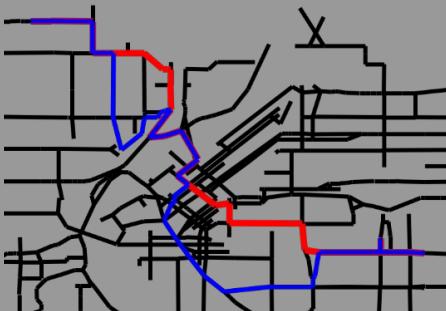
DU Campus



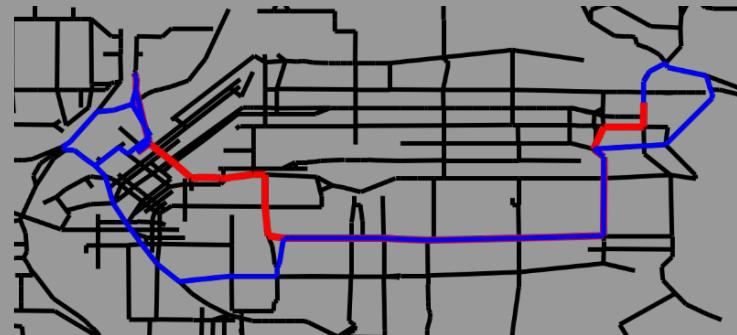
5 Points



Union Station



City Park



Overall Analysis

- 8 of the top 20 most used paths for the shortest paths are Shared Roadways or Unprotected Bike Lanes
- Safety greatly affects the path choice with current bike route infrastructure
- May see large increases in path length (5.1 miles vs 6.25 miles)
- Current infrastructure insufficient for the cautious rider
- Cherry Creek Trail is essential for rider comfort

Recommendation (Frequency)

- We want to improve the “unsafest” paths that are used the most often
- Add protected bike lanes to the following streets:
 - Emerson from 1st to Louisiana
 - Louisiana from Logan to Franklin

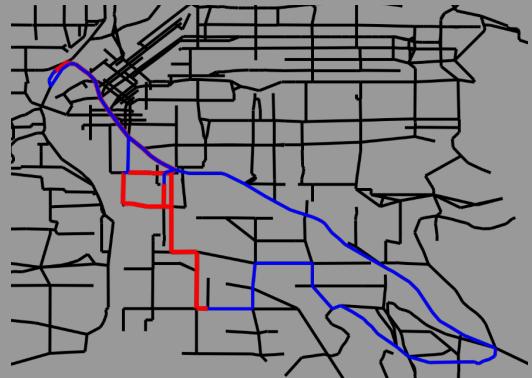
Frequency of Edges in Regular Shortest Paths



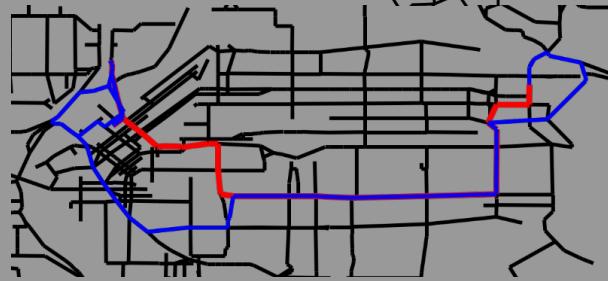
Recommendation (Burden)

- Issues:
 - Greatly extended ride time
 - No options for other points of entry and exit
- Examples:
 - University of Denver
 - City Park
- Building up infrastructure

DU Campus

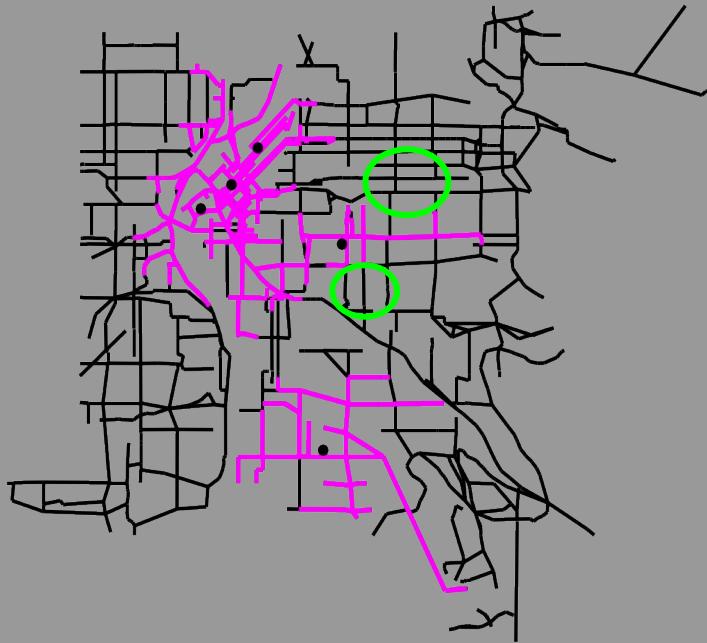


City Park



Recommendation (Feasibility)

- Access is limited far from shared use paths
- Build more protected bike lanes that connect to shared use paths



Possible Improvements

- Better data sources
 - Account for neighborhood streets
 - Account for low traffic shared roads
- How do Denver's planned upgrades affect our analysis
 - Shapefile for the proposed streets in the Denver Moves: Bicycle Program
- Can we improve our analysis by identifying neighborhoods that are more willing to commute via bike



References

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Questions

