

Light Rail and Park&Ride facilities in Sioux Falls

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Outlines

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- Adding a light rail

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- P&R case

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Introduction

Sioux Falls

- Most populous city in South Dakota
- More than 200'000 inhabitants (rapidly growing : 125 000 in 2000) ^a
- Superficy of 210 km²
- Nice waterfalls
- 9 bus lines ! Run 6 days per week, \approx every 30 min.
- Public on-demand service to supplement the bus lines.

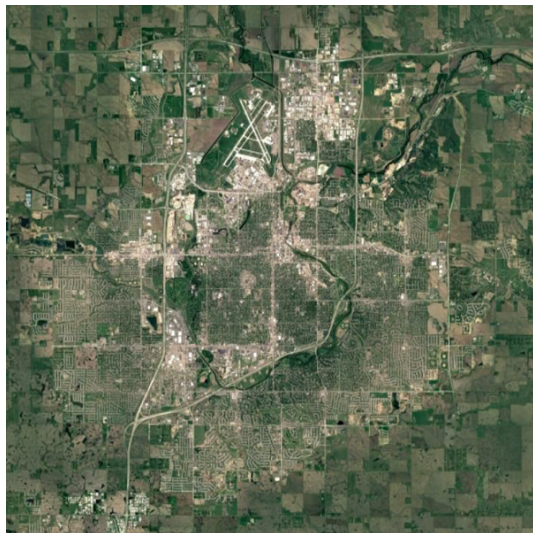
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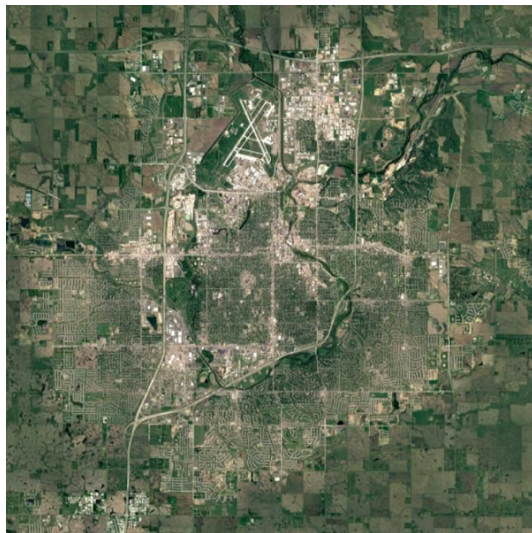
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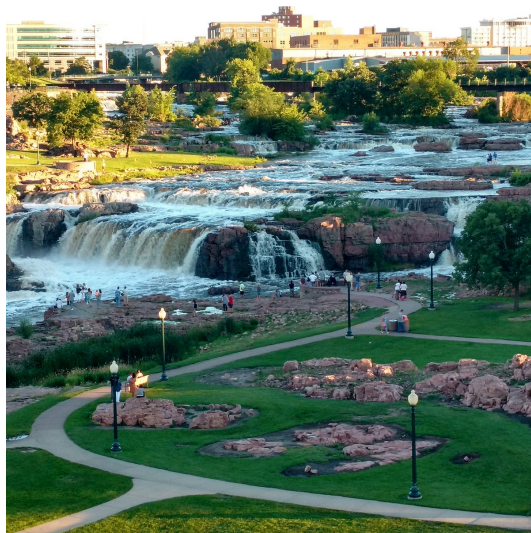
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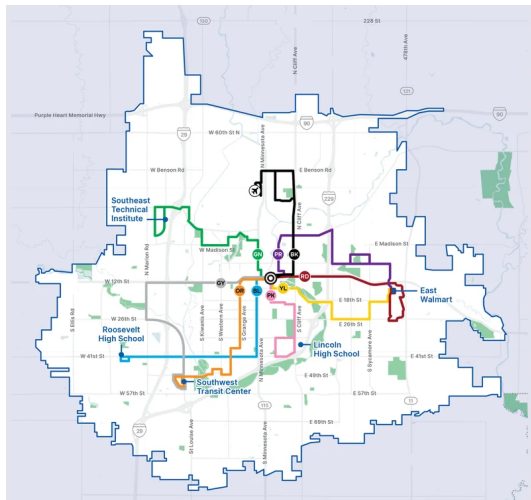
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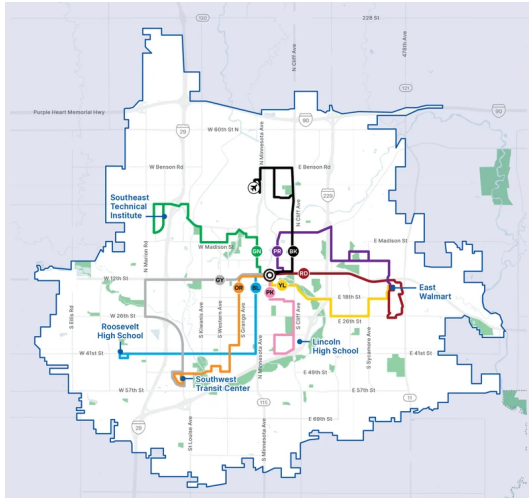
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Adding a light rail



- Now let's imagine the city of Sioux Falls decides to enter in the 21st century
- And want to replace a bus line by a light rail line with Park & Ride facilities.
- What will be the impact on the traffic ?

Our study

Considering the classic 'Sioux Falls' benchmark network, and the current bus network of the city of Sioux Falls.

- Add light rail transit lines to match current bus lines and the most used road links.
- Test the traffic conditions in the 3 cases :

Base No light rail

Light Rail Light rail can only be taken when origin and destination is served by the network.

P&R Light rail can only be taken when origin **or** destination is served by the network.

Methodology

Defining transit lines

- 1 Match the classic SiouxFalls network to the bus map (and vice-versa)
- 2 Compare with the Base situation to identify the most used road links.
- 3 Define transit lines
- 4 Compute distance and time of travel for the transit line

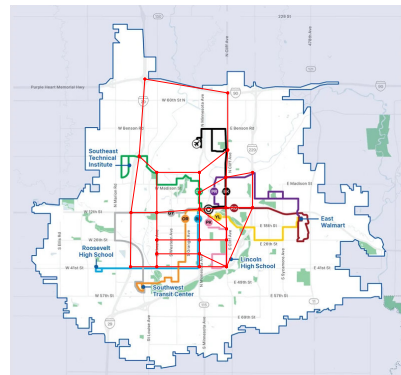


Figure: Sioux Falls nodes and edges matched on the bus map

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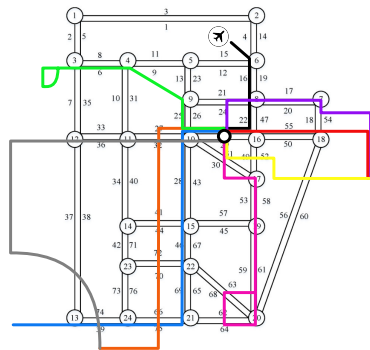
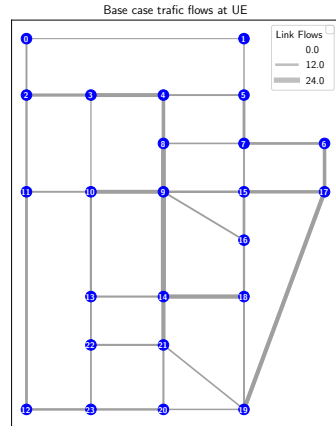


Figure: Sioux Falls bus lines matched on the classic network

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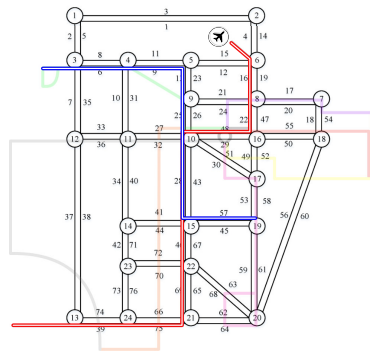


Figure: The two lines defined

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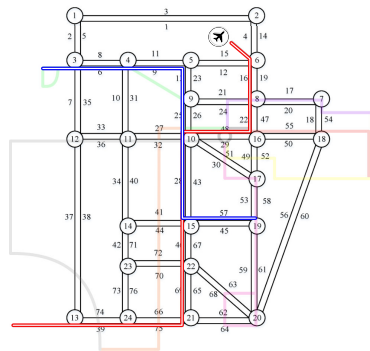


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Modelling trafic (Base case)

Classic Frank-Wolf algorithm

- 1 Update travel times
- 2 Descent direction (All-or-nothing assignment on the shortest path)
- 3 Determine step (line search)
- 4 Update link flows

Modelling trafic (Light Rail case)

Two layered approach

- The light rail network is another network
- For now : no connections between the two layers (no Park and Ride)
- For groups where origin and destination on the light rail network: change all-or-nothing assignment.
 - Compute the shortest path on both Networks
 - Assign the trafic only on the one with the shortest time (can use the labels of Dijkstra)

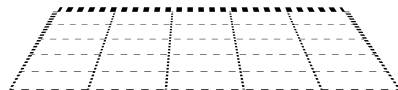
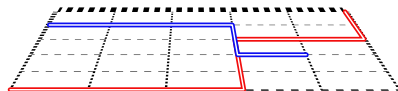


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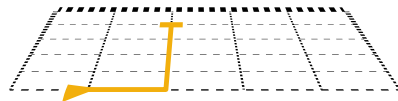
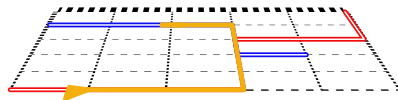


Figure: Shortest paths

Modelling trafic (P&R case)

Two layered approach, with connections

- Park & Ride facilities serve as connections between the two layers
 - But, need to enforce only use one P&R facility
 - Separate onboarding and offboarding links
 - 3 possible networks
 - (All-or-nothing assignment) For every group:
 - Compute travel time without light rail
 - If the origin is at a station, compute travel time with offboarding links
 - If the destination is at a station, compute travel time with onboarding links
- ⇒ Assign trafic according to the one with the shortest time

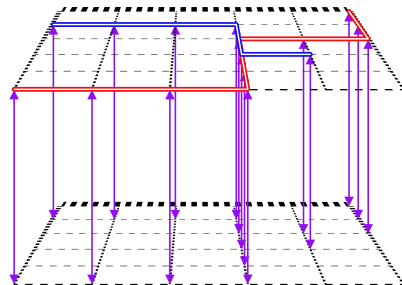


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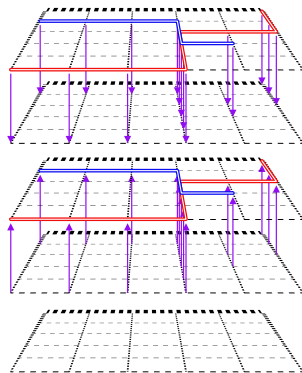


Figure: 3 networks

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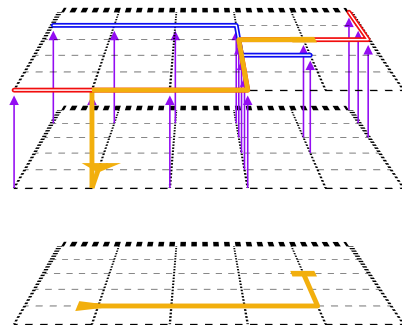
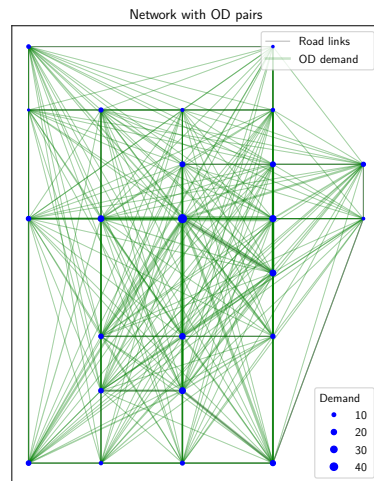
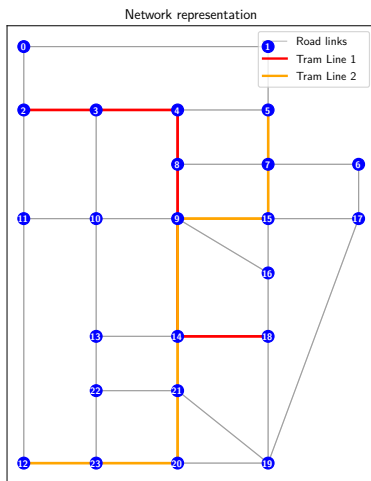
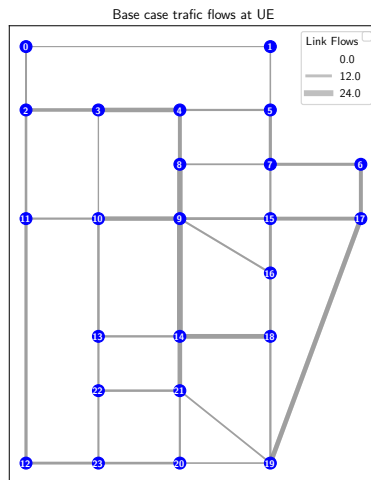


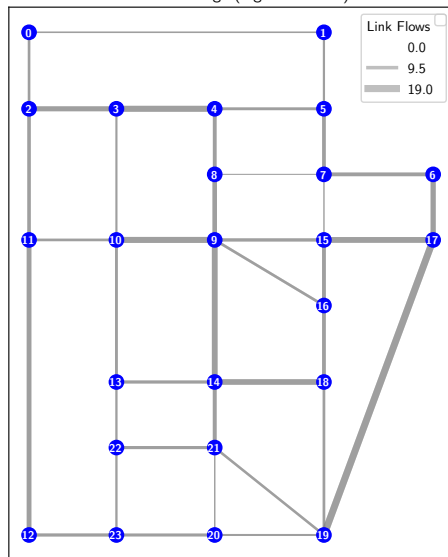
Figure: Shortest path example (onboarding links only)

Results

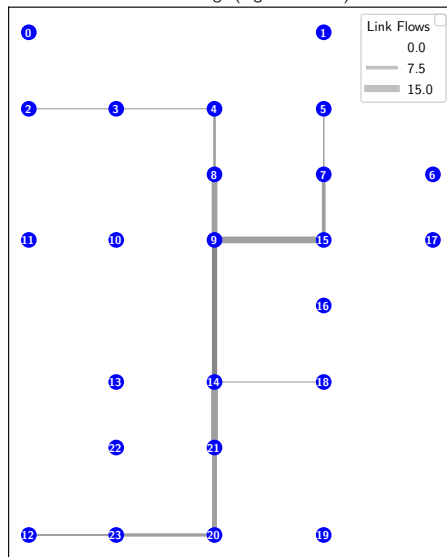




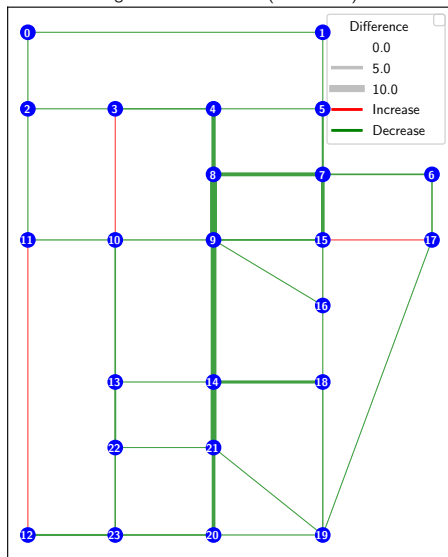
Road links usage (Light Rail case)



Tram links usage (Light Rail case)

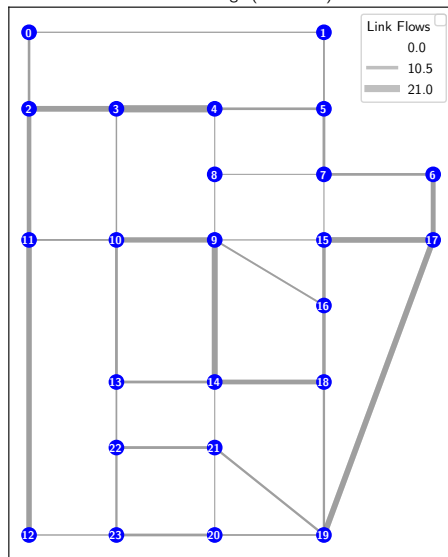


Light Rail vs Base case (Road traffic)

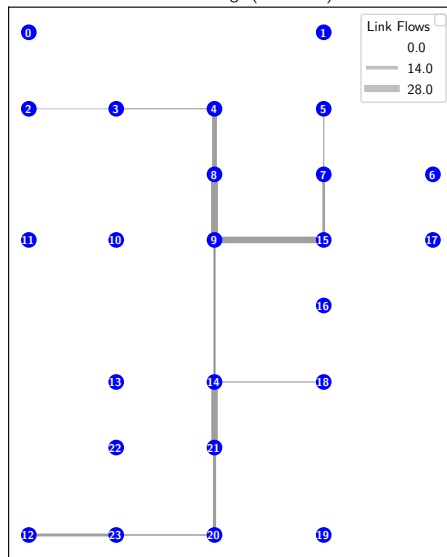


- As expected, we see a decrease in traffic along the light rail lines.
- Link 7-8 is also seeing improvement although there are no tram along this link.
- Marginally, there are small differences outside of the tram network.

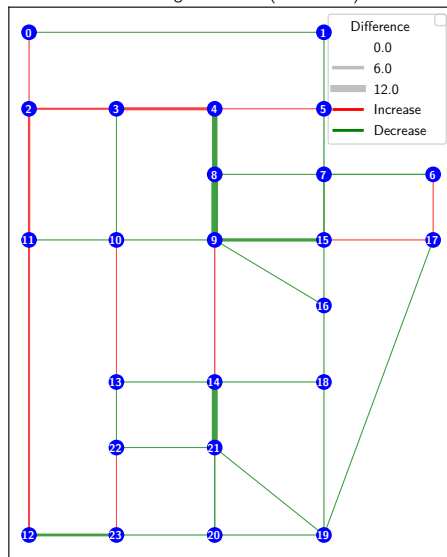
Road links usage (P&R case)



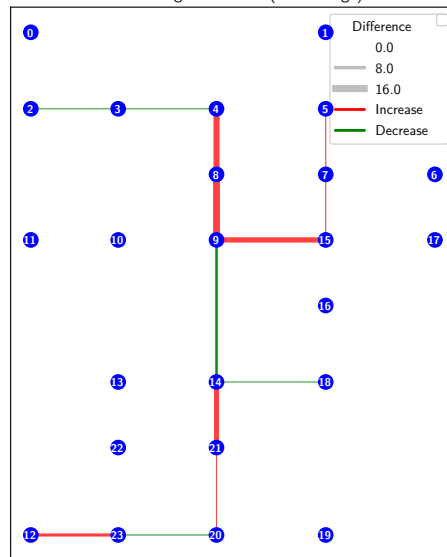
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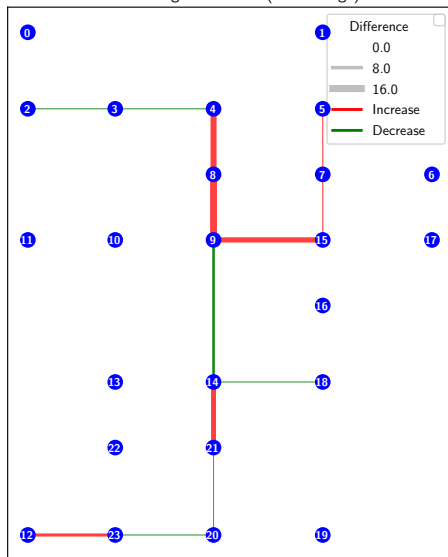
P&R vs Light Rail case (Road traffic)



P&R vs Light Rail case (Tram usage)



P&R vs Light Rail case (Tram usage)



- Better usage of the Light Rail in the central links.
- Less people are using the light rail on the external branches of the tram.
 - P&R facilities replace them
- Link 9 to 14 (on both tram lines)

Conclusion

- Our results prove the benefit of adding P&R as a mean of improving the impact of a transit line.
- However, our study has some limitations :
 - 1 The only costs considered are travel time. We did not take into account the disadvantages of having to transfer (between road and rail or between two transit lines), or other costs (for example, parking prices).
 - 2 The travel time estimation for the light rail was approximated (we took a constant speed of 25 miles/hour)
 - 3 We considered the addition of P&R facilities at all stations, but in practice this is unrealistic (less place downtown, prioritise limiting road usage inside the city)