Improving the battery efficiency on electric cargo cycles for urban centers

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Dr. Kevin Gingerich

CLUE 2023 Symposium
May 11

Last Year Review

Adonai Garcia receives the 2023 Graduate Student Research Excellence Award in Civil Engineering

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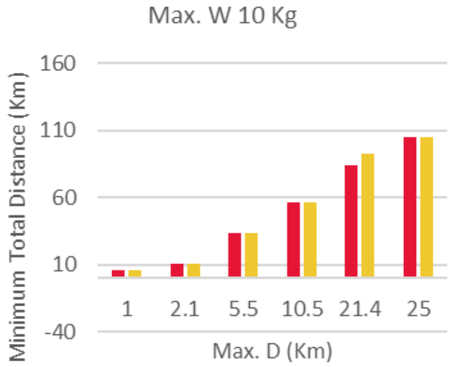
Adonai Garcia

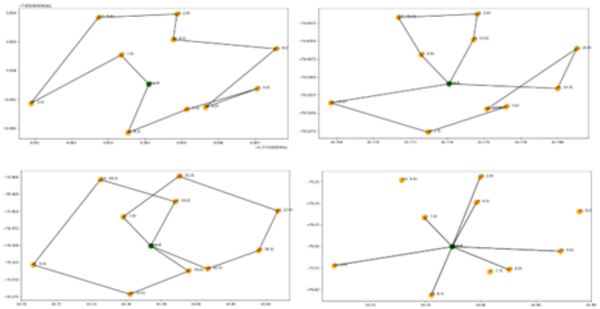
Congratulations to Adonai Garcia who was named the recipient of the 2023 Graduate Student Research Excellence Award in Civil Engineering.

The award acknowledges innovative and novel research accomplishments that have had or have the potential for significant impact in the field of Civil Engineering.

The adjudication committee recognized Adonai's exceptional dedication to advancing research in transportation, sustainability and entrepreneurship, as well as his outstanding research accomplishments and leadership skills. Adonai's research focuses on route choice modelling, electric cargo bikes, GIS, urban planning and ridesharing, with the goal of shedding light on important issues related to sustainability, efficiency and safety in transportation.

Mathematical Model





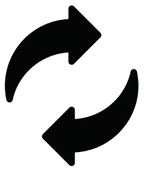
Agenda

- Literature Review
- Motivation
- Pilot in BC
- Results
- Model vs. Reality
- Conclusion

Literature Review

Electric Cargo Cycles (ECCs) can replace other modes

- Lovejoy and Handy (2012)
- Choubassi, C., Seedah, D., Jiang, N., & Walton, C. (2016)
- Niels, Holf, & Bogenberger (2018)
- Gruber and Kihm (2016)
- Koning and Conway (2016)
- Figliozzi et al. (2017, 2020)
- Sheth, M., Butrina, P., Goodchild, A., & McCormack, E. (2019)
- Dalla Chiara et al. (2020)
- …

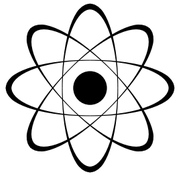


ECCs are attractive and convenient for cities and individuals

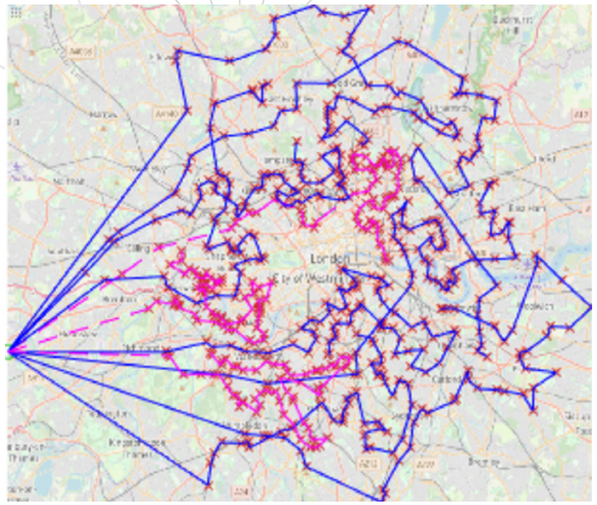
- MacArthur, J., Dill, J., & Person, M. (2014)
- Gruber, J., Kihm, A., & Lenz, B. (2014)
- Riggs (2016)
- Heinrich, L., Schulz, W. H., & Geis, I. (2016)
- O'Sullivan (2017)
- Anderluh, Hemmerlmayr, & Nolz (2017)
- cargobike.jetzt(2018)
- Hess, A.-K., & Schubert, I. (2019)
- Llorca, Carlos; Moeckel, Rolf (2021)
- Chiara et al. (2023)
- …

Multiple models have been developed

- Tipagornwong, C., & Figliozzi, M. (2014)
- Choubassi, C., Seedah, D., Jiang, N., & Walton, C. (2016)
- Grangier et al. (2016)
- Anderluh et al. (2017)
- Wang et al. (2017)
- Naumov and Starczewski (2019)
- Shojaei, MohammadHossein (2020)
- Giglio, Carlo; Musmanno, Roberto; Palmieri, Roberto (2021)
- …



Motivation



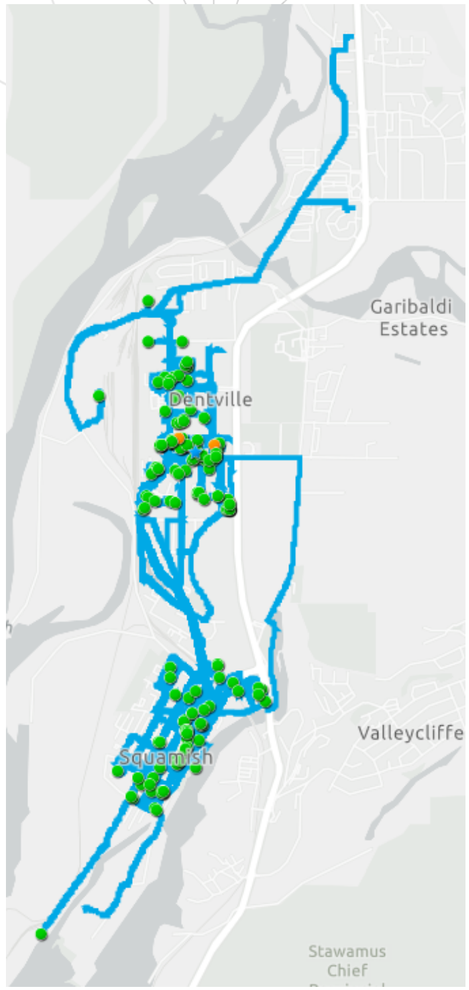
Source: Bayliss, Christopher; Bektaş, Tolga; Tjon-Soei-Len, Vernon; Rohner, Remo (2023)

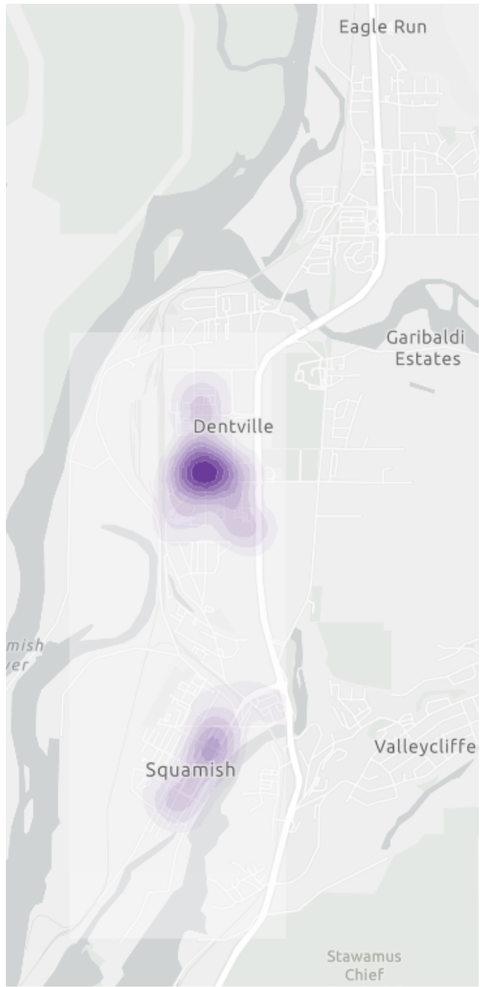
Source: Choubassi, C., Seedah, D. P. K., Jiang, N. & Walton, C. M (2016)

Pilot in BC

- Courier and Freight company
- 1 Babboe Pro Trike
- 3 month of data
- GPS points on Strava
- Elevation, Weight, Speed, # Packages
- 55 trips, +130K points

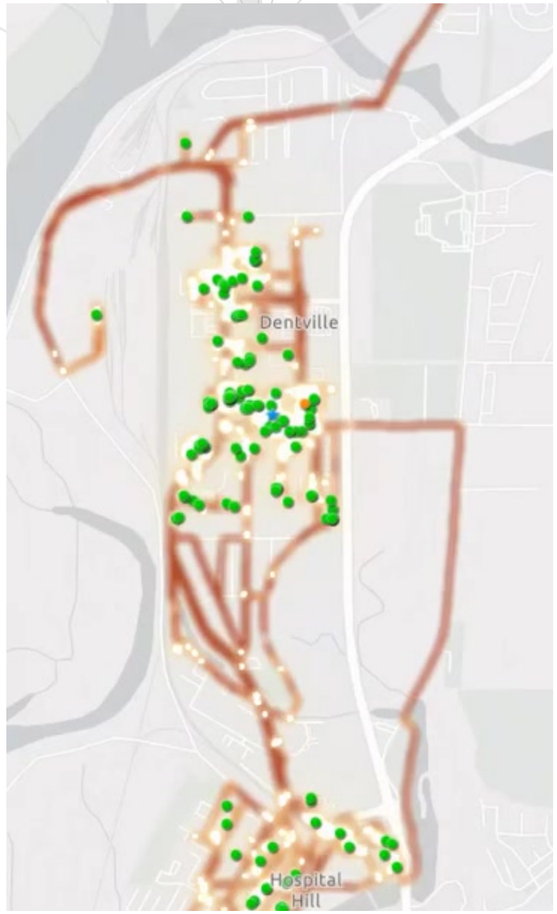
Results





- ECC returned to the depot
- 1 trip per day
- 36 trips considered
- Customers in the same area to the depot
- No battery monitor connected
- No optimization tool used

Results

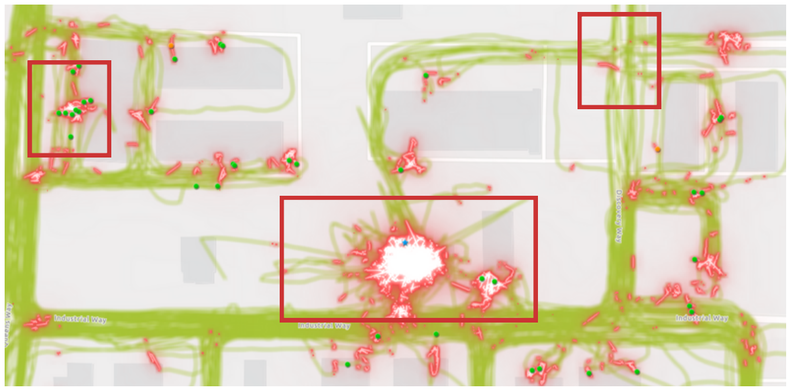


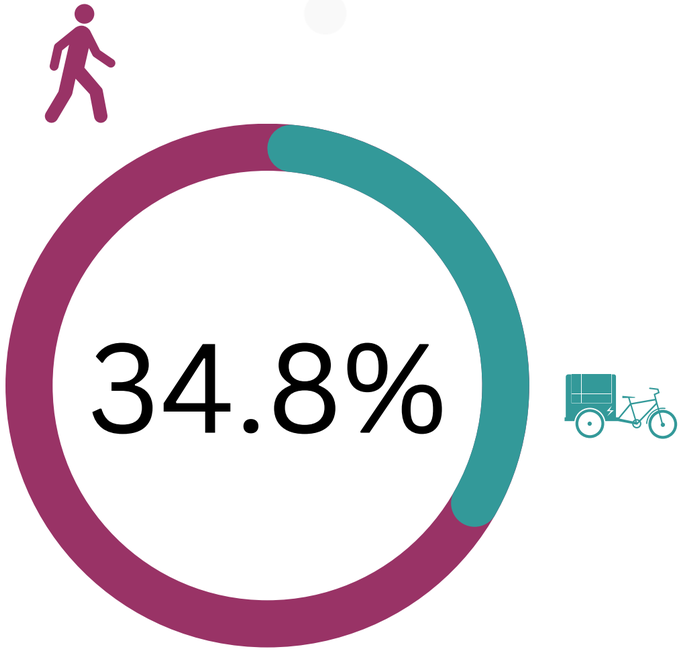
0 - 2 km/h M

Speed increases on main roads

We can identify when the user is walking or has stopped based on the speed

34.8% of the time, the speed was under 2.5 km/h



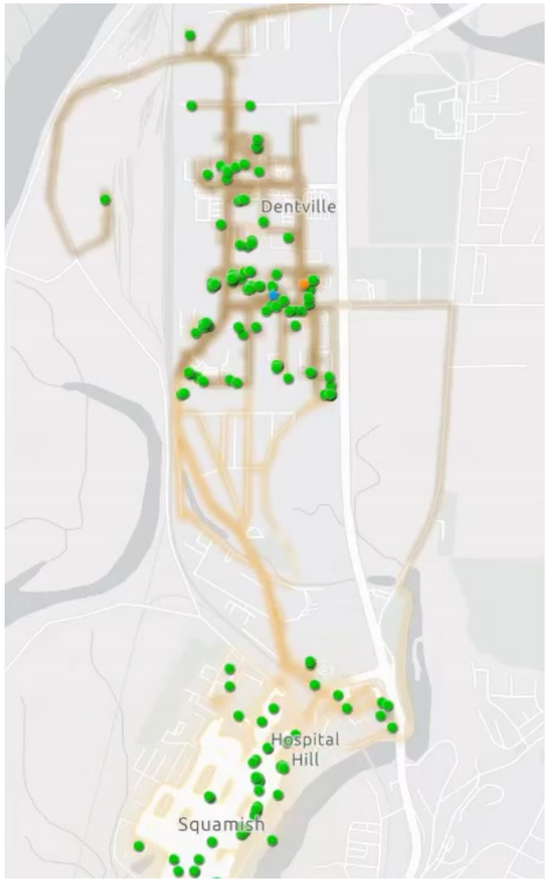


Results

0 - 2 kg Mir

Weight is mainly concentrated around stops

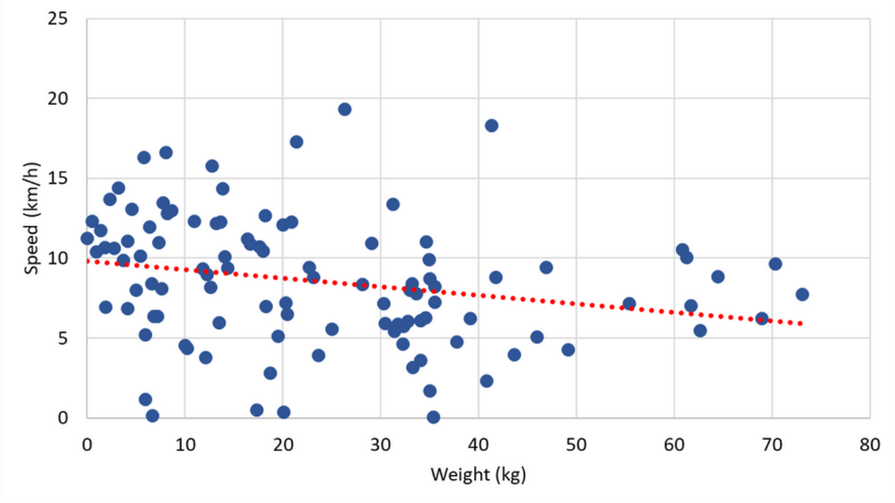
The elevation changes from south to north



5 - 7 m 5.3

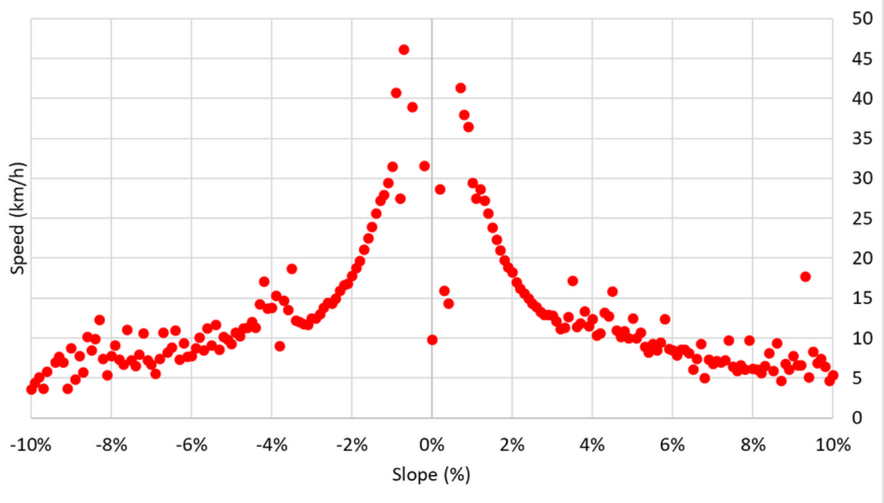
Results

Speed and Weight



Speed decreases when weight increases

Speed and Slope

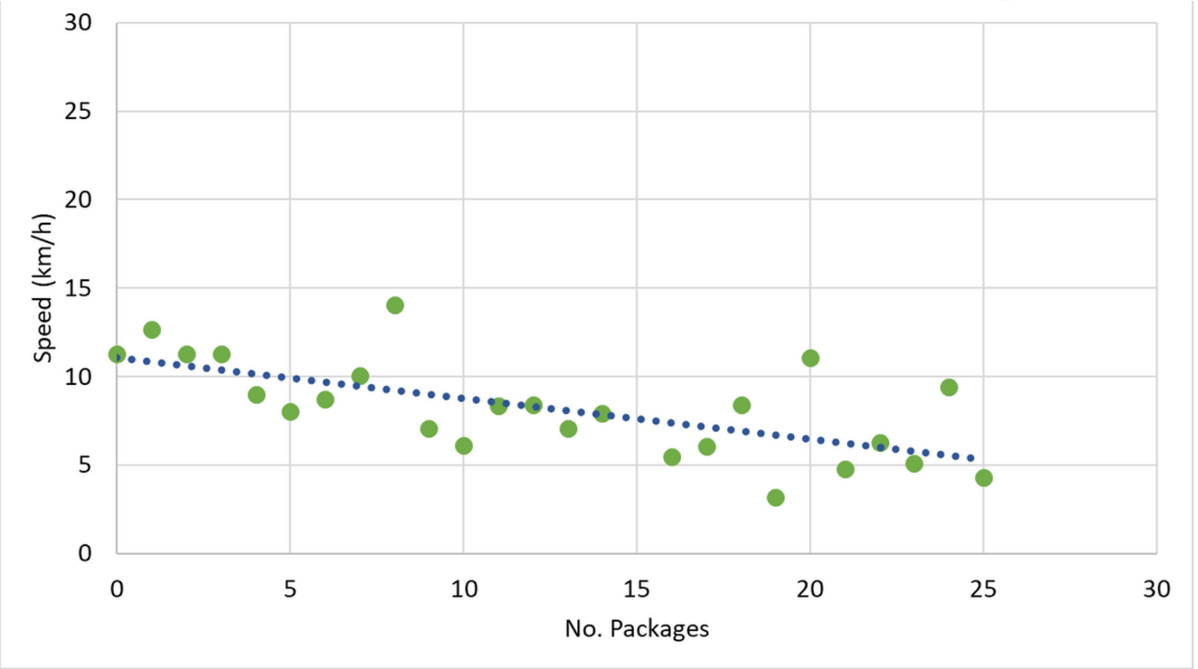


Speed increases when the slope is closer to zero

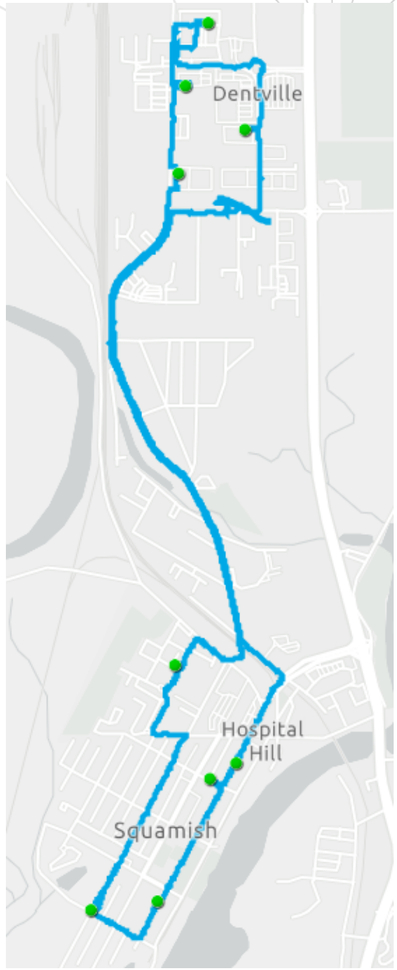
Results

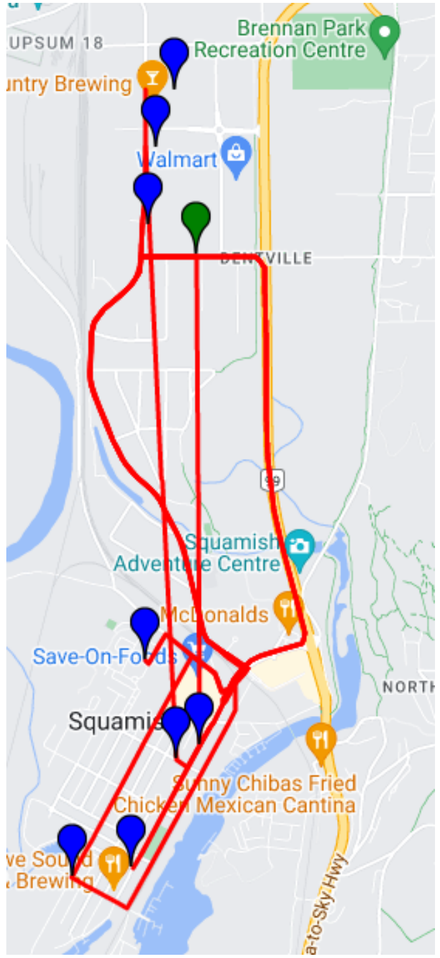
Speed decreases when number of packages per trip increases

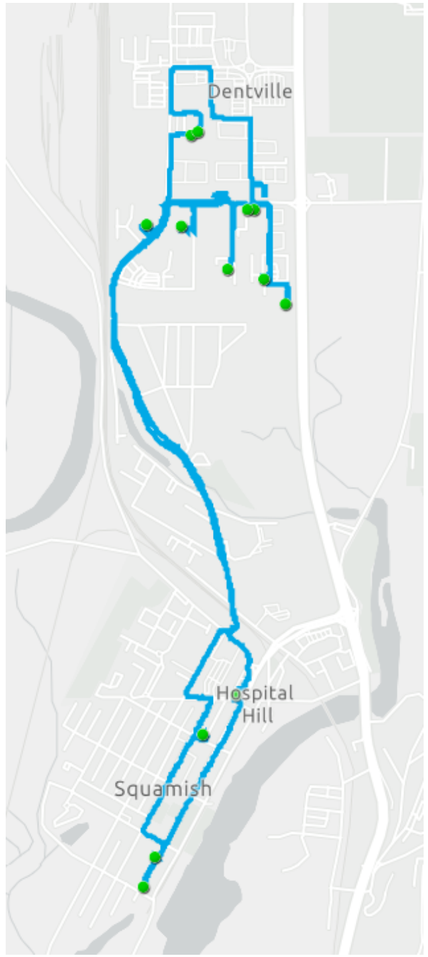
R2 = 0.4209

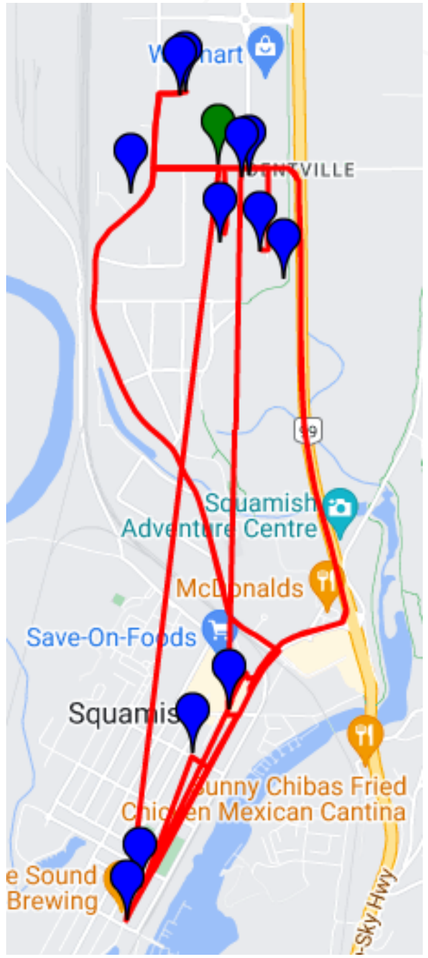


Model vs. Reality

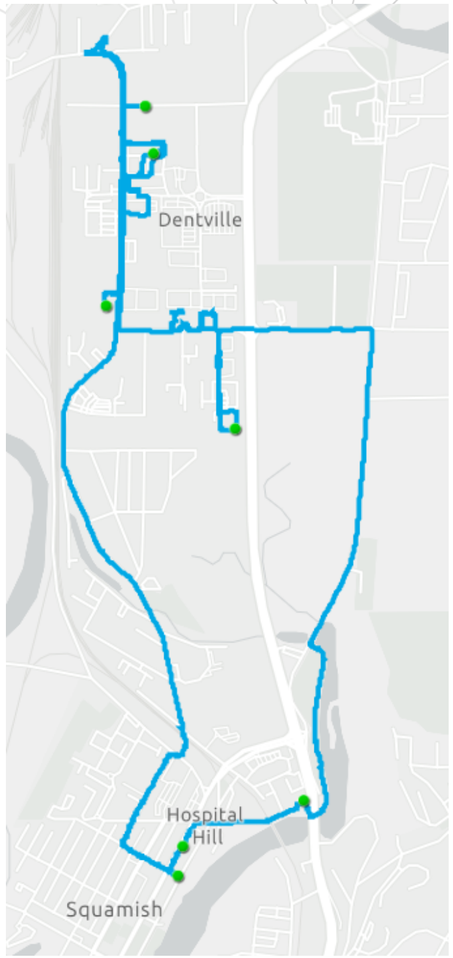


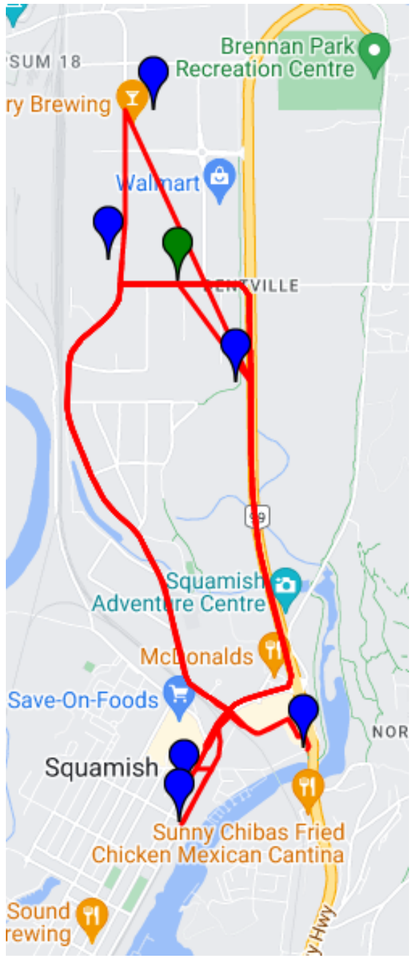


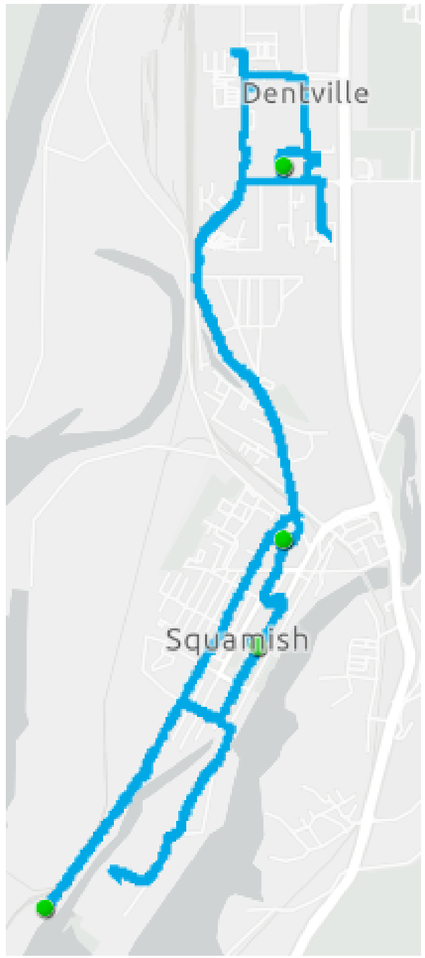


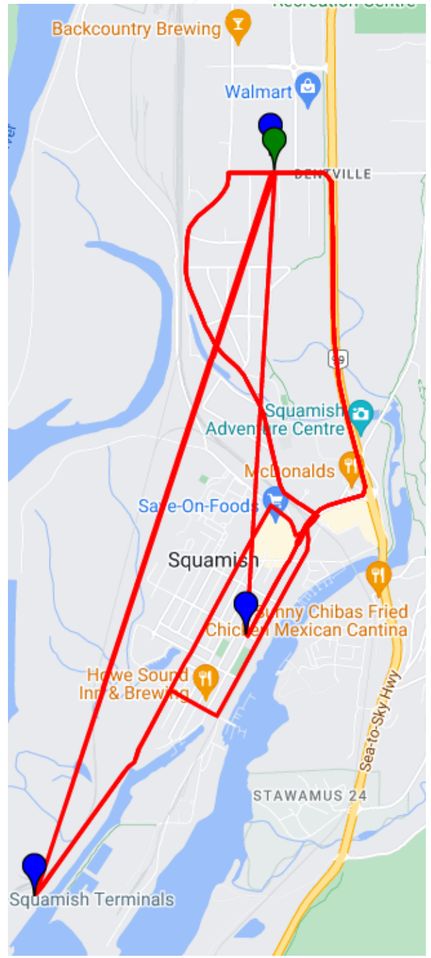


Model vs. Reality









Model vs. Reality

Model vs. Reality

Route Choice Model based on the Level of Comfort for Electric Cargo Cycles

Adonai Garcia; David Tran

Conclusion

- The model can help identify walking / stopping time.
- Speed is correlated to some of the variables considered in the model.
- ECCs need to be replaced for another three wheeler that can gather data from the battery.
- New algorithm should include other elements: type of infrastructure (road, sidewalk, etc.), mode (walking, biking), etc.

Our Greenway

$92,608.26

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