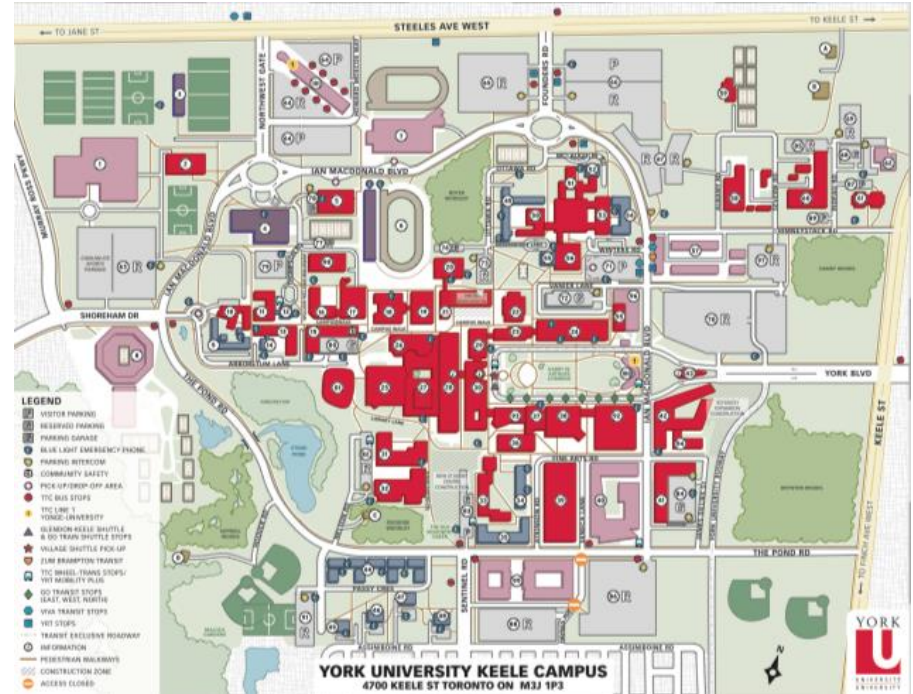# EZ-WAYS

An Accessibility Routing Application for York University Keele Campus

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MOTIVATION

- York University Keele Campus is largest post-secondary campus in Canada[1]

  - Complex network of buildings and road, both old and new

 - Navigating around the campus can be challenging

http://maps.info.yorku.ca/files/2013/02/KEELE_Map_Colour.pdf

MOTIVATION

- Statistic Canada's 2017 Canadian Survey on Disability shows:[2]
    - 7.7% of Ontarians identify to have mobility disability
    - Of this, 17.5% will attend post-secondary institution

- Projecting to York University's student population of approx. 54,000, we **expect 728 students to have ambulatory disability**
    - This is only considering students *not* faculty, staff, visitors, etc.

MOTIVATION

- All campus features do not meet accessibility requirements and are not "accessibility friendly"

  - This makes it even more difficult for individuals with additional accessibility needs to navigate around the campus

  - Examples:

    - Non-automated doors

    - Lack of elevators

    - Poorly lit pathways
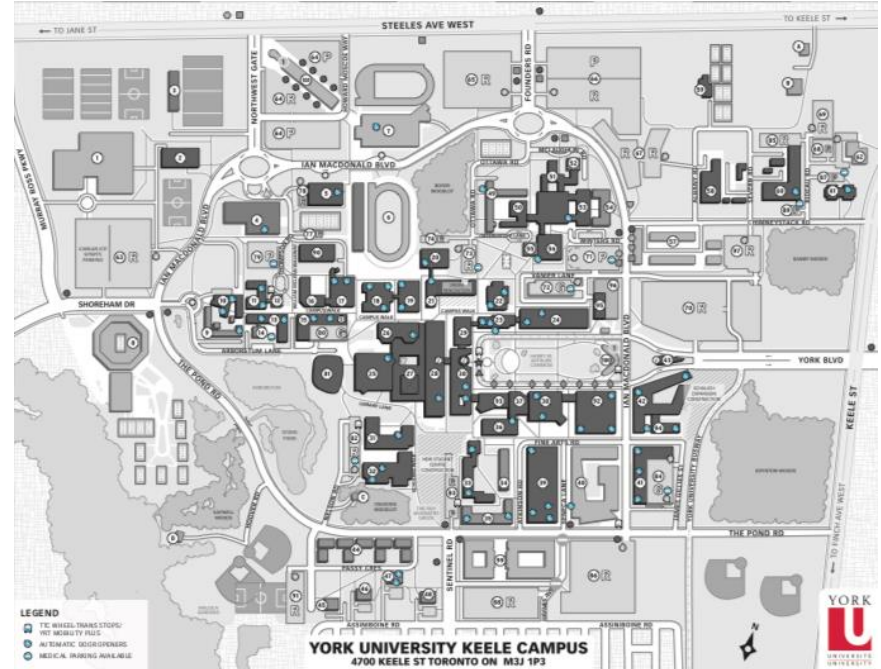
http://maps.info.yorku.ca/files/2013/02/KEELE_Map_Accessibility.pdf

OUR PROBLEM STATEMENT

A number of barriers, primarily physical, restrict access to certain areas of the York University Keele campus for persons with disabilities.

Devise a way to improve the accessibility of York University Keele Campus.

OUR USERS

- Wanted product to be useful for individuals both with and without additional accessibility needs

- Additional accessibility requirements classified into:

  - Ambulatory

  - Non-ambulatory

- Due to large number of possible additional accessibility needs, focused on improving accessibility for those with mobility requirements

  - i.e. Individuals requiring wheelchairs, walkers, crutches, canes, etc.

OUR REVISED GOAL

To improve the accessibility of York University Keele Campus for persons who have an ambulatory disability
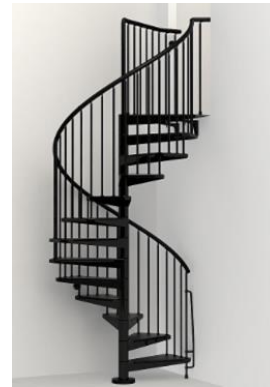
PRELIMINARY IDEAS

- Retrofit accessibility systems to mobility obstacles
  - Examples:
    - Automated/power-assisted doors, wider doors
    - Ramps, elevators, escalators, etc.

https://www.dreamstime.com/

http://www.barrier-free.com

https://www.homedepot.com

https://www.titanramps.com

PRELIMINARY IDEAS

- Develop a system that favours accessible regions for those in need
  - Adjust specific campus operations to occur in buildings meeting all accessibility requirements
  - Examples:
    - Reschedule/relocate courses in which individuals requiring additional accessibility support are enrolled, teaching, etc. to specific buildings
    - Relocate key campus features (cafeterias, stores, etc.) to be in accessible spaces

http://www.mapformation.com

https://www.istockphoto.com

PRELIMINARY IDEAS

SOLUTION	PROS	CONS
Retrofitting Accessibility Systems	- Many readily available products exist - Just a matter of implementing	- Costly - Disruptive to daily campus activities during implementation
Restructuring Student/Faculty/Staff Schedules and Relocating Operations	Can directly control for number of obstacles faced by individuals	- No building may still meet *all* accessibility needs - Complex - Needs to be carefully repeated every semester - Disruptive to individuals not requiring additional aid

THE BEST SOLUTION

Campus Routing Application

EZ-WAYS

http://130.63.133.90:8000/Apps/ENG4000/

SOLUTION DESCRIPTION

- Created application that:

  - Aids in navigating a user around campus

  - Provides seamlessly integrated indoor and outdoor routes to user depending on their input accessibility requirements

    - Makes use of routing algorithms to determine shortest path route, avoiding user specified obstacles

THE BEST SOLUTION

| SOLUTION	PROS	CONS

Campus Routing System	● Not disruptive to daily campus operations both during implementation and use
	
	● Usable by various types of individuals
	
	● Being a web application, can be used on mobile devices and/or computers
		● Does not directly solve campus' accessibility issues
		   ○ Instead, users to "go around" problems
		
		● Has "expiry date"
		   ○ Only useful if accessible route not known

THE BEST SOLUTION

- To extend the lifetime and improve the quality of the product, the application was designed to:

  - Collect and model the critical points on campus

  - Inform YorkU Administration about these points

    - To make the university aware of the problems and encourage them to make the necessary changes

  - Be updatable in the future

    - To model the campus' dynamic/current accessible features
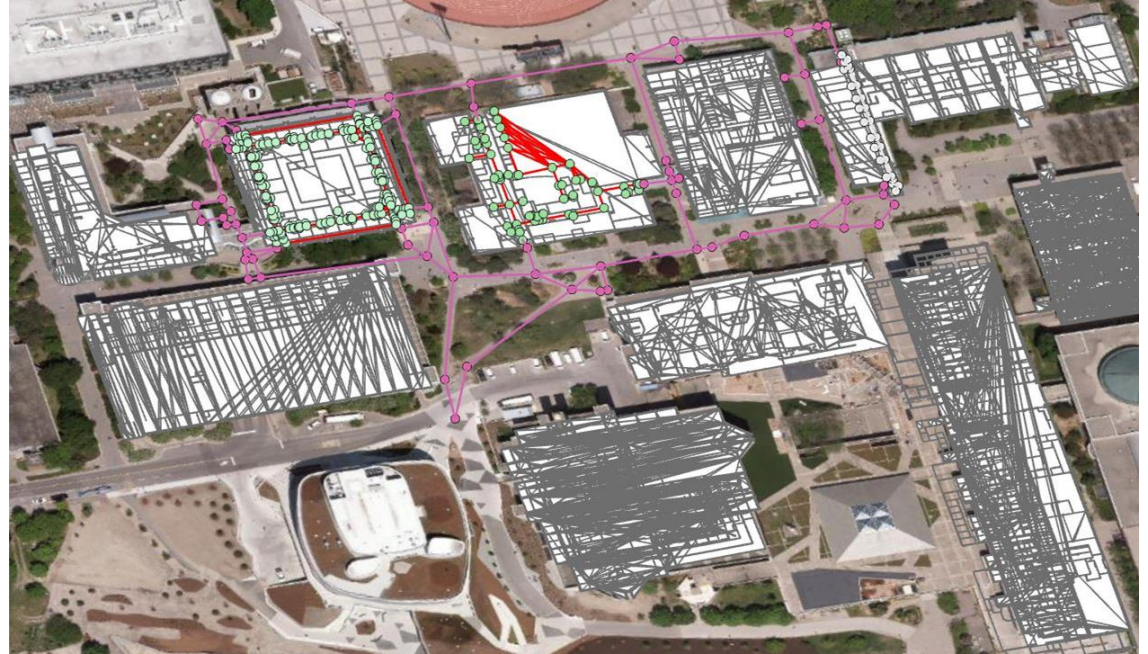
APPLICATION CREATION
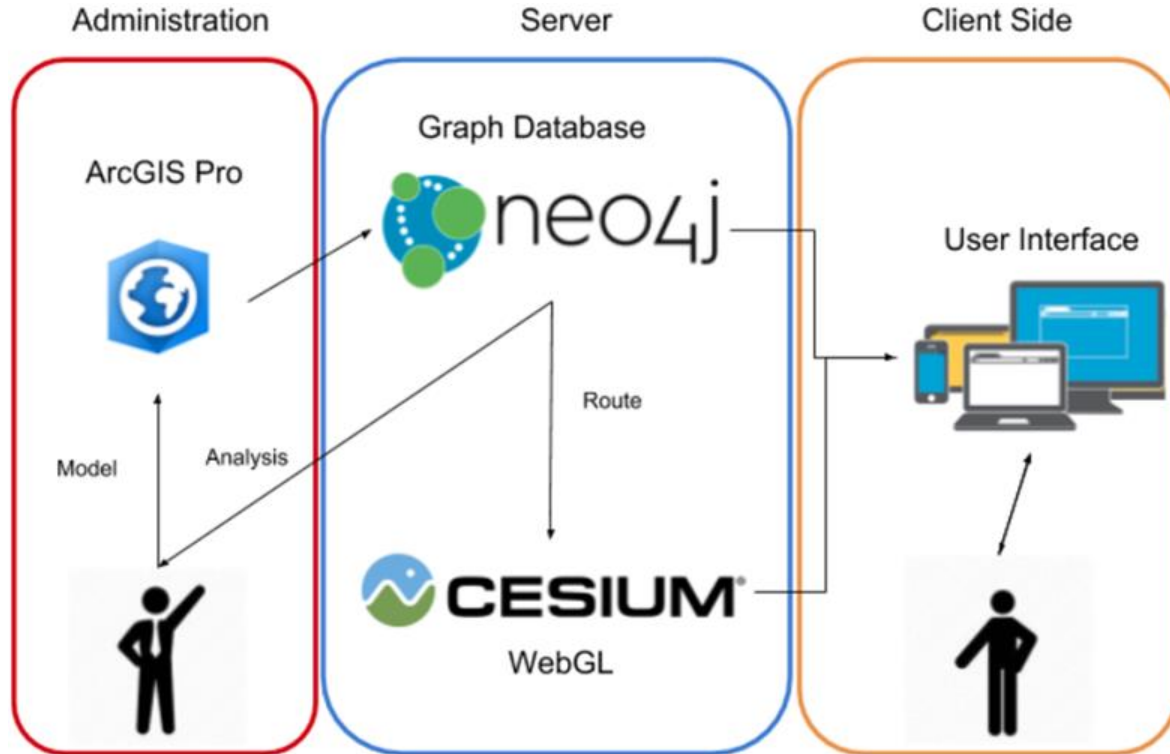
CAMPUS MODEL
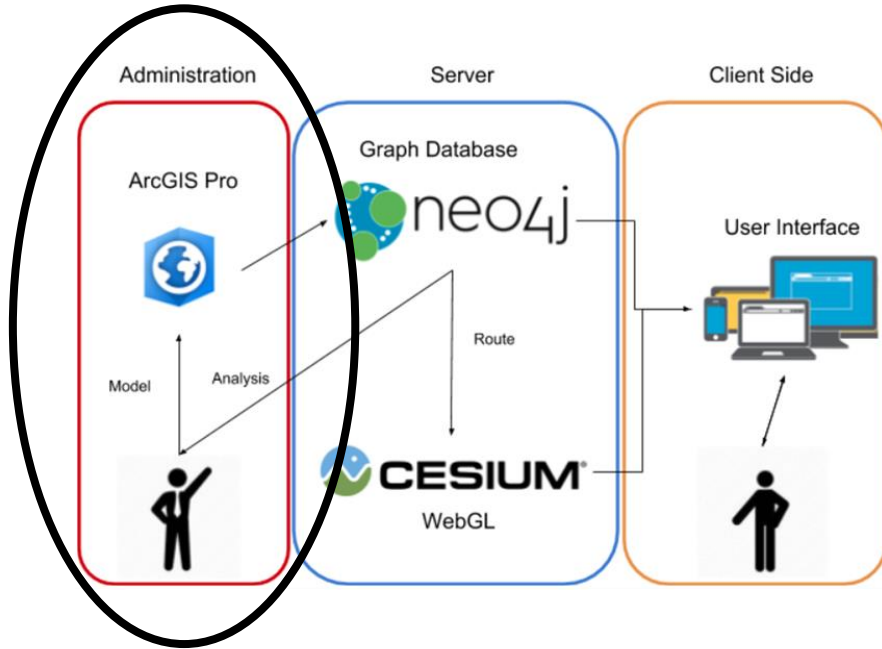
- Model of campus' accessibility created using:

  - Personal knowledge and experience to identify accessible features

  - Given 3D building models from CSBO

  - ArcGIS Pro

CAMPUS NETWORK CREATION

- Routes identified in ArcGIS Pro

  - Against ESRI Basemap and given 3D campus building models

- Routes given attributes denoting whether accessible or not

ROUTE DETERMINATION
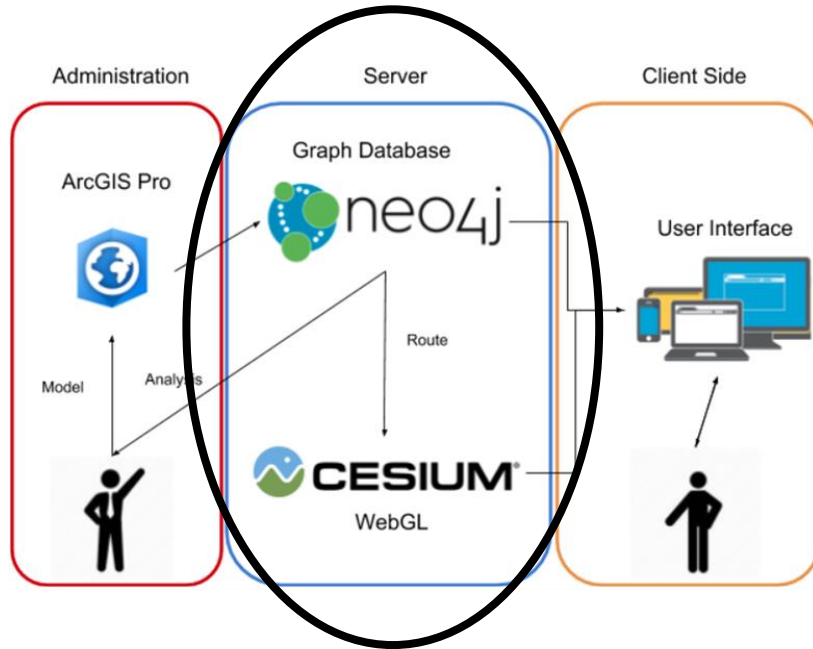
- To query and determine the optimal routes used:
  - Neo4J (Graphing Database)
- To acquire user input and present optimal routes used:
  - Cesium (Web Mapping Application)

CESIUM USER INPUT

EZ-Ways
Location Information

Input Starting Point
Select Building:
Select Room

➡️ User selects starting location

Input Destination
Select Building:
Select Room

➡️ User selects desired destination

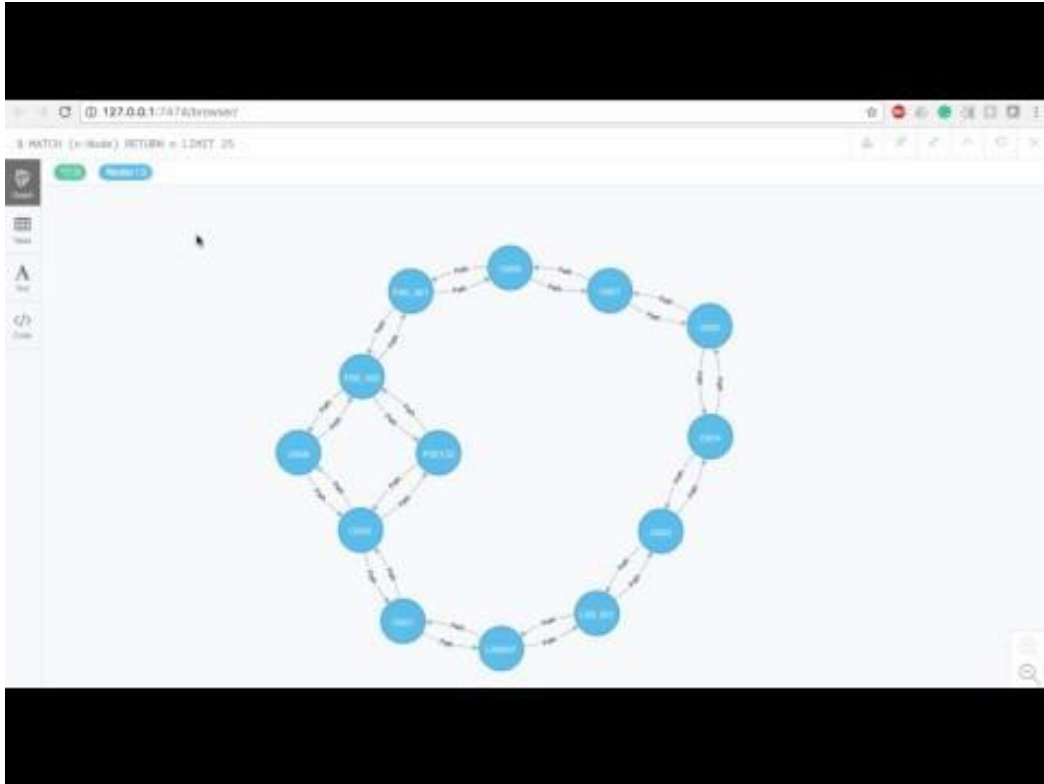**Accessibility Options**
🔘 Accessible Friendly
⚪ Accessible Friendly Off

Calculate Route

➡️ User specifies whether want to avoid mobility obstacles *(Accessible Friendly)* or not (*Accessible Friendly Off*)

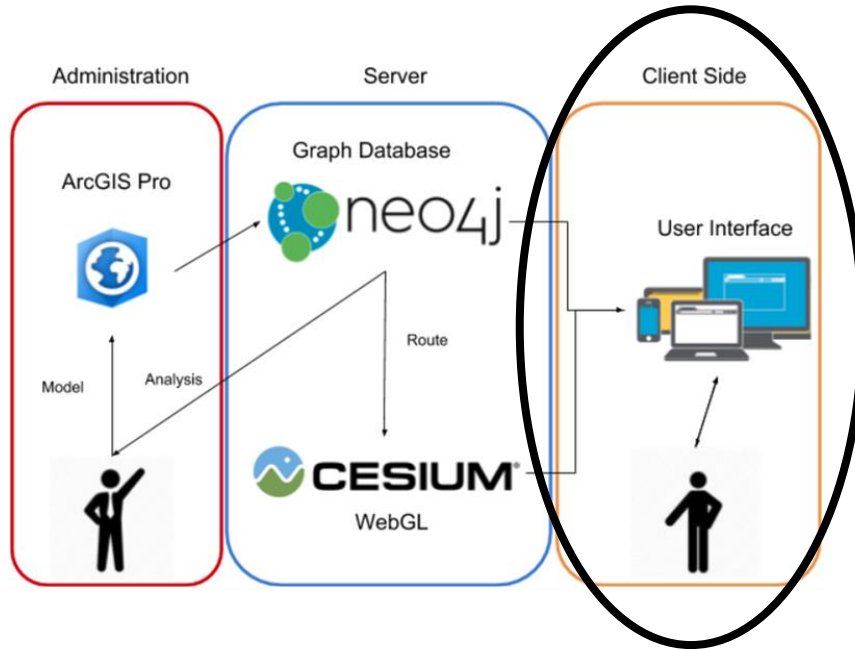**View Options**
Building Transparency

➡️ User adjusts viewing parameters

NEO4J

- Network of paths stored in graph database

- Routes are calculated by (a modified) Dijkstra's algorithm

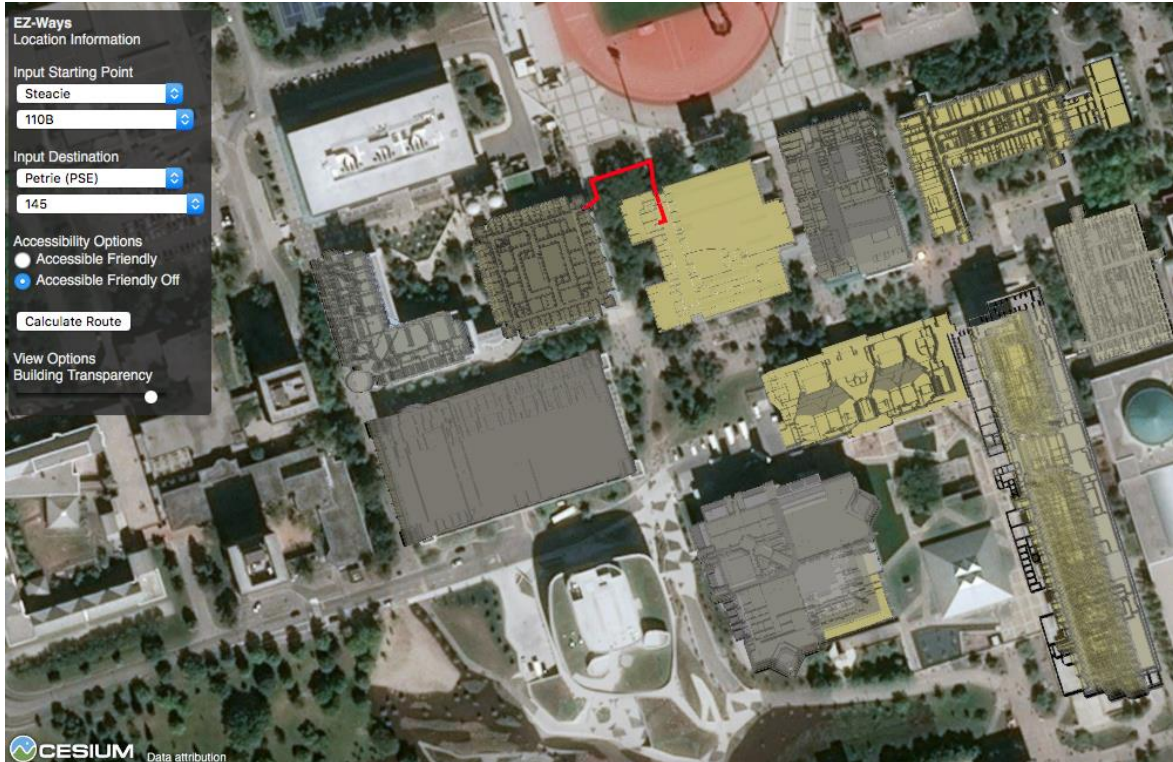- Optimal route output to Cesium

- Graph analysis capability

ROUTE PRESENTATION

- Cesium overlays results against 3D campus model

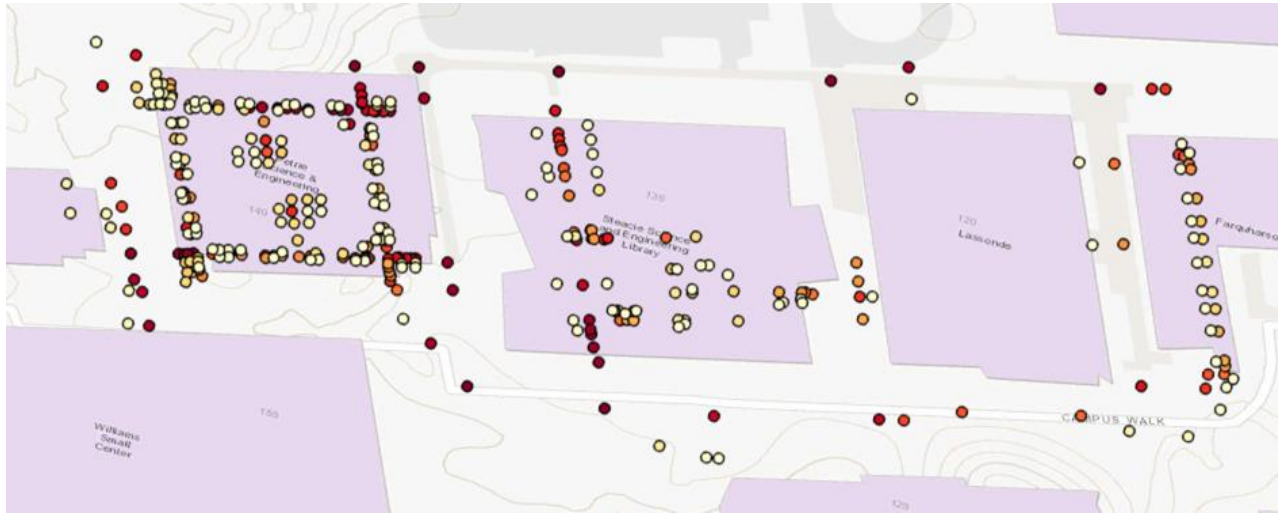- As web application, user can use application on most devices

CESIUM

- Optimal route displayed in red

- Due to given datasets, **must adjust transparency** to view indoor paths

- Designed to display error messages when route could not be determined

CRITICAL POINTS MAP

- Critical points identified by "Traffic Score"
  - A measure of how many times each node is visited by a user
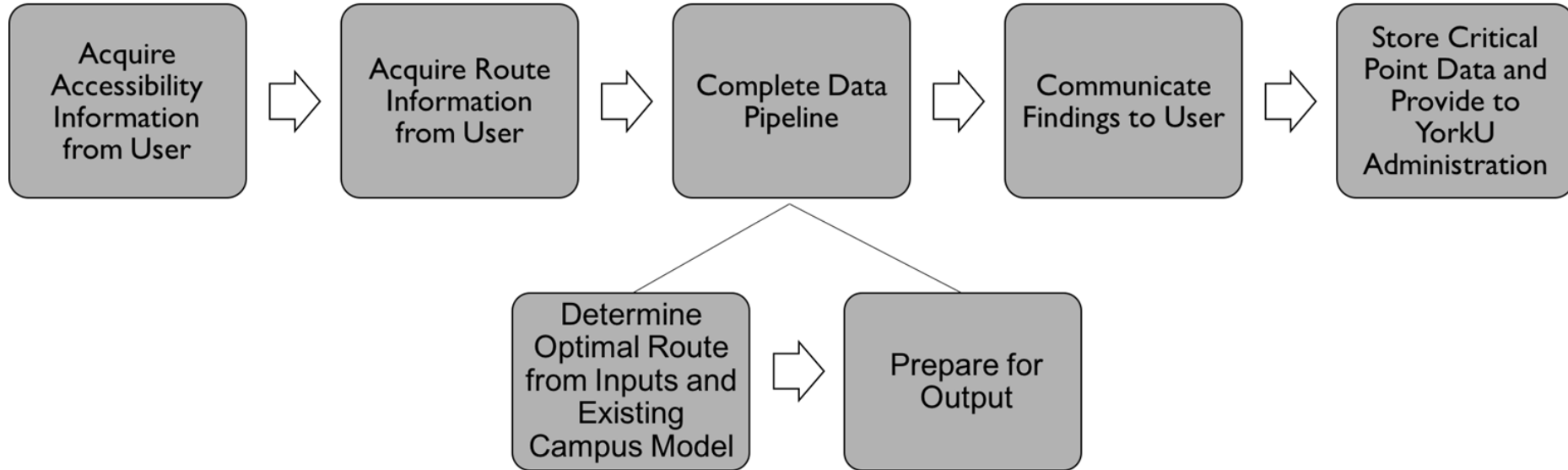- Critical points identified by "Betweenness Centrality"

Red - High Frequency   White -
Low Frequency

APPLICATION WORKFLOW

Acquire Accessibility Information from User → Acquire Route Information from User → Complete Data Pipeline → Communicate Findings to User → Store Critical Point Data and Provide to YorkU Administration

Determine Optimal Route from Inputs and Existing Campus Model → Prepare for Output

EZ-WAYS DEMO

- Live demo: http://130.63.133.90:8000/Apps/ENG4000/

- "Product walkthrough"

CONDUCTED TESTS

Basic Route Tests

- Route Visualization Test
- Obstacle Avoidance Test

Interface Tests

- User Location and Destination Input Test
- Accessibility Features Test

Validation Tests

- Clarity of Application
- Effectiveness of Application

Optimality Tests

- Shortest Route Algorithm Test
- Output Speed Test
- Accumulator Test

Other Tests

- Server Test
- Deterioration Test
- User Privacy Test
- User Safety and Accessibility Needs Test
- Device compatibility

PRODUCT BENEFITS

- Optimal route provided within seconds

- Usable on various devices

- 3D representation of results aids in visual interpretation

- Features manuals for updating product for future accessibility networks

COMPETING PRODUCTS

AXS Map

- Map showing accessibility status of features worldwide

- Members share accessibility of features (ex. washrooms, entryways) through defined rating system

- Users can find accessible features in their area

- Rates feature accessibility out of 5

AccessNow

- Pin-point map of accessibility status of features worldwide

- Crowdsourcing to determine accessibility status of features

- Users find accessible features in their area

- Has mission to change inaccessible features to accessible ones in the future

- Rates feature accessibility out of 4

Visit AXS MAP through: https://www.axsmap.com
Visit AccessNow through: http://accessnow.me

COMPETING PRODUCTS

AXS Map:

COMPETING PRODUCTS

AccessNow:
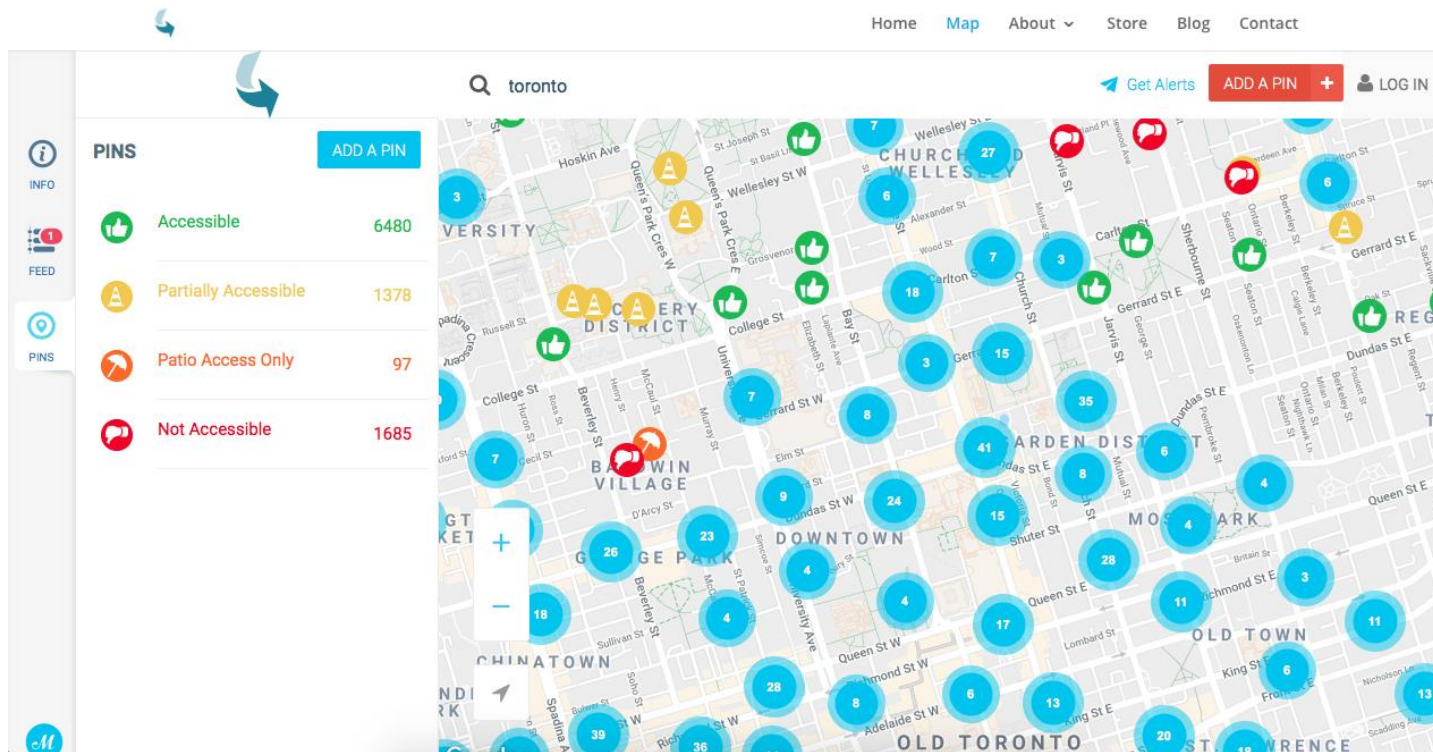
A COMPARISON WITH EZ-WAYS

AXS Map and AccessNow	EZ-Ways
- Do not provide accessible routes - Pin-pointing maps that redirect to Google Maps - Accessibility status dependant on crowdsourced data - Accessibility status rated out of multiple levels - Do not provide indoor accessibility information	- Routing system - Features pin-pointing accessibility status through critical points maps - Accessibility status defined by developers - Binary feature accessibility - Through accessible Friendly: ON or OFF toggle - Indoor and outdoor routing

FUTURE OF PRODUCT

- Incorporate additional buildings and multiple stories into campus model
  - Currently restricted to first floor of PSE, FARQ, and Steacie
  - Could allow for more advanced routes:
    - Minimizing outdoor time, number of doors encountered
    - Fastest routes
    - Brightest paths

- Extend to service more complex accessibility needs
  - Example:
    - Maximum path slopes

FUTURE OF PRODUCT

- Tracking to identify user position along route

- Alternative interface view
    - Perspective vs. Bird's Eye

- From web application to mobile application

- Expand beyond university campus
    - Simple creation methods mean easy map generation of *any* region

CONCLUSIONS

"Inclusion - The action or state of including or being included within a group or structure"[3]

Our product is a step towards a more inclusive and inclusive and accessible world.

REFERENCES

[1]   "Vice-President Finance and Administration of York University". Yorku.ca. 2013-09-18. Retrieved 2014-01-06.

[2]   Statistics Canada. (2017, 2 15). *A profile of persons with disabilities among Canadians aged 15 years or older, 2012*. Retrieved from Statistics Canada: http://www.statcan.gc.ca/pub/89-654-x/89-654-x2015001-eng.htm

[3]   Google. (2018, 24 2018). *Inclusion - definition.* Retrieved from Google Canada: www.google.ca/search?q=inclusion&oq=inclusion&aqs=chrome..69i57j0l5.2303j0j7&sourceid=chrome&ie=UTF-8