

# Software Engineering Project

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# Outline

- Tools and resources
- Methodology
- C++ implementation
- Matlab implementation

# Tools and resources

## IDE

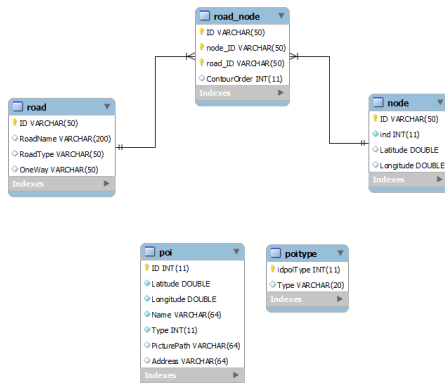
- Qt 5.1 with OpenGL
- Matlab 2013Ra

## Group meetings and coordination

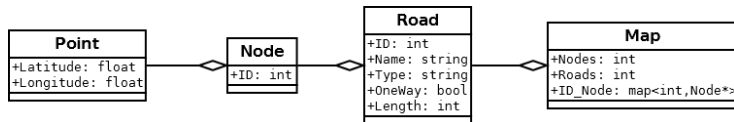
- Trello
- Git and Bitbucket

## Database

- MySQL Server 5.6
- PostgreSQL



- Main Structure:



- Loaded in memory through QMYSQL Driver
- Displayed using GL\_STRIPES of OpenGL
- Creation of a map of ID\_Node\* because of the complexity
  - Avoiding Queries
  - Avoiding double loops

# C++: Dijkstra's algorithm

- Other kind of algorithms:
  - Bellman-Ford and SPFA
  - Jonhson's algorithm
  - Floyd-Warshall algorithm
  - Dijkstra's algorithm
- Why? Performs better with non negative values
- How it works?
  - 1 Initialize D to 0 in the diagonal and  $\infty$  in non connected nodes
  - 2 Suppose that  $a = x$  (current node)
  - 3 Check all adjacent nodes of a except the ones that are marked
  - 4 If  $(D_i > D_a + d(a, v_i))$  then,  $D_i = D_a + d(a, v_i)$
  - 5 Marked as completed the node a
  - 6 We take as next current node the smaller in D
  - 7 Go back to step 3 until there are nodes not marked

# C++: Adjacency Matrix

- Sparse Matrix of the Euclidean distance between nodes (Eigen library)

0	3	0	0	0
22	0	0	0	17
7	5	0	1	0
0	0	0	0	0
0	0	14	0	8

Results measured  
under Debug mode  
and dependent on the  
performance of each  
processor

Values:	22	7	3	5	14	1	17	8
InnerIndices:	1	2	0	2	4	2	1	4

Table 1: Sum up of the benefits of Sparse matrices

	Matrix	Sparse
Num. nodes	$\simeq 84 \cdot 10^6$	$\simeq 16 \cdot 10^3$
Memory	$\simeq 336$ MB	$\simeq 64$ KB + Zero vector
Time	>30 sec	<1 sec
Dijkstra	>30 sec	<3 sec

# Route path

- Functions:

- Path calculation
- Distance and time
- Export

- General case:

Same road  $\rightarrow$  NO  $\rightarrow$   $Angle < 180 \rightarrow$  Right

Same road  $\rightarrow$  NO  $\rightarrow$   $Angle > 180 \rightarrow$  Left

Same road  $\rightarrow$  YES  $\rightarrow$  Distance

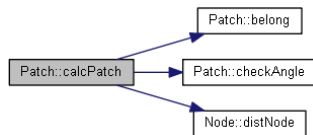


Figure : Functions involved in the route path calculation

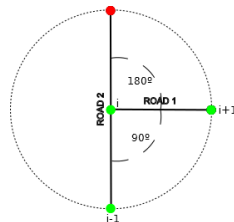
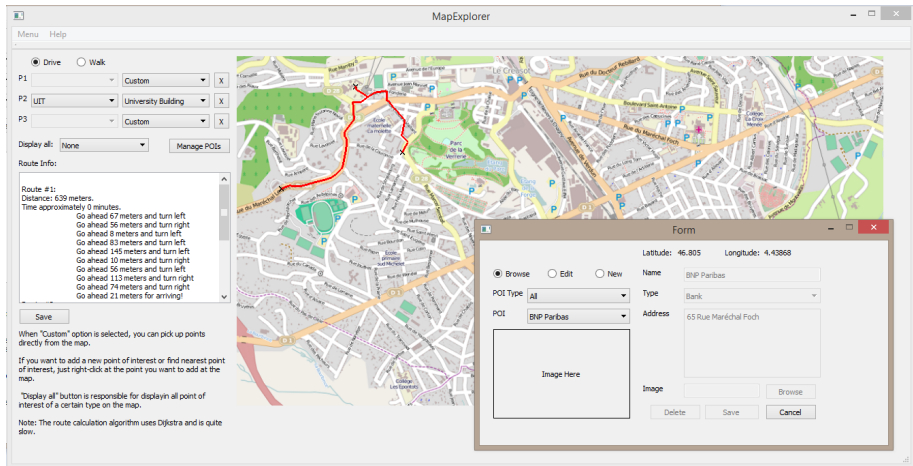


Figure : Example of road intersection

# Graphical User Interface (C++)



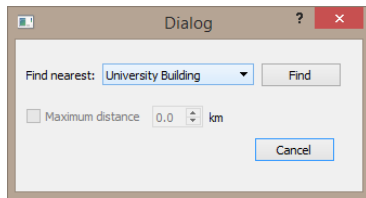


# Normalization and displaying

- Geographic coordinates (latitude, longitude)
- OpenGL (x,y)
  - Map Texture
  - glViewport, glOrtho and Qt Widget's size
- QGLWidget

# Route selection

- Point from the map
- Point of interest
- Nearest Point of interest



Find nearest

<input checked="" type="radio"/> Drive <input type="radio"/> Walk			
P1	<input type="text"/>	<input type="text" value="Custom"/>	<input type="button" value="X"/>
P2	<input type="text" value="St Patrick's Pub"/>	<input type="text" value="Bar/Restaurant"/>	<input type="button" value="X"/>
P3	<input type="text" value="Condorcet"/>	<input type="text" value="University Building"/>	<input type="button" value="X"/>

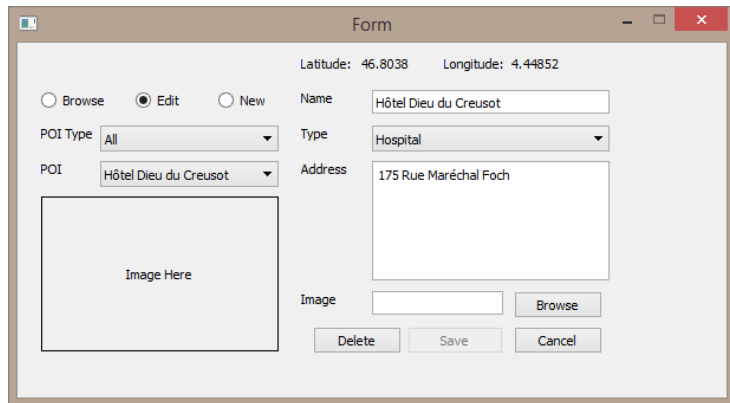
Route selection interface



Route output

# POI Management

Add, modify and delete points of interest



The screenshot shows a software window titled "Form" with a standard Windows-style title bar (minimize, maximize, close buttons). The window contains the following elements:

- Coordinates:** Latitude: 46.8038 Longitude: 4.44852
- Actions:** Three radio buttons labeled "Browse", "Edit" (which is selected), and "New".
- POI Type:** A dropdown menu currently showing "All".
- POI:** A dropdown menu currently showing "Hôtel Dieu du Creusot".
- Name:** A text input field containing "Hôtel Dieu du Creusot".
- Type:** A dropdown menu currently showing "Hospital".
- Address:** A large text area containing "175 Rue Maréchal Foch".
- Image:** A large rectangular box on the left labeled "Image Here". To its right is a smaller text input field and a "Browse" button.
- Buttons:** At the bottom right, there are three buttons: "Delete", "Save", and "Cancel".

# Matlab implementation

## Getting the data

- PostgreSQL database
- Queries were made only once.
- Created objects can be saved in .MAT files
- No need to recreate object on each program start

# Matlab implementation

## Data Structure

- Objects of 4 classes were constructed.
- No pointers in Matlab.
- Solution: handle classes.



Figure : Simplified diagram of relationship of a classes

# Matlab implementation

## The shortest path

- Dijkstra's algorithm
- Determine the window on which the closest nodes and projections will be searched.
- Find the closest node on determined window.
- Find the closest projection (if possible) on the same window.
- Update the adjacency matrix according shortest distance.

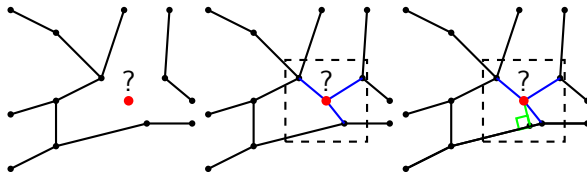
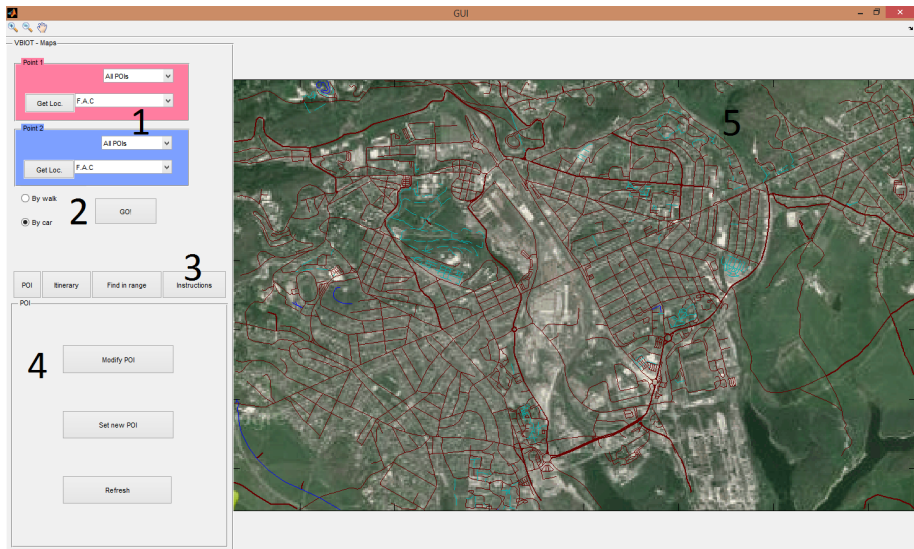


Figure : Finding the shortest point/projection for the random point on window domain

# Graphical User Interface (GUI)



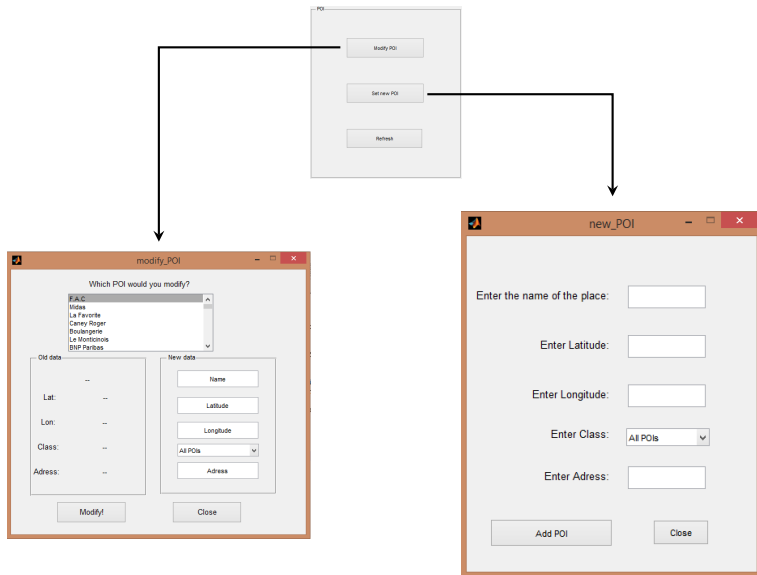
# Insertion of points

- Point from a list
- Filter by class
- Get Location from the map
- Walk / Car
- GO!

The screenshot shows a web application interface for inserting points. It consists of two main sections, 'Point 1' (pink background) and 'Point 2' (blue background). Each section contains a dropdown menu labeled 'All POIs' and a 'Get Loc.' button next to a text input field containing 'F.A.C.'. Below these sections are two radio buttons: 'By walk' (unselected) and 'By car' (selected). A 'GO!' button is located at the bottom right of the interface.



# Manipulating Points of interest



# Itinerary

- Adding a third point
- Getting and storing the distance
- How it works
- Cost of time

The screenshot shows a web application window titled "Itinerary". Inside, there is a green-bordered box labeled "Point 3". Within this box, there is a dropdown menu labeled "All POIs" and a button labeled "Get Loc.". Below the button is a text input field containing "F.A.C.". Below the green box, there is a label "Maximum distance: (in meters)" and a text input field containing "--". At the bottom of the window is a button labeled "GO!".

# Find in a Range

- Using Point 1 data
- Selection of classes
- Distance
- Slow process

Find in a range

Select your current location by using POINT 1 in the upper left corner

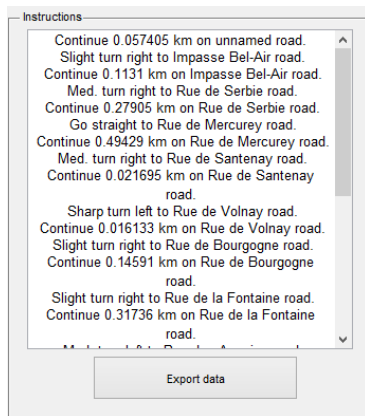
What do you want to find?

Maximum distance: (in meters)

FIND!

# Generation of the instructions

- Generating instructions from shortest path
- Setting a scroll bar
- Exporting this data
- Default text when missing data



# Conclusions

- Matlab is more suitable for prototyping and vectorizing operations than C++
- C++ deals easier with events produced by the user
- C++ allows to export a final released version of the project while to run Matlab program you must have Matlab installed
- Performance on C++ implementation is higher but at the same time makes necessary to pay attention to memory leaks
- Some functionalities regarding to the GUI are limited in one developing environment but not in other and vice-versa.

# Thank you for attention!

# Questions?