



the mind of movement

Using ML to help solve online VRPs

Nitin Ahuja

OR meets ML | Bologna | 11.03.2019



Content of **Presentation**

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Where we come from?



Online VRP

CVRP PD TW

- Given the current:
 - position and availability of each vehicle
 - schedule of each vehicle
- In comes an order for which:
 - pickup needs to happen within the next 30 minutes
- Out goes a response within ONE SECOND saying one of the following:
 - order can be served by a particular vehicle
 - order cannot be served in current circumstances



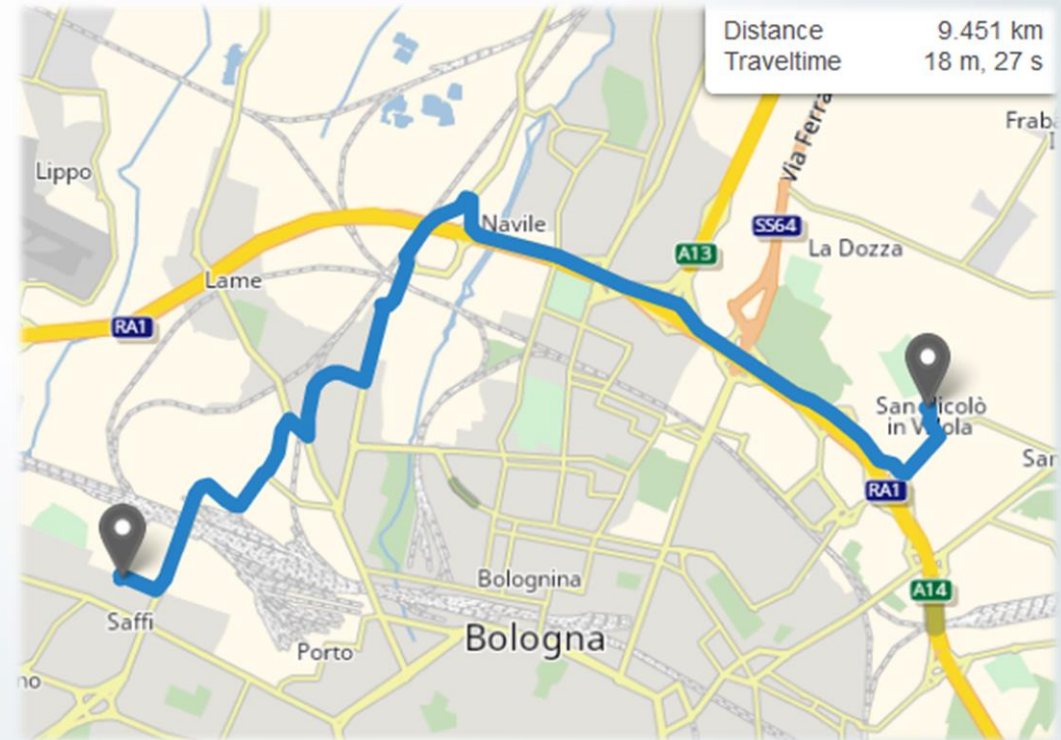
Online *** problem

From now onwards, we may keep any online problem or algorithm in mind.

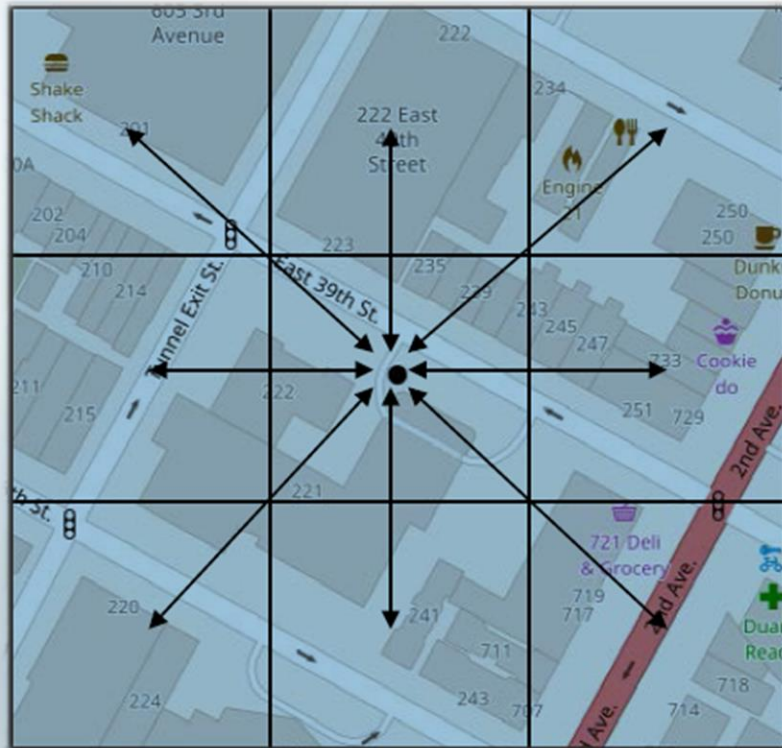
One main aspect: it intensively needs travel times (and distances) !

Travel times? Ask your favourite routing engine!

- Travel time depends on:
 - start time and day
 - season and weather
 - type of vehicle
 - etc.
- Average response time per query:
 - between 5 and 15 milliseconds



Travel times? Use a fast estimator!



- Average response time per query:
 - at most 1 millisecond
- Accuracy not guaranteed

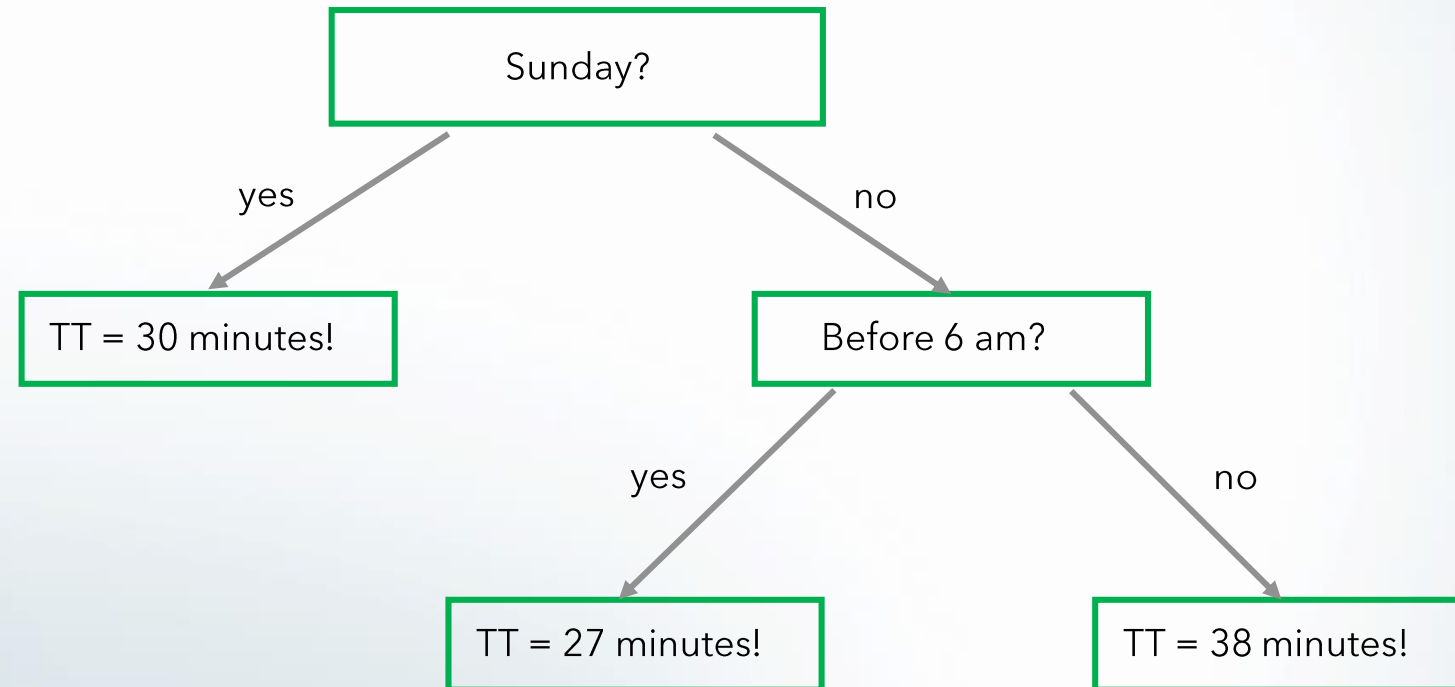
Use a fast estimator based on ML !

ML approaches for estimating travel times

- K-Nearest Neighbor - Laha, Putatunda, 2017
- Artificial Neural Networks - Fan, Gurmu, 2015
- Random Forest - Bansal, Jaiwal, et al., 2016

We experimented with Random Forest (RF) to learn travel times (TTs).

A decision tree in random forest



Random forest: an experiment

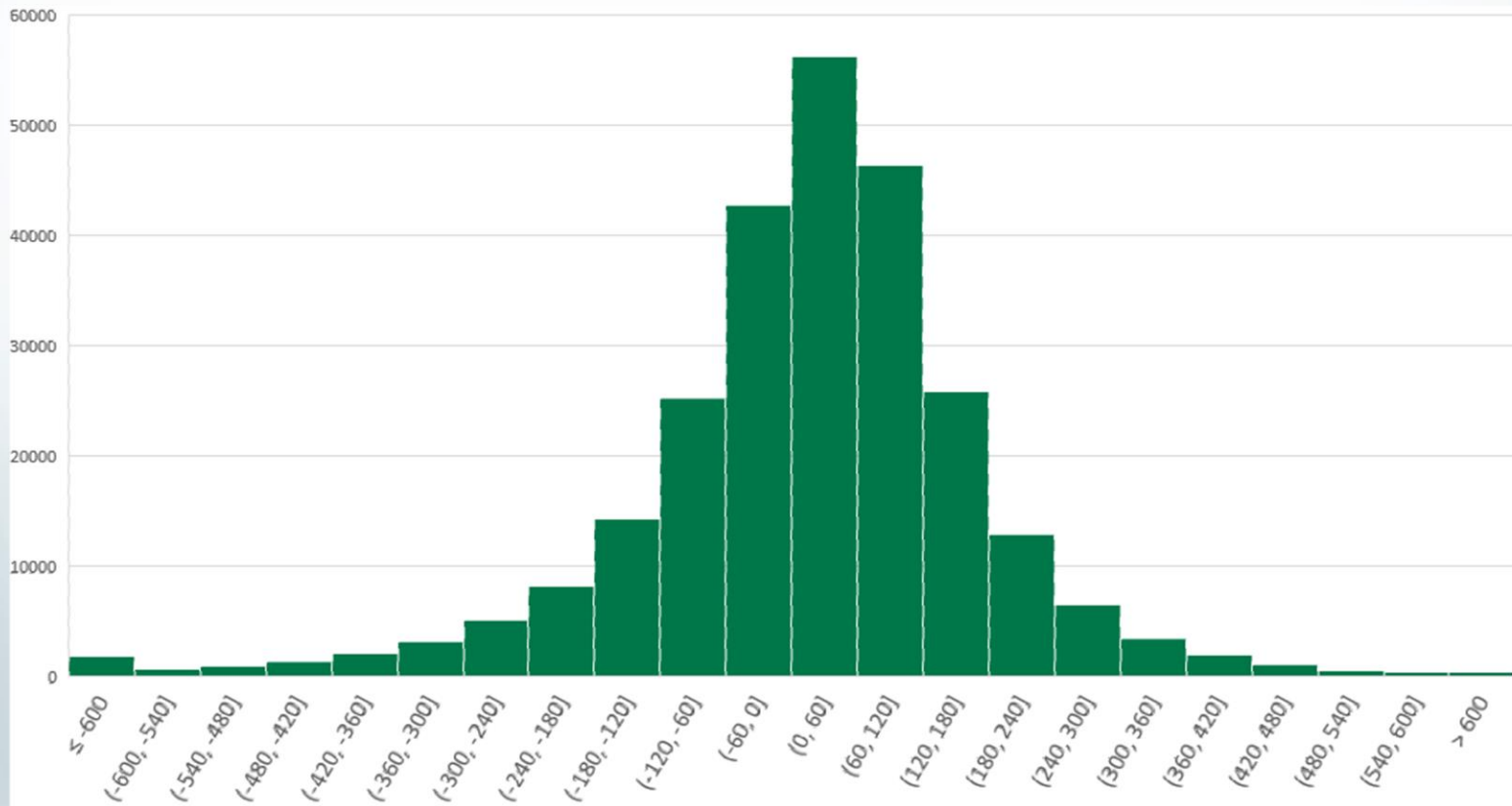
Training data → NYC taxi data

- Long term training data:
 - 01.02.2016, 0:00 – 08.02.2016, 0:00
- Short term training data:
 - last 30 minutes
- Test data:
 - 08.02.2016, 0:00 – 24:00

Features

- Start- and end-coordinate
- Hour of day
- Day of week
- Travel distance
- Euclidean distance
- Number of trips in the last 30 minutes
- Average speed of trips in the last 30 minutes

Result: distribution of predicted travel time



Result: variable importance

Variable	Importance
Start-Latitude	0.024
Start-Longitude	0.039
End-Latitude	0.027
End-Longitude	0.052
Hour of day	0.045
Day of week	0.013
Travel distance	0.483
Euclidean distance	0.183
Number of trips - last 30 minutes	0.027
Average speed of trips - last 30 minutes	0.107

Challenge: ML needs data

- Where to get data from?
- How to save data?
- Data protection laws
 - EU: GDPR
 - Effective May-2018
 - US: California Consumer Privacy Act, 2018
 - Effective January-2020
 - Asia: ??

Challenge: data & algorithms for predicting future orders

- Predict future pickups and deliveries
 - Type of goods
 - Quantity
 - Location
 - Time



Thanks for your attention!
Grazie agli organizzatori!

