Mobility prediction Based on Machine Learning Algorithms

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03.11.2021

Scope

- State of the art for mobility prediction
- Mobility prediction based on machine learning
- SVM algorithm introduction
- System model for applying SVM
- Simulation results
- Conclusion and further work plan
- References

State of the art for mobility prediction

- Mobility prediction has been widely applied to mobile communication but mobility prediction is a challenging problem due to the complicated traffic network.
- Plenty of researches have been done in this area.

- Non-Machine-Learning-based mobility prediction

[1]. Lagrange interpolation in Descartes coordinate system is used here to simulate movement history information of UE.
[2]. Proposes Long Short-Term Memory (LSTM) networks and Dead Reckoning (DR) framework to predict next location of UE

- Machine-Learning-based mobility prediction

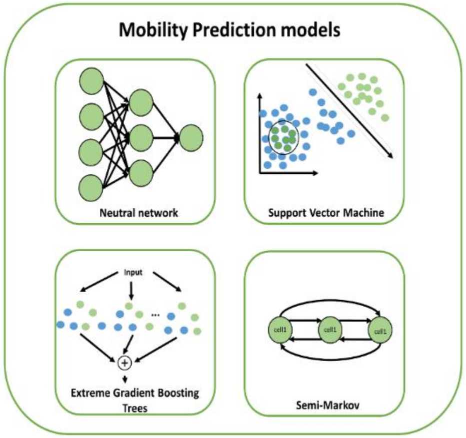

Fig.1 Mobility prediction models

Support Vector Machine (SVM) algorithm

- SVM algorithm creates a line or a hyperplane (so-called decision boundary) in N-dimensional space (N- the number of features) which distinctly separates the data into classes.
- There are plenty of possible methods to choose hyperplanes used for deciding the classes of the datasets.
- The objective is to find a plane that has the maximum margin.

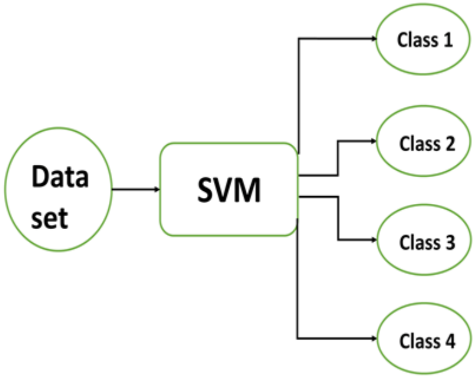

Fig.2 SVM classifier

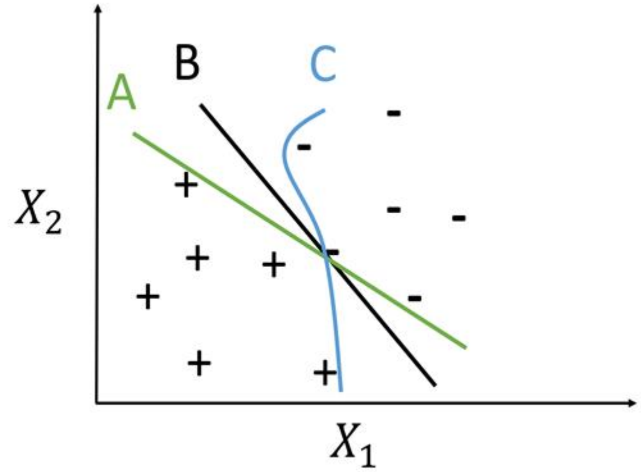

Fig.3 Possible hyperplanes

Kernel function

- Simple SVM: Typically used for linear regression and classification problems.
- Kernel SVM: Has more flexibility for non-linear data because you can add more features to fit a hyperplane instead of a two-dimensional space.

We have the standard way of writing linear model for SVM model

$$Z(x) = (w^T x + b)$$

More completely, the classification function, $g(z)$ is defined as:

$$g(z) = \begin{cases} 1 & if\ z \geq 0 \\ -1 & if\ z\ \leq 0 \end{cases}$$

So combined with $z(x)$,the complete model for SVM is:

$$g\big(z(x)\big) = g(w^T x + b)$$

System mode

- A highway scenario with two routes, three lanes, and one direction generated by using SUMO.
- Generated random driving cars.
- Vehicles choosing Route1 are marked with a number ”0”.
- Vehicles choosing Route2 are marked with a number ”1”.

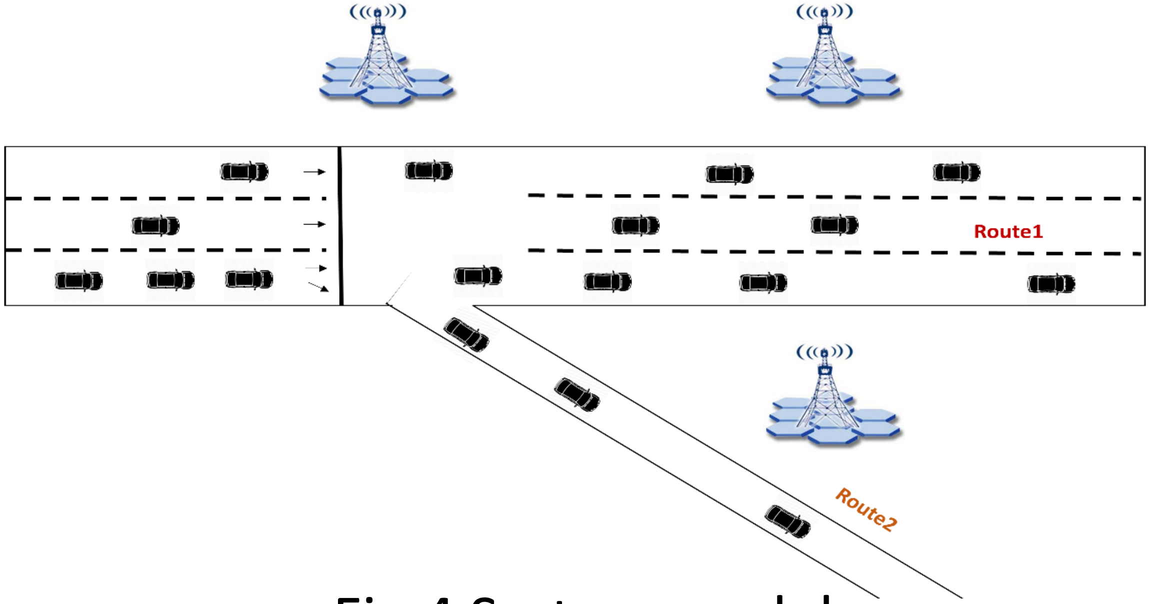

Fig.4 System model

Application of SVM

- SVM simulator is developed in Python
- SVM is pre-purposed to predict vehicular user route.
- Input data: $X(u_i, t_i, y_i)$
  u_i:UEi's location, t_i:time slot, y_i:UEi's route
- Mapping function: $Y = f(X)$

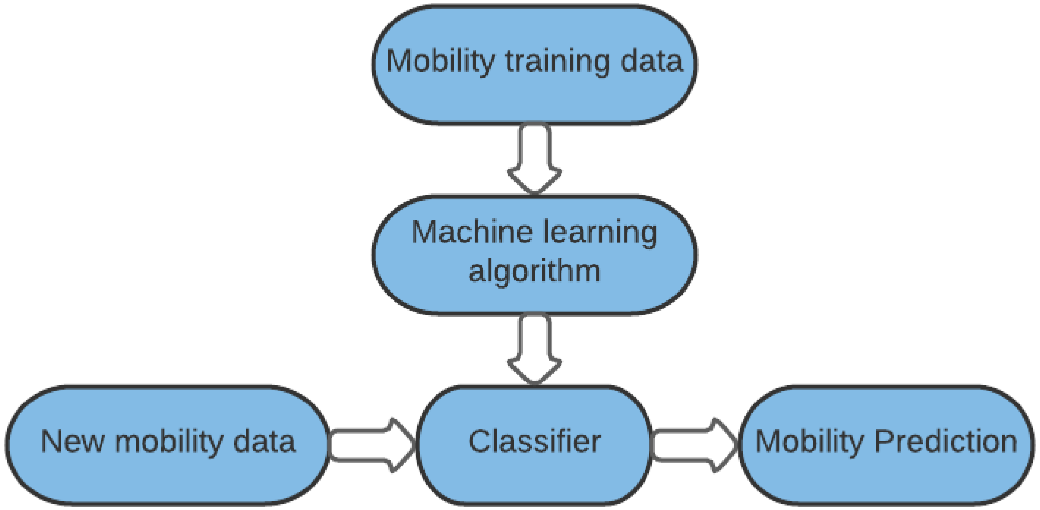

Fig.5 Mobility prediction process

Simulation results

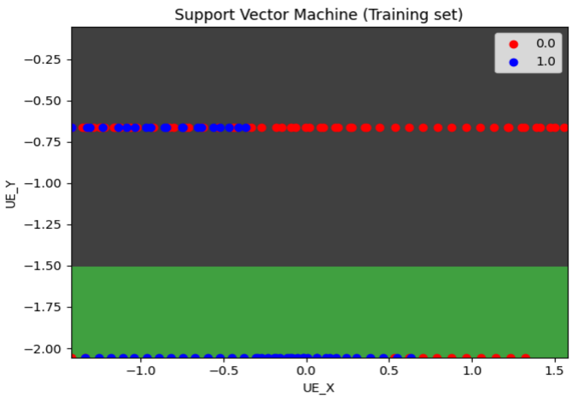

Fig 6. SVM training set for 400 examples

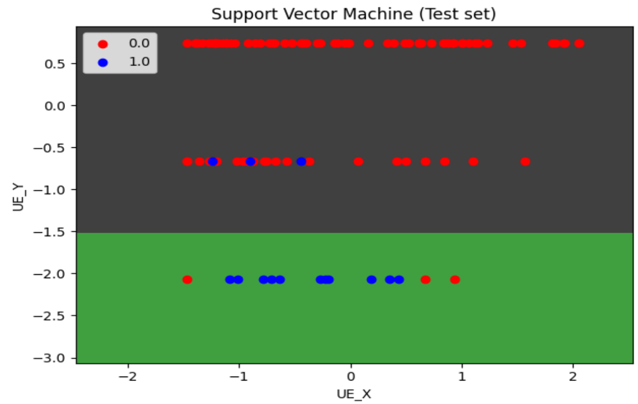

Fig 7(a). SVM testing 10 examples

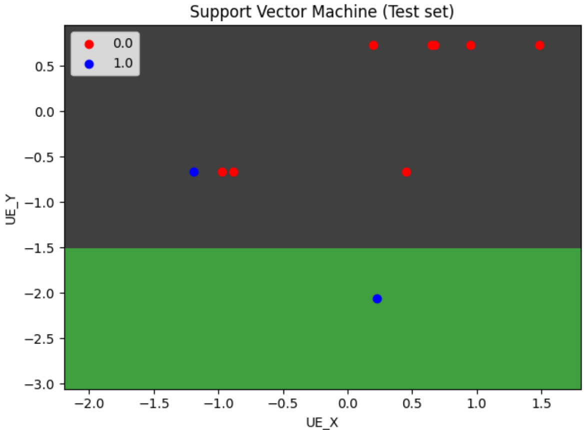

Fig 7(b). SVM testing 100 examples

Mobility prediction accuracy

Testing examples	400 training examples
10	90%
20	90%
30	86.07%
40	92.5%
50	94%
60	95%
70	92.8%
80	93.75%
90	93.3%
100	94%

The average prediction accuracy is 92.2%

Conclusion and Futher work plan

- We deployed a highway scenario and collected massive traffic data using SUMO for training the SVM model.
- By applying the SVM algorithm, we can predict which route the traffic user will take.
- The prediction accuracies for the specific scenario is considerably good.
- Mobility prediction will advantage for further handover (by applying mobility prediction, try to reduce the handover frequency and increase the continuity of communication service); resource allocation; detect traffic congestion conditions; route planning; vehicle dispatching,.ect.

References

[1] Shi, Rao, Yunfeng Peng, and Liang Zhang. ”A user mobility prediction method to reduce unnecessary handover for ultra dense network.” In 2019 28th Wireless and Optical Communications Conference (WOCC), pp. 1-5. IEEE, 2019.

[2] Liu, Qian, Gang Chuai, Jingrong Wang, and Jianping Pan. ”Proactive Mobility Management With Trajectory Prediction Based on Virtual Cells in Ultra-Dense Networks.” IEEE.

[3] https://github.com/mahesh147/Support-Vector-Machine.

Thanks for your attention.

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