PLAN of STUDY/RESEARCH for the academic year **2016/2017**

Name: **Elisa** **Surname:** **Iacomini**

CYCLE: **XXXII**

- Curriculum

[X] Mathematics for Engineering
[ ] Electromagnetics
[ ] Science of Materials

C	
R	
S	
Visto	

C: Courses

- Processi stocastici (6 cfu) - Prof. E. De Santis, Università "La Sapienza" dipartimento di Matematica
- Introduzione al Calcolo Parallelo con MPI e OpenMP (3 cfu) - presso CINECA
- Equazioni di Hamilton-Jacobi e problemi asintotici su network (6 cfu) - Prof. A. Siconolfi, Università "La Sapienza" dipartimento di Matematica.
- INdAM Workshop: Transport Modeling and Management - presso INdAM, Roma, Marzo 2017
- School on Uncertainty Quantification for Hyperbolic Equations and Related Topics - presso il GSSI, L'Aquila, aprile 2017
- 26th Summer School on Parallel Computing - presso CINECA, Roma, luglio 2017.

R: Research perspectives

In this project I deal with the study of numerical methods for traffic forecast on large networks, following the work done during my master thesis [4].
The main goal of the thesis was the sensitivity analysis of the LWR model for traffic flow on large networks, obtained by measuring the difference between solutions coming from different input parameters.
The LWR model was extended to networks using both the classical and the multi-path method, with global and local approaches, see [3, 6]. In order to compare different LWR solutions we used the Wasserstein distance. A large variety of numerical methods for computing this distance were compared, and each method was described with its advantages and disadvantages [2, 9, 11, 12]. The traffic uncertainty was evaluated for different initial data, different fundamental diagrams and different vehicle distributions at junctions.

Starting from these results, I plan to study the sensitivity of the traffic flow with respect to the green/red cycles of traffic lights, knowing that it has been already shown that a perturbation on a single junction causes consequences for the traffic flow on the whole network for long times. It

would be also reasonable to solve a control problem to find the optimal configuration of traffic lights of a small area, following the ideas in [1, 7, 8].
By means of the same techniques, I plan to minimize the emissions of vehicles' engines controlling the traffic lights and the network in general. This is obtained by complementing the LWR model with a model for the emissions from the exhaust pipe and a diffusion model describing how the pollution emission propagates in the air [5, 10].

S: Supervisor

Prof. Fabio Camilli

Dott. Emiliano Cristiani (IAC).

References

[1] B. Argall, E. Cheleshkin, J. M. Greenberg, C. Hinde, P. Lin, *A rigorous treatment of a follow-the-leader traffic model with traffic lights present*, SIAM Journal on Applied Mathematics, **63** (2002), 149-168.

[2] J. D. Benamou, Y. Brenier, *A computational fluid mechanics solution to the Monge- Kantorovich mass transfer problem*, Numerische Mathematik, **84** (2000), 375-393.

[3] M. Briani, E. Cristiani, *An easy-to-use algorithm for simulating traffic flow on networks: theoretical study*, Networks and Heterogeneous Media, **9** (2014), 519-552.

[4] M. Briani, E. Cristiani, E. Iacomini, *Sensitivity analysis of the LWR model for traffic forecast on large networks using Wasserstein distance*, Cornell University Library, arXiv:1608.00126 (2016).

[5] D. L. Buckeridge, R. Glazier, B. J. Harvey, M. Escobar, C. Amrhein, J. Frank, *Effect of Motor Vehicle Emissions on Respiratory Health in an Urban Area*, **3** (2002), 293-300.

[6] M. Garavello, B. Piccoli, Traffic Flows on Networks, AIMS Series on Applied Mathematics, USA, Volume 1, 2006.

[7] S. Göttlich, M. Herty, U. Ziegler, *Modeling and optimizing traffic light settings in road networks*, Computer & Operation Research, **55** (2015), 36-51.

[8] S. Göttlich, U. Ziegler, *Traffic light control: a case study*, Discrete and Continuous Dynamical Systems - Series S, **7** (2014), 483-501.

[9] J. M. Mazòn, J. D. Rossi, J. Toledo, *Optimal mass transport on metric graphs*, SIAM Journal Optimization, **25**, (2015), 1609-1632.

[10] S. Samaranayake, S. Glaser, D. Holstius, J. Monteil, K. Tracton, E. Seto, A. Bayen, *Real-Time Estimation of Pollution Emissions and Dispersion from Highway Traffic*, Computer-Aided Civil and Infrastucture Engineering, **29** (2014), 546-558.

[11] S. M. Sinha, Mathematical Programming: Theory and Methods, Elsevier Science & Technology Books, 2006.

[12] K. Treleaven, E. Frazzoli, *Computing Earth Mover's Distances on a road map with applications to one-way vehicle sharing*, American Control Conference (2014), 5420-5427.