Course 1.204 From Human Mobility to Transportation Networks
Fall 2014
1:00 - 2:30 PM, Room: 1-371

Instructor: Marta C. González, 1-153, Phone: 617-715-4140

Office Hours: Fridays 11-12 PM, after class or by appointment

Readings: PDFs of relevant book chapters and articles will be available on-line

Prerequisites:* 1.001 and 1.010 or any programming experience.

Course Outline:

Week 1: Opening
Sept 5:

- Course Goals and Motivation.
- Students presentation and expectations.
- Sample paper: Rythms of Social Interaction: Messaging with a Massive On-line Network.

Week 2: Extracting Behavior from Human Digital Traces
Sept 9:

- No Classes

Sept 11:

- Behavioral data identifying structure in routine

1. Article Behavioral Ecology and Sociobiology (Eagle et al)

Week 3: Extracting Behavior from Human Digital Traces
Sept 16:

- Matlab Exercises to determine Eigenbehaviours

Sept 18:

- Student Group Guided Activity: Review Eigenbehaviours

Week 4:
Sept 23:

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*or permission of instructor

- No Classes

Sept 25:

- Visualization Class

Week 5: Characterizing Urban Population Density
Sept 30:

- Modelling Urban Growth

Sept 2:

- Density of Population Exercises

1. Chapter 1, Ben-Avraham and Havlin. Diffusion and Reactions in Fractals and Disordered Systems
2. Michael Batty & Paul Longley (1994) Fractal Cities: A Geometry of Form and Function (Academic Press, San Diego, CA and London)
3. P. Ball, Why Society is a Complex Matter: Meeting Twenty-first Century Challenges with a New Kind of Science (Chpter 9)
4. Makse et. al, Modelling Urban Growth Patterns, *Nature*, **377**, (1995).

Week 6: Commuting
Oct 7:

- Student Group Guided Activity: Review of Density of Populations and Cities

Oct 9:

- Models of Commuting

1. Article PloS ONE (Simini et al.)

Week 7: Human Mobility
Oct 14:

- Student Group Guided Activity: Review Models of Commuting

Oct 16:

- Parsing Trajectories

1. Project Lachesis:Parsing and Modeling Location Histories.

Week 8: Human Mobility
Oct 21:

- Individual Mobility Patterns

Oct 23:

- Student Group Guided Activity: Review Individual Trajectories

1. Nature Article: Human Travel Patterns (Brochmann et al.)
2. Nature Article: Individual Travel Patterns (Gonzalez et al.)

Week 9: Human Mobility and Netwroks
Oct 28:

- Introduction to Networks

Oct 30:

- Student Group Guided Activity: Visualizing Trajectories

1. Processing.org documentation and examples.
2. D. J. Watts and S. H. Strogatz, **Collective dynamics of small-world networks**. *Nature*, **393**, 440-442, (1998).
3. A-L. Barabási and R. Albert, **Emergence of Scaling in Random Networks**. *Science*, **286**, 509-512, (1999).

Week 10: Networks Science
Nov 4:

- Networks Measures

Nov 6:

- Student Group Guided Activity: Review Network Models

1. D. J. Watts and S. H. Strogatz, **Collective dynamics of small-world networks**. *Nature*, **393**, 440-442, (1998).
2. A-L. Barabási and R. Albert, **Emergence of Scaling in Random Networks**. *Science*, **286**, 509-512, (1999).
3. Barabasi, On-line Network Science Book.

Week 11: Networks Science
Nov 13:

- Spatial Networks

- **Article EPJB "The Spatial Structures of Networks" (Gastner et al.)**
- **Review Physics Reports Spatial Networks (Marc Barthelemy)**

Week 12: Network Science
Nov 18:

- Project Plan Presentations

Nov 20: Spatial Networks

1. **Article EPJB "The Spatial Structures of Networks" (Gastner et al.)**
2. **Review Physics Reports Spatial Networks (Marc Barthelemy)**

Week 13: Networks Science
Nov 25:

- Structure of the Air Transportation Network

Nov 27:

- Thanksgiving Day

1. Article PNAS: Air Transportation Networks (Guimera et al.)
2. Article PNAS: Weighted Networks (Vespignani et al.)

Week 14: Networks Science
Dec 2:

- Structure of Urban Movements: Polycentric Activity and Entangled Hierarchical Flows

Dec 4:

- Wrap-up and Questions about the project presentations

1. Article PLoS ONE:Structure of Urban Movements: Polycentric Activity and Entangled Hierarchical Flows

Week 15: Projects Presentation
Dec 9:

- Final Projects due

Dec 11:

- Final Projects due

Evaluation

Assignments ($4x15\%$) 60%

1. HW1 Eigenbehaviours due 09/25
2. HW2 Density of Population 10/14
3. HW3 Human Travels, due 10/28
4. HW4 Networks Properties, due 11/13

Guided Activity 20%

1. Group 1 Eigenbehaviours, on 09/18
2. Group 2 Density of Population, on 10/07
3. Group 3 Commuting, on 10/14
4. Group 4 Human Trajectories, on 10/23
5. Group 5 Vizualizing Trajectories, on 10/30
6. Group 6 Networks Models, on 11/06

Project 20%

1. Project Plan Presentations, due 11/20 (%5)
2. Final presentation, due 12/09 & 12/11 (%5)
3. Final written report, due 12/07 (%10)

1. **Project Option Eigenbehaviors:** Jiang *et. al* Clustering Daily Patterns of Human Activities in the City.
2. **Project Option EigenBehaviors:** N. Eagle, A. Clauset, A. Pentland, and D. Lazer (2010), "Inferring friendship network structure by using mobile phone data", Proceedings of the National Academy of Sciences (PNAS)
3. **Project Option Individual Mobility:** Chaoming Song, et al., Limits of Predictability in Human Mobility, Science 327, 1018 (2010);
4. **Project Option Individual Mobility:** Nature Physics Article, Modelling the scaling properties of human mobility (Song et al.)
5. **Project Option Individual Mobility:** Unravelling Daily Mobility Motifs (Schneider et. al)
6. **Project Option Population Density:** Collective behavior in the spatial spreading of obesity (Makse et.al)
7. **Project Option Population Desity:** Laws of population growth (Stanley et. al)
8. **Project Option Commuting:** Article PNAS: Multiscale mobility networks and the spatial spreading of infectious diseases (Balcan et al.)
9. **Project Option Networks and Mobility:** Spatial Networks a Review (Marc Barthélémy)
10. **Project Option: Networks and Mobility:** Understanding metropolitan patterns of daily encounters (Axhausen et al.)
11. **Project Option: Networks and Mobility:** User Movement in Location-Based Social Networks (Leskovec et al.).
12. **Project Option Networks:** Finding and evaluating community structure in networks (M. E. J. Newman and M. Girvan)
13. **Project Option:** Review Physics Reports Spatial Networks (Marc Barthelemy)
14. **Project Option Networks:** Article PRL "Modeling Urban Street Patterns" (Barthélemy et al.)
15. **Project Option Networks:** Article PRL "Networks and Cities: An information Perspective" (Rosvall et al.)
16. **Project Option Networks:** Article PRL "Price of Anarchy in Transportation Networks" (Youn et al.)