# Urban Mobility Scaling

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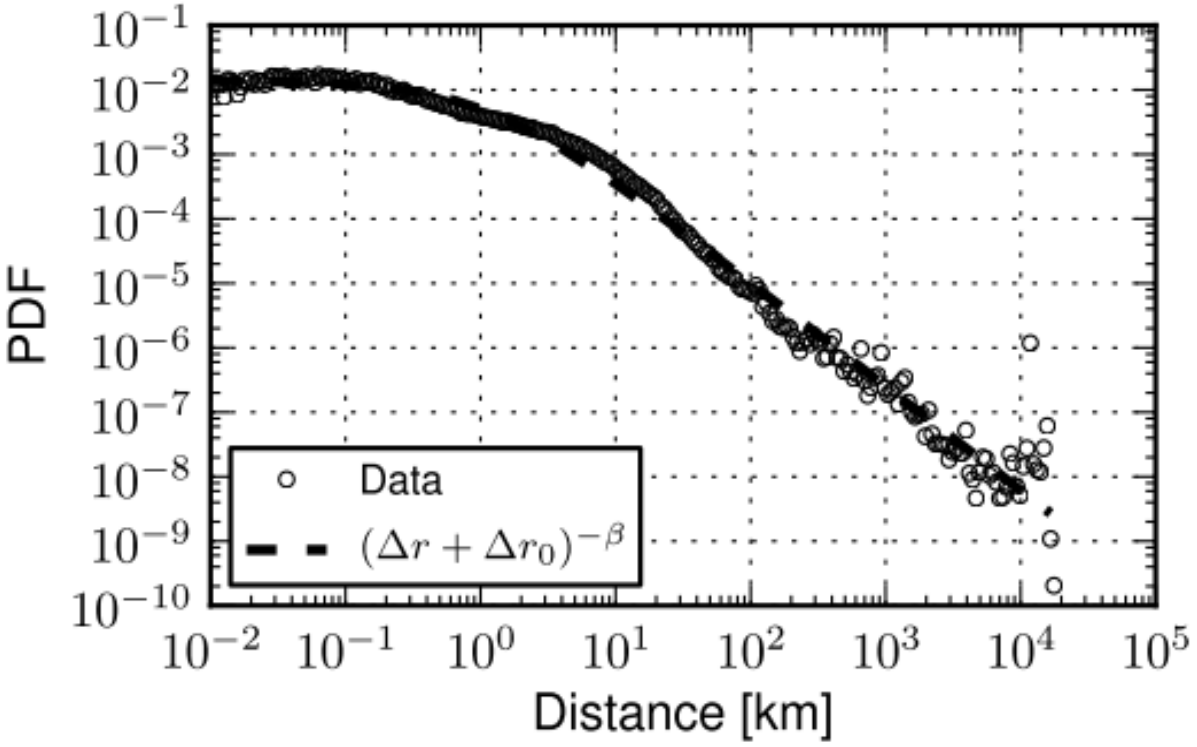
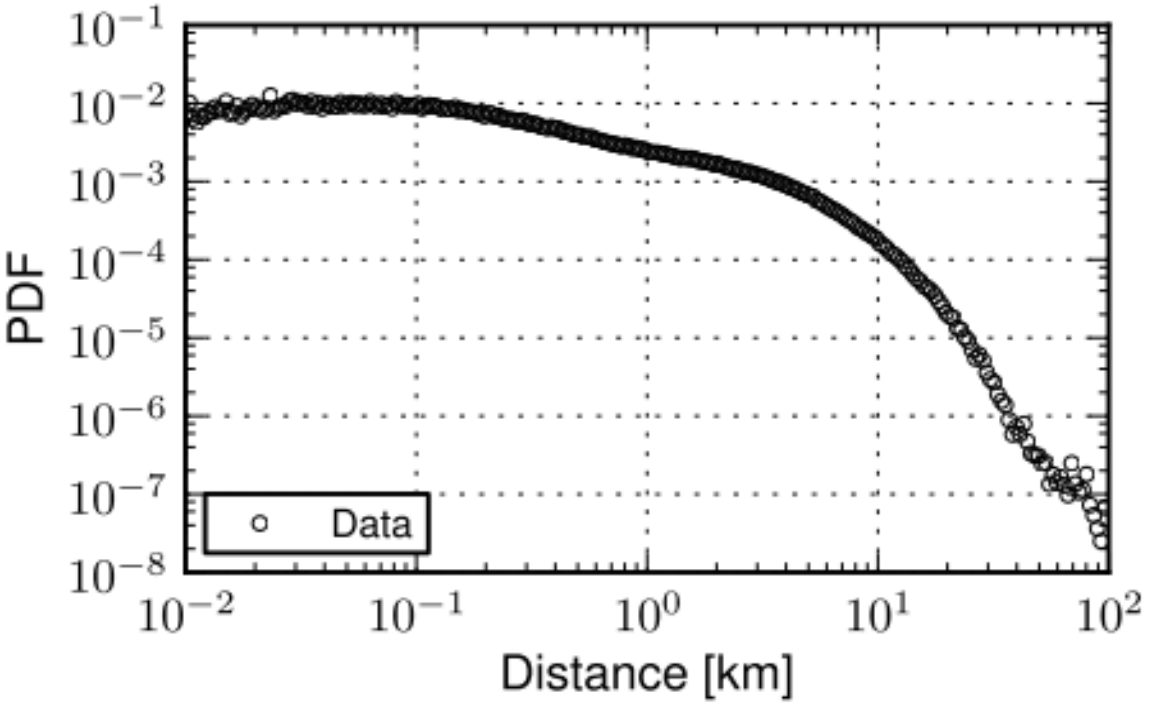
# Background




(Noulas 2012) found longer trip lengths well-described by power laws having exponent  beta = 1.5, claiming agreement with previous work (Gonzalez; Brockmann).

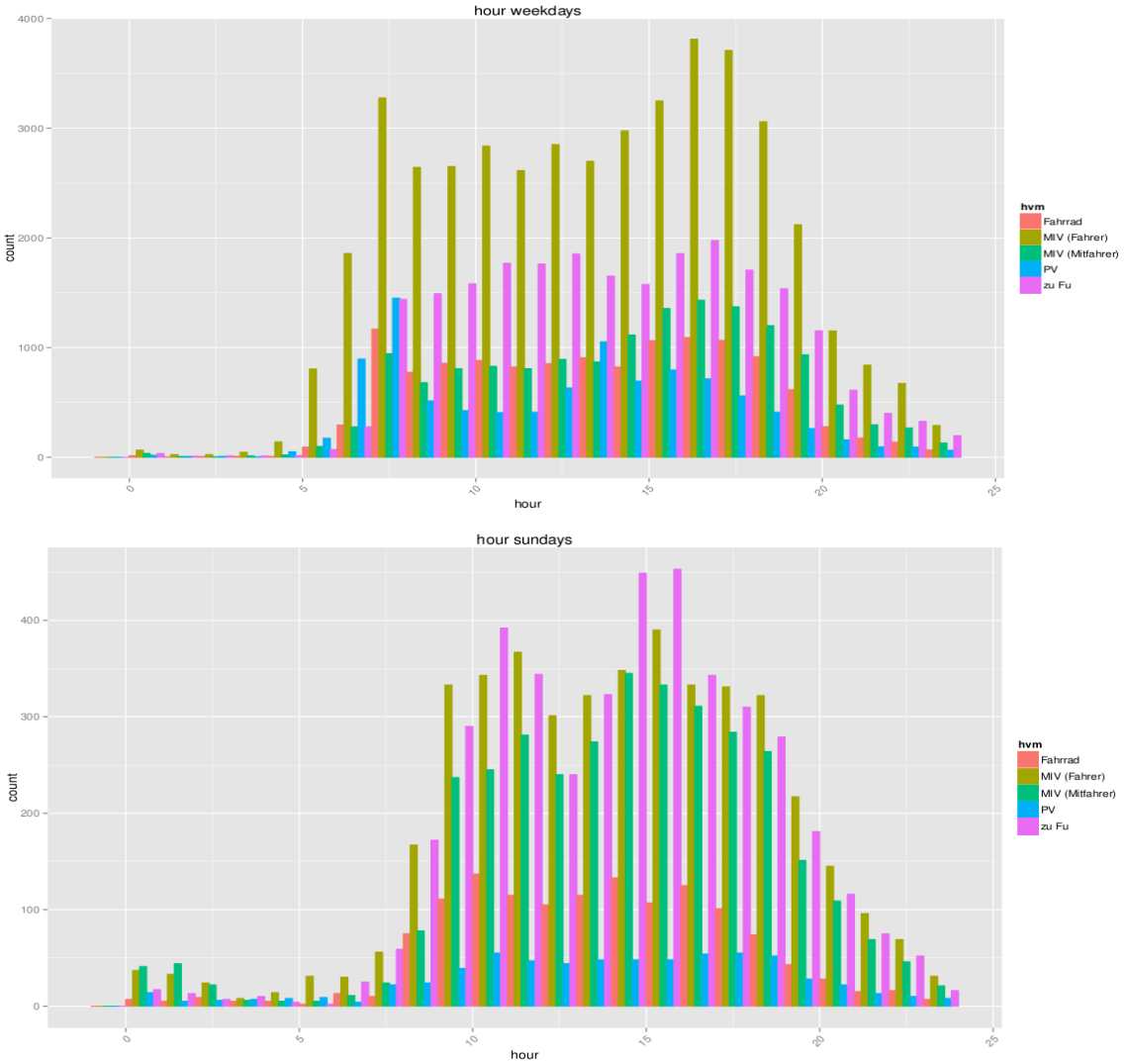
# Background




However,  were unable to fit trip lengths approaching 10^1 km, claiming that urban movements cannot be approximated by power law distributions or a physically relevant function...”

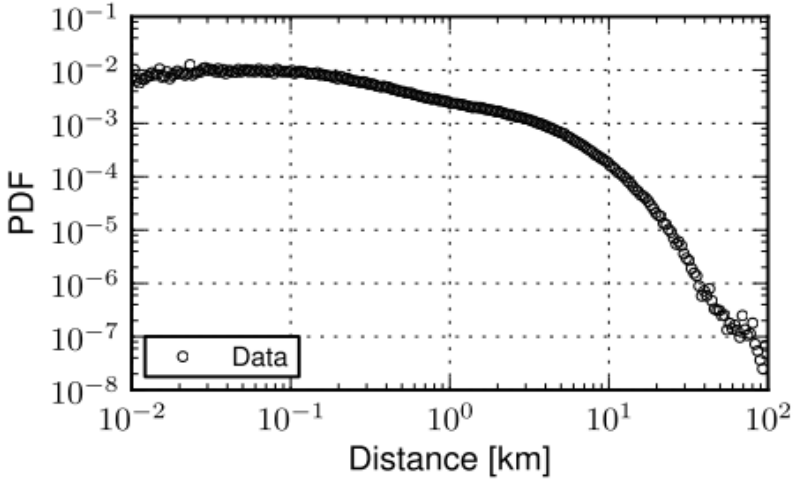
This then motivates them to look toward “intervening opportunity” arguments to describe urban mobility patterns.

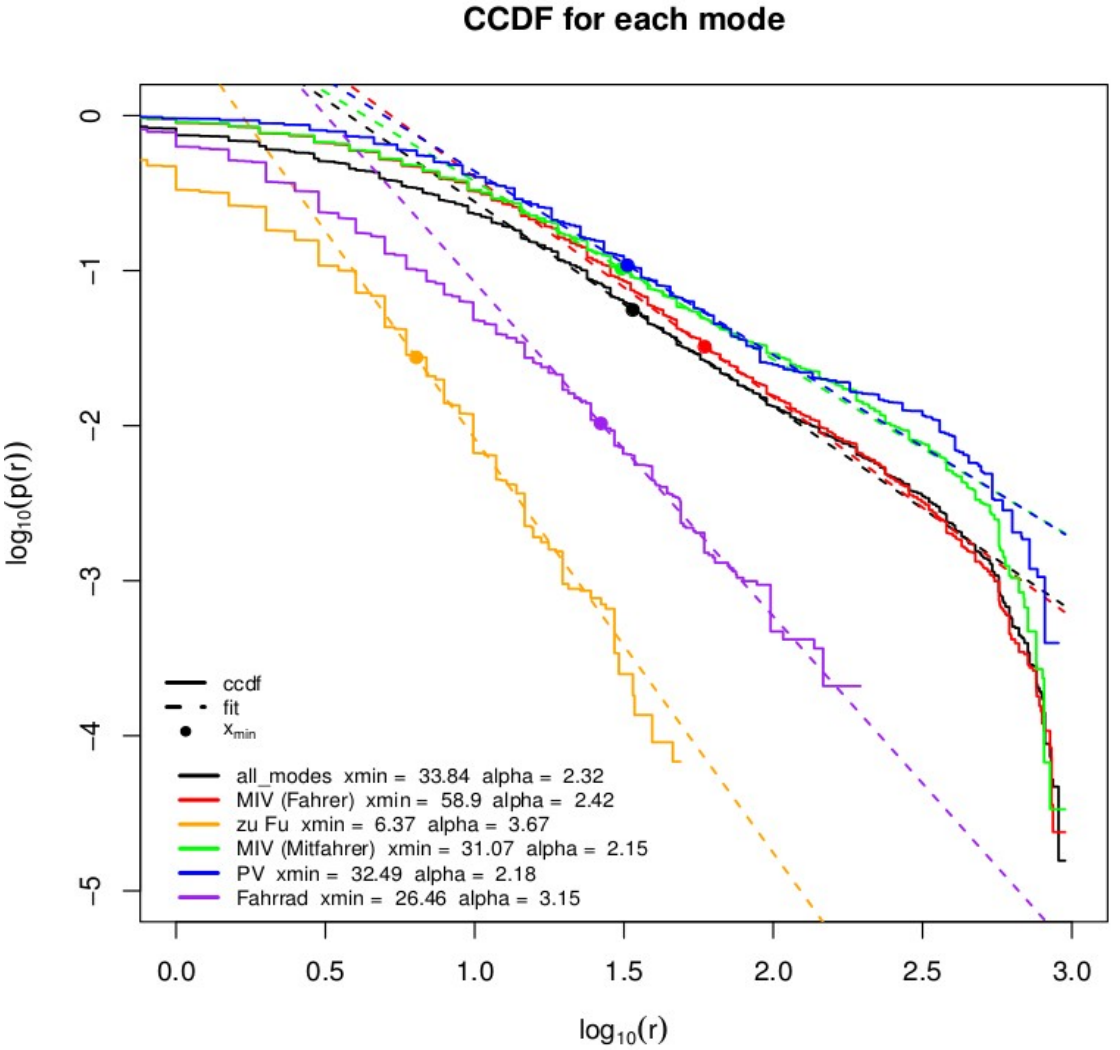
# Modes!




But... different modes seem to contribute *significantly* to mobility statistics. (also note apparent non-stationarity)

# Modes!



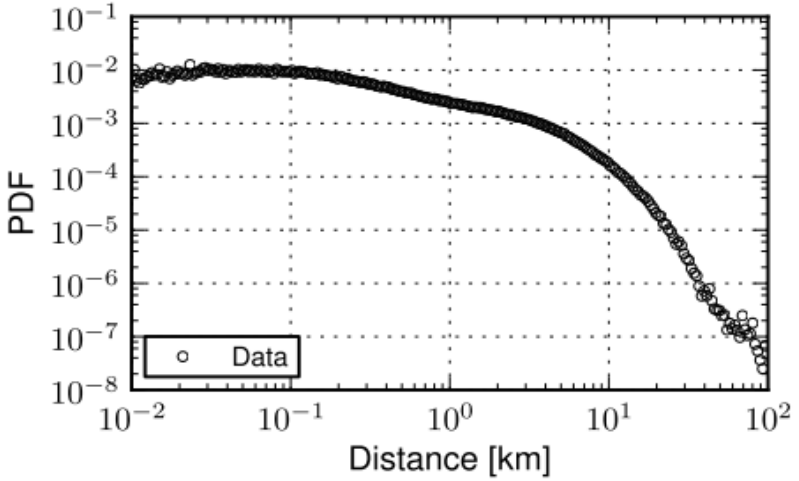



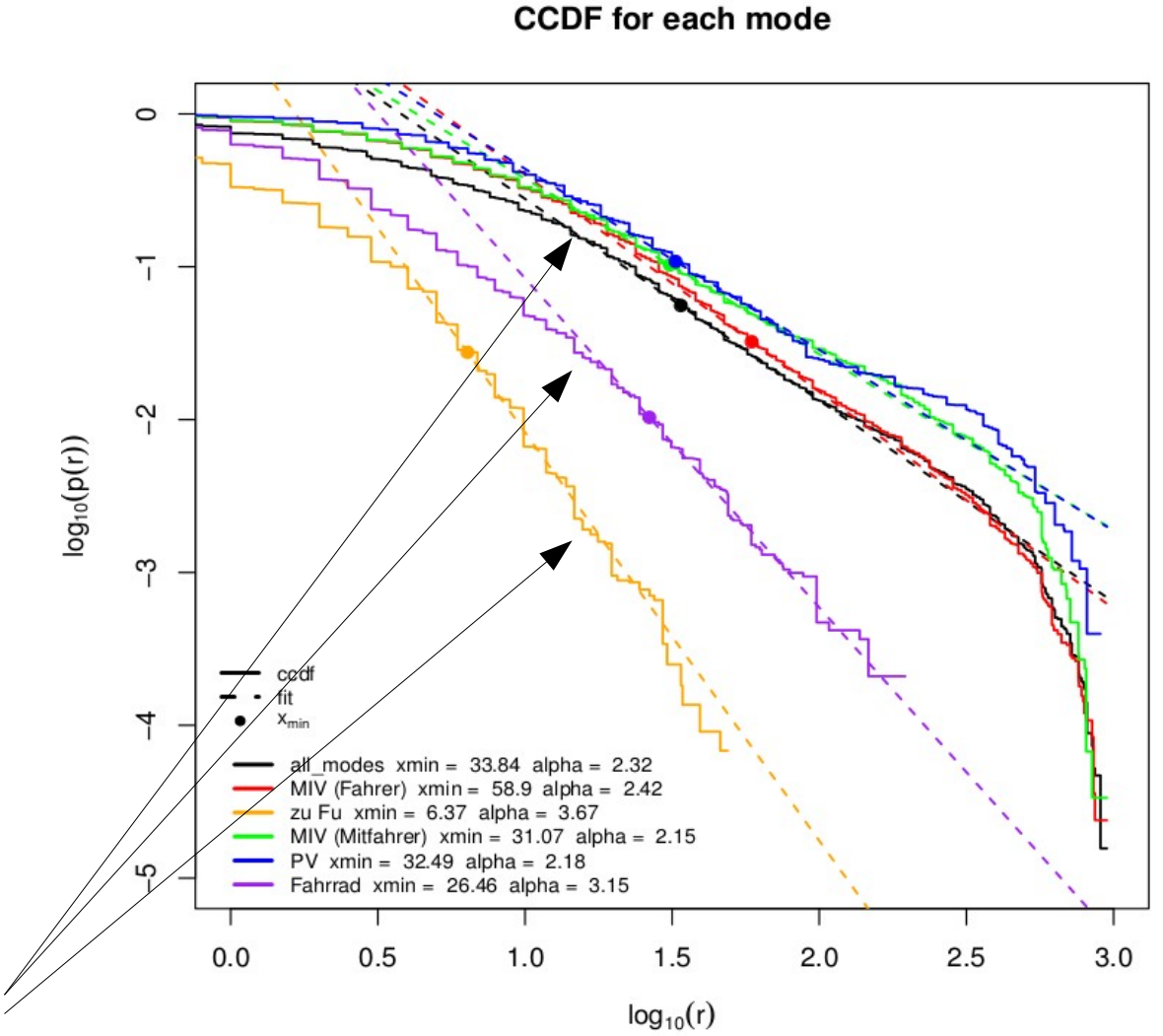

However, 'big data' mobility papers have not used *mode*, therefore confounding trips of modes having very different characteristics, leading to 'data acrobatics' to try to deal with urban-scale trips.

Here we have not even refined by city size or Bundesland!

(Note the fit to power laws are stastistically not good, we show them only to demonstrate the information contained in mode data, and look forward to fitting to other distributions.)

# Modes!

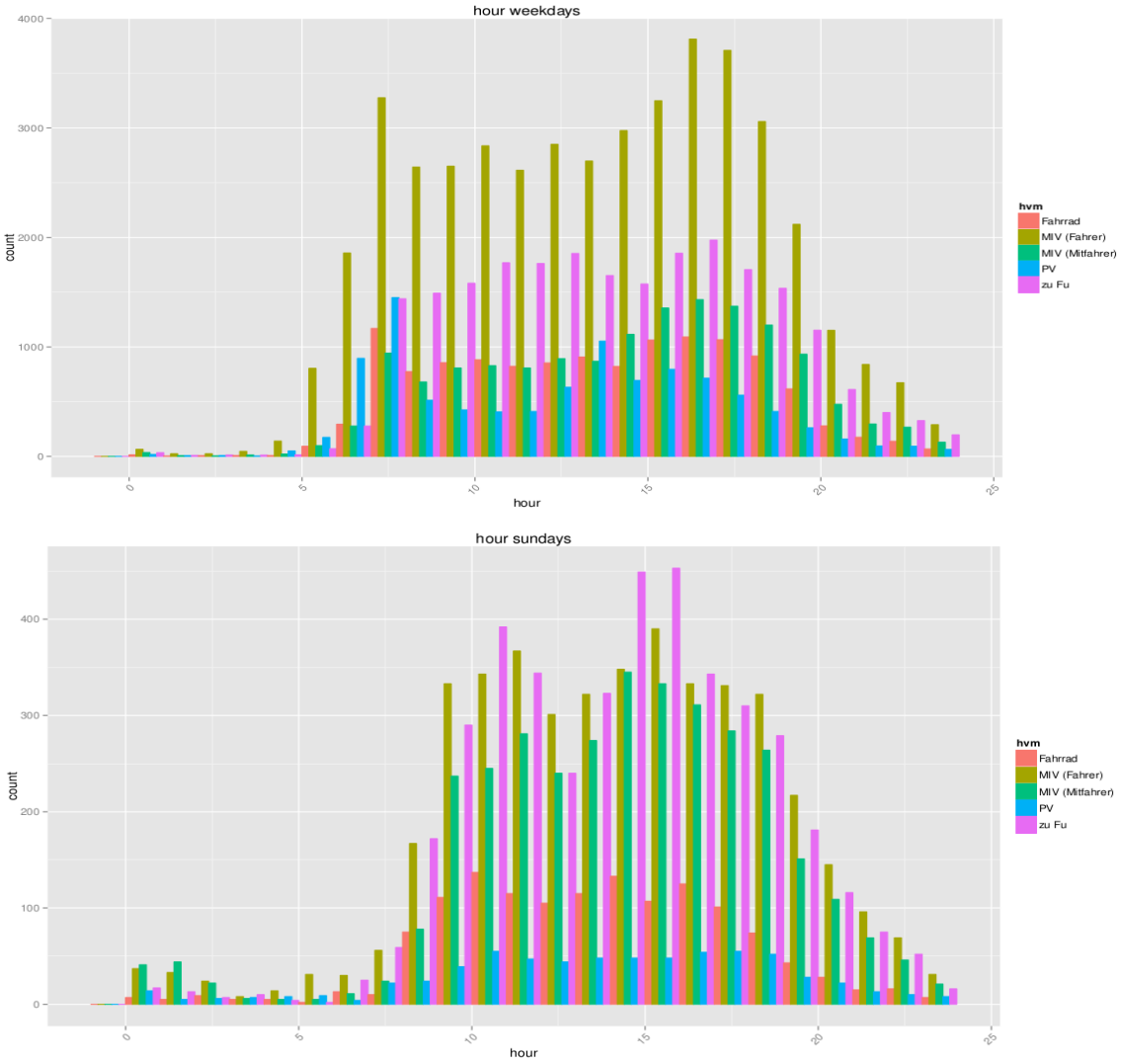



What do these ratios tell us?

- About 'place density'?
- About infrastructure?

# Modes!




Also note the apparent correlation of mode-share with trip purpose...

# Modes!

- So, we expect mode to enable significant 'big data' analysis of urban mobility scaling.
- Suddenly, time, energy, correlation length, social networks, and infrastructure seem to all be important characteristics distinguishing these 'short-range', 'low-energy' modes.
- System oscillation between stationary states or phases implies embodied of energy to make transition.
- Relationships between trip length and mode implies energy relationship worth studying (physical models?).
- Relationships between length/time and mode imply small-world relationships in infrastructure due to Marchetti's constant. (i.e. time constraint → choose 'long hops' using fast modes)
- Regarding Noulas' mention of place-density, note that the information-sampling characteristics of different modes seem to matter.  (e.g. the way we visit places over space by walking vs. driving)
- “Energy potential' of friendships and rideshare?

# Plan – Break down Mobility Statistics by Mode

- Use trip data from Mobility in Germany 2008 (Infas, DLR)
- Respond to Noulas' article that is unable to fit/characterise trip lengths on the urban scale
- Find stationary periods in data, fit trip length, trip duration, inter-trip time at these periods.
  - Compare sub-categories by city-size, Bundesland, **mode**.
  - Try to understand processes/effects that generate them.
  - Describe urban-scale trip lengths and durations.
  - Address place-density hypothesis.
- Further:
  - Mode-share trip length and relation to place density?
  - Diffusion? (c.f. Brockmann 2006; Gonzalez 2008)
  - Energy (modes give energy information)
  - Rideshare (Cici, 2013)

# References


- Noulas, A., et al., PloS one, 2012
- Gonzalez, M., et al., Nature, 2008
- Brockmann, D., et al., Nature, 2006
- Cici, B., et al., Hotmobile 2013