presentation notes

before introduction

- ever taken a graph course: street maps big motivational example
- i thought: give me big servers and 1000 years & i can build google maps!
- But: bus, tram and trains aren't waiting for you!
- go home now: takes longer, than going home in 10 minutes -> time changes something about the route that I take -> deeper: time changes the graph representation of city
- questions emerge
  - what exactly does time change?
  - how could we model this change?
  - do our normal algorithms work?

Motivation

clip school day

- show clip
- french researchers: put RFID on everybody in a school -> track proximity & social interactions
- only info:
  - who is teacher/student
  - proximity every x minutes
  - class mates
- visualization possible
- why interesting? INCREDICBLE story telling
- temporal graph rich in information
- studying this: insights in

Google maps

- what does google maps use temporal data for:
  - account for traffic
  - road closures
  - transit schedules
- e.g. Bus departs in 15 mins -> travel distance of bus depends on departure -> some connections might not exist at some points in time
- pretend for now: modified Dijkstra/A* is used for shortest path calculations (heuristic for A* takes both spatial as well as temporal information into account)

Distributed systems

- many applications: rely on large p2p (peer to peer) systems -> prone to errors

- availability of distributed resources -> e.g. server might fail at some point in time or have throttled bandwidth -> should adapt to changes with:
  - self organization
  - self healing
  - self adaption
- temporal reachability queries
- or: study some properties that hold under any circumstance (e.g. small temporal diameter, . . .)

for physical/chgemical model### for physical/chgemical modelss

- real-world temporal changes can be modeled with temporal graphs
- paper: how do chemicals react in dissolved organic matter !?
- no more questions xD

How to (visually) represent temporal graphs

- normal graphs: strong representation
- dilemma: how to show the third (temporal) dimension?
- research topic
- some ideas in pictures
  1. flow of time symbolized horizontal axis
  2. edge labels (more about that later)
  3. actual passage of time
  4. 3 dimensional drawing -> here: domain-specific

How to model temporal graphs

- static graph G = (V, E) where every edge is labeled with 0 or more natural numbers
- labels correspond to time steps (-> seconds, days, months; when each edge is available) -> more general: any descrete artificial measure of time

labeled and temporal graphs

- first: take a step back
- labeled graph $G = (V, E, \lambda)$
- in general case: labels can be anything
- NOW: temporal graphs -> no labels for vertices -> Z is set of natural numbers (2^N)
- why on one slide? -> closely related
- interpretation of labeled graph as temporal graph possible and vice versa
- e.g. proper edge-labeling
- looks trivial, but has deeper meaning!
- no 2 edges appear at same time
- exercise!!!

Transitivity of reachability in static graphs

- not my only proof, i swear :)
- no rigeous proof, but rather intuition
- please ignore that we haven't defined reachability yet

-> not transitive - what can we learn from this? - fundamental structural differences between static and temporal graphs - ideas and algorithms that rely on transitivity of reachability in static graphs might not work in temporal graphs

Second notation

- time edges
- exercise!!!

static expansion of graphs

- notion of storing separate graph per time step
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