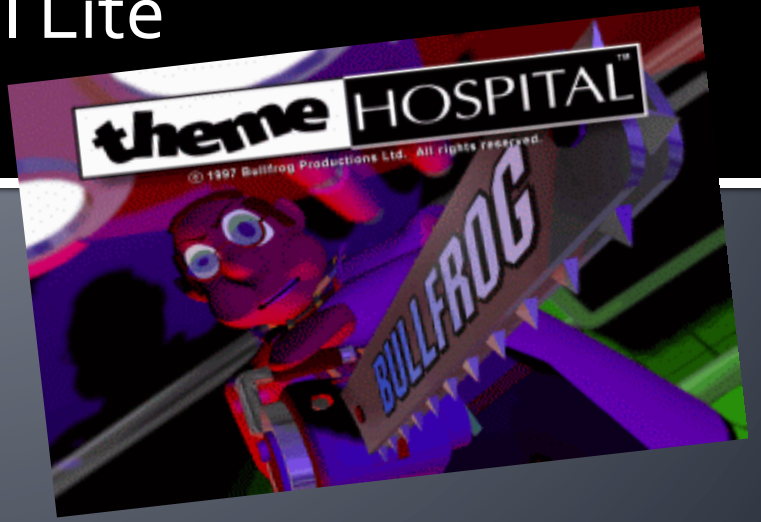
Faculty of Mathematics and Physics
Charles University in Prague
30th March 2015

C# Made Easy!

Programming II

Workshop 07 –Theme Hospital Lite
Part 3 – Code Architecture



Workshop 07
Outline

1. Test
2. Revisiting Workshop 06
3. Full Assignment Specification
   - The Simulation

Test 07

Test

Find the test here (no-ads):

http://goo.gl/02Zu03

Permanent link:

https://docs.google.com/forms/d/1-h9Bkfw1x9HzrBJKP-rJFeY0BqGJx5F7XL9J825JVak/viewform

Time for the test:

15 min

Topic

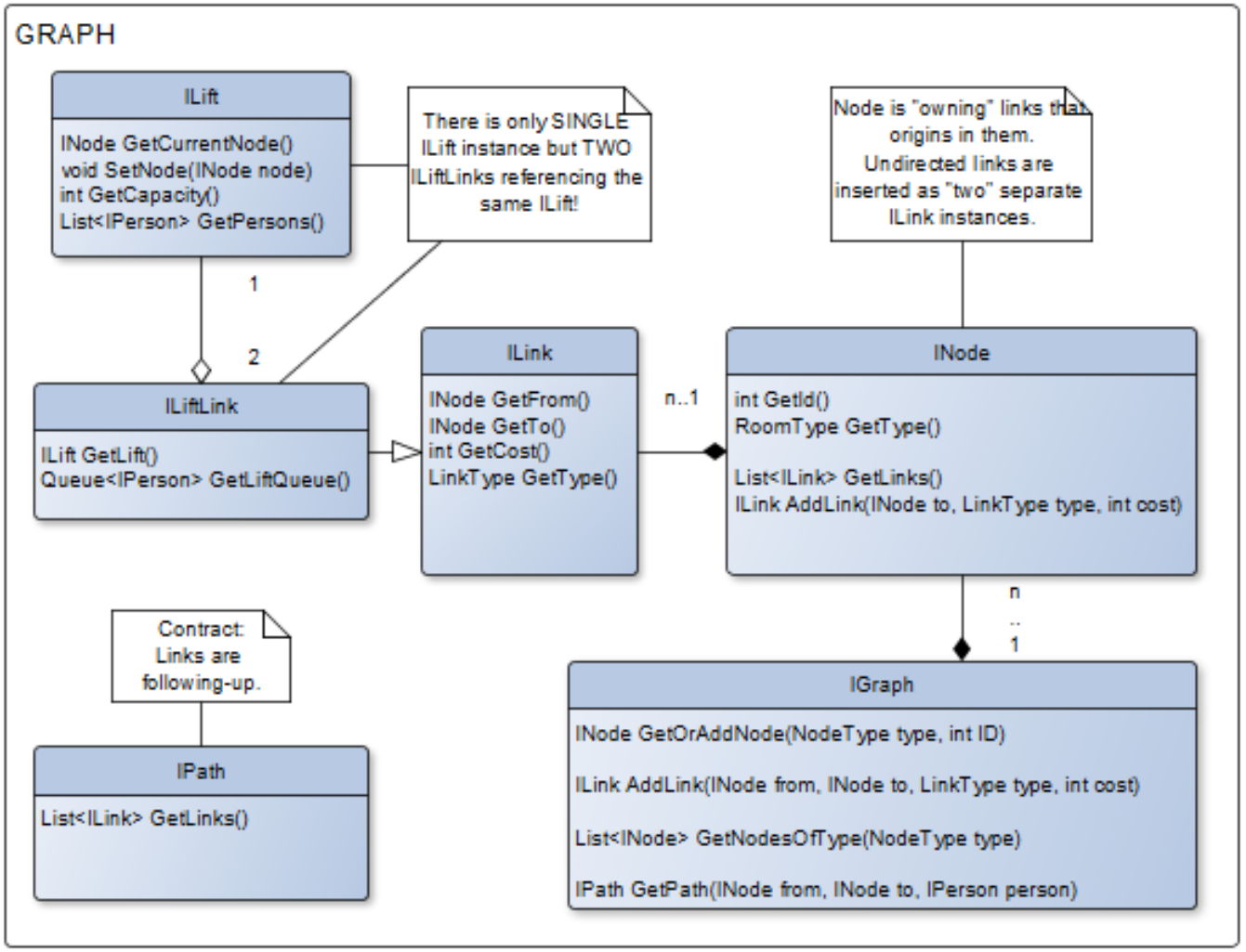
Let's talk about architecture

Architectural Requirements
What functionalities should be modelled?

- Let's write them down using plain language:
- Points of focus:
  - How to model LIFTs?
    - **http://goo.gl/eAyhbC**
    - https://docs.google.com/forms/d/11Cc5FoUpFthiBhK_HVEAWu_Vok5qx65G9pn1AB8mCJE/viewform
  - How to model PERSONs?
    - **http://goo.gl/l5Pj01**
    - https://docs.google.com/forms/d/1X3C4qAdFlvw3ras6S8z11MDqu8mvxKPsbpgYWnns-48/viewform

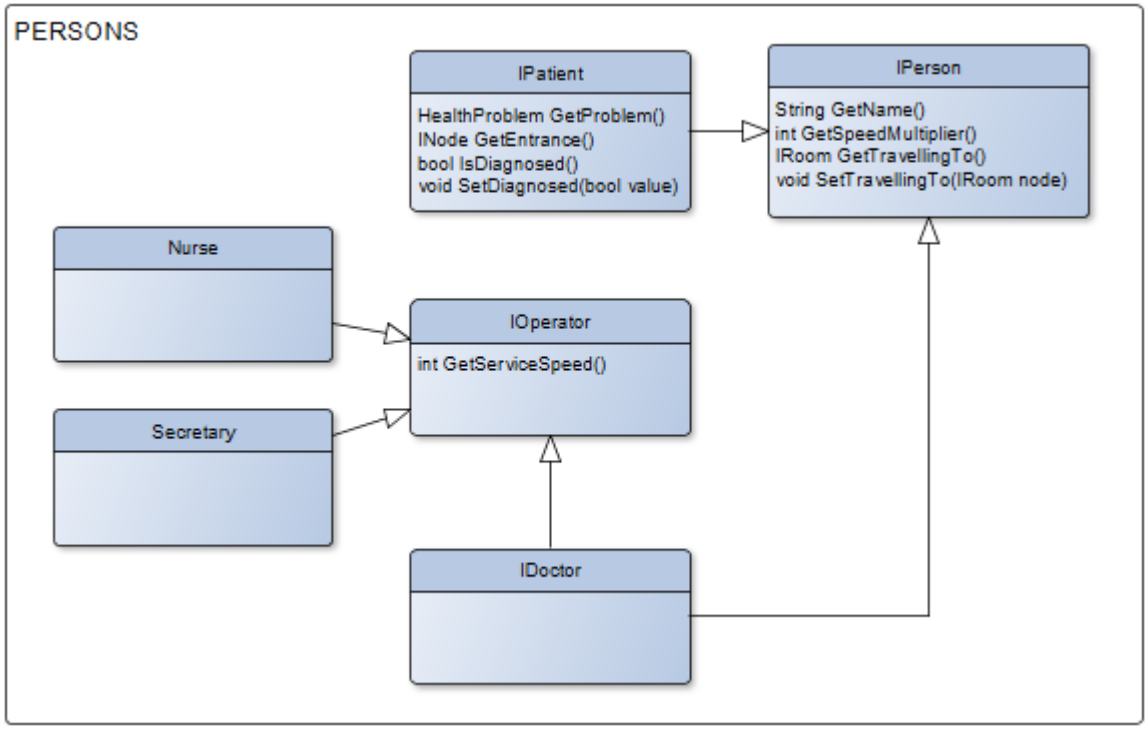
Architectural Requirements

LIFTs (Graph)



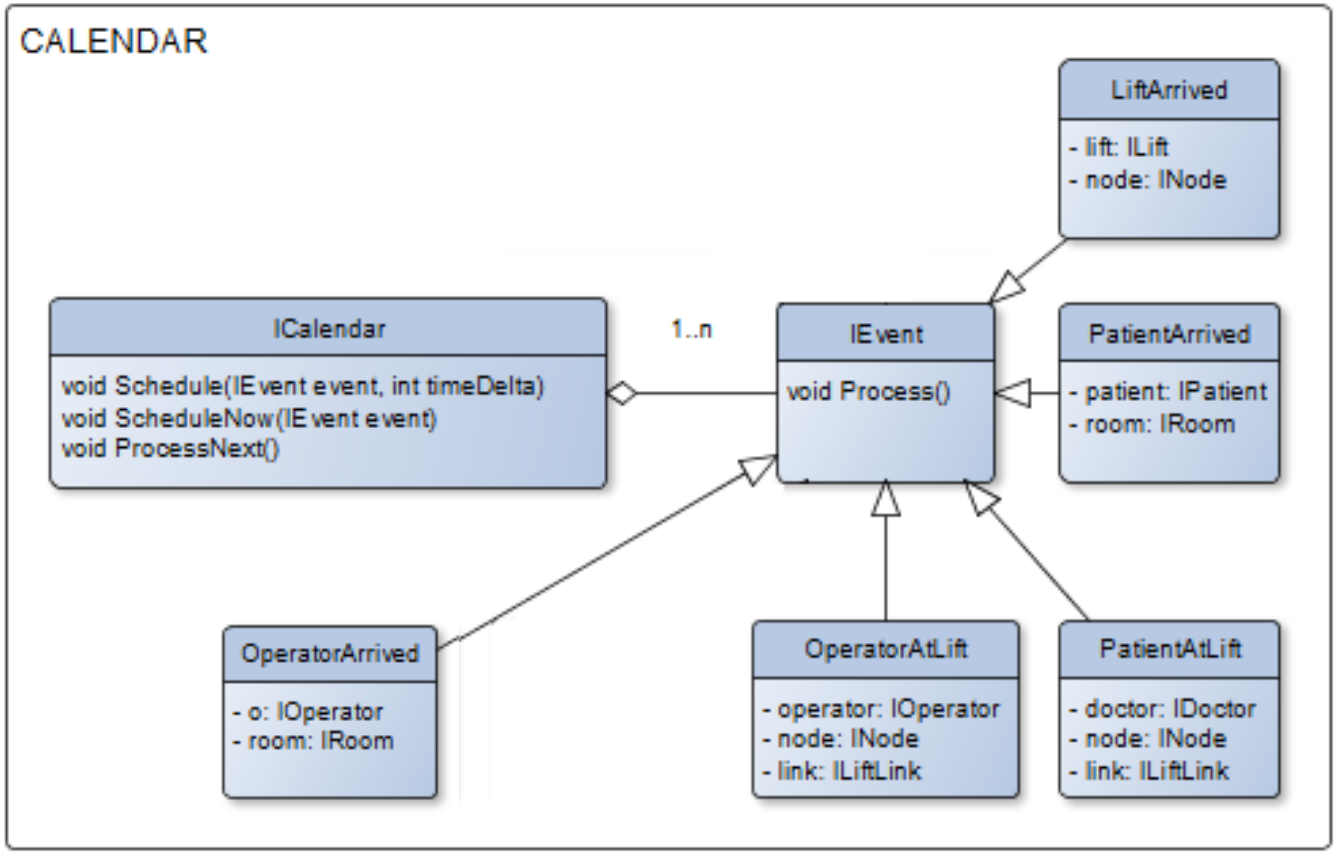
Architectural Requirements

Persons



Architectural Requirements

LIFTs (Events)

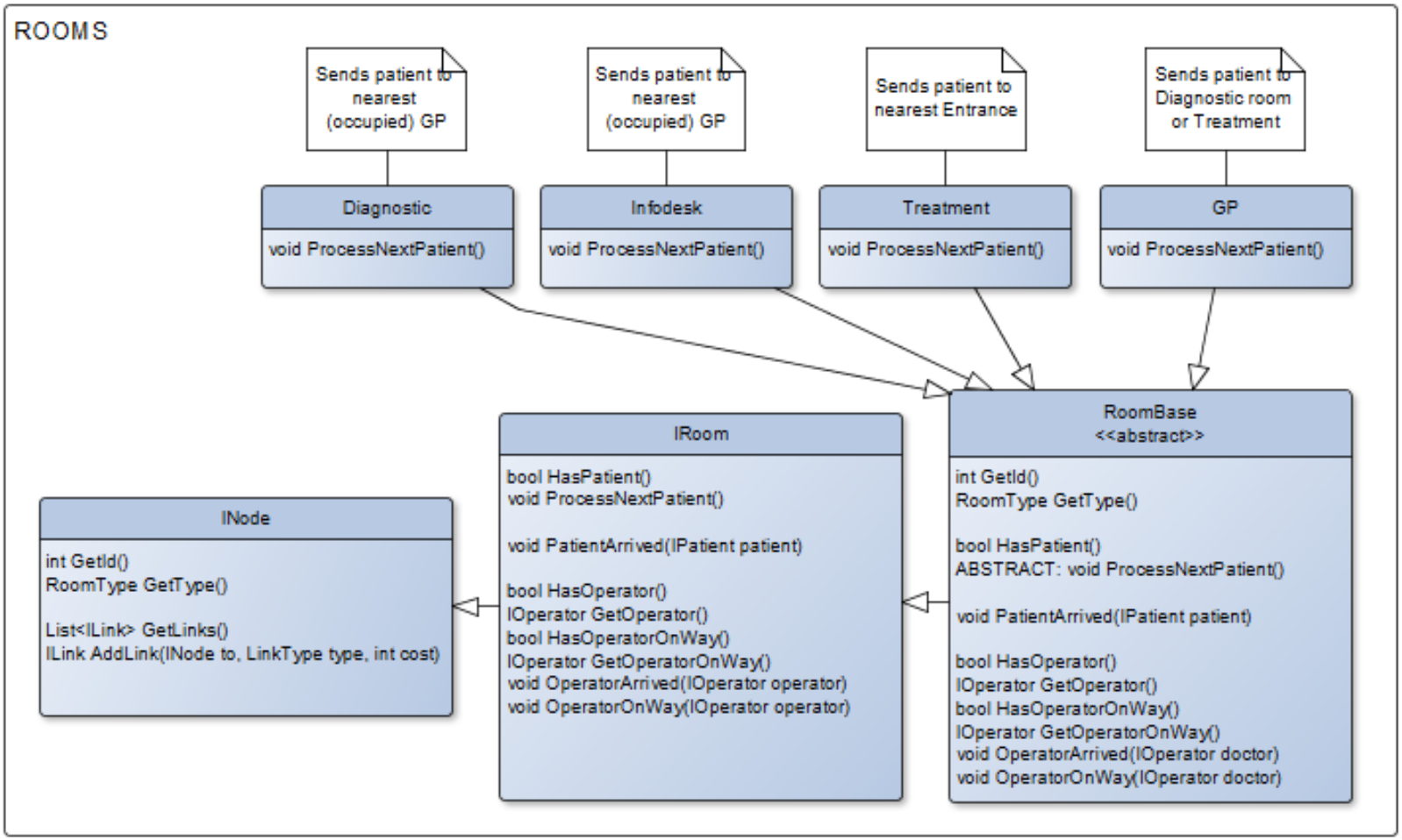


Architectural Requirements
What functionalities should be modelled?

- Points of focus:
  - How to model ROOMs?
    - **http://goo.gl/HksaVm**
    - https://docs.google.com/forms/d/1IH4GEzhBI9DYfCJXqVk2Ry9xsNboKb5Mk5M1D9clzUc/viewform
  - How to prepare for "experimentation with simulation"?
    - **http://goo.gl/gHJZzx**
    - https://docs.google.com/forms/d/1P8yvOozPqL2_Zs2KquV8hKwfmuP9RwWrs5FbosWwVHY/viewform

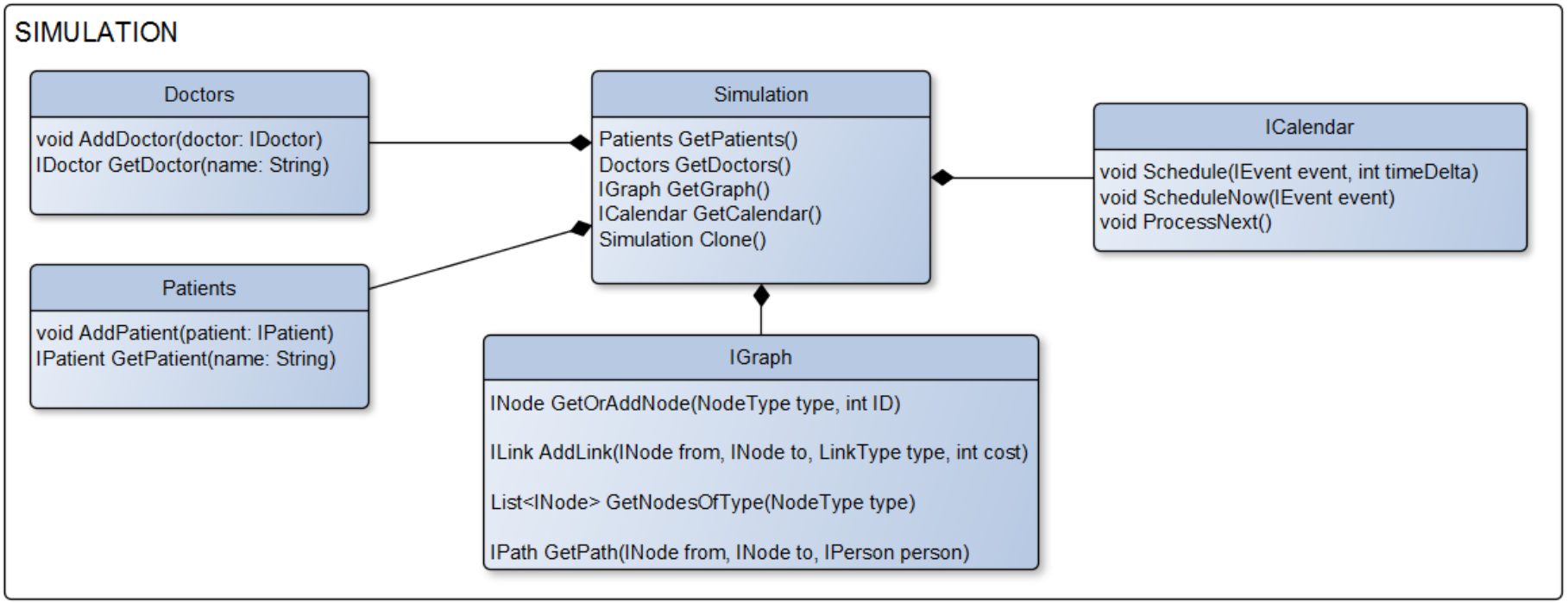
Architectural Requirements

ROOMs (Events)



Architectural Requirements

Simulation



Architectural Requirements
RESPONSEs

- Brainstorming results
  - How to model LIFTs?
    - https://docs.google.com/spreadsheets/d/1YekZx3sdRKBNNH5cfolGtyiexIDLIGWRrcpbna38xGM/edit?usp=sharing
  - How to model PERSONs?
    - https://docs.google.com/spreadsheets/d/1yfGLPMPSm6_rF5RBmNlBd52GE60Ctxt7y7WX8gwL5qQ/edit?usp=sharing
  - How to model ROOMs?
    - https://docs.google.com/spreadsheets/d/1cjoVvQ4ejuJ5HTkowEdNdHBKpS80wUg1ElyWrDRhfIk/edit?usp=sharing
  - How to prepare for "experimentation with simulation"?
    - https://docs.google.com/spreadsheets/d/1NI26yp1LRbJ9NVInxf5MXdK7J_WPepcBk5u30L8sDqg/edit?usp=sharing

Theme Hospital Lite

FULL ASSIGNMENT SPECIFICATION

1. Introduction
2. Graph & Rooms
3. Patients
4. Staff (Doctors, Nurses, Secretaries)
5. Navigation
6. The Simulation
7. Input specification
8. Output specification
9. Task summary

Theme Hospital Lite

1. Introduction

- Rooms / Places
  - Info Desk, GP, EEG, Sono, X-Ray, Psycho, Treatment
- Staff
  - Secretaries, Doctors, Nurses
- Various hospitals
  - Different topologies between rooms
  - Walking / Lift-riding
- Source of income
  - Patients
    - Various age (speed of walking)
    - Various health problems (need special type of diagnoses)
- Our objective
  - Maximize the profits!

=> Minimize the number of doctors that you need for a given day

Theme Hospital Lite

2. Graph & Rooms

- Hospital == Oriented graph with costs at edges
- Nodes are “Rooms/Places”
  - `ENTRANCE`
  - `INFODESK`
  - `GP`
  - `EEG`
  - `SONO`
  - `XRAY`
  - `PSYCHO`
  - `TREATMENT`
  - `NODE`
- There can be multiple places of a given room type!

Theme Hospital Lite

2. Graph & Rooms

- Hospital == Oriented graph with costs at edges
- Edges are of two types
  1. Corridors/Stairs
     - Oriented edges
     - Has a base cost in "seconds" (positive integer number)
     - Cost is modified by person's `WalkingMultiplier`!
  2. Lifts
     - Non-oriented edges (rides both ways)
     - Always runs between two nodes only
     - Has a maximum capacity
     - Has a base cost in "seconds" (positive integer number)

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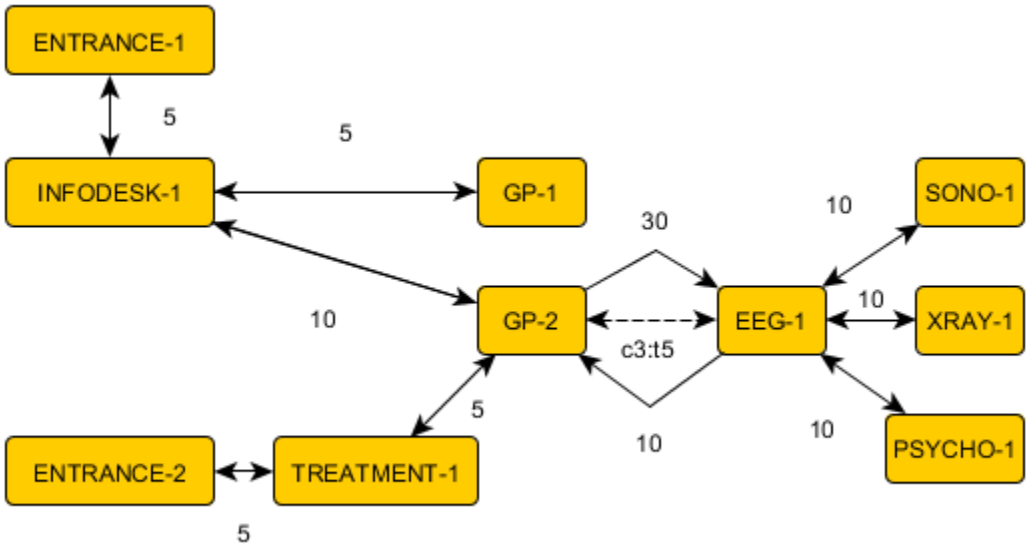
2. Graph & Rooms

- Example 1



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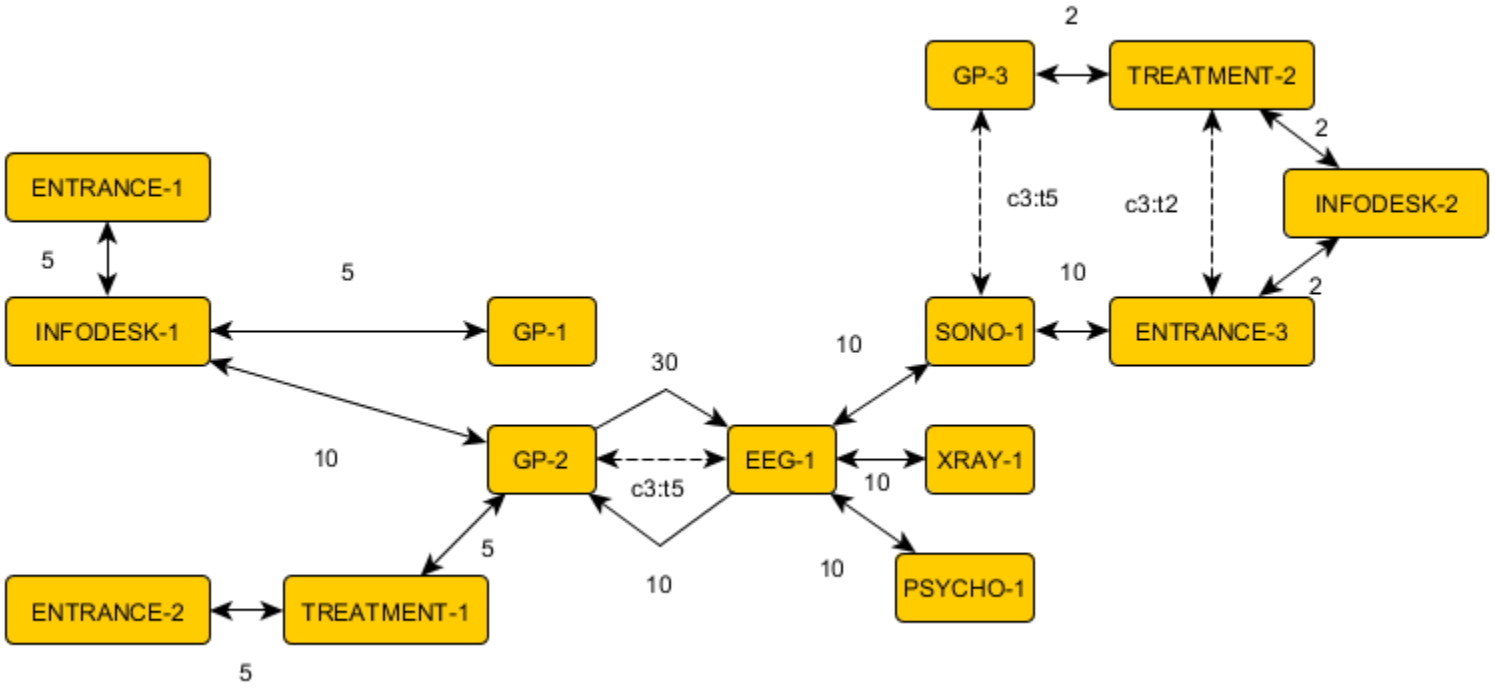
2. Graph & Rooms

- Example 2



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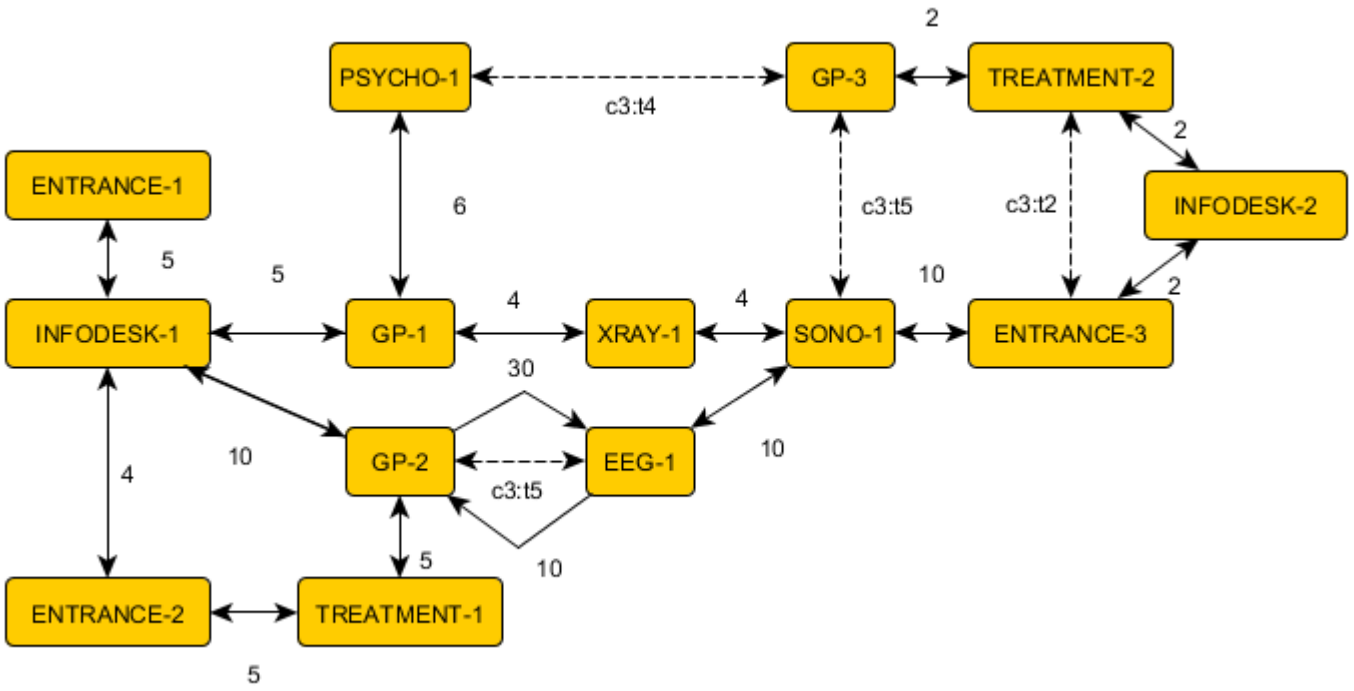
2. Graph & Rooms

- Example 3



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2. Graph & Rooms

- The link's cost is always in "seconds"
- So if lift's cost is "10" it means it travels the link in 10 seconds.
- If person with `speedMultiplier` 2 is travelling through "walk" link of cost `20`, then it means it will take them `2*20=40` seconds
- If person with `speedMultiplier` 2 is travelling through "lift" link of cost `20`, then it means it will take them `20` seconds (`speedMultiplier` does not affect lift-link traversal)

Assignment 5
3. Patients

- Each patient has own health problem / disease
- Each patient enters a hospital from a pre-set entrance (you cannot choose, which entrance the patient use to get into the hospital)
- The type of disease is treated as if "known in advance", it is a part of the input

- List of health problems / diseases:
  - CARDIAC
  - PNEUMONIA
  - HIP-PAIN
  - NEUROTIC

Assignment 5
3. Patients

- The patient's route through the hospital is "fixed" in a sense that they always travel through a "fixed" types of rooms.

  ENTRANCE (as defined)
  => INFODESK
  => GP
  => specific diagnoses room determined by patient's health problem
  => GP
  => TREATMENT
  => ENTRANCE (used as exit)

- Mapping between Health problems and Specific diagnostics:
  - CARDIAC -> EEG
  - PNEUMONIA -> XRAY
  - HIP-PAIN -> SONO
  - NEUROTIC -> PSYCHO

- E.g. when the patient has "PENUMONIA" it will travel to "XRAY" room

Assignment 5
4. Staff

- Every room (except node) requires some staff in order to be "functional"; each room may be occupied by single "operator" only
- There are 3 types of staff persons:
  - Doctors – GPs, specific diagnose rooms
  - Nurses - TREATMENTs
  - Secretaries – INFODESKs
- Only doctors are going to be simulated in detail, they will have to travel between their rooms
- Each doctor has own `speedMultiplier` specified
- Nurses and secretaries will be fixed in a concrete room for the whole day and every such room will have one

Assignment 5
4. Staff

- Every staff member will have `serviceSpeed`
- Person's `serviceSpeed` will determine how long it takes to "process" some patient
- As nurses and secretaries won't travel between TREATMENTs resp. INFODESKs, the serviceSpeed will be associated with concrete room
- The same does not apply to GPs and other diagnostic rooms as the time required to "process" a patient there will be determined by a doctor who will work in the room

Assignment 5
5. Navigation

- Only Patients and Doctors needs to be navigated around the hospital
- Patients always travels to the "nearest" room of some type
- Doctors travel between rooms only if some condition is met (typically when they are required somewhere and they are in the room that noone is using / is about to use)

Assignment 5

5. Navigation

- Patient always travels (gets send) to the "nearest" room of some type
- Patient's route always looks like this

  Patient enters the hospital via pre-set ENTRANCE
  -> Travels to the nearest INFODESK
  [waits there to be processed / gets processed]
  -> Travels to the nearest GP (regardless doctor's presence)
  [waits there to be processed / gets diagnosed]
  -> Travels to the nearest diagnose room for patient's health problem (regardless doctor's presence)
  [waits there to be processed / gets diagnosed]
  -> Travels to the nearest GP (regardless doctor's presence)
  [waits there to be proessed / receive final diagnose]
  -> Travels to the nearest TREATMENT
  [waits there to be treated / receive treatments]
  -> Exits via the nearest ENTRANCE

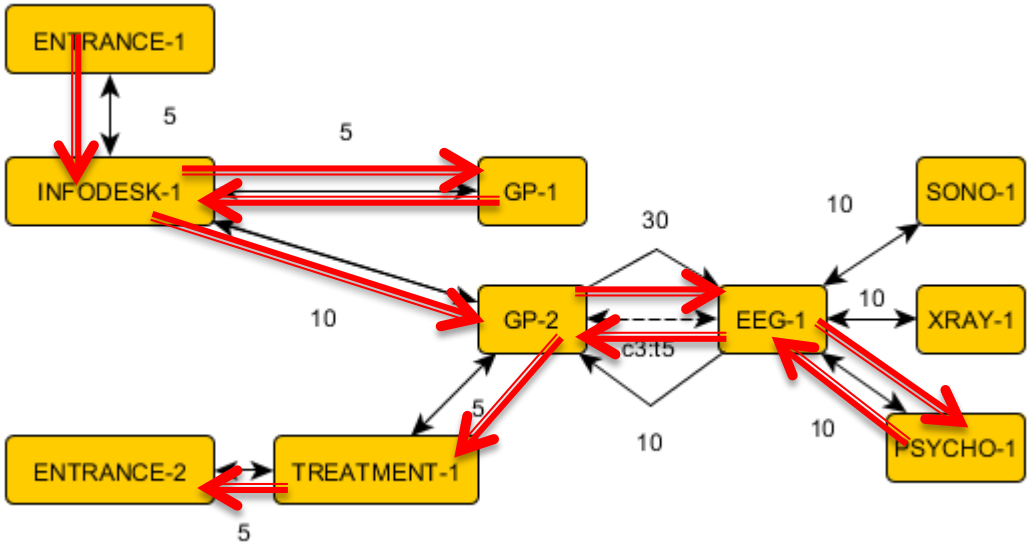
Mapping between health problems and specialized diagnostic rooms:

- CARDIAC -> EEG
- PNEUMONIA -> XRAY
- HIP-PAIN -> SONO
- NEUROTIC -> PSYCHO

Theme Hospital Lite

5. Navigation

- Example for a NEUROTIC Patient who is entering the hospital via ENTRANCE-1 and `speedMultiplier 2`



- Total path cost is:

`2*5+2*5+2*5+2*10+5+2*10+2*10+5+2*5+2*5 = 120`

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5. Navigation

- Beware of lifts! You must simulate them!
- Every lift has some `capacity` and operates between two nodes
- You have to track where the lift is
- And a person (patient or doctor) will have to wait for the lift if not available right now
- Note that a person will only wait if the lift's queue is not bigger than the lift's `capacity`

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6. The Simulation

- Initial state
  - Lifts are at their starting node as specified by the input
  - All nurses and secretaries are at their TREATMENTs, resp. INFODESKs
  - All doctors you wish to "use" in the current simulation run must be placed into some room (mind the requirement that there can be single "operator" within the room only)
  - The simulation begins at 8:00:00 (hospital opens at 8:00 AM)

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6. The Simulation

- Patients
  - Each task defines a set of patients that will visit the hospital during the day; each patient is associated with an arrival `time` and `entrance`, which they enter the hospital
  - They navigate the hospital as specified within (5)
  - They never dies due to their health problem

Theme Hospital Lite
6. The Simulation

- INFODESK / TREATMENT
  - Each info desk / treatment has a „service speed associated“, that is, how much time it needs to “tell the patient how to navigate around the hospital”, resp. “cure the patient”
  - This speed is fixed
  - There can be any number of patients waiting in the queue of an infodesk / treatment

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6. The Simulation

- GPs / Specific diagnose rooms
  - Similar to INFODESK/TREATMENT, but this time, the speed of service is determined by the doctor who is in the room
  - There can be any number of patients waiting in the queue of this room as well
  - Doctor will never leaves his/her room while there are patients in the queue or patients that are travelling to the room right now

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6. The Simulation

EVENT

- **Person arrives to the node which they need to use a "lift" from**
  - Following cases may occur:
  1. Lift is there => Person will immediately use it
  2. Lift is not there & Waiting queue is not full & Lift is not riding => Lift gets "called" and starts to travel to the node the person is at, the person will wait for the lift to arrive
  3. Lift is not there & Is riding & Waiting queue (of lift capacity length) is not full => Person will wait for the lift to arrive
  4. Lift is not there & Waiting queue is full => Person will take detour

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6. The Simulation

EVENT

- **INFODESK / TREATMENT is not working and has a patient in a queue**
  - Next patient gets "processed" at the speed of the room
  - After it gets "processed" it is decided where it will navigate next (the nearest room) and the patient begins to navigate to the next room

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6. The Simulation

EVENT

- **GP / Diagnose room has a doctor, who is not working and there is a patient in a queue**
  - Next patient gets "processed" at the speed of the doctor
  - After it gets "processed" it is decided where it will navigate next (the nearest room) and the patient begins to navigate to the next room

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6. The Simulation

EVENT

- **Doctor finished the last patient within the queue of his/her GP room and there is no patient on their way to doctor's room**
  - Two cases may arise
    1. There is no other room that has a patient trying to "use" or navigating to in order to "use" it => doctor stays in his/her current GP room
    2. There is such a room and
       - 2.1 There is a doctor who is navigating there => doctor ignores it and stays
       - 2.2 There is no doctor travelling there =>
         - 2.2.1 And this doctor is the nearest one who can leave his/her GP => s/he will travel there
         - 2.2.2 Is not the nearest one => stays in his/her current GP room

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6. The Simulation

EVENT

- **Doctor finished the last patient within the queue of his/her Specific diagnostic room and there is no patient on their way to doctor's room**
  - Whenever there is no queue, two cases may arrise
    1. There is no other room that has a patient trying to "use" or navigating to in order to "use" it => doctor goes to the nearest unoccupied GP
    2. There is such a room and
       - 2.1 There is a doctor who is navigating there => doctor ignores it and stays
       - 2.2 There is no doctor travelling there =>
         - 2.2.1 And this doctor is the nearest one who can leave his/her GP => s/he will travel there
         - 2.2.2 Is not the nearest one => stays in his/her current GP room

Theme Hospital Lite

6. The Simulation

EVENT

- **Patient starts to navigate to the unoccupied room and there is a doctor who is neither working nor has a patient on route**
  - Nearest such a doctor will start to travel to this room

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7. Input Specification

- Now you will have to simulate LIFTs!
- This means that you have to know where lift "begins"

Lift link: `[ <lift-start-left-link> | <lift-start-right-link> ]`

```
lift-start-left-link: 'L<--(lift:c' <capacity>
  ':t'<cost> ')-->'

lift-start-right-link: '<--(lift:c' <capacity>
  ':t'<cost> ')-->L'
```

Theme Hospital Lite

7. Input Specification

INPUT: <int> '\n' [<node> ' ' <link> ' ' <node> '\n']+ <int> '\n' [<patient> '\n']+ <int> '\n' <int> [<infodesk/treatment> '\n']+ '\n' <int> [<doctor> '\n']+ '\n'

<node>: <node-type> '-' <id>

<node-type>: ['ENTRANCE' | 'INFODESK' | 'GP' | 'EEG' | 'SONO' | 'XRAY' | 'PSYCHO' | 'TREATMENT' | 'NODE']

<id>: <int>

<int>: [1-9][0-9]{0,1}

<link>: [<walk-link> | <lift-link>]

<walk-link>: [<non-oriented-walk-link> | <oriented-walk-link>]

<non-oriented-walk-link>: '<--(walk:' <int> ')-->'

<oriented-walk-link>: '--(walk:' <cost> ')-->'

<lift-link>: [<lift-starts-left-link> | <lift-starts-right-link>]

<lift-starts-left-link>: 'L<--(lift:c' <capacity> ':t'<cost> ')-->'

<lift-starts-right-link>: '<--(lift:c' <capacity> ':t'<cost> ')-->L'

<cost>: <int>

<capacity>: <int>

Theme Hospital Lite

7. Input Specification

INPUT: <int> '\n' [<node> ' ' <link> ' ' <node> '\n']+ <int> '\n' [<patient> '\n']+ <int> '\n' <int> [<infodesk/treatment> '\n']+ '\n' <int> [<doctor> '\n']+ '\n'

<patient>: <name> ':' <speed-multiplier> ':' <health-problem> ':' <node> ':' <time>

<name>: [A-Z][a-zA-Z]+

<speed-multiplier>: <int>

<health-problem>: ['CARDIAC' | 'PNEUMONIA' | 'HIP-PAIN' | 'NEUROTIC']

<time>: [0-2][0-9] ':' [0-2][0-9] ':' [0-2][0-9]

Theme Hospital Lite

7. Input Specification

INPUT: <int> '\n' [<node> ' ' <link> ' ' <node> '\n']+
<int> '\n' [<patient> '\n']+ <int> '\n' <int> [
<infodesk/treatment> '\n']+ '\n' <int> [<doctor>
'\n']+ '\n'

<infodesk/treatment>: <node> ':' <service-time>

<service-time>: <int>

<doctor>: <name> ':' <speed-multiplier> ':'
<service-time>

Theme Hospital Lite

8. Output Specification

Output:

Which doctors are you going to use and in which rooms they should begin in + when the last patient leaves the hospital (reaches his/her exit ENTRANCE node).

The hospital opens at 08:00:00.

The hospital closes at 18:00:00.

[<doctor-start> '\n']+ <finishing-time>

<doctor-start>: <name> ':' <node>

<finishing-time>: <time>

Theme Hospital Lite

9. Task summary

- You are given
  - A hospital
  - Patients
  - Pool of doctors
- You have to come up with a solution that consists of
  - Which doctors are you going to use for a day
  - Which rooms they will start in (at 8:00:00)
- Such that
  - All patients get treated and exit the hospital by the hospital's closing time (18:00:00)
- Try to come up with the best solution
  - That is to minimize number of doctors you need + finishing the day as fast as possible
  - You can score bonus points if you come up with one of the best solutions! (up to +10)

Assignment 7
Send me an email

- Email: jakub.gemrot@gmail.com
- Subject: **Programming II – 2015 – Assignment 07**
- Zip up the whole project and send it
- You WILL NOT find the assignment in CoDex!
- Deadline: **12.4.2015 23:59**

Questions?
I sense a soul in search of answers…

- Sadly, I do not own the patent for perfection (and will never do)
- In case of doubts about the assignment or some other problems don't hesitate to contact me!
  - Jakub Gemrot
    - gemrot@gamedev.cuni.cz