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A Deterministic QoE Formalization of User Satisfaction Demands (DQX)

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CSG Overview
Quality-of-Experience Decompiling
Example
Toys QoE Prediction (?)

CSG
Communication Systems Group

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Background

- Studies
  - Diploma in Physics (UOC)
  - MSc in Computer Science (AUEB)
  - PhD in informatics (UZH)
    - Mobile termination service monopoly liberation
    - Quality-of-Experience (QoE)
- Work experience
  - Hellenic Armed Forces
  - Web Marketing Services
  - Physics teacher
  - Jr. Researcher (UZH)

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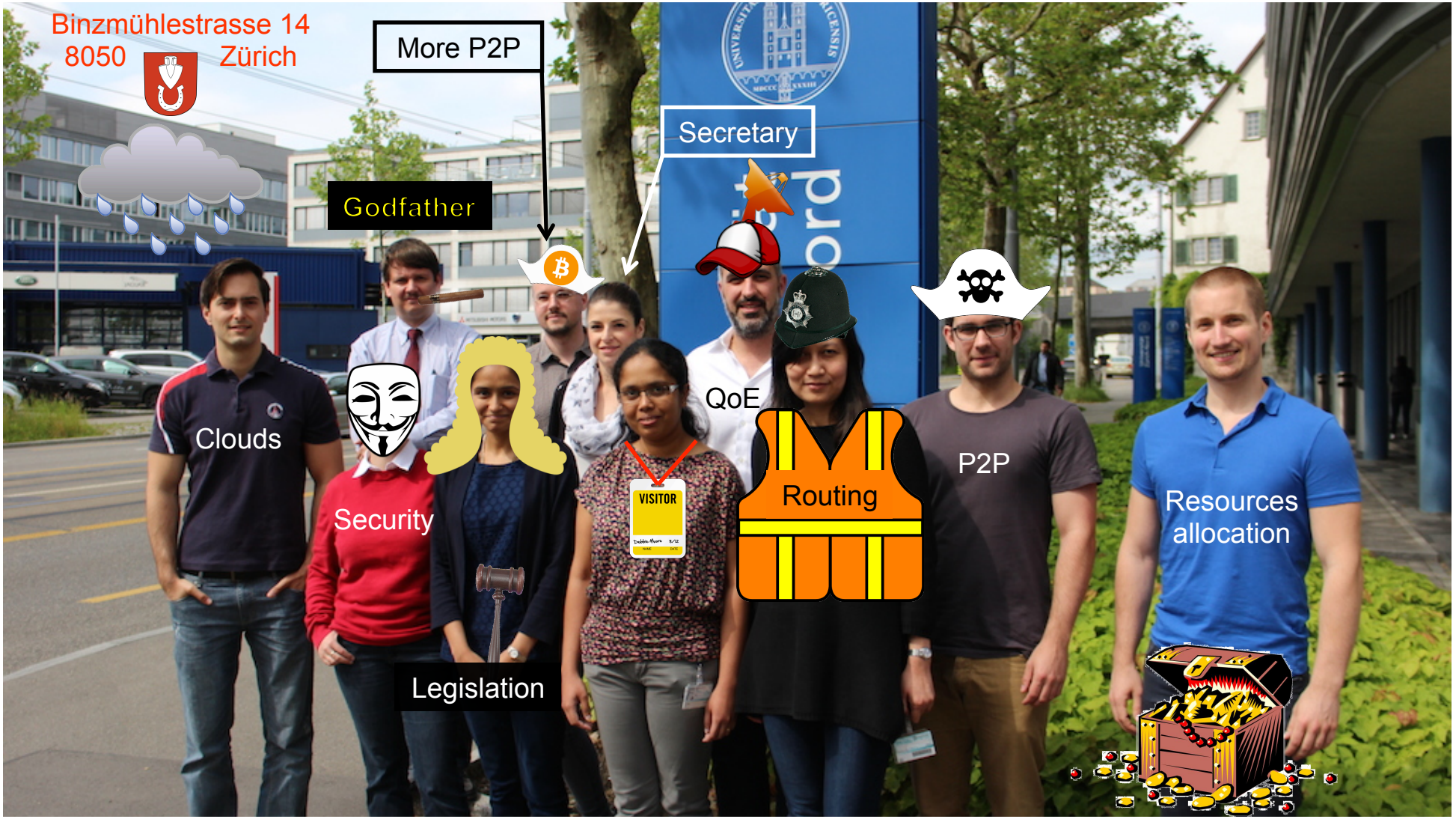
The CSG@IFI UZH



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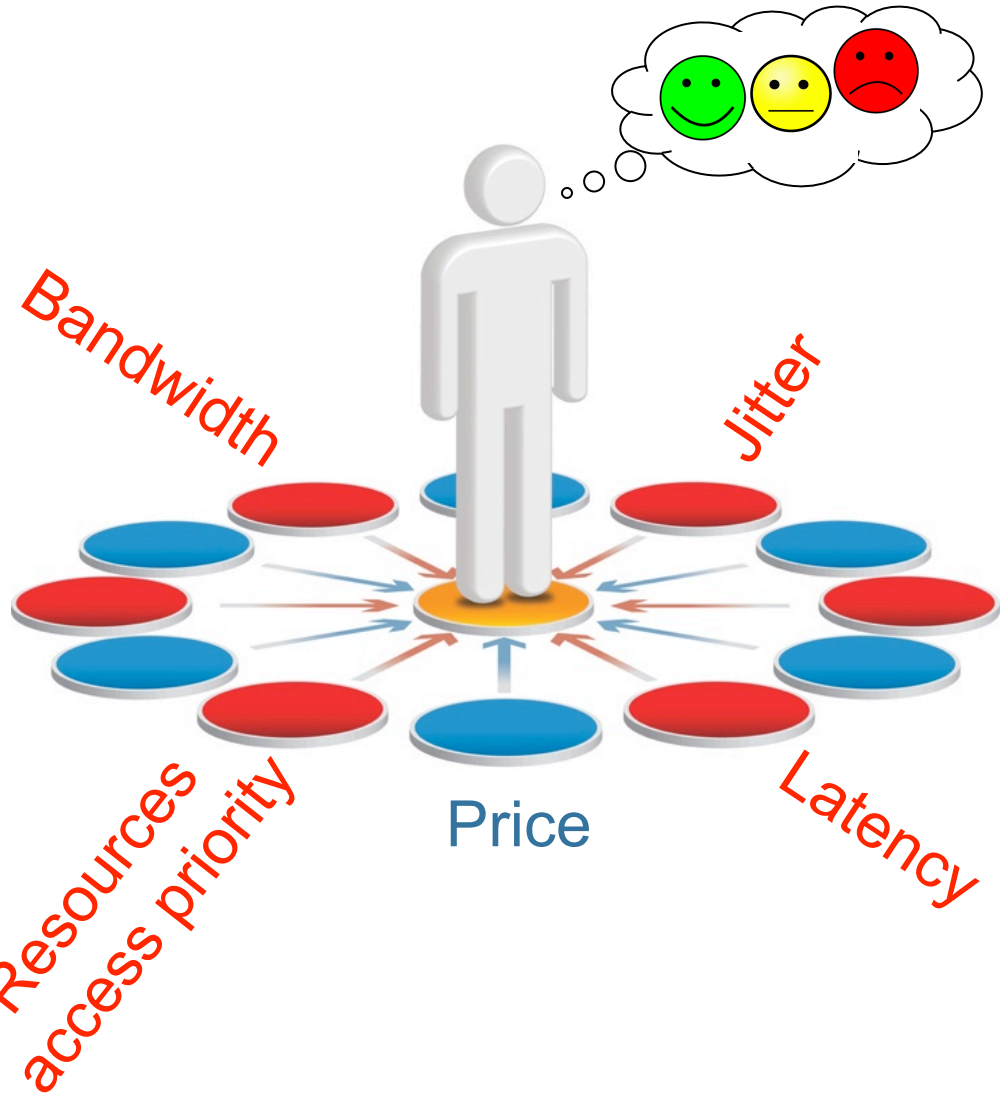
Quality-of-Experience (QoE)

- User-centric concept
- End-users satisfaction
  - Diverse variables
    - Technical variables
    - Economical variables
- QoE is measured with end-users feedback
  - Surveys
    - Time consuming



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QoE-related Variables

- Defined in the Service Level Agreement (SLA)
  - Technical specification
  - Price
- “Defined” by the service-specific demands
  - Min bandwidth for HD video streaming
  - Max delay for VoIP services
- What if one or more variables do not meet the SLA or service’s demands?
  - QoE is decreasing
- Is the Service Provider (SP) able to do something about it?

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SP Potential Reaction on Underperformance

- Charge for the underperforming period a lower fee
- Offer more resources in the future for the same price
- Sounds fair but:
  - which is the minimum price reduction that would satisfy the end-user?
  - which service upgrade would satisfy the end-user with the minimum cost for the SP?

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Proposed Solution

- Formalizing QoE in steps
  1. Identify the variables that affect QoE
  2. Characterize those variables
     - Increasing Variables (IVs) - The more you have the better it is
     - Decreasing Variables (DVs) - The more you have the worst it is
  3. Select the ideal/desired/expected/agreed value of a variable
  4. Considering the service specifications select the best and the worst values of the variable
  5. Identify the effect of each variable's variation
     - Influence factors
  6. Identify the importance of each variable

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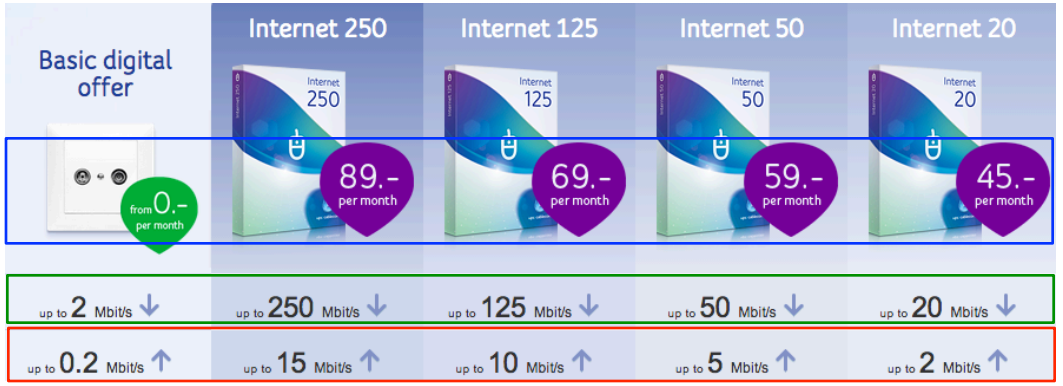
Example – Steps 1 and 2

- Scenario: Internet plans of an ISP for home customers in some places in Switzerland
- Step 1: Variables identification
  - Uplink bandwidth
  - Downlink bandwidth
  - Price
- Step 2: Variables characterization
  - IVs
    - Uplink bandwidth
    - Downlink bandwidth
  - DVs
    - Price



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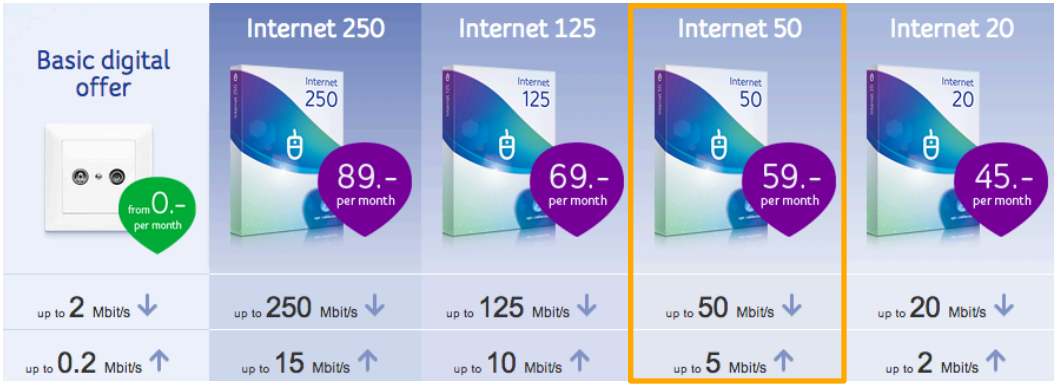
Example – Step 3

- Step 3: Select the ideal/desired/expected/agreed value of a variable
  - Assume a customer selected the “Internet 50” option
  - Ideal values based on the SLA
    - Uplink bandwidth: 5 Mbit/s
    - Downlink bandwidth: 50 Mbit/s
    - Price: 59 CHF/month



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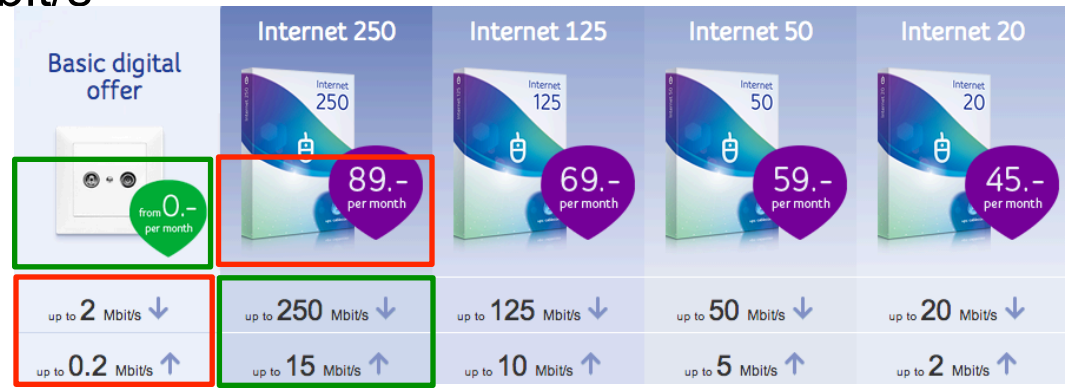
Example – Step 4

- Step 4: Select the best and worst values per variable
  - Best values
    - Uplink bandwidth: 15 Mbit/s
    - Downlink bandwidth: 250 Mbit/s
    - Price: 0 CHF/month
  - Worst values
    - Uplink bandwidth: 0.2 Mbit/s
    - Downlink bandwidth: 2 Mbit/s
    - Price: 89 CHF/month



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Example – Steps 5 and 6

- Step 5: Identify the effect of each variable's variation
  - When a customer is starting to get annoyed/getting pleased?
    - Estimate/Assume/Extract this information from the Customer Care department statistics about report of problems
      - *E.g.*, 50% less than expected bandwidth dissatisfies a customer
      - *E.g.*, 25% discount would satisfy a dissatisfied customer
- Step 6: Identify the importance of each variable
  - How a customer selects a plan in this scenario?
    - Estimate/Assume/Extract through a survey:
      - 50% based on the price
      - 30% based on the downlink bandwidth
      - 20% based on the uplink bandwidth

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DQX

Expected value
Step 3

Influence factor
Step 5

Best and worst values
Step 4

$x \in [x_{\min}, x_{\max}]$

QoE equation for DVs

$$e_d(x) = 4e^{-\left(\frac{x}{x_0}\right)^m \ln 4/3} + 1$$

Variables characterization
Step 2

QoE equation for IVs

$$e_i(x) = 4(1 - e^{-\left(\frac{x}{x_0}\right)^m \ln 4}) + 1$$

Generic QoE equation

$$E(X) = 1 + 4\prod_{k=1}^{N}\left[\frac{e_{(ivd)}(x_k) - 1}{4}\right]^{w_k}$$

Variables selection
Step 1

QoE

QoE-related
variables values

Importance factor
Step 6

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DQX Key Characteristics

MOS	Quality
5	Excellent
4	Good
3	Fair
2	Poor
1	Bad

- The expected value of a variable results a Mean Opinion Score (MOS) 4
- The best (or larger) value of a variable results a MOS 5
  - Measures can be taken against underperforming
- The worst (or less) value of a variable results a MOS 1
- By multiplying individual MOS instead of a weighted summary it is ensured that underperforming variables are reflected to the final MOS even if all other variable's values are excellent

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Toys QoE Prediction (?)

- What makes a kid happy?
  - Number of features (IV)
    - Interaction
      - Other toys/equipment
      - The kid
    - Functionality
      - Music
      - Light
      - Remote control
  - Energy autonomy (IV) = $f(\#\ features)$
  - Portability
    - Size (DV) = $f(\#\ features)$
    - Weight (DV) = $f(\#\ features)$

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Thanks for your attention!

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