Towards Social Serious Gaming in the IoT

Concept and prototype development

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Introduction

- Internet of the Things
  - Distributed sensing, computation and actuation

- Cyberphysical system
  - Digitalization of real-world physical processes

- Cloud computing and Service Oriented Architecture

- Any kind of application domains

- Grand challenge on analytics
  - Descriptive analytics
  - Diagnostic analytics
  - Predictive analytics
  - Prescriptive analytics
IOT Application System Design Process

- Requirement analysis and elicitation from user and market
  - Digitalization of system and processes
  - Huge availability of process data
  - Exploitation for:
    - Instruction and training
    - Performance assessment
    - Coaching
- System architecture
- Implementation
- (User testing)
IoT Social Gaming Platform concept

User personal device:
- Feedback
- Coaching
- User interaction.

Field devices (things):
- Sensors
- Local eval.n interpretation

Cloud servers:
- Competition management
- Data aggregation
- Data mining
- Analytics
- Social networking
  ....
Application in the Automotive Domain

Personal Info station
- User interaction
- Feedback
- Coaching

Vehicle Info Station
- C-Park
- CoNav
- C-ACC
- CDM
- G-Drive
- PTO

Central Info Station
- Virtual Coin management
- Competition mgt
- Data aggregation
- Analytics
- Social networking
- ....
Social Gaming Services (I)

VC Bank
- Token economy mgmt
- User profiling
- App balancing
- Bonuses/maluses
- Happy hours/areas

Virtual Coins

App
- User performance metrics
- App Logic
- Serv Level Selector

Virtual Coins

Real world rewards
- Bus tickets
- Parking slots
- Reserved area access
Social gaming services (II)

Competition service

- Self and social comparisons
- Periodic (time and space-based) competitions
- Several different apps can be aggregated in competitions
- Game features (Charts, comparison and ranking, badges)
- Feeds to the VC server
Implemented System Architecture

- Recorded input from Trento test site
- VDP
- VDP consumer
- Driver Performance Assessment
- Evaluator
  - Dynamic Sliding Window
  - Kohonen Neural Network
  - K-Nearest Neighbor
  - Linear Distance
- Compet. server
- Virtual coins server
- OSGi – in vehicle
- SG-CB Application
  - Android application for user access
Algorithms used for evaluation

- Unsupervised learning
- Classification of signal patterns into clusters
- Event-based penalizing criterion
- Batch processing (2-5 minutes)

- Supervised learning (training set)
- Sample by sample classification
- Combination of signals
- K=1
- Suited for immediate feedback and coaching

- Comparison with ideal linear functions (single signals by now)
- Sample by sample evaluation
- Suited for immediate feedback and coaching

- Recognition of significant windows of signal values
- Detection of events
- Suited for event-based feedback and coaching
Early algorithm tuning tests

- Vehicular signals gathered by CRF vehicles in Trento
  - Three 20-minute drives
  - Different drivers on the same road

<table>
<thead>
<tr>
<th>App name</th>
<th>Evaluation algo</th>
<th>Signals evaluated</th>
<th>Signal weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green drive 1</td>
<td>Linear distance</td>
<td>Acceleration, RPM, fuel consumption</td>
<td>Equally weighted linear combination</td>
</tr>
<tr>
<td>Green drive 2</td>
<td>Kohonen Neural Networks</td>
<td>Acceleration, brake</td>
<td>Equally weighted linear combination</td>
</tr>
<tr>
<td>Green drive 3</td>
<td>K-Nearest Neighbors</td>
<td>Speed and brake</td>
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<tr>
<td>Green drive 4</td>
<td>Dynamic Sliding Window</td>
<td>Speed</td>
<td></td>
</tr>
<tr>
<td>Fluid traffic</td>
<td>Linear distance</td>
<td>Speed</td>
<td></td>
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</tbody>
</table>
Drive evaluation
(*avg values of the algorithms, different inputs*)

**Kohonen Neural Networks**

**Linear Distance**

**K-Nearest Neighbors**

**Dynamic Sliding Window**
Preliminary analysis

- The Kohonen Neural Networks tends to penalize minor harsh, suited for personal training (self comparison and improvements)
- K-NN has nominal penalizing criterion in which certain patterns are provided as a sample set to the system and specific harsh patterns are picked up and penalized.
- The Linear distance and sliding windows tend to be subject to noise
  - Need for hysteresis/low pass filetring
- Sliding windows allows detecting events, thus warning the driver at the end of the event
- Importance of processing different signals and target different events and goals
Conclusion and ongoing work

- **Driver assessment**
  - Preliminary analysis presented
  - Comparison between algorithms with same inputs
  - Noise robustness
  - More test drives are needed
    - Different vehicles
  - Semantic analysis for driver coaching

- **System implementation (Serious Game for Mobility and Transportation)**
  - UI on vehicle and smartphone
  - Social networking
  - Integration of different apps
    - Parking
    - Collaborative Adaptive Cruise Control
    - Collaborative Navigation
    - Collaborative Driving and Manoeuvring
    - Public Transport Optimization

- Flexible social gaming platform
  - Service Oriented Architecture
  - Different application domains
Thank you for listening

QUESTIONS?