# Ubilife – Research on smart education and wellbeing

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UbiLife

SMART EDUCATION & WELLBEING

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SMART EDUCATION & WELLBEING

**Mission**: foster research on ubiquitous and context-aware technologies, applications and services in the fields of education and wellbeing

**Focus**: context-aware platforms for applications and games

**Approach**: combine ubiquitous and interactive technologies to enable interplay between virtual and real worlds.

Prof. Teemu Laine
ubicomp, games, software engineering

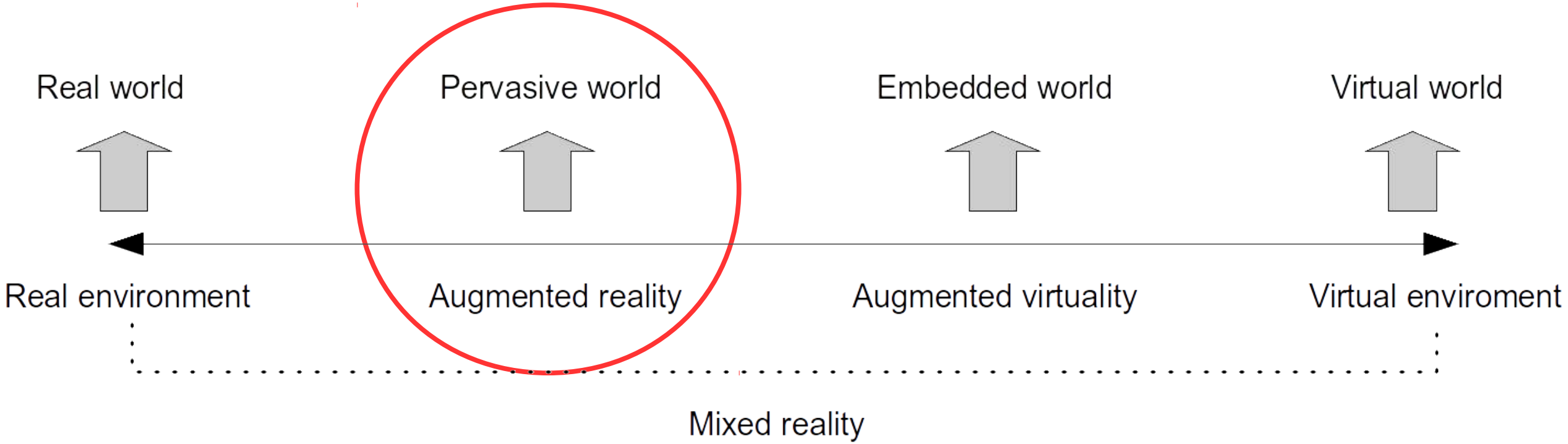
Prof. Haejung Suk
3D modeling, animation, graphics

Prof. Adil Khan
human activity recognition, data mining

+more

아주대학교 AJOU UNIVERSITY 1973

# Reality-virtuality continuum




*Based on Milgram's & Kishino's reality-virtuality continuum*

# Examples of ubiquitous computing usage

- Since Mark Weiser's vision of ubiquitous computing (ubicomp) in the 1990’s, ubiquitous systems have been developed for various purposes, such as:

Exercise and entertainment

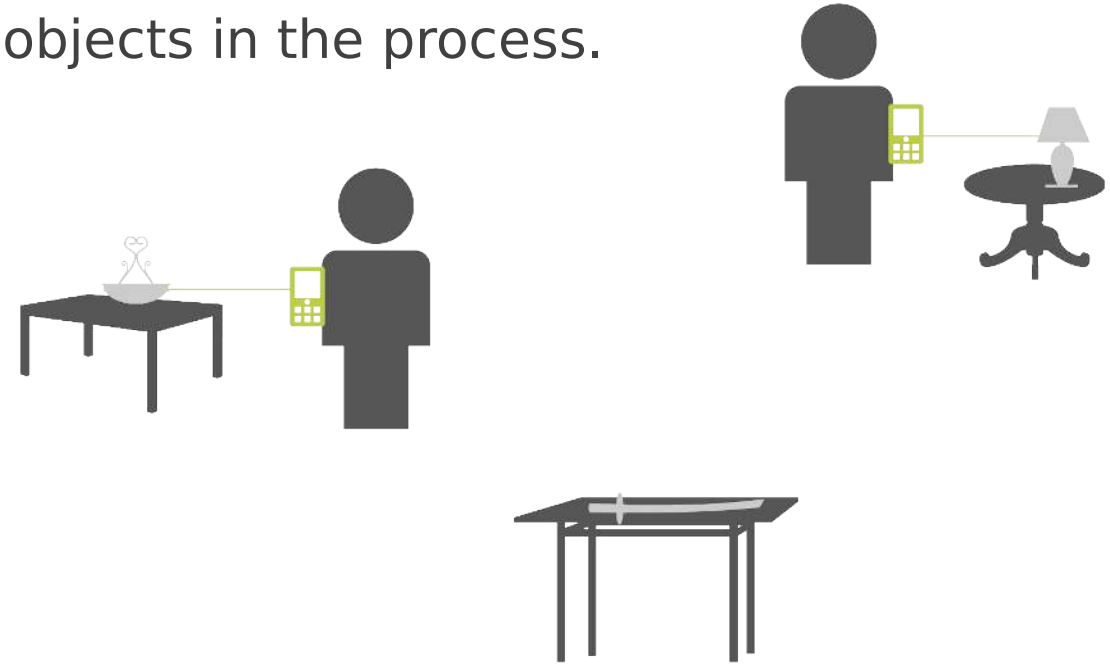
Tourism

Transportation and supply chains

Education

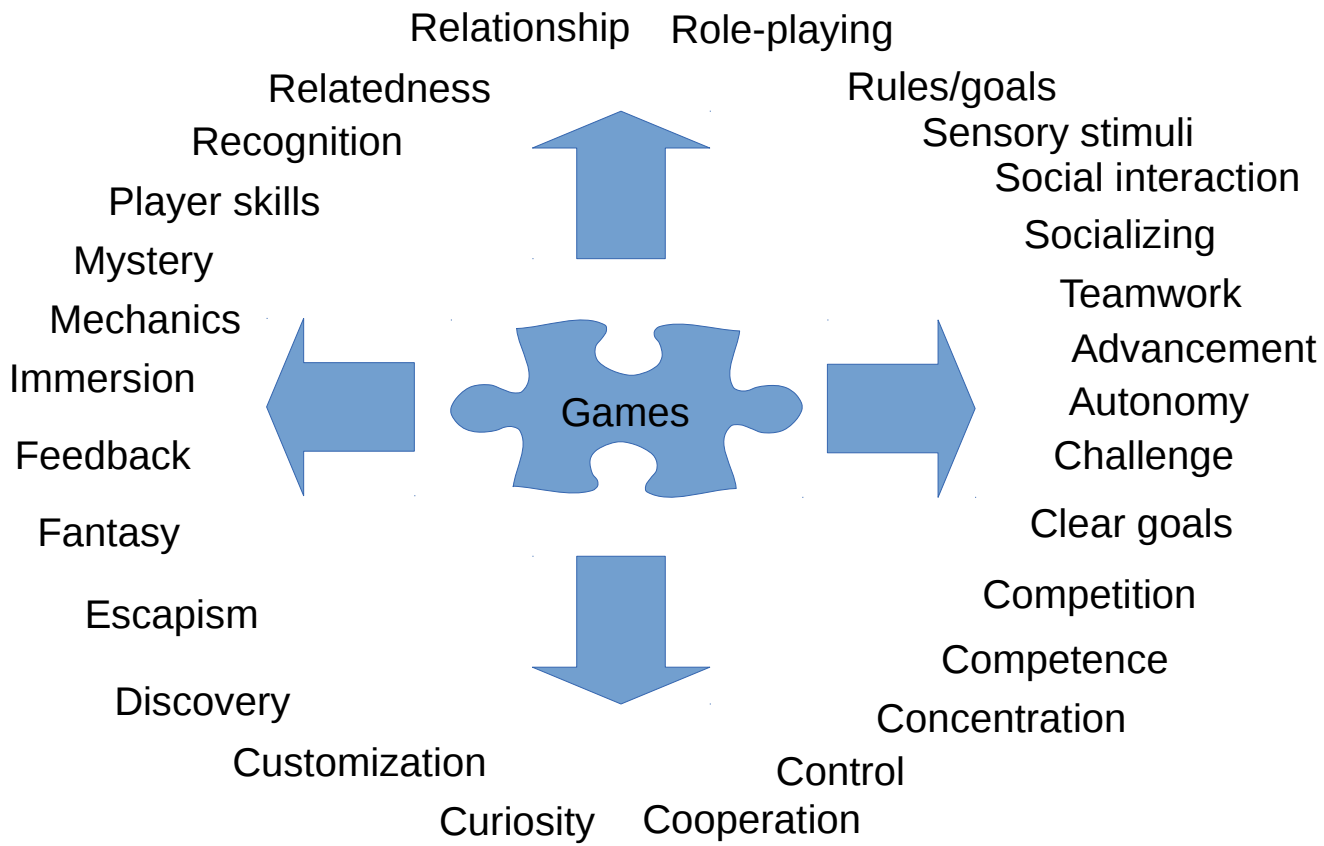
# Context-awareness in ubiquitous computing

- Detecting the user's context (situation): where, what, when, with whom, etc.
- Providing *context-sensitive* content and services to the user (usually by mobile device).
- Using real world objects in the process.



# Why games?

- Games are known to be engaging and motivating*

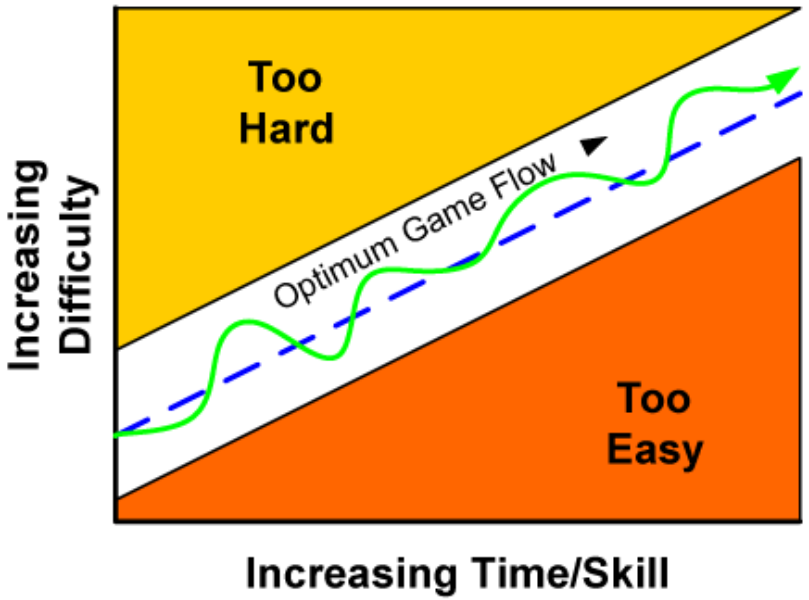



* some game motivators discovered by Eeva Nygren from gaming literature

# Why games?

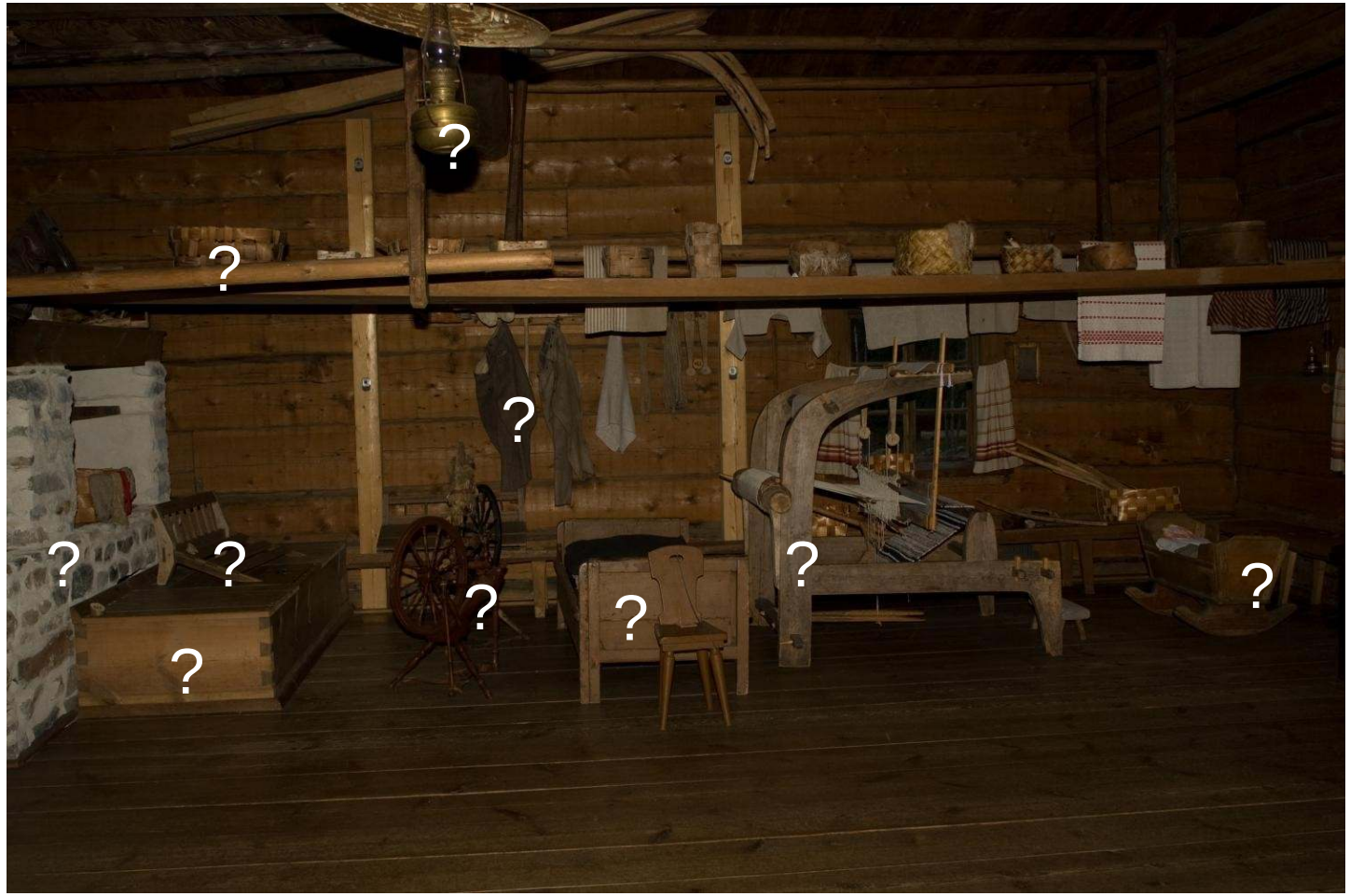
- Appropriately balanced games are known to help the player enter the flow*

  *“Flow is the mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment.”* (Wikipedia)




** The flow theory by Csikszentmihalyi*

# History: LieksaMyst (2008-)



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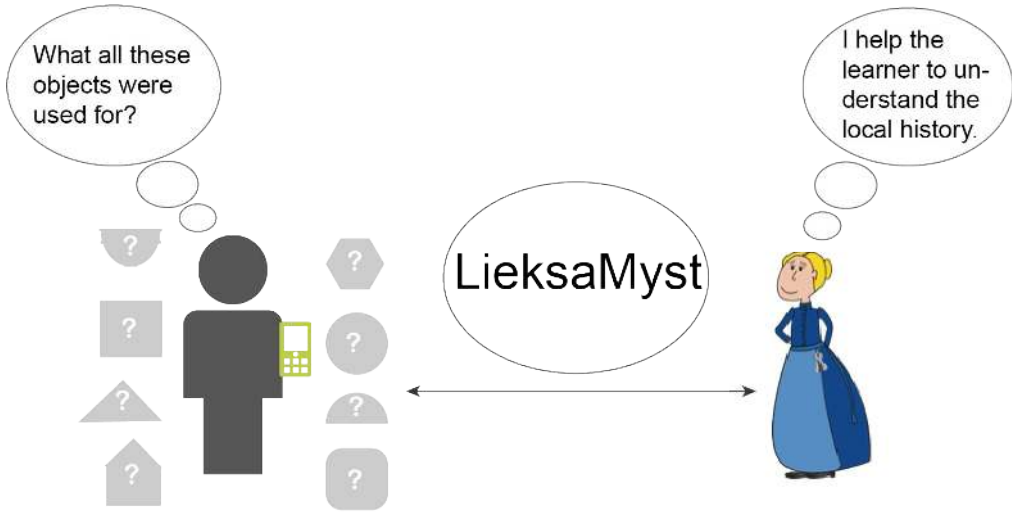


a)

b)

c)

d)

e)

f)

g)

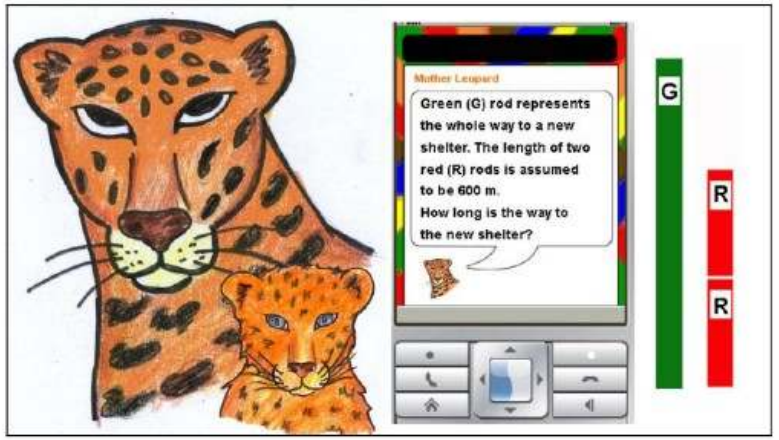
**a-b**: Jussi lets player to choose which level (time period) to play.

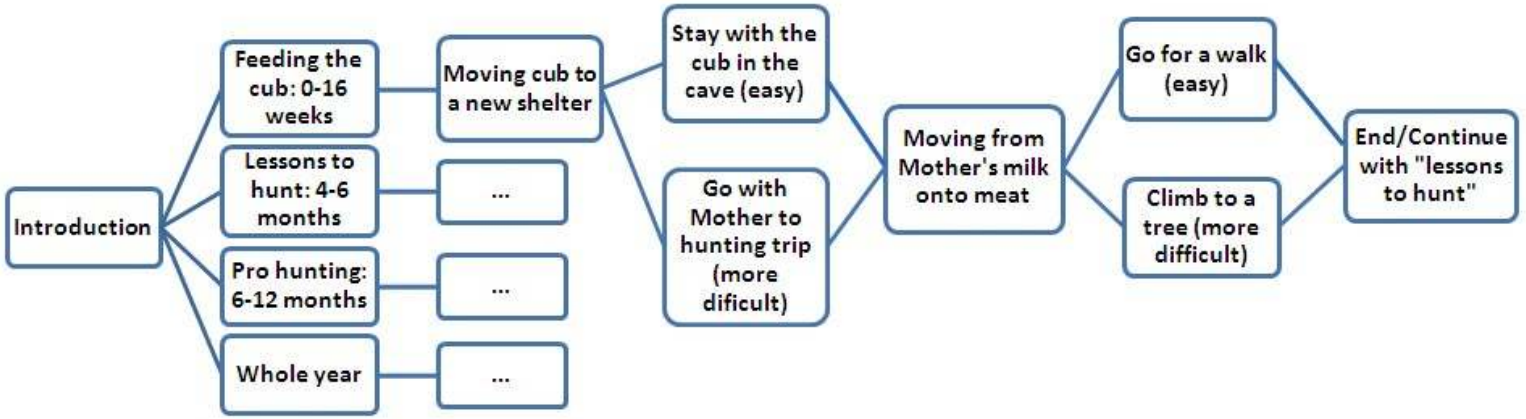
**c-d**: Story combines text, images and audio. Jussi's character is taciturn and even slightly impolite.

**e-g**: In addition to multiple choice questions, Jussi asks the player to locate objects and input code.

# History: UFractions (2009-2011)

- Fractions learning game for kids (South Africa, Finland, Mozambique)
- Combines a story on mobile phone with wooden fraction rods



Introduction
Phone
Mother leopard gives birth to a cub whose name is Senatla.
Continue

Introduction
Mother Leopard
Red (R) rod is 8 kg. Black (B) rod tells Mother leopard's weight.
Continue

B


R

# Digital natives today

- Television: 4 hours per day*
- Computer: 1.5h per day*
- Mobile (SMS): 3364 messages / month (teenagers)*
- Media time of 5-8 year olds: 2:21 per day**
- More than 40 million overweight children in 2010***

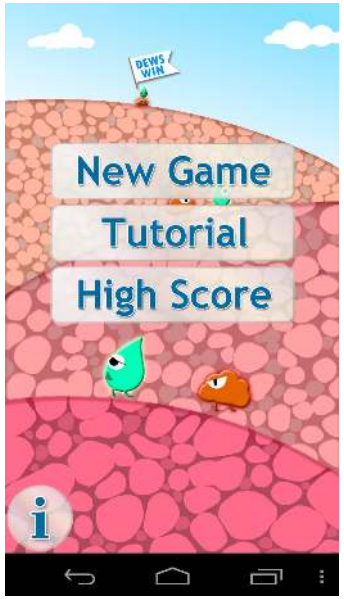
* Children, Adolescents, and the Media. American Academy of Pediatrics, 2013.
** Zero to Eight – Children's media use in America. Common Sense Media, 2013.
*** Obesity and overweight – Fact sheet no 311. World Health Organization, 2012.

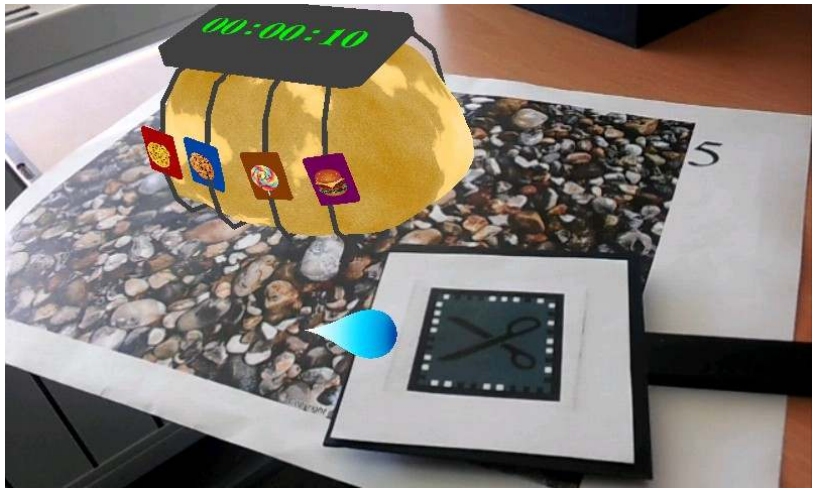
# What is exergaming?

- A game genre that involves physical exercise.
- The goal: make physical exercise more fun
- Exergame typically tracks the player's movement or other body parameters (e.g., heart rate)
- Benefits:  Energy expenditure, weight loss, improved fitness through increased heart rate, improved stamina and recovery, improved motor skills, coordination and balance, social interaction, improved self-esteem, increased motivation and enjoyment, academic performance, visual-spatial skills, attention (Staiano & Calvert, 2011)

# Calory Battle AR

- Location-based treasure hunt exergame
- GPS for location detection (Google Maps API)
- Augmented Reality to embed virtual objects in the physical world
- Time limits to encourage running



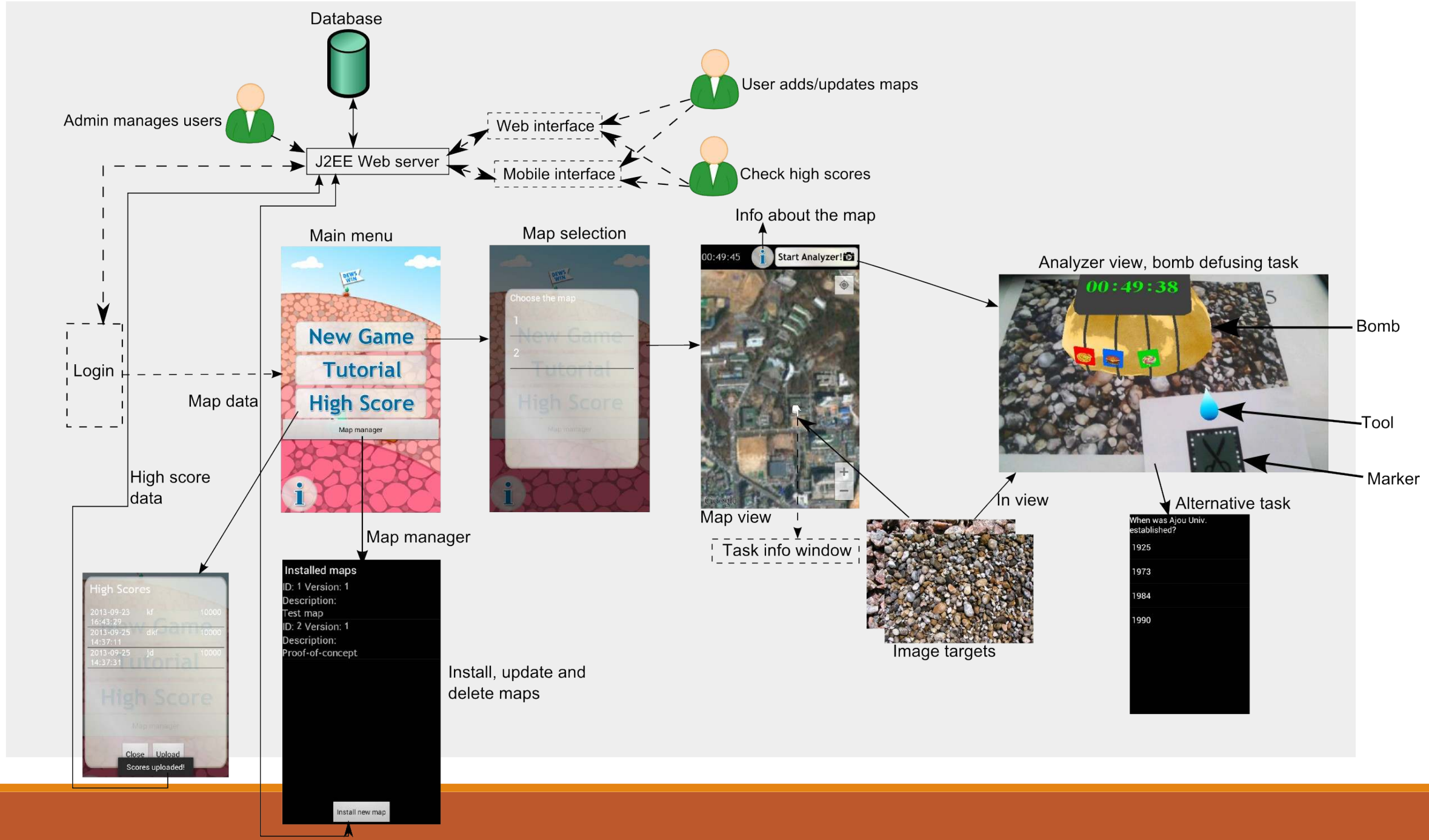


# Calory Battle AR: The Story

- **The Dews** (good guys)
  - Need our sweat to survive
  - Cast spells on us that make our bodies healthier and our minds brighter

- **The Caloroids** (bad guys)
  - Have deployed *calory bombs* around the game area which, when exploded, makes us lazy and unhealthy.

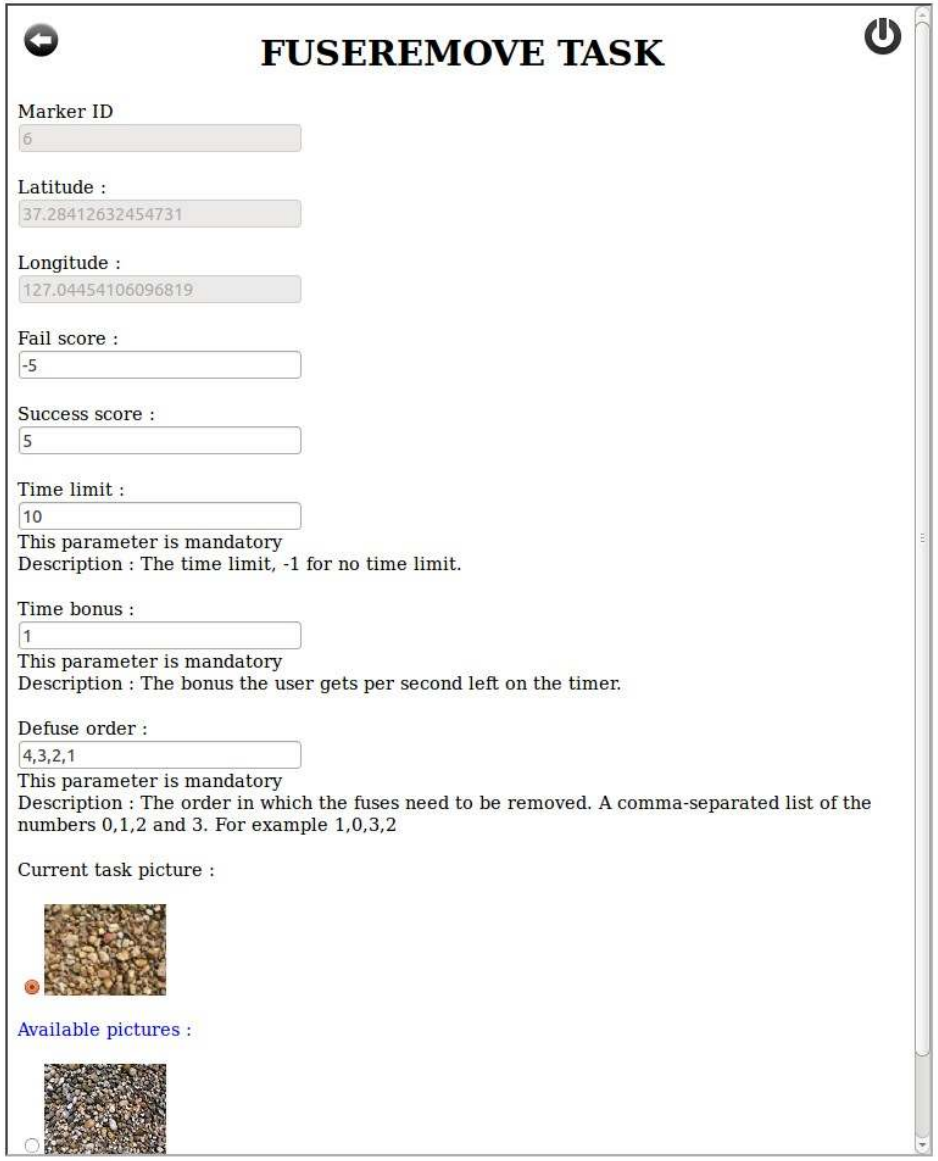
- **The Player**
  - Helps the Dews to get rid of the calory bombs (or solve other challenges)


Database
Admin manages users
J2EE Web server
Web interface
Mobile interface
User adds/updates maps
Check high scores
Login
Map data
High score data
Main menu
New Game
Tutorial
High Score
Map manager
Map selection
Choose the map
Info about the map
Start Analyzer!
Map view
Task info window
Image targets
In view
Analyzer view, bomb defusing task
00:49:38
Bomb
Tool
Marker
Alternative task
When was Ajou Univ. established?
1925
1973
1984
1990
Map manager
Installed maps
ID: 1 Version: 1
Description:
Test map
ID: 2 Version: 1
Description:
Proof-of-concept
Install new map
Install, update and delete maps
High Scores
Close
Upload
Scores uploaded!

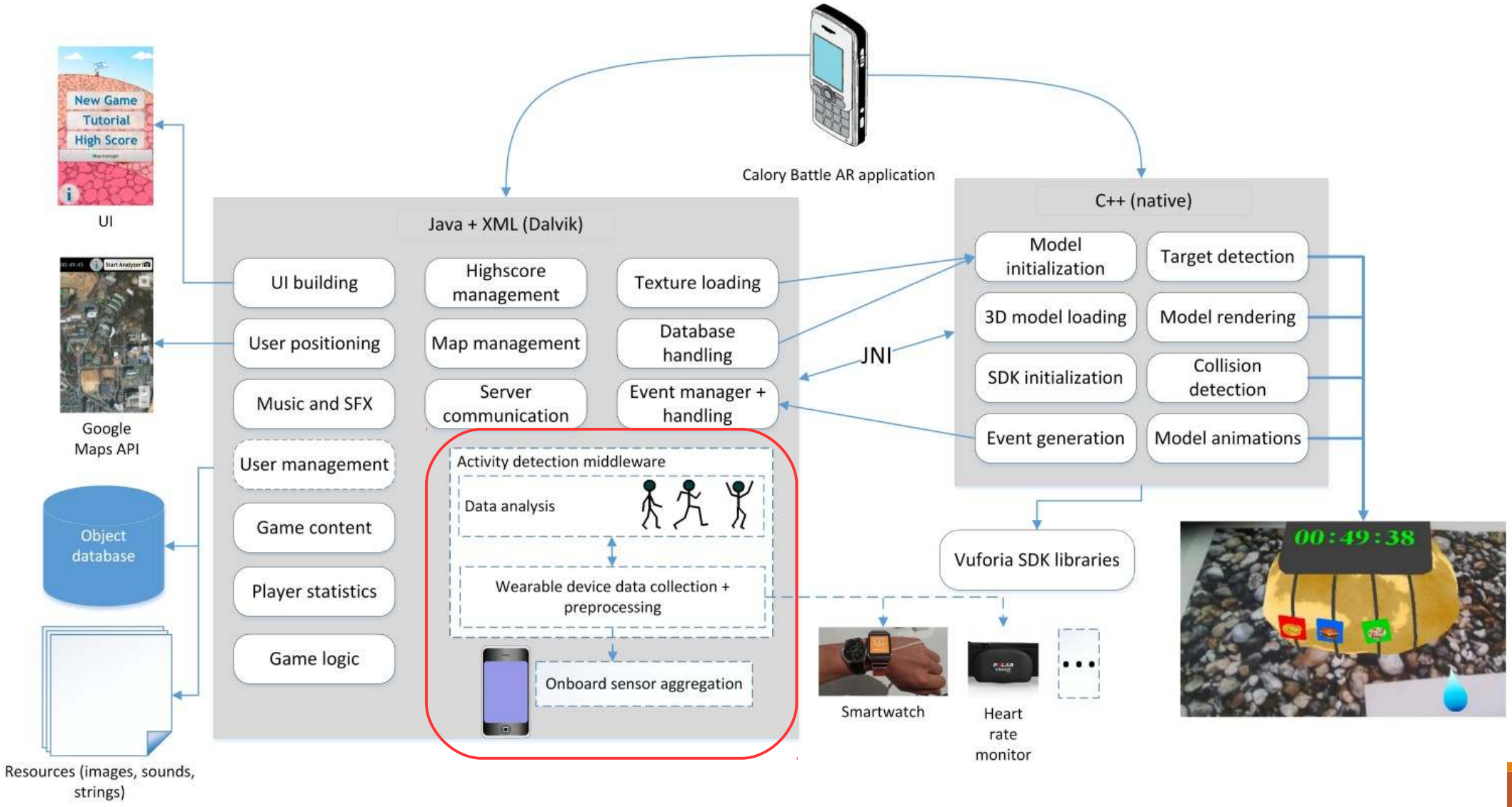
# Videos

- UI & Game play:
  http://www.youtube.com/watch?v=2uLjNndXLEU
- Test with primary school children in Korea:
  http://www.youtube.com/watch?v=ETPjAzC8-4o

# Content editor (web-based)



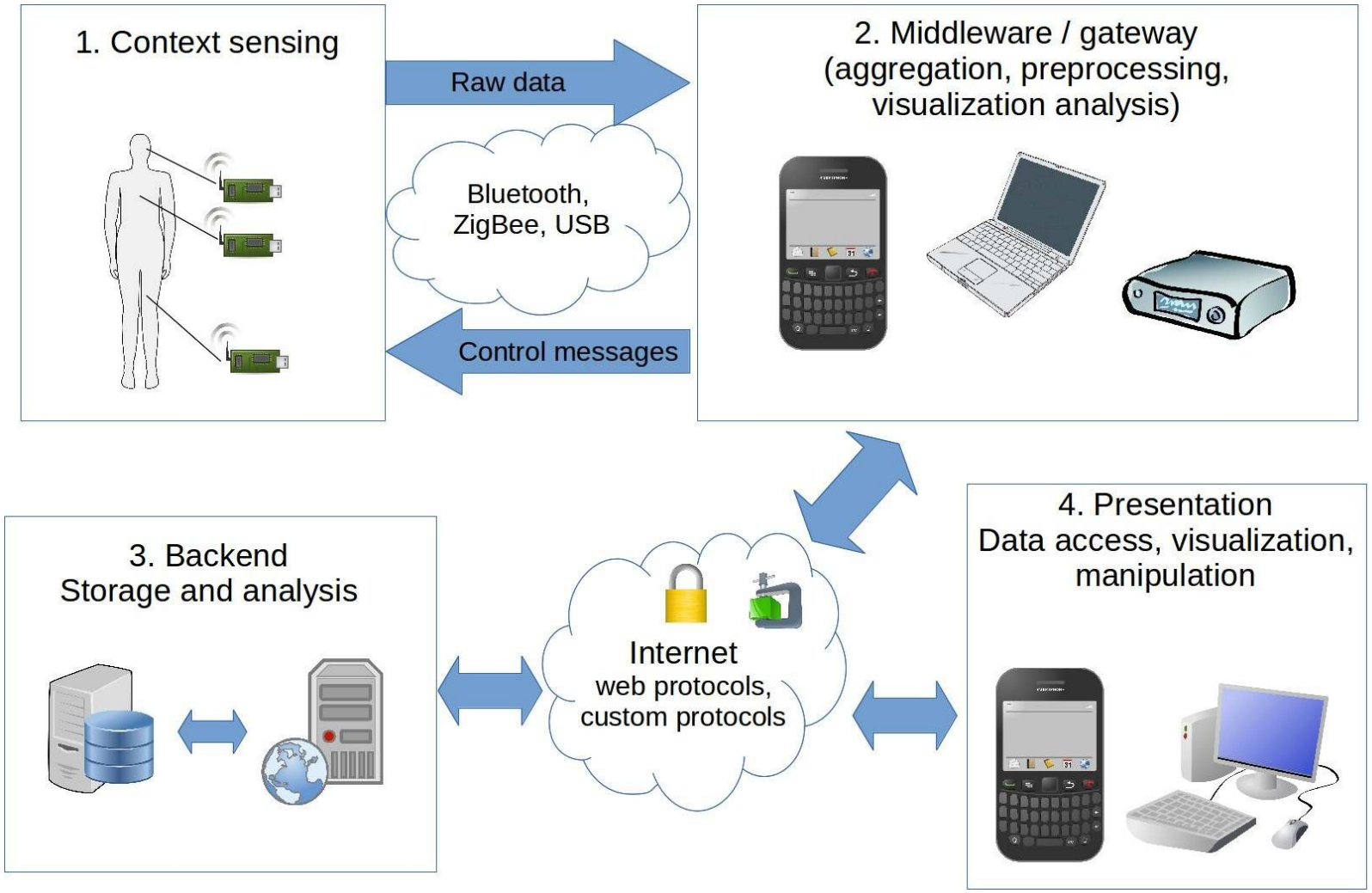
# Calory Battle AR client architecture



# Need for a middleware

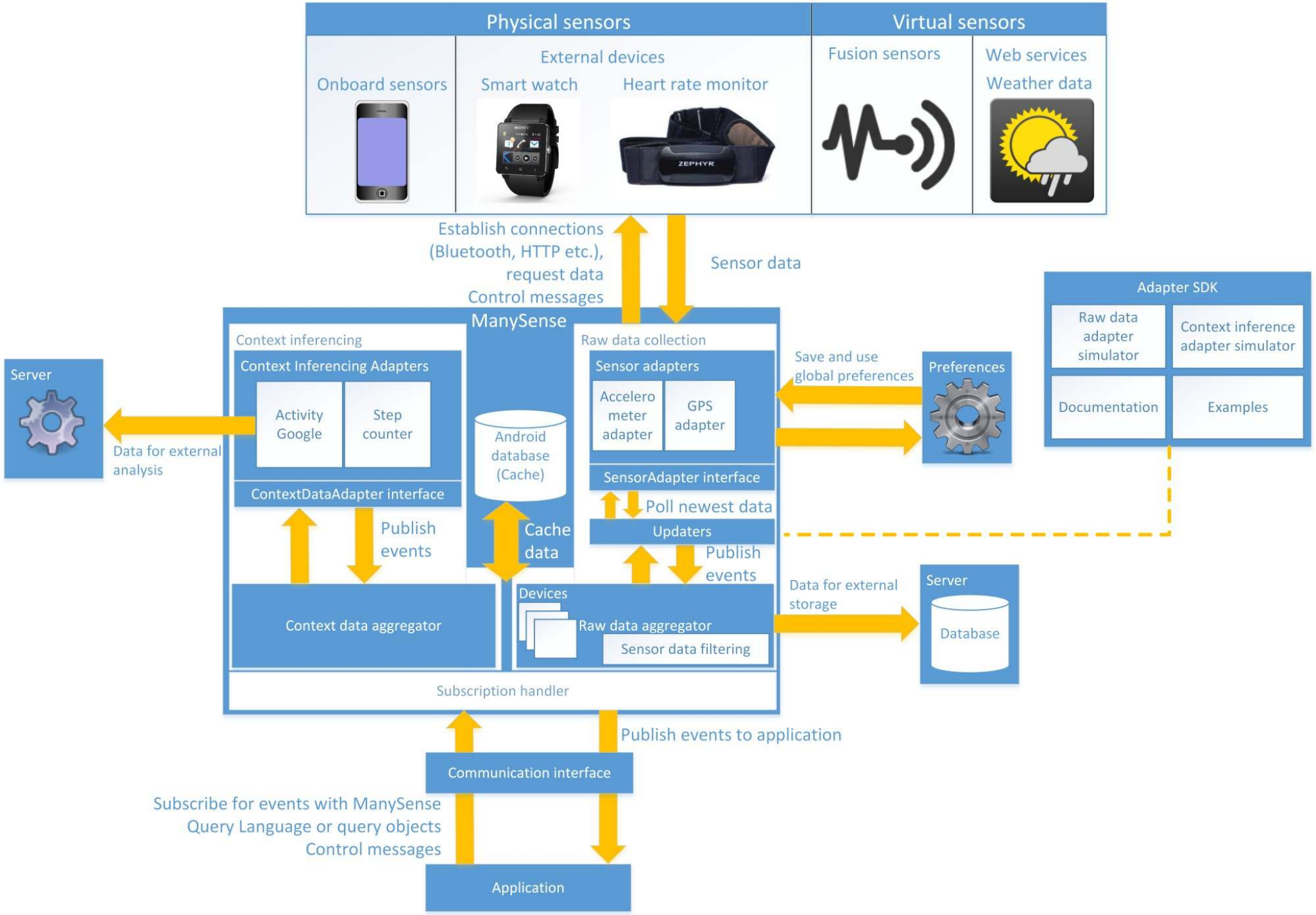
- The heterogeneity of various sensors and other sources of contextual data
  - Different device APIs – developers must write code to add support for new sensors in each application.
  - Different communication methods (Bluetooth, ZigBee, USB, TCP/IP)
- Different context inferencing requirements
  - Ex) a sport tracker application might need to know the user's current activity based on wearable sensors
- We need a middleware that can provide raw and processed data from heterogeneous sensors through a unified API.

# Generic layered architecture for context-aware systems



# ManySense context-aware middleware

- Android-based middleware that bridges the gap between the heterogeneous sensors and applications wishing to use them.
- To ManySense, a “sensor” means both hardware sensors, fusion sensors (e.g., linear acceleration, orientation) and online data sources (e.g., web services).
- Profides also access to context inferencing algorithms that use the raw sensor data to infer higher level context data such as the user’s current activity.


Physical sensors
Virtual sensors
External devices
Onboard sensors
Smart watch
Heart rate monitor
Fusion sensors
Web services
Weather data
ZEPHYR
Establish connections
(Bluetooth, HTTP etc.),
request data
Control messages
Sensor data
ManySense
Context inferencing
Context Inferencing Adapters
Activity
Google
Step
counter
ContextDataAdapter interface
Publish
events
Context data aggregator
Android
database
(Cache)
Cache
data
Raw data collection
Sensor adapters
Accelero
meter
adapter
GPS
adapter
SensorAdapter interface
Poll newest data
Updaters
Publish
events
Devices
Raw data aggregator
Sensor data filtering
Subscription handler
Server
Data for external
analysis
Save and use
global preferences
Preferences
Adapter SDK
Raw data
adapter
simulator
Context inference
adapter simulator
Documentation
Examples
Data for external
storage
Server
Database
Publish events to application
Communication interface
Subscribe for events with ManySense
Query Language or query objects
Control messages
Application

# Adapter interfaces

- New sensors and context inferencing algorithms can be added through adapter interfaces. We currently have
  - Sensor adapters:
    - Phone: accelerometer, linear accelerometer, gravity, GPS, magnetic field, orientation
    - Sony Smart Watch 2: accelerometer, light
    - Zephyr heart rate meter
    - Open Weather web service: temperature
  - Context inferencing adapters:
    - Activity detection using Google's activity detection API
    - Step counter

# More features

- Encapsulated implementation – the programmer simply defines what kind of data is needed, and the middleware will provide it.
- Multiple concurrent subscribers.
- Dynamic resource management for high performance.
- Optional filtering (high-pass, low-pass) to improve raw data.
- Control messages (e.g., set sensing interval, scheduling).
- Adapter SDK to assist third-party developers in adapter creation.
- ManySense Query Language for easier control.
- Data caching and remote storage services.
- Preferences.

# Programming with ManySense

- ManySense runs as a background service in a separate process. To access the middleware, application developers need to:
  - Add the ManySense library to build path
  - Open connection to the ManySense service and send a request for data
  - Implement call-back methods to process incoming data

```
//Initialize connection
SubscriberConnection conn = new SubscriberConnection(this);
conn.registerListener(this); // this class implements the listener interface
conn.openConnection();

// send subscription message(s)

//Unsubscribing
conn.sendQuery("unsubscribe from *");
conn.closeConnection();
```

# ManySense Query Language

- ManySense can be controlled by sending runtime queries in ManySense Query Language (e.g., start/stop data collection, set data collection interval, set data filter, set data collection scheduling)

```
subscribe to phone/accelerometer, smartwatch/accelerometer
commands delay 50
filters lowpass 0.6

modify subscription in phone/accelerometer
commands sendonlynewdata true
send until 22-10-2014 12:00:00

unsubscribe from *

subscribe to context/activityGoogle
commands delay 10000
send for 30 minutes
```

# Future work for ManySense

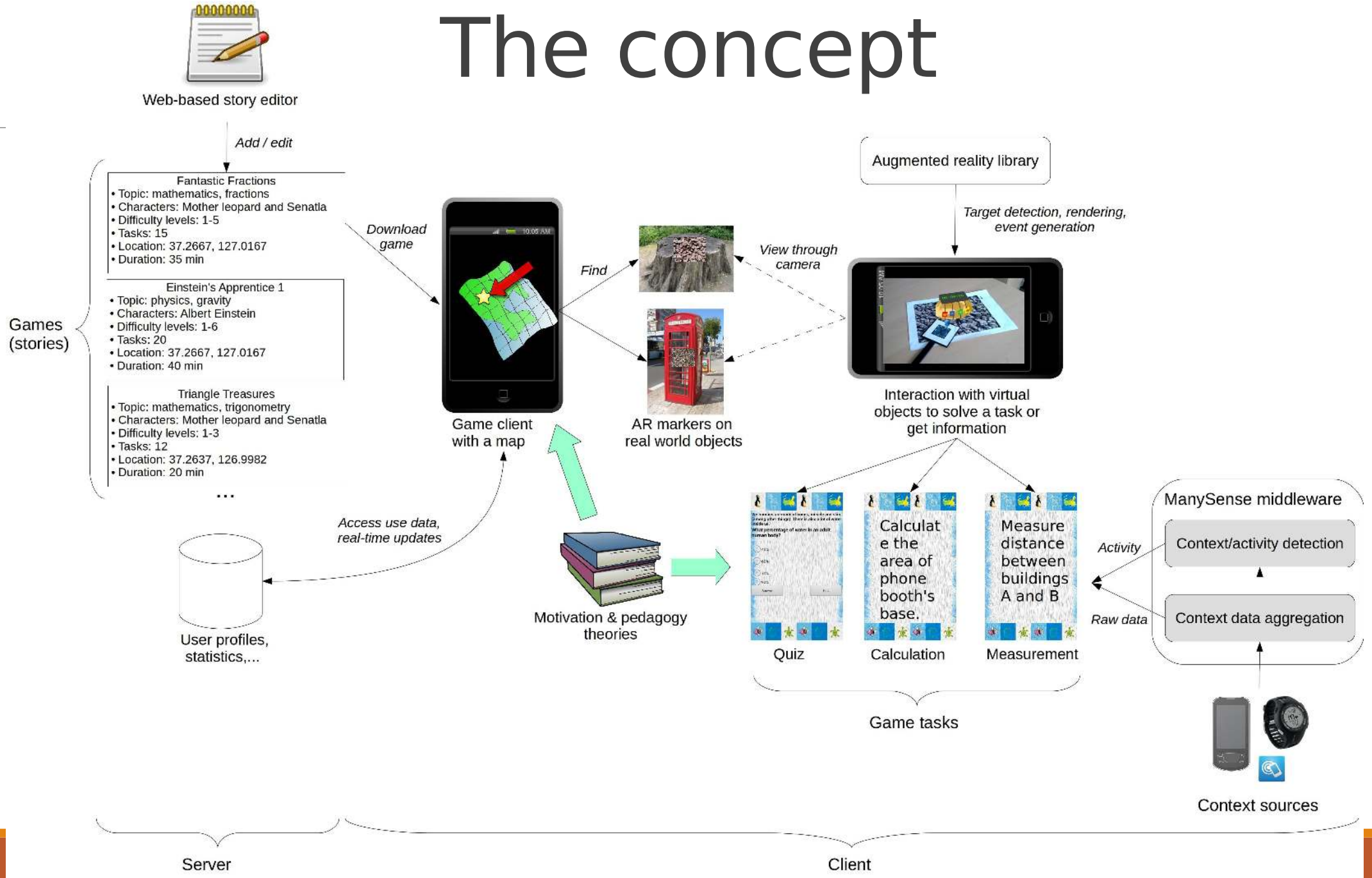
- Data caching & real-time visualization
- Online analysis
- Ontology-based context modeling
- Development of sensor and context inferencing adapters

# ScienceSpots AR

- Children's interest in science has been declining* because of:
  - Lack of relevance to the real world
  - Lack of motivation
- Context-awareness and augmented reality can solve the real world relevance problem.
- Games can solve the motivation problem.
- **ScienceSpots AR**: a platform for story-based context-aware games for science learning

*Osborne et al. “Attitudes towards science: A review of the literature and its implications,” Int. J. Sci. Educ., vol. 25, no. 9, pp. 1049–1079, Sep. 2003.
*C. Porter and J. Parvin, “Learning to Love Science: Harnessing children’s scientific imagination,” 2008.

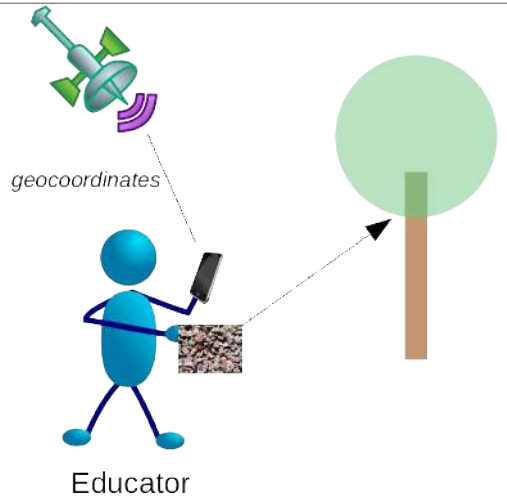
# The concept


Web-based story editor
Add / edit
Games (stories)
Fantastic Fractions
• Topic: mathematics, fractions
• Characters: Mother leopard and Senatla
• Difficulty levels: 1-5
• Tasks: 15
• Location: 37.2667, 127.0167
• Duration: 35 min
Einstein's Apprentice 1
• Topic: physics, gravity
• Characters: Albert Einstein
• Difficulty levels: 1-6
• Tasks: 20
• Location: 37.2667, 127.0167
• Duration: 40 min
Triangle Treasures
• Topic: mathematics, trigonometry
• Characters: Mother leopard and Senatla
• Difficulty levels: 1-3
• Tasks: 12
• Location: 37.2637, 126.9982
• Duration: 20 min
...
Download game
Game client with a map
Find
AR markers on real world objects
View through camera
Augmented reality library
Target detection, rendering, event generation
Interaction with virtual objects to solve a task or get information
Access use data, real-time updates
User profiles, statistics,...
Motivation & pedagogy theories
Quiz
Calculate the area of phone booth's base.
Measure distance between buildings A and B
Calculation
Measurement
Game tasks
ManySense middleware
Activity
Raw data
Context/activity detection
Context data aggregation
Context sources
Server
Client

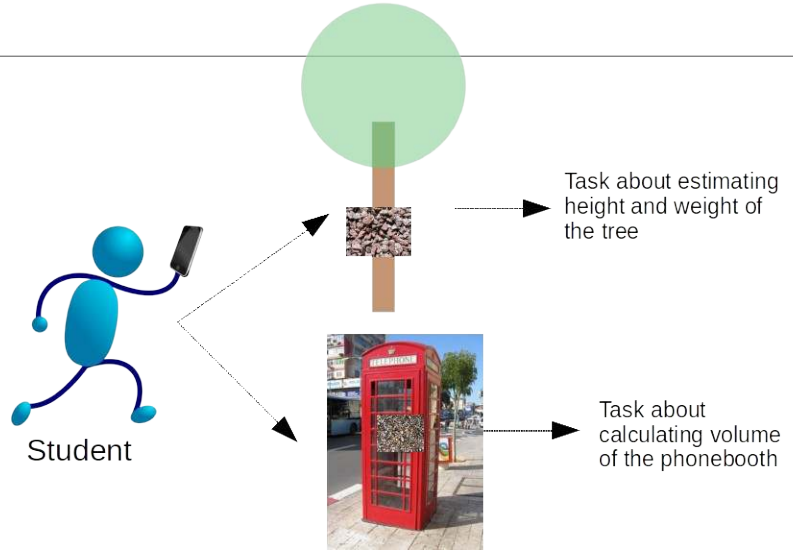
# Key features

- Customizable stories created by educators and learners with a story editor
- Inventory of reusable task templates, game characters, media assets
- Augmented reality content visualization and interaction
- Real-time usage statistics for educators
- Multiplayer tasks
- Context-awareness through ManySense

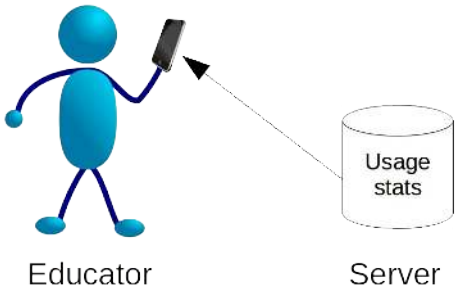
# Example scenario



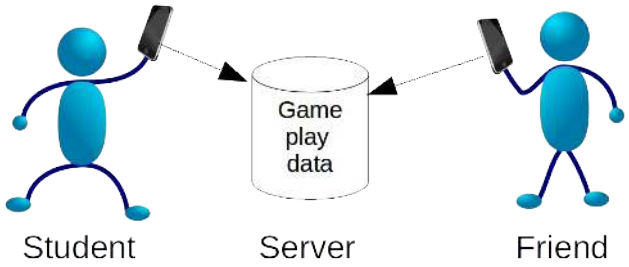

1. Educator creates and deploys a story




2. Student plays through the story and solves all tasks that the educator has created




3. Educator follows the game progress in real time and makes interventions as necessary



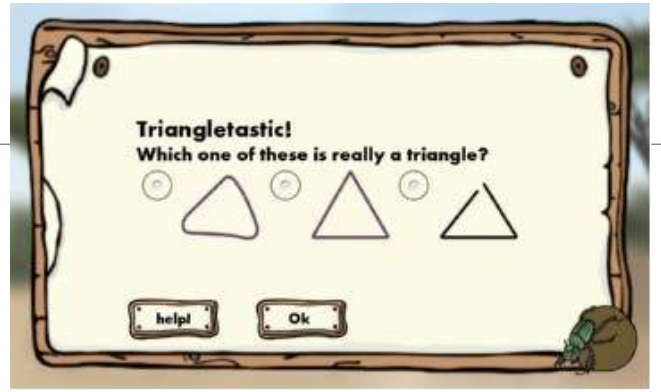

4. Student reviews game play data later and share the experience with friends

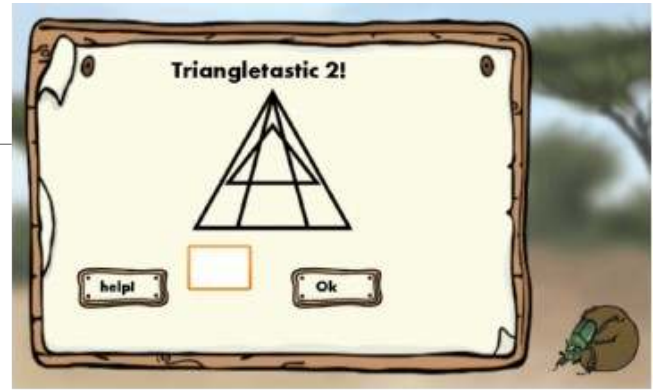
# Leometry

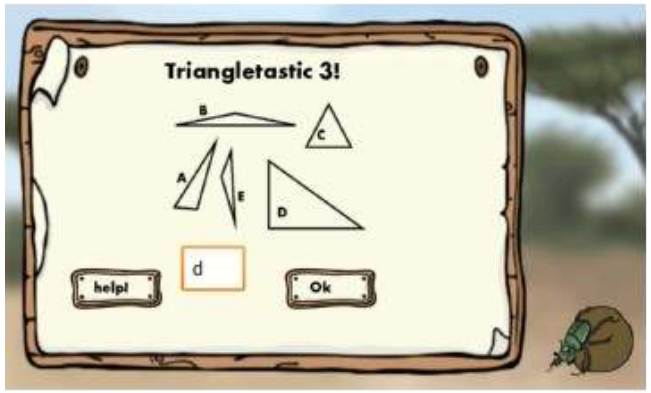
- First prototype game on geometry for the ScienceSpots AR platform.
- A story of mother leopard and her cub who escape from poachers with help of a dung beetle.
- The player solves geometry challenges at real-world spots.
- Colourful and polished UI to attract young players.
- Augmented reality features.
- Evaluated at the SciFest 2014 festival in Joensuu, Finland.
- Beta will be released in July 2014.

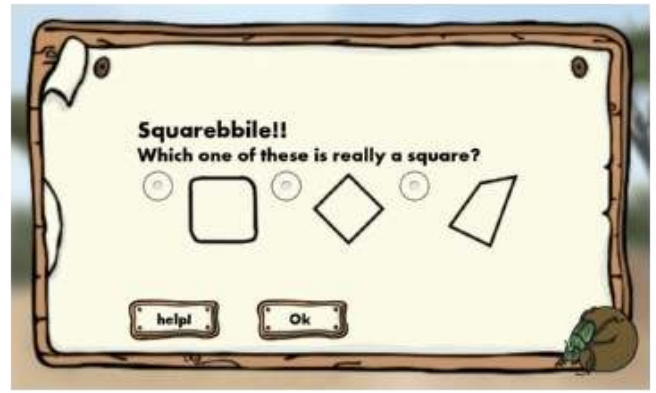
# Challenges

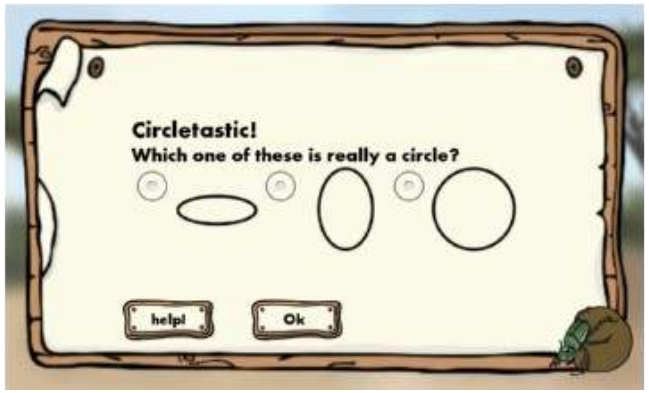
- Geometry challenges are based on Van Hiele levels for geometry education. Currently the game content covers levels 1 and 2 on triangles, circles and rectangles.

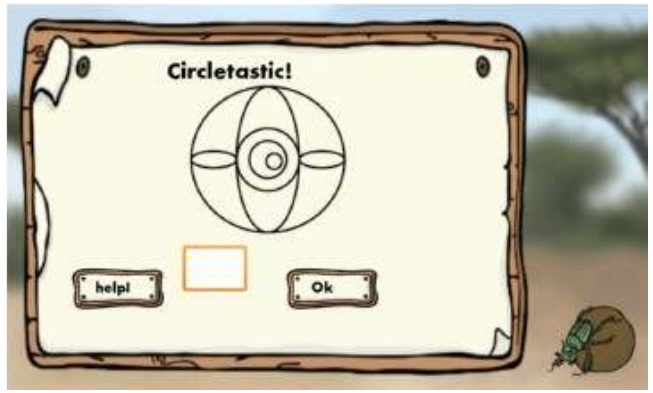


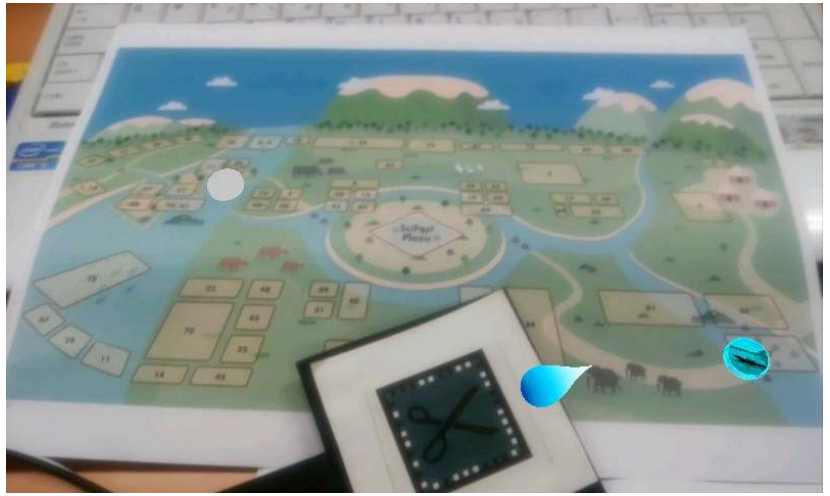



# User interface (not the latest)

Game play video: https://www.youtube.com/watch?v=6J2U0C-AL2o

# Augmented reality features

- The game map
  - The player sees location of challenges as 3D objects floating on top of the physical map.



- In the “boss” challenge the player must disarm AR traps set by poachers.
  - Similar to defusing bombs in Calory Battle AR.

# Q&A

Thank you!