Particularities of Visualisation of Medical and Wellness Data through a Digital Patient Avatar

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Vadym Kramar, **Markku Korhonen**, **Yury Sergeev**
@oamk.fi
Oulu University of Applied Sciences, School of Engineering,
Pehr Brahe Center for Industrial and Services ICT (PBOL)

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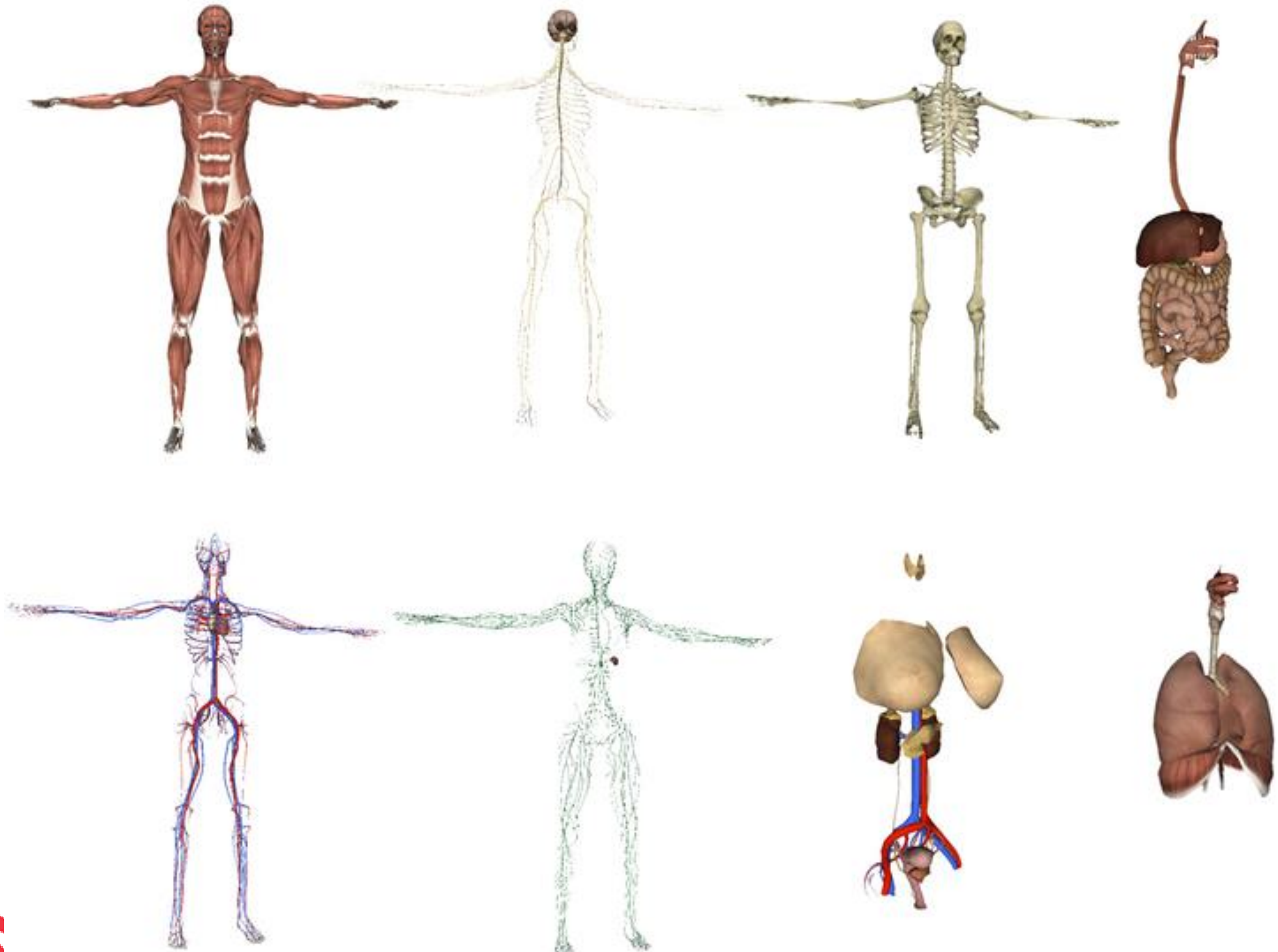
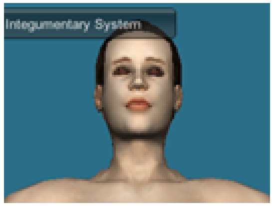
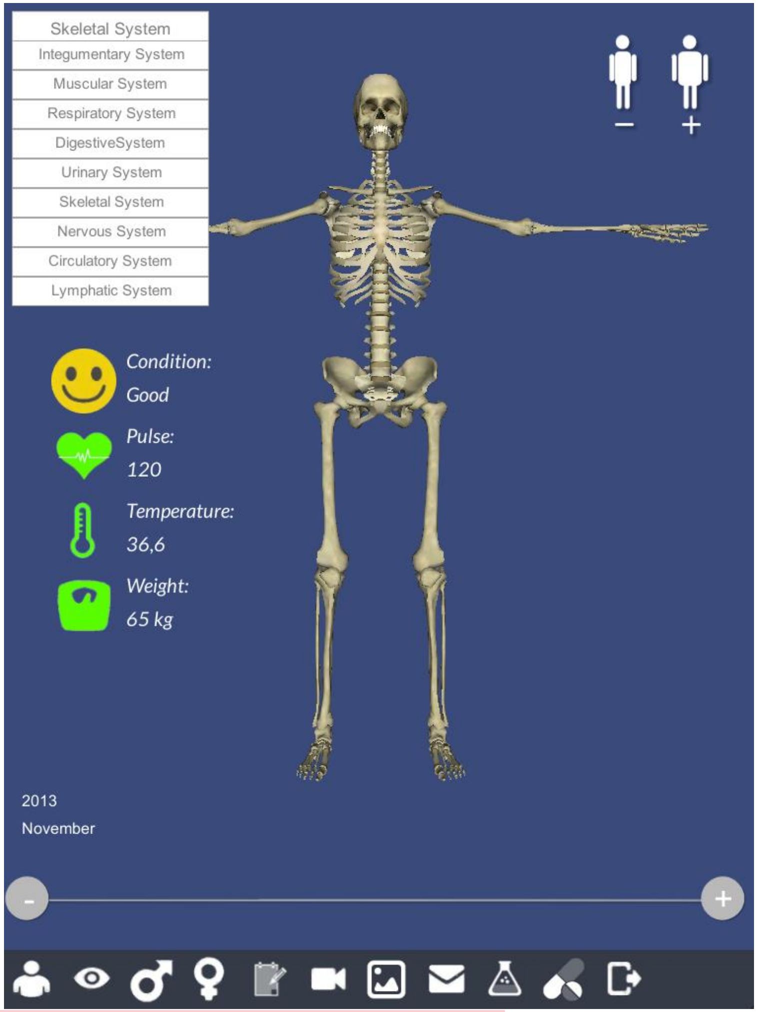


Biological Systems



- Integumentary
- Muscular
- Respiratory
- Digestive
- Urinary
- Skeletal
- Nervous
- Circulatory
- Lymphatic



Medical Data Exchange

- Health Level Seven (HL7)
- Digital Imaging and Communications in Medicine (DICOM)
- System of Concepts to Support Continuity of Care (ISO EN 13940, CONTSys)
- Electronic Health Record Communication (EHRcom, EN 13606)
- Health Informatics - Service Architecture (ISO EN 12967, HISA)
- ISO 18308
- ASTM E2369
- Biomedical Research Integrated Domain Group (BRIDG) model
- SNOMED Clinical Terms (SNOMED CT)
- Logical Observation Identifiers Names and Codes (LOINC)
- International Classification of Diseases (ICD)
- openEHR
- MedDRA
- Translational Medicine Ontology (TMO)
- Foundational Model of Anatomy (FMA)
- Health Data Ontology Trunk (HDOT)

What is a common denominator? RDF? OWL?
Anything else?

Micropapular weak is a disorder __located in__ the skin, and a __morphology__ of Maculopapular rash

```
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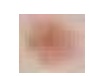
How to visualise this?



Source: http://www.w3.org/wiki/HCLS/ClinicalObservationsInteroperability/

Relevant Projects

- Integrated Biomedical Informatics for the Management of Cerebral Aneurysms (@neurIST)
- Association Studies As¬sisted by Inference and Semantic Technologies (ASSIST)
- Integration of viral genomics with clinical data to predict response to anti-HIV treatment (EuResist)
- A Strategy for the EuroPhysiome (EuroPhysiome)
- Advancing Clinico-Genomic Trials on Cancer (ACGT)
- Health-e-Child
- The European Virtual Human Immune System (ImmunoGrid)
- Virtual Laboratory for Decision Support in Viral Disease Treatment (ViroLab)
- Semantic Grid Browser for the Life Sciences Applied to the Study of Infectious Diseases (Sealife)
- Integrating Information from Molecule to Man: Knowledge Discovery Accelerates Drug Development and Personalized Treatment in Acute Stroke (I-Know)
- Patient specific image-based computational modelling for improvement of short- and long-term outcome of vascular access in patient on hemodialysis therapy (ARCH)
- Integrated cardiac care using patient specific cardiovascular modelling (euHeart)
- ICT enabled prediction of cancer reoccurrence (NeoMARK)
- Patient specific simulation and preoperative realistic training for liver surgery (PASSPORT)
- Computational prediction of drug cardiac toxicity (PreDICT)
- From patient data to personalised healthcare in Alzheimer's Disease (PredictAD)
- Road mapping technology for enhancing security to protect medical and genetic data (RADICAL)
- ACTION-Grid
- Clinically Oriented Translational Cancer Multilevel Modelling (Contra Cancrum)
- Highly Accurate Breast Cancer Diagnosis (HAMAM)
- Image-based Multi-scale Physiological Planning for Ablation Cancer Treatment (IMPPACT)
- The Osteoporotic Virtual Physiological Human (VPHOP)
- Multi-level patient-specific artery and atherogenesis model for outcome prediction, decision support treatment, and virtual hand-on training (ARTreat)
- Development of an Open-Source Software Library for the Interactive Visualisation of Multiscale Biomedical Data (MSV)
- Personalised models of the neuromusculoskeletal system (NMS Physiome)
- Grid-enabled pan-Atlantic platform for large scale simulations in paediatric cardiology (Sim-e-Child)
- Interoperable Anatomy and Physiology Project (RICORDO)
- Transatlantic Tumour Model Repositories (TUMOR)
- Future and Emerging Technologies for the Virtual Physiological Human (VPH-FET)
- Patient specific modelling and simulation of focused ultrasound in moving organs (FUSIMO)
- A Social Collaborative Working Space Semantically Interlinking Biomedical Researchers, Knowledge And Data For The Design And Execution Of In-Silico Models And Experiments In Cancer Chemoprevention (GRANATUM)
- Promoting and Monitoring Biomedical Informatics in Europe (INBIOMEDvision)
- Integrative Cancer Research Through Innovative Biomedical Infrastructures (INTEGRATE)
- From data sharing and integration via VPH models to personalised medicine (p-medicine)
- Evidence-based Diagnostic and Treatment Planning Solution for Traumatic Brain Injuries (TBIcare)
- Quantitative model of thrombosis in intracranial aneurysms (THROMBUS)
- Virtual Gastrointestinal Tract (VIGOR++)
- Airway Disease Predicting Outcomes through Patient Specific Computational Modelling (AirPROM)
- Patient-specific spinal treatment simulation (MySpine)
- Virtual Physiological Human: Sharing for Healthcare - A Research Environment (VPH-Share)
- Digitally Integrated Scientific Data for Patients and Populations in User-Specific Simulations Research Area (DISCIPULUS)
- Modelling and simulation environment for systems medicine (Chronic obstructive pulmonary disease -COPD- as a use case) (Synergy-COPD)
- Digital Patient (DIPACT)
- Models and simulation techniques for discovering diabetes influence factors (MOSAIC)
- Semantic Infostructure interlinking an open source Finite Element tool and libraries with a model repository for the multi-scale Modelling and 3d visualization of the inner-ear (SIFEM)
- The Digital Radiation Therapy Patient (DR-THERAPAT)
- Model-Driven Paediatric European Digital Repository (MD-Paedigree)
- Multiscale Immune System SImulator for the Onset of Type 2 Diabetes integrating genetic, metabolic and nutritional data (MISSION-T2D)
- A Demonstration of 4D Digital Avatar Infrastructure for Access of Complete Patient Information (MyHealthAvatar)
- Virtual Physiological Human: Personalised Predictive Breast Cancer Therapy Through Integrated Tissue Micro-Structure Modelling (VPH-PRISM)
- Generic Open-end Simulation Environment for Minimally Invasive Cancer Treatment (GOSMART)
- Virtual Physiological Human: DementiA Research Enabled by IT (VPH-DARE@IT)

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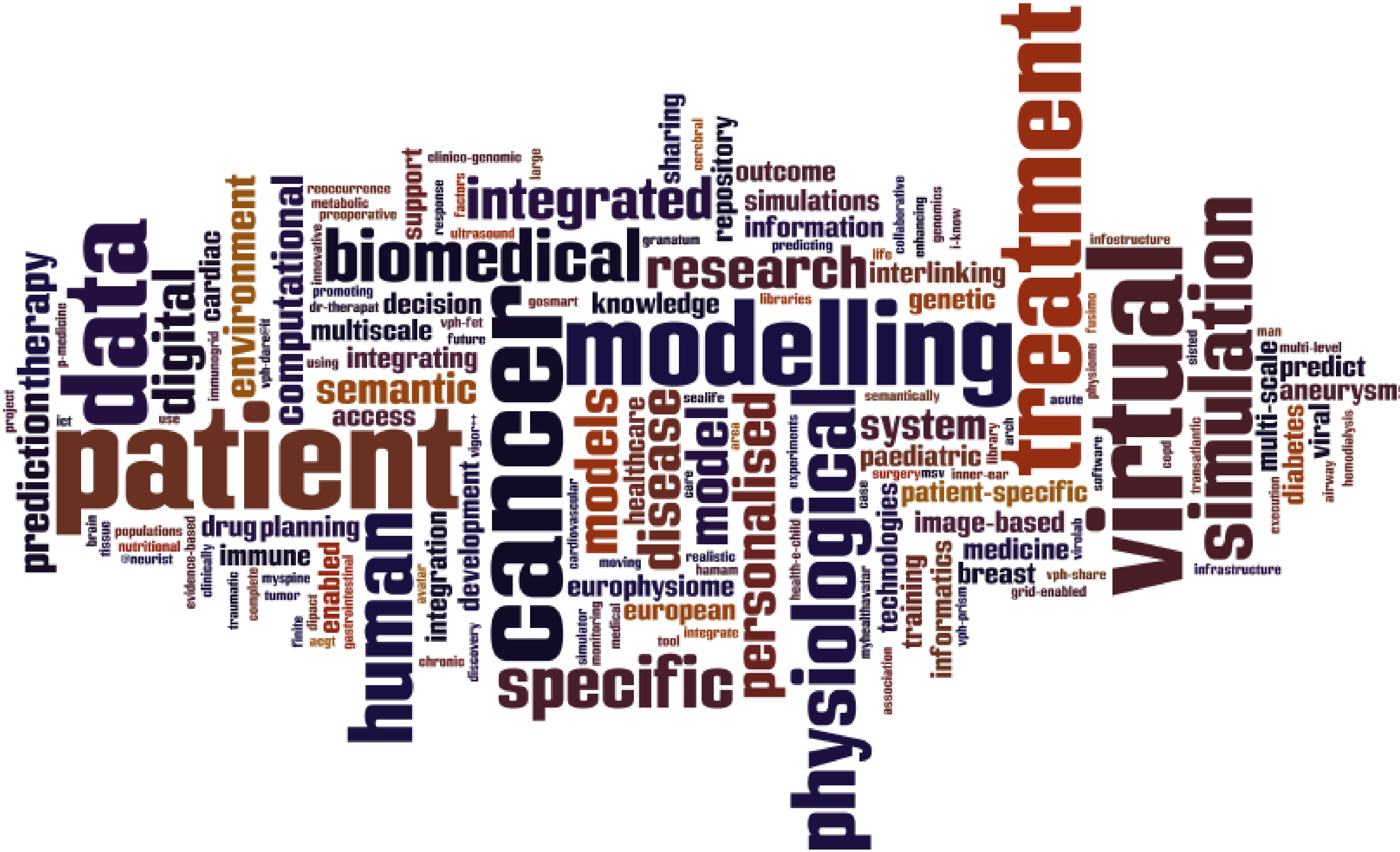
Word Cloud



Health Care Use-Case Example: Cardiological disease risk modelling

As a cardiologist prepares for an appointment, he opens the patient's profile, which is a **3D model of a patient (avatar)** in a specialised software system. By pointing the mouse to different areas of the avatar, the doctor sees **results of the previous analysis and health-checks**. Nothing indicates any problems, the patient has been healthy.

While the patient tells about his symptoms, the doctor types **notes**. All the nouns are analysed and pop-up messages propose the possible **need for clarification or indicate associated problems**. The doctor may **reject or use the suggestions**, and as a result the doctor has a full enough description of the patient's complaint. He **observes** that the patient did not sleep much recently and appears to be nervous.

The doctor notices that the heart is **highlighted in the avatar**. Directing the mouse pointer to the avatar's heart, the doctor moves the **timeline slider** and sees that years ago the patient complained of pain in his heart. It happened when the patient was a student and had a heavy examination period. He slept very little at that time and was very anxious. Based on the addition of the current symptoms, the **system proposes** a **set of analyses** to the doctor and a **list of required checks**.

As soon as results of all the analyses and checks are ready, doctor sees a **pop-up message** with a **warning**. EKG shows that patient has a problem with his heart. The system has **simulated a development of a problem** and found that such patient's hobby as power-lifting is not recommended in a given case until the problem is eliminated. By moving a slider of a **simulation timeline** the doctor sees that the problem may **progress** really fast and thus the patient must be **forewarned** immediately. By moving a slider of a **zooming scale**, the doctor observes that area of patient's heart where the problem is. Along with **3D model of a problem**, he sees **results of analyses and checks** as well as **recommended treatment**.

Home Care Use-Case Example: Preventive and informative visualization

An elderly woman (70-years old) lives alone in her flat. She does not want to move to a nursing house, and still prefers to go shopping herself. She used to bring heavy (as for her abilities) bags from supermarkets.

A **specialised software system** built-in into a **living environment** receives data from a heartbeat monitor worn by the woman and discovers the extra high heart-beat. At the same time built into a floor **sensor** reports that a weight of a woman is 10 kg higher than usually. By **matching** this **data** with **information** that “Visit a supermarket” **event** is over and comparing with other **historical data**, the system runs **simulation** and **concludes** that carrying relatively heavy weight is dangerous for woman’s heart.

The **system sends a video-message** to woman’s daughter. On a video a **result of a simulation** is shown: an **avatar** of the woman is carrying a plastic bag to which the following **label** is attached: “Supermarket, 10 kg”. A heart of the avatar is **blinking red**, and **results** of heartbeat **measure** is shown. Then avatar falls down and result of simulation of heart’s **problem is displayed**. The daughter calls to his mother and tries to explain her how dangerous it is to carry in hands heavy parcels from supermarkets.

Home Care Use-Case Example (cont.): Preventive and informative visualization

In a long while, the woman does not still listen to daughter's advices and brings a heavy parcel from a supermarket. As it was **anticipated by a simulation**, she gets a heart attack. She does not have time to push a "Panic Button" on her wrist. Immediately based on data from a **fall-detection system** and the **heart-beat monitor**, the system causes the "Human in danger" **alarm**.

The woman's daughter and first-aid dispatcher receive the same **multimedia message**: avatar is laying down, its heart is red and **shown in a larger size**, and heartbeat is **displayed** on the **virtually-attached label**. The daughter has only given information, but a medical professional may access to any **complementary data** that may help - from all **sensors** around the woman. Supplementary data that is available and displayed on the avatar, and around it – at those **places** where data were obtained.

The same **information** (avatar, its position and available **supplementary data**) is **sent** to a doctor of an ambulance car (he uses a **mobile version** of the system). The ambulance car doctor is able to browse a **medical records** of the women up-to a **current moment** – for being **better prepared** to **treat** his new patient **properly**.

Wellness Use-Case Example: Visualised self-control

A family couple, both at the age of 45, decide to loose some of their extra weight. Every of them launches a **personal** “Loosing weight” programme using a specialised software system **built-in into a living environment**. The system **guides** them both to visit a nutritionist. They apply for an **appointment**, and **give permissions** to check their **nutrition data**.

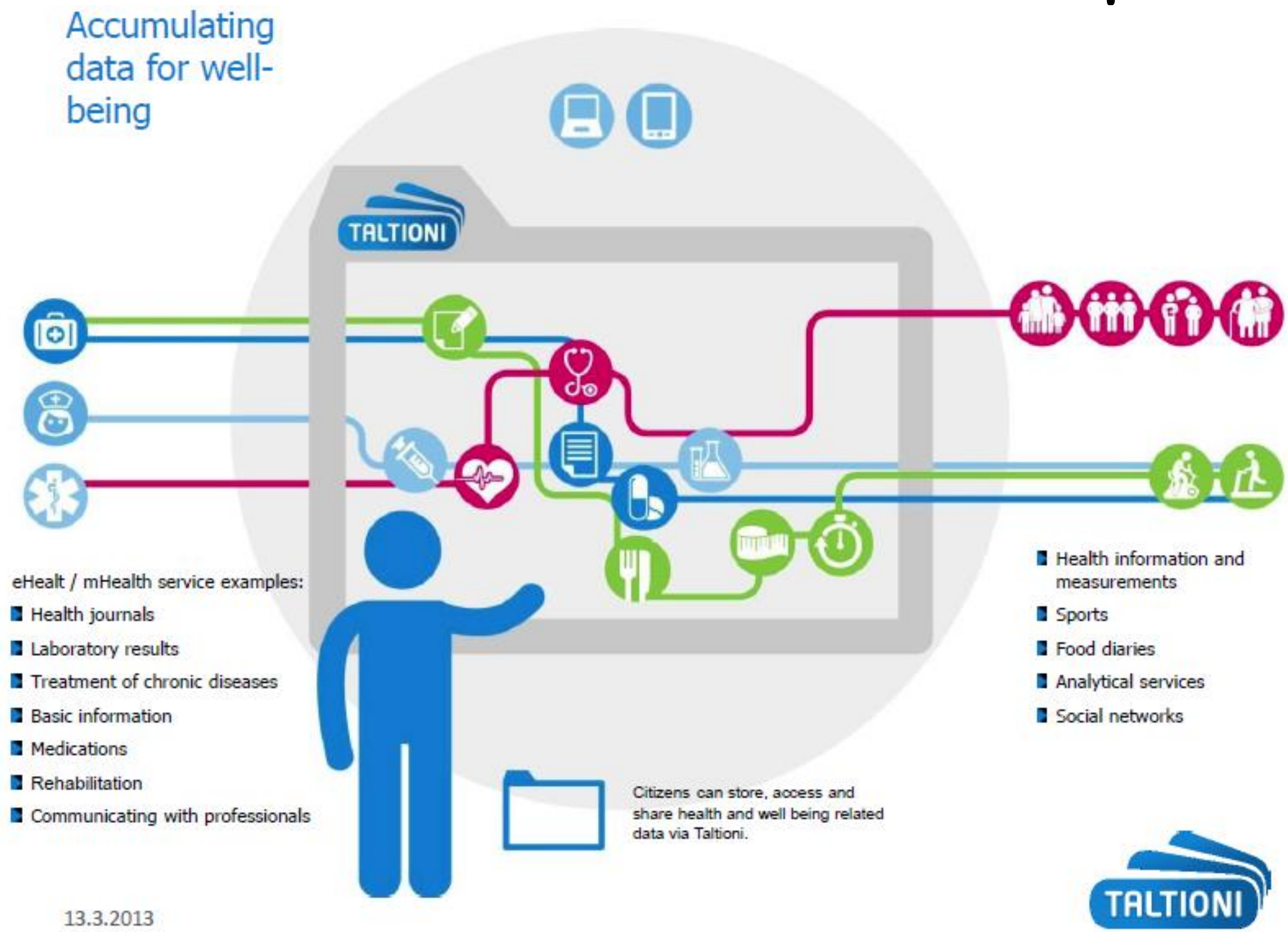
The nutritionist receives information about **dietary habits** of a family couple. This information is a result of **processing data** from a refrigerator, the “Cooking aid” software, movement detectors, weight sensors, and those systems that are providing **wellness and social life services**. The nutritionist prescribes a set of analysis and checks.

As soon as results of all the analyses and checks are ready, the software **system models** bodies of both family members. By observing their avatars, both family members are able to see their **skin transparent** in those areas where fat is. They can **zoom in** and see their fat **structure in details**.

By doing exercises and changing their dietary habits, both family members lose weight; they can **observe progresses** and **compare** those with previous **states** by using **timeline sliders** of their avatars.

When the special diet is over, and the family couple comes back to **usual life**, the system continues to observe nutrition habits and **stile of life** of the family. In case the system observes **unwanted changes**, it **informs** family members of those. The family couple may see a **result of simulation** showing how those unwanted changes may affect to their weigh.

Medical and Wellness Data – Finnish Experience



Source: Tuomas Teuri, Taltioni – growing eHealth ecosystem

Conclusion and Discussion

- Clear benefits of visualisation of medical and wellness data through a digital patient avatar.
- Solutions for consumers?
- Efficient and interoperable data managements systems: how to deal with Big Data?
- Quality of data and efficiency of automated knowledge-retrieving systems in a course of entire data processing chain – from data acquisition until final representation – how to achieve?
- Data certification and provisioning that ensure privacy, security, and trust?
- Seamless immersion into a model from the highest level of observation (an avatar in a virtual world) until the finest-graining levels (nano-biomedicine)?
- Visualisation processes?
- Multidisciplinary R&D projects are needed.

Q&A

Thank you for your attention!

Vadym Kramar

vadym.kramar@oamk.fi

Mobile: +358 44 327 0770