

# Personalized HealthCare and Agent Technologies

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# AGENDA

- 1 Introduction 
- 2 Personalization in Medicine and HealthCare
- 3 E-Coaching in Medical Domains
- 4 Personalized and E-coaching Medicine - Agents
- 5 Conclusions

# 1 Introduction

- Remarkable **gains in life expectancy** => current society of an **ageing global population**
- Prevalence of disease and disability =>
  - need for **constant healthcare monitoring** and support of **elderly/disabled** people
  - **platforms and tools** for monitoring, **smart support and making personalized recommendations** to old people
  - **Ambient Intelligence (Aml)** - a new paradigm in IT aimed at **empowering people's capabilities** by the means of **digital environments** (sensitive, adaptive, and responsive to human needs, habits, gestures, and emotions).
  - **Aml - for healthcare monitoring** (sensors technology) and personalized support, incorporate **artificial intelligence, data mining, and agent technology**
  - Aml - for **health and wellness, home rehabilitation**, assessment of treatment

# 1 Introduction

## Modern approaches in HealthCare

- During **usual patient activities** - wide range of **data has been collected, processed, analyzed and proper decision making can help patients** in everyday activities.
- **Software (and intelligent) agents** - widely used in medical systems: **AI and pervasive (seamless) computing.**
- **Intelligent software agents** – deal with a variety of **medical and health related problems.**
  - patient and treatment information access, community care, decision support systems (DSS), patient scheduling, training, hospital management, elder citizen care, self-care and automatic health monitoring

# 1 Introduction

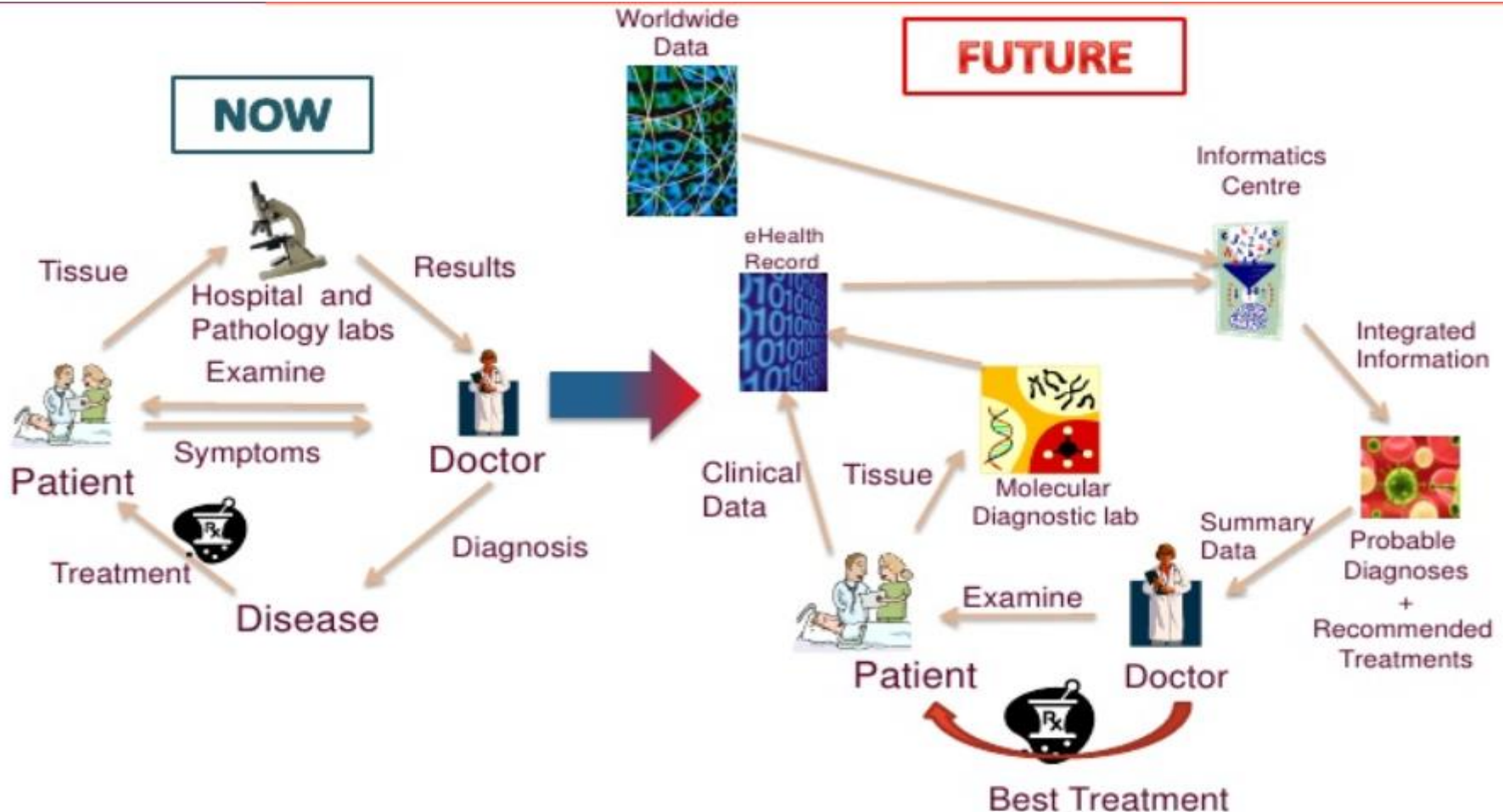
- **Aml** systems are widely used in medicine and healthcare – important **characteristics**:
  - **Context Aware**: exploits the **contextual and situational info**.
  - **Personalized**: **personalized/tailored** to the needs of each individual.
  - **Anticipatory**: can **anticipate the needs of an individual** without the conscious mediation of the individual.
  - **Adaptive**: **adapts to the changing needs** of individuals.
  - **Ubiquity**: is embedded and is **integrated into our everyday environments**.
  - **Transparency**: recedes into the background of our daily life in an **unobtrusive way**.

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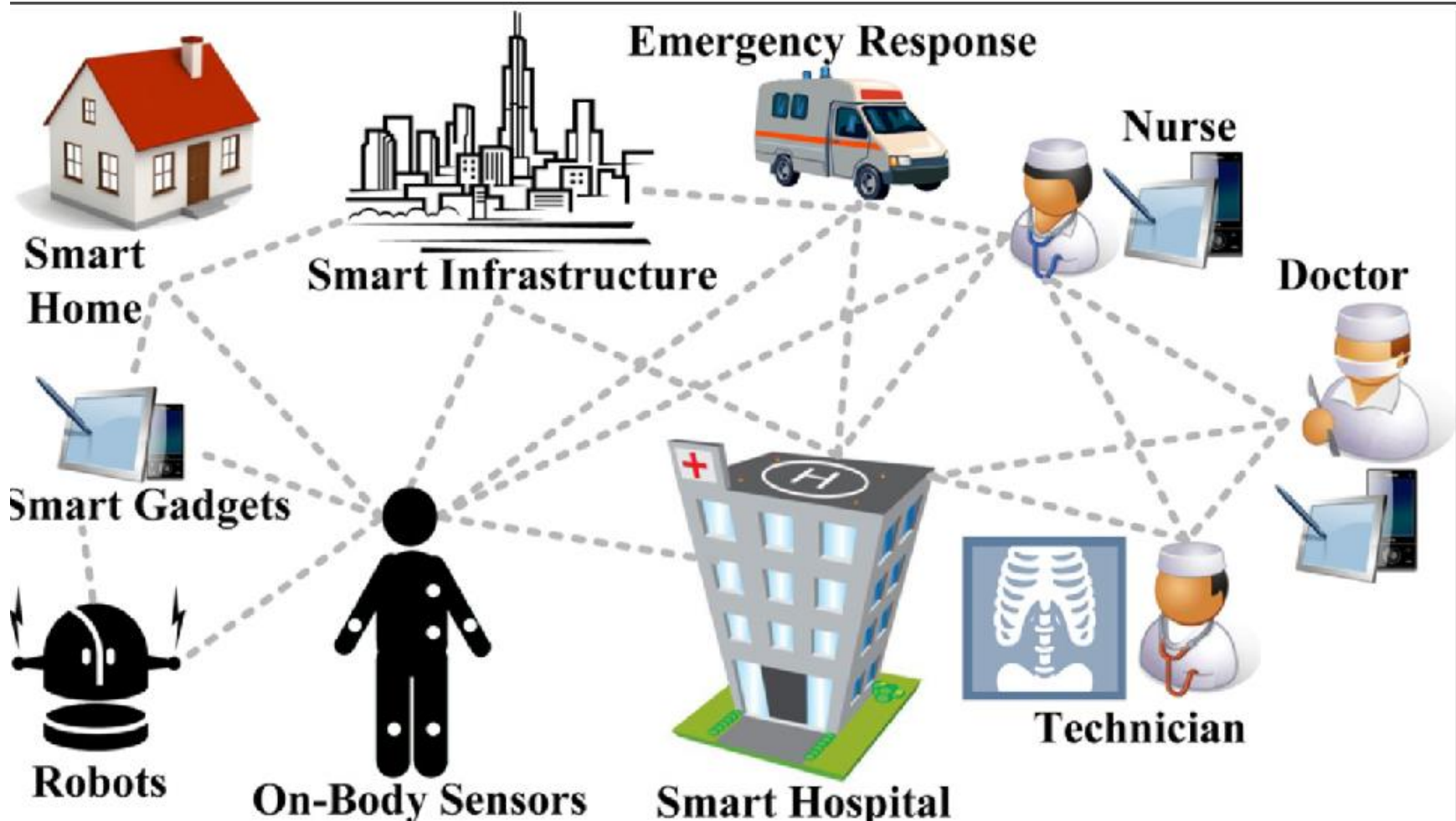
# 2 Personalization in Medicine and HealthCare

- Rapidly changing ICT is essential bases and "push ahead" for innovative approaches in medicine and healthcare



# 2 Personalization in Medicine and HealthCare

- Transparent and unobtrusive way





## 2 Personalization in Medicine and HealthCare

- Rapid use **smartphones and 3G and 4G networks** - **expanded use of health devices** (influenced medical aspects like healthcare of aging people)
- **Low-cost sensors, range of wearable devices** - **monitor detailed clinical metrics**: blood pressure, heart function, glucose and insulin levels, and medicine intake and so on.
- **Patients are moving into different technological interconnected worlds** - through smartphones/tablets can access different health data and **monitor their daily activities**.
- Patients can **share their results and behavior (social networks)** and engage in lifestyle improvement games with their peers.

## 2 Personalization in Medicine and HealthCare

- **Hyper-connected patients** – open directions of research, help ageing population to cope with everyday activities smoothly and independently: ubiquitous and smart environments, personalized medicine, healthcare e-coaching.
- **Platforms, AAL (Ambient Assisted Living), Aml environments**
  - **boost patients in their leaving space function**
  - **provide flexible and intelligent services:** Pervasive Ubiquitous Computing and Artificial Intelligence (AI), Networks, Sensors and **Unobtrusive Human Computer Interfaces (HCI)**

## 2 Personalization in Medicine and HealthCare

- Personalized medicine and healthcare
  - collect information from the patient to better tailor his/her needs
  - prediction, prevention and treatment of illness that is targeted to patients' needs.
- **Data collection by sensors distributed** throughout the environment
  - Communicate physiological variables to a **mobile smartphone** or other **computerized device**
  - **Gadgets allow the ongoing monitoring** of functional status in **real time (fine tuning of therapy)**
  - **Efficient ways of collected data analyses**; identify **areas for improvement**; **provide education** on how to achieve desired health goals; **gamification** to increase engagement; **encouraging individuals** to share their achievements with friends (compete and collaborate);

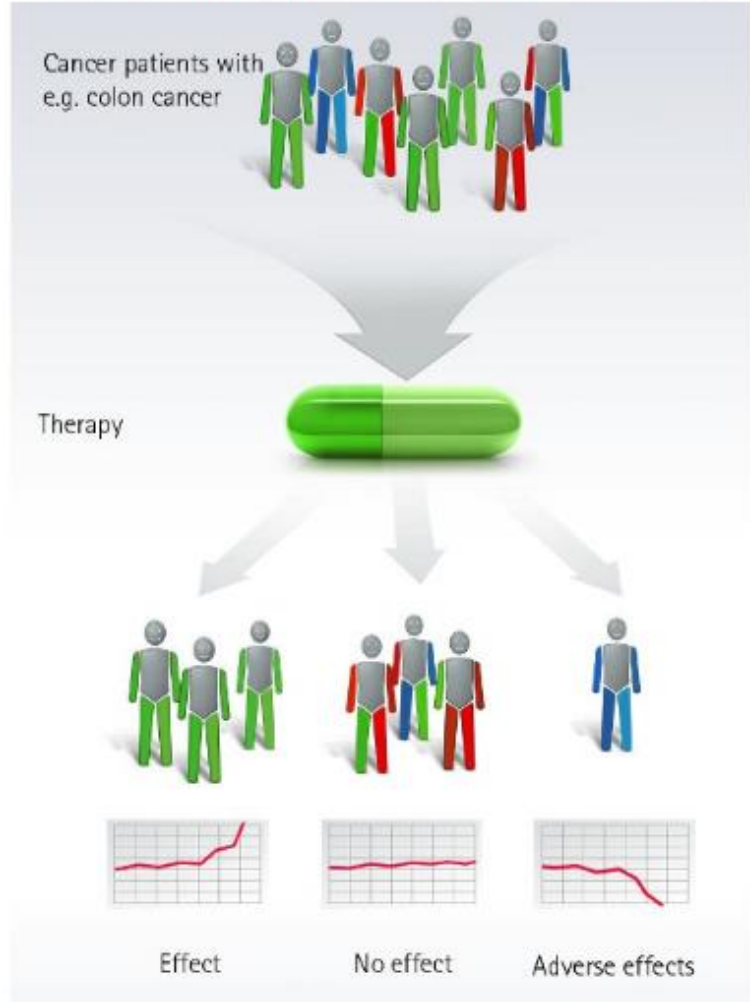
## 2 Personalization in Medicine and HealthCare

- **Range of ICT platforms, intelligent DM algorithms** (telehealth, wearable devices, and sensor driven detection software in homes) is a key challenge in achieving following demands
  - **Help older people to stay independent and healthy** for as long as possible
  - ...to **manage simple chronic conditions**
  - ... that **complex co-morbidities remain independent**
  - ... to **minimize the time** they have to spend in hospital.
- **Agent technologies** play important role and can significantly help in developing **higher-quality personalized** services

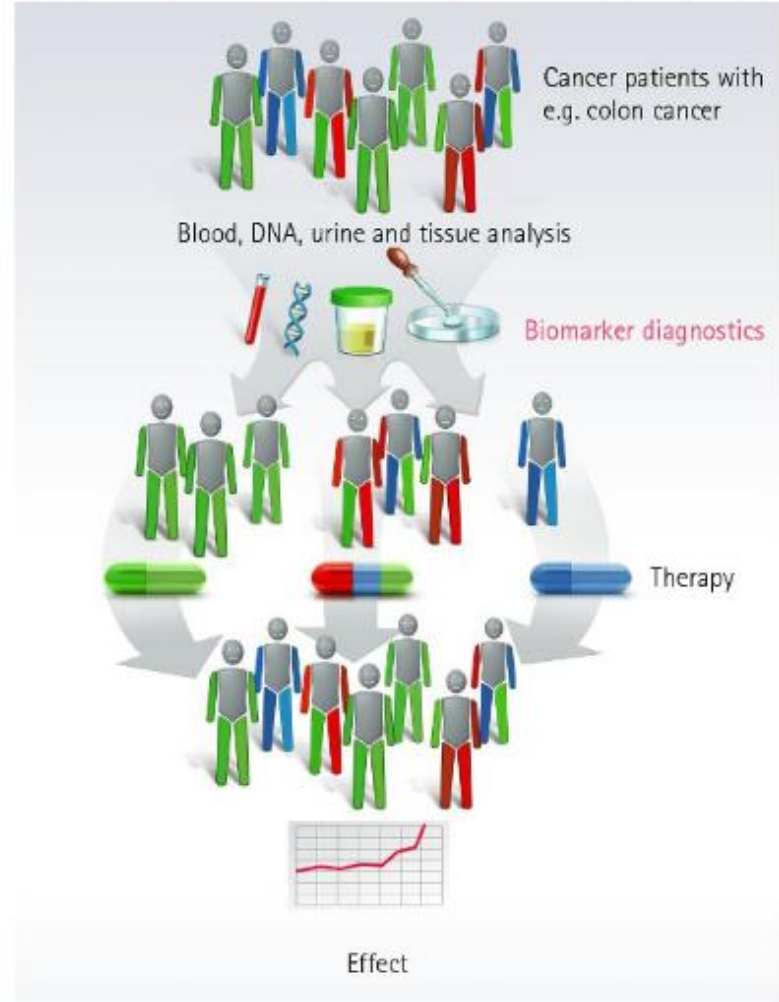
# 2 Personalization in Medicine and HealthCare

## Personalized medicine: Tailored treatment

Medicine of the present: one treatment fits all



Medicine of the future: more personalized diagnostics



# AGENDA

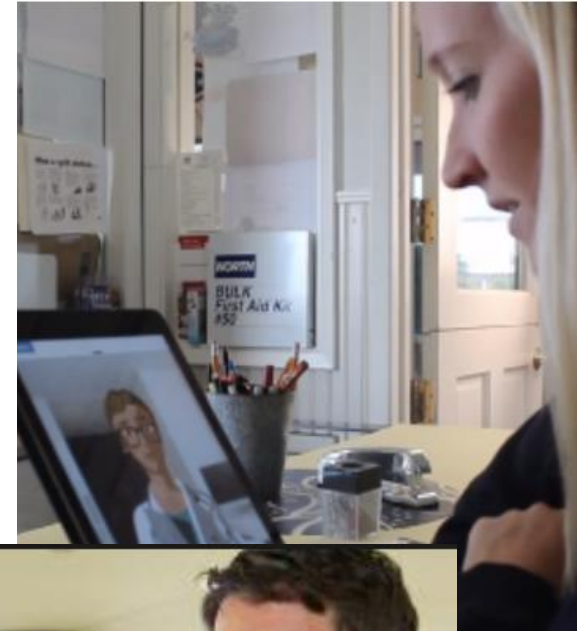
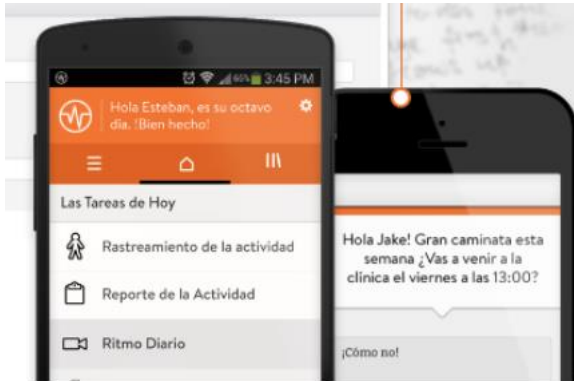
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## 3 E-Coaching in Medical Domains

- **Coaching is new trend in different aspects of human everyday activities** - promote relationships, feedback, care, conversation, collaboration, answers, and bonding between different persons, groups, and communities.
- **E-coaching** (effect of extensive use of the internet) - online process, **greatly expands the possibilities.**
- **Personalizes e-coaching** - can play significant role in **supporting people to achieve their health goals**, properly maintain their healthy behavior.
- Change of focus **from a disease-centered** approach towards a **patient-centered approach**
- E-coaching includes many aspects - persuasion, behavior change, personal contact and a type of recommendations.

# 3 E-Coaching in Medical Domains

## Healthcare and Virtual Agents

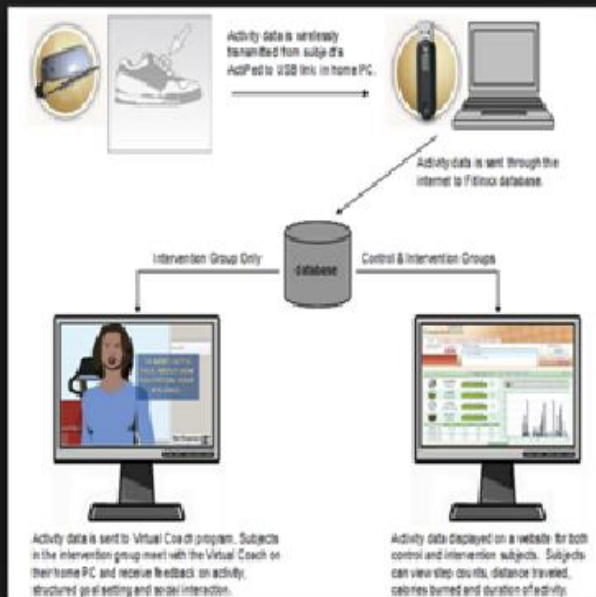




## 3 E-Coaching in Medical Domains

- **E-coaching process prerequisites - personalization, contextualization and frequent adaptation.**
- **E-coaching in personalized medicine is oriented to emotional and cognitive technologies:**
  - Wearables
  - Cognitive Health (Cognitive Enhancement, Cognitive Assistance)
  - Remote Patient Monitoring (for Activity Detection)
  - Medication adherence (Different Devices, Reminder Systems, Coaching and Advising, Coordination Systems)
- **Agent technologies are perfect candidates to take a role of e-coaches that supports automated self-help therapies.**

# 3 E-Coaching in Medical Domains



## JMIR-An Internet-Based Virtual Coac...

Journal of Medical Internet Research - 1448 x 1432  
- Slikovno iskanje

Figure 1. Illustration of technology used in the study and flow of data.

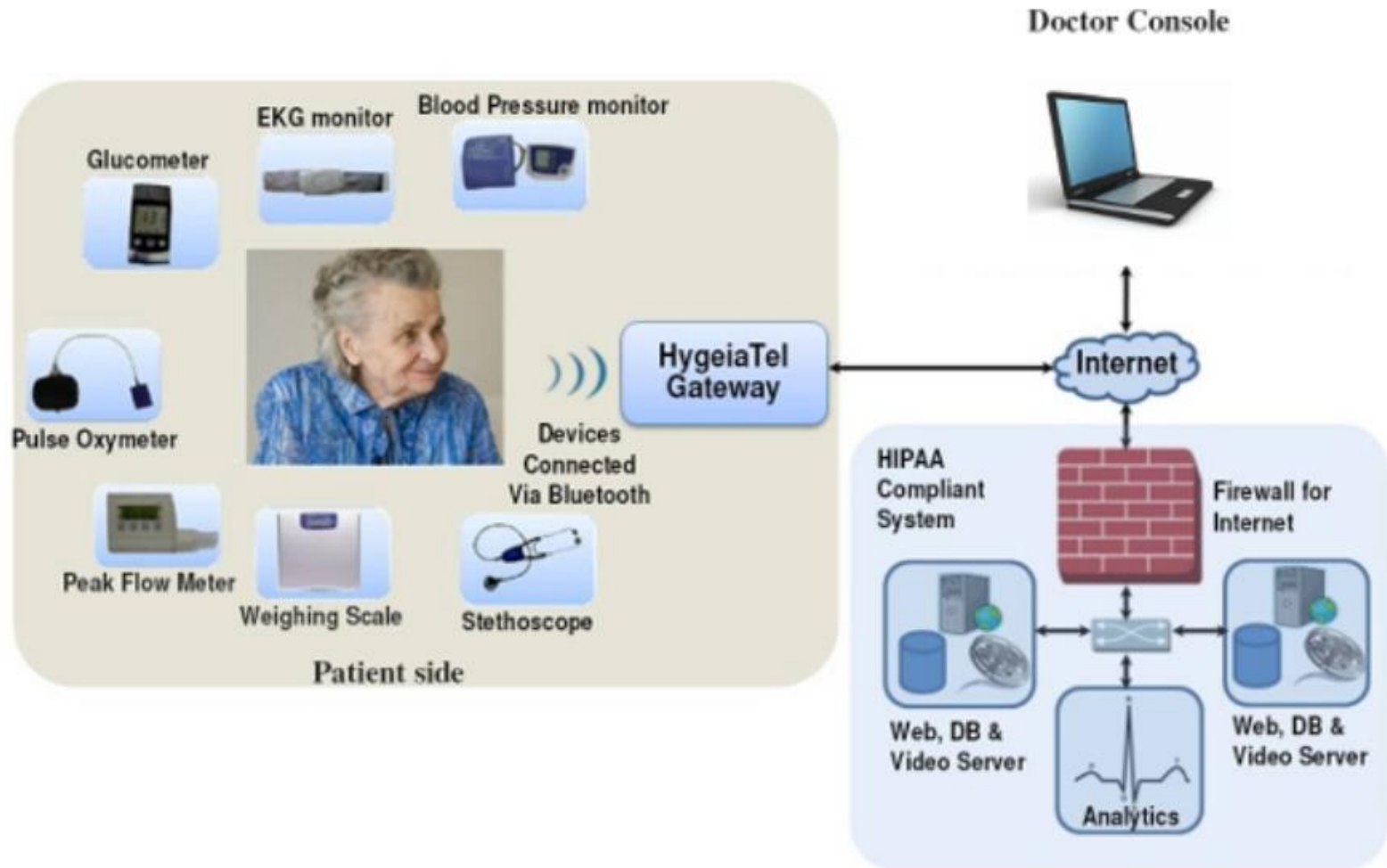
- Obišči stran
- Ogled slike
- Deljenje z drugimi

### Sorodne slike:



Slike so lahko avtorsko zaščitene. Pošljite pomoč - Pojdi povratne informacije

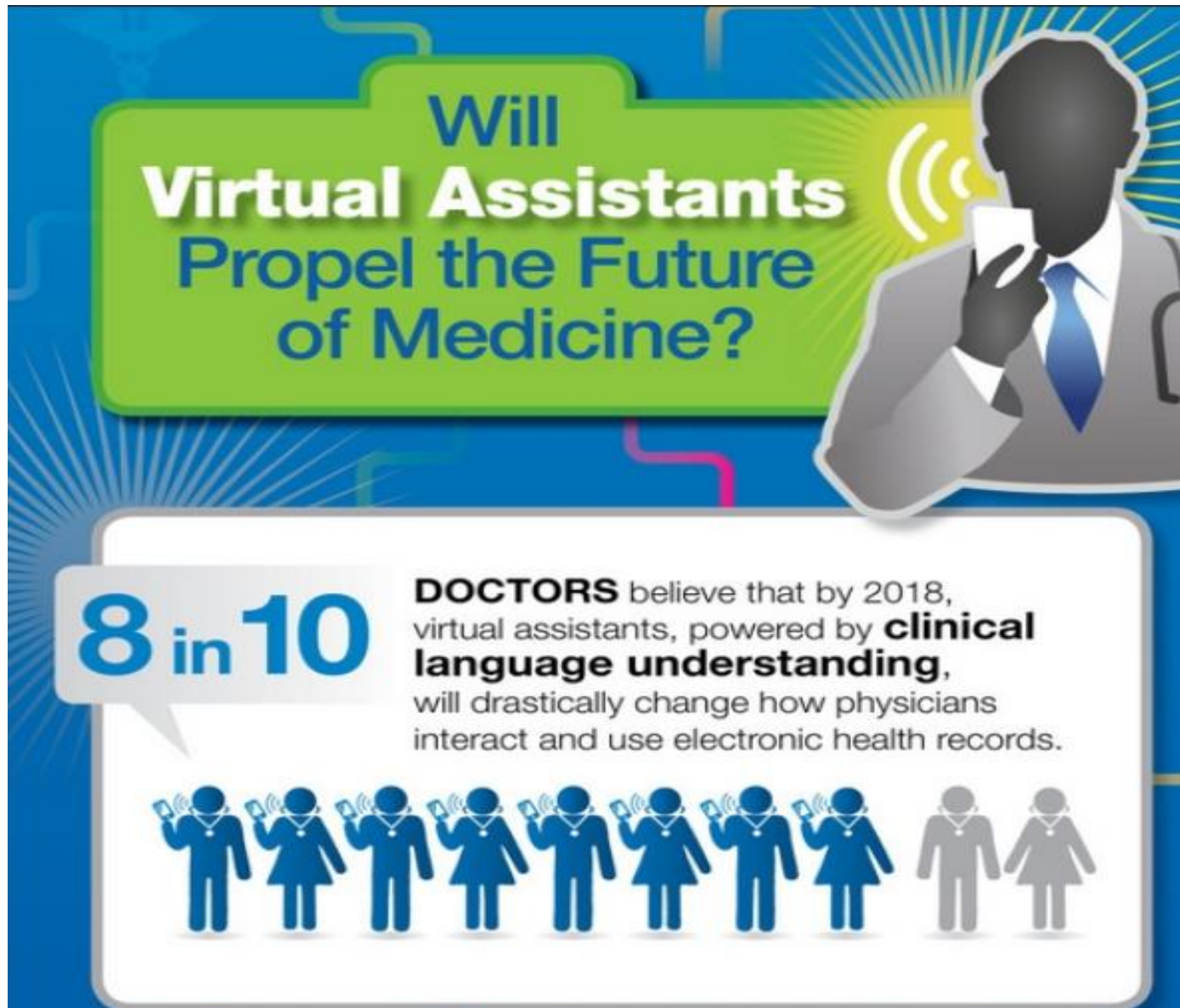
# 3 E-Coaching in Medical Domains



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## 4 Personalized and E-coaching Medicine - Agents



## 4 Personalized and E-coaching Medicine - Agents

- Different **wearable devices collect a pile of data** about patient and his/her environment.
- **Patient** is able to **view the instant and historical data** on their **mobile devices**
- **AI and ML techniques** are used to **analyze this data comprehensively**
- Such **platforms/services** have to **provide** the real-time hands-free **feedback and instructions through the sophisticated user interfaces** (visually, acoustically and tactilely).
- **Sophisticated user interfaces** (facilitate HCI) - realized as different **personal virtual and visual agents (avatars)**.

## 4 Personalized and E-coaching Medicine - Agents

- The development of **Aml-based software** requires creating increasingly **complex and flexible applications**.
- **Activities in Aml healthcare** environments are supported:
  - Autonomous **decision making agents** that incorporate learning mechanisms,
  - Agents **able to respond to events by (pre)planning in execution**.
- With good **reasoning and planning mechanisms agents facilitate** acquiring
  - **data from different devices** that patients use
  - data from **patients everyday living environment**.
- **Agents are good mechanisms that support straight coordination and communication among wireless medical devices.**

## 4 Personalized and E-coaching Medicine - Agents

- **Multi agent systems (MAS)** have been applied from **single healthcare activity** (knowledge-based medical system) to **complex, multi-component based systems**.
- **Use of MAS in healthcare initiates new applications** - personalized and socialized healthcare **systems with tailored recommendation capabilities**.
- **Agents and MAS** play role in
  - abstraction tools, predominantly for **modeling devices and their interactions**,
  - serve as **personal assistants**
  - recently as **virtual e-coaches and advisors in patients' emotional and cognitive activities**.



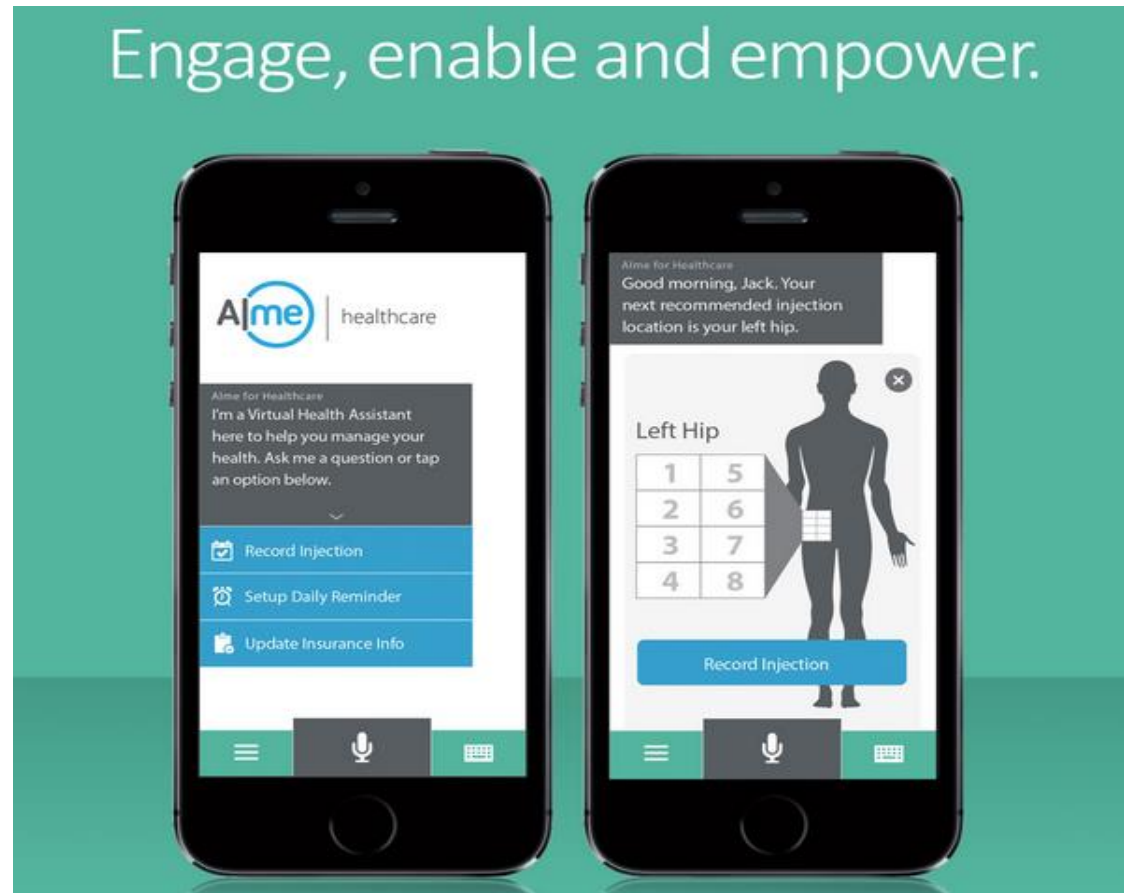
## 4 Personalized and E-coaching Medicine - Agents

- **Full potential of Aml** - sophisticated knowledge representation, reasoning, **AI and agent-oriented technologies**.
- **Software agents** can be **incorporated** in different **health platforms and applications**:
  - **supporting an expert's decision making** (based on big and complex data collected from wearable devices and environmental sensors),
  - **accessing and making use of distributed data sources**
  - **coordination of the execution of assistive technology** for healthcare activities.

# 4 Personalized and E-coaching Medicine - Agents

The **agent** needs to have

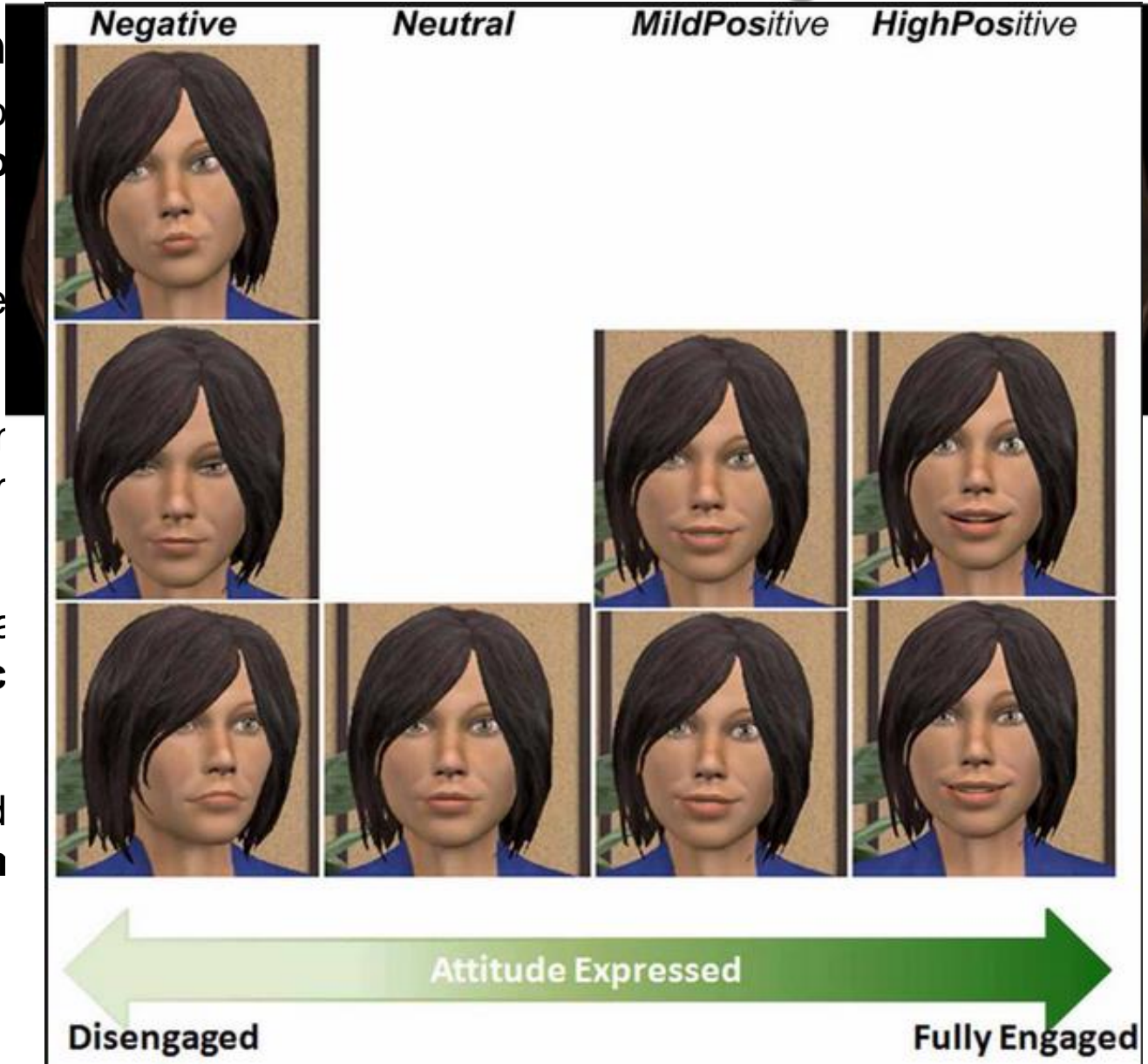
- wide range of **data and knowledge about the patient**,
- the particular **topic** of the **dialogue**,
- data about the **physical and social living environment**.



# 4 Personalized and E-coaching Medicine - Agents

- Agent

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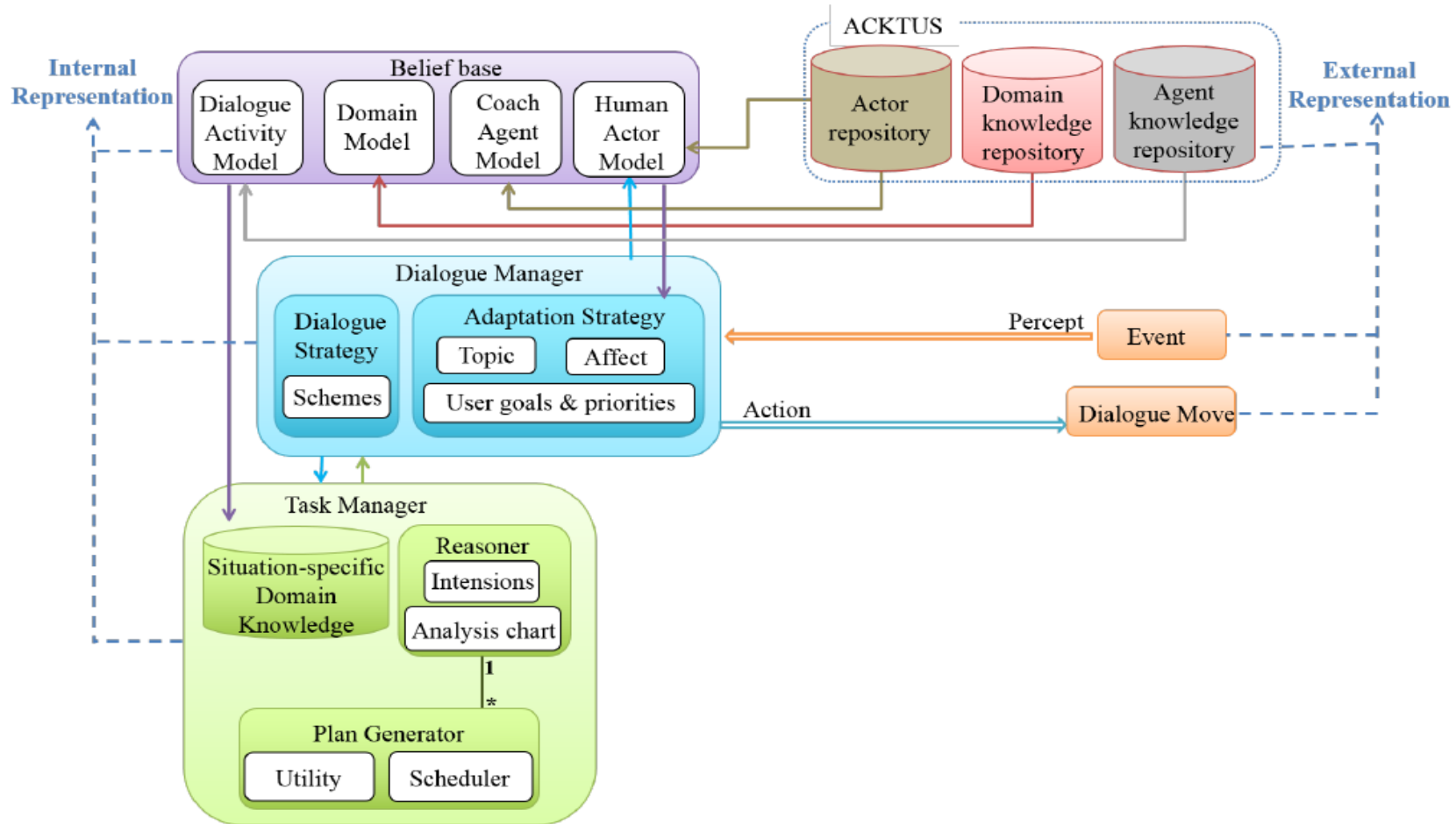
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# 4 Personalized and E-coaching Medicine - Agents

- General structure of cognitive agent architecture (Baskar 2014) that could be used in personalized medical e-coaching



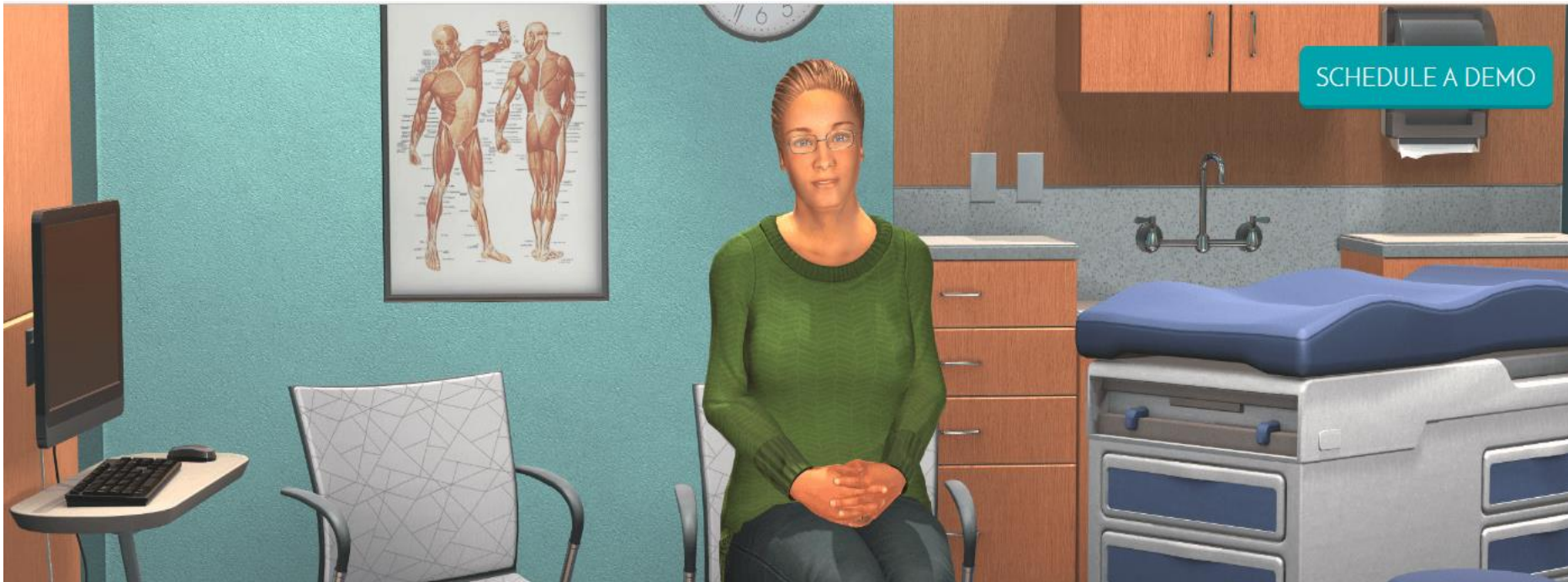
## 4 Personalized and E-coaching Medicine - Agents

- **The knowledge about the patient's activities – complex:** observation of personal and environment activity (by the seamlessly integrated sensors as a part of a ubiquitous computing environment).
- **Different kinds of dialogues** between **virtual agent** (e-coach) and **patient** could be performed
  - **Information-seeking dialogues**, where patient seeks the answer to some medical and health questions
  - **Inquiry dialogues** when the patient collaborates with virtual e-coach to obtain an answer to specific question
  - **Deliberation dialogues**, in this dialogs both participants collaborate to decide what course of action should be adopted
  - **Persuasion dialogues** involve virtual e-coach seeking to guide and persuade patient to perform some activities and solve some situations adequately in accordance with his health state.

# 4 Personalized and E-coaching Medicine - Agents

MURSION®

- Virtual Standardized Patient Training & Therapy, Duke University



HEALTHCARE

## 4 Personalized and E-coaching Medicine - Agents

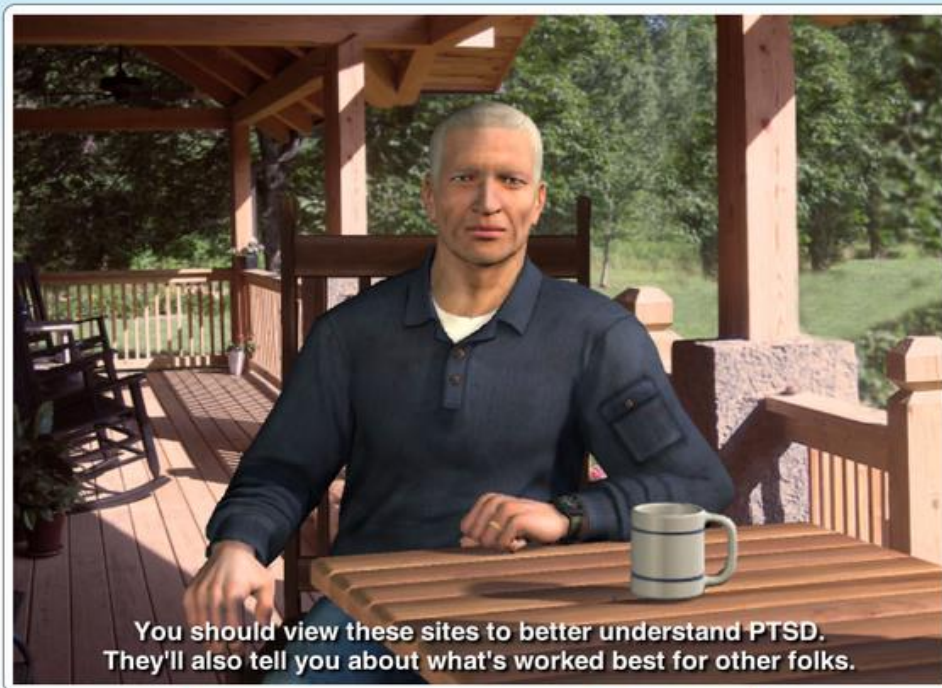
- Mursion's virtual standardized patient (VSP) simulators **offer medical educators a powerful new tool to enhance a blend of technical and interpersonal skills:**
  - Improving the **communication skills of a doctor** delivering a negative diagnosis
  - **Increasing the effectiveness of therapy skills** of psychologists
  - **Enabling prospective nurses to master giving an effective patient history and coaching interview**
  - **Allowing pediatric healthcare providers to train in scenarios** involving a parent and an elementary-age child
  - **Enhancing the debriefing skills** of a surgical team

# 4 Personalized and E-coaching Medicine - Agents



**Need to talk to someone NOW?**  
**Call this Helpline:**  
 **866-966-1020**

**Welcome Guests!**  
 Username:   
 Password:   
 Registration is **OPTIONAL**  
 Learn more about profiles **HERE**



Hello, welcome to Simcoach.

Some things before we get started: I'm based on the real experiences of warfighters and their families, but I am not a real human, so please be patient with me, and talk in short sentences. Far as conversations go, I'm best at talking about PTSD and depression. I'm not a shrink, but I'm here to help.

I'd like to ask you a few questions to get to know you a bit. Ok?

**no**

I think I can help you better if I know where you're coming from.

ok?

**no**

that's ok

What's the major concern that brought you here today?

Alright I'll check those out.  **SEND**

**STREAM** **NOTES**

 **PRINT**



# 4 Personalized and E-coaching Medicine - Agents



- Study and advancement of **uses of virtual reality (VR) simulation technology for clinical purposes**
- Using VR for **mental health therapy, motor skills rehabilitation, cognitive assessment and clinical skills training**
  - **Mental and Behavioral Health** - assessment, training and treatment of stress-related disorders.
  - **Game Based Rehabilitation** - deliver comprehensive, evidence-based rehabilitation training approaches for hospital, clinic, client populations.
  - **Neurocognitive Assessment and Training** - for individuals with stroke, traumatic brain injury and similar neurological disorders
  - **Virtual Humans - believable and more natural interactions**; simulated standardized patients for medical training, and personalized coaches for rehabilitation and wellness

## 4 Personalized and E-coaching Medicine - Agents

- **Software agents** also can be used in **other medical domains, support different tools/platforms in patient-centered environments**
  - **Planning and resource management** - focus on planning medical processes; monitoring of staff, patient health; hospital and clinical resources management.
  - **Decision support systems/knowledge base systems** - utilize knowledgebase and apply data analysis techniques, pattern recognition algorithms, knowledge inference techniques.
  - **Data management systems** – focus on health data extraction, representation, organization, storage, retrieval, and presentation.
  - **Remote care/self care systems** - systems designed for automated patient monitoring remotely, and patient self-care.
  - **Multifunction systems** – perform multiple tasks related to a complete healthcare solution, usually very complex.

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- 

# 5 Conclusions

# Health



# Care

Virtual Health Care across the continuum

146500974/Virtual Health Care Visual Image/V1/ Page 1 out of 2

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# 5 Conclusions

○ Where to go further



# 5 Conclusions

- **Immersive educational tool, Kids's Hospital Los Angeles** - "... prepare medical staff with the most realistic environment ... that they experience the fast-moving, life-and-death, decision-making process multiple times and create strategies to make fast and accurate decisions for when children's lives are in the balance,"



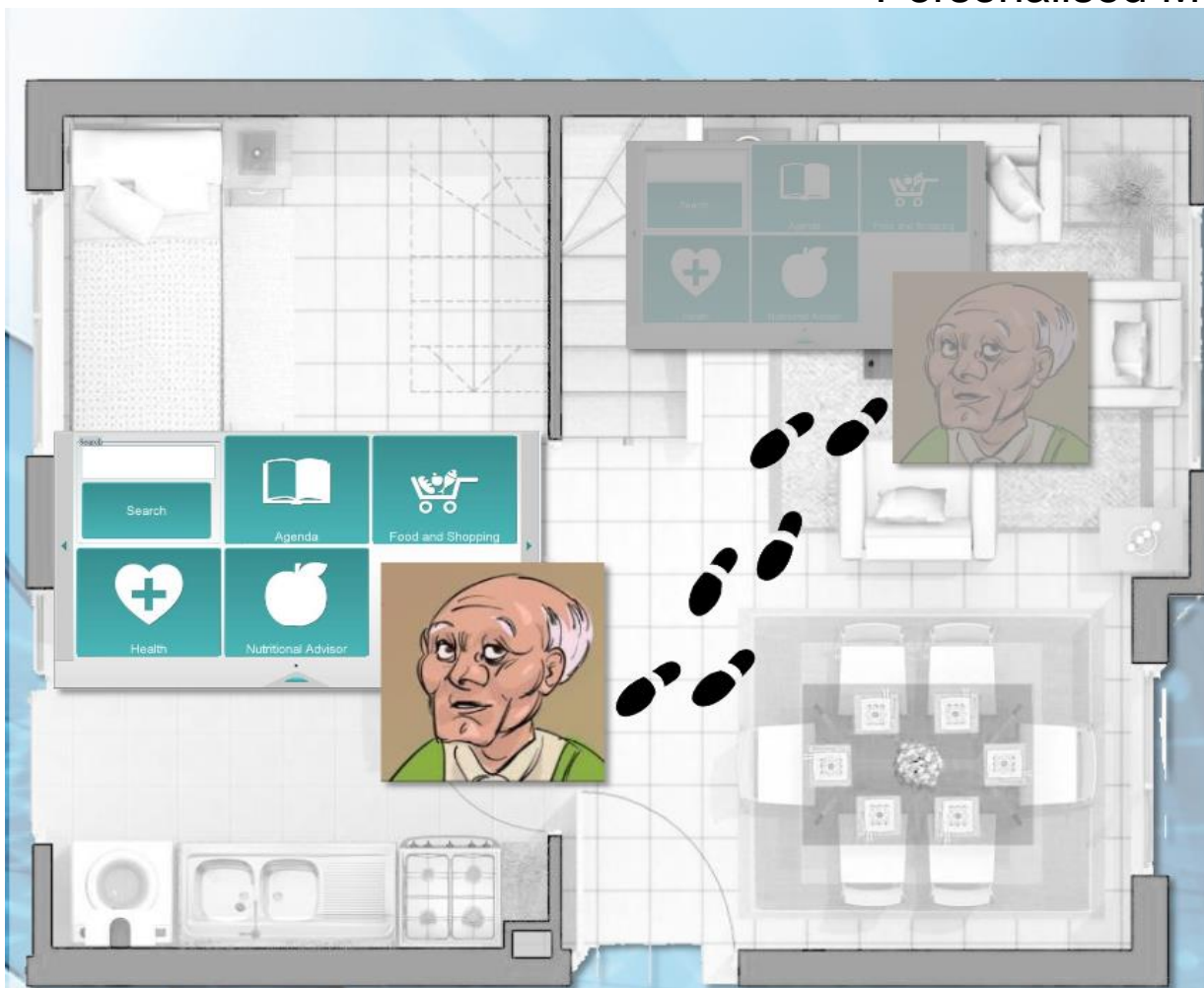
# 5 Conclusions



Provide runtime support for the execution of AAL

*UNIVER*sal open platform and reference  
Specification for *AMBIENT* Assisted Living

Bases for contemporary projects in  
Personalised Medicine



## “Follow-me” example

### Use Case:

An application is being displayed at the TV in the living room, where the user is. The user moves to another room, the kitchen, and then the application “follows” the user and it is displayed in a screen at the kitchen while faded out in the TV.

### universAAL Features behind the scene:

- The platform is running in a multinode environment (AAL Space)
- The platform automatically reacts to changes in context of the user (i.e. location).
- User interface framework is context aware and adapts its output to the context of the user.
- Contextual information is shared between all the nodes in the AAL Space.
- The hardware providing localization information is connecting universAAL platform through an abstraction layer that allows the connection of any home automation desired technology. Currently supported: ZigBee, KNX, Zwave, FS20, Bluetooth HDP...

# 5 Conclusions

## New service – nutrition advisor



uCC - universAAL Control Center is a universaal component that supports an easy integration of new uAAL services provided by the uStore into the AAL space and its different nodes, reducing the time and the complexity of the integration process: installation, customization (configuration, personalization) and maintenance.



### “uCC and uStore”

#### Get a new service from uStore:

Step 1: User accesses uStore through uCC specific button in the main panel.

Step 2: User searches and purchases a new AAL Service and starts the downloading and installation process.

Step 3: uCC guides the user in accessing Service Level Agreement, personalization and configuration, and finally makes the deployment of the new application in the local instance.

Step 4: the new icon is waiting to be pushed to give access to the experience of the new application.

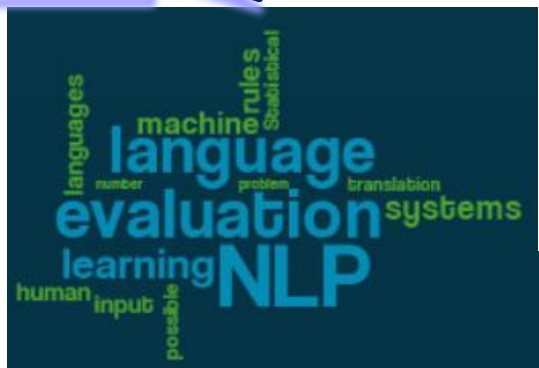
Uninstallation: users can uninstall the application in case they do not want to have it any more.



Advanced NLP

# 5 Conclusions

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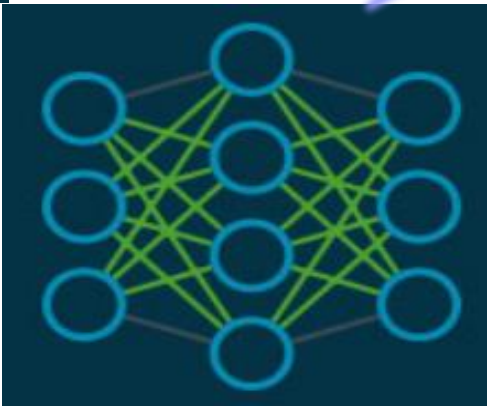


IR



ML

AR



IBM's Watson technology platform

# 5 Conclusions

- **IBM's Watson technology platform - NLP and ML to glean insights from huge amount of undigested data.**
- **Cognitive capable computing system**
  - **able to analyze high volumes of data,**
  - **process information like a human by understanding NL,**
  - **generating hypotheses based on evidence, and learning at it goes.**

# 5 Conclusions

**Innovative relationship between IBM and Cleveland Clinic** has included a variety of Watson **projects**:

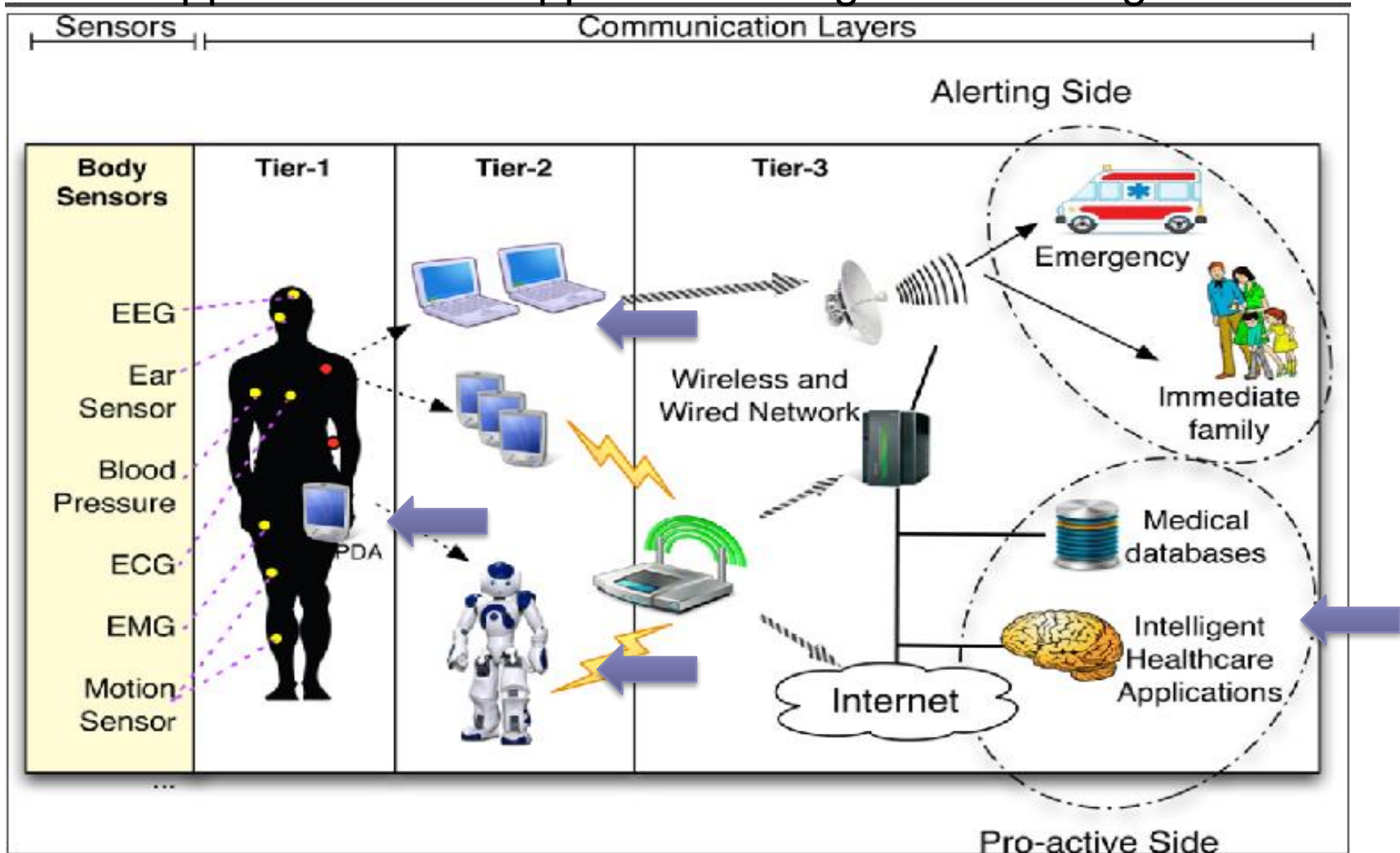
- 2011: joined forces to train the **technology** to “**think**” like a doctor.
- 2013: collaboration with physicians and students to **develop a Watson EMR assistant to help physicians** quickly summarize and cull **relevant insights from electronic medical records**.
- 2014: began pilot of Watson for Genomics to aid its research into **new cancer treatments based on a patient's genetic makeup**
- 2014: announced that IBM Watson would play a significant role as a **tool to help students analyze symptoms based on evidence-based insights rather than rote memorization**. Watson will become a vital part of a Health Education Campus (2019)
- 2015: IBM acquired Explorys, a **healthcare intelligence cloud company that has built one of the largest secured clinical data sets** in the world, representing more than 50 million lives

# 5 Conclusions

- Rapid development of range of ICT components has significant influence on personalized medicine and virtual e-coaching.
  - **Health analytics** - advanced methods and models to **analyze Big and Complex Data**.
  - **Predictive modeling** - **smart models** to predict behaviors, to prevent diseases and to **personalize healthcare**.
  - **Visualization of data** – **presentation of data** in meaningful way to **support reliable decision making**.
  - **Integration of mobile (hardware and software) technologies** – integration with data-platforms enable **automated services and tailor feedback and recommendations**.
  - **Personal communication and recommendations between patient and virtual e-coach** - In these area **agent technologies definitely could play extremely important role**. Virtual Human support and empower communication, personalization and increase motivation of patients.

# 5 Conclusions

Great opportunities for application of agent technologies



# Personalized HealthCare and Agent Technologies

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