SMART AGING:
TOPICS, APPLICATIONS, TECHNOLOGIES, AND AGENDA

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DREXEL UNIVERSITY College of Computing & Informatics

Questions

Do you like to get older?

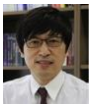
How many years did you *decide* to live?

Contents

- **Smart Aging Definition, Needs, Backgrounds**
- Components of Smart Aging Technologies
- Smart Aging Technologies
  - Wearables and IOT
  - Mobile Healthcare
  - Apps
  - AI-based Devices/Systems
  - Biomedicine and Genetics
  - Google/MIT/Drexel Projects
  - Healthcare Data Warehouses
  - Data Lake
- NIH Projects and Text Mining Results
- Suggestions and Research Topics
- Summary

Acknowledgement

- Yongjun Zhu, PhD, SungKunKwan University



- Min Song, Ph.D, Yonsei University

- Tatsawan Timakum, PhD candidate, Yonsei University

- Su-Ryeon Ryu, MS Student, Yonsei University

- Han-Joo Lee, PhD, Yonsei University

My Drexel colleagues who participated in SA workshops

My Journey on Smart Aging

- **Deputy Director, NSF-Sponsored Research Center on Visual & Decision Informatics (CVDI), 2012-2014.**
  - Worked with 13 different companies
  - Managed 12 big data projects

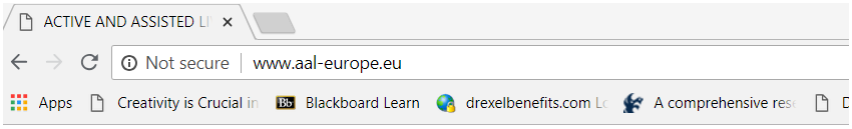
- **Smart Aging Project Opportunity**
  - **CVDI industry members were extremely interested in healthcare projects**
  - **An opportunity to create $X00M project at the National Level (2014-2016)**
  - **Drexel's *Cell2Society* Project (2018-)**

Smart Aging

- Concepts for Mitigating the Effects of Aging

- *Improvement of elderly people's life* by managing various healthcare challenges by intelligently *utilizing biomedicines, digital healthcare, big data & analytics, IOT, and communication technologies.*

Ambient Assisted Living (AAL)
Active and Assisted Living (AAL)



AAL PROGRAMME

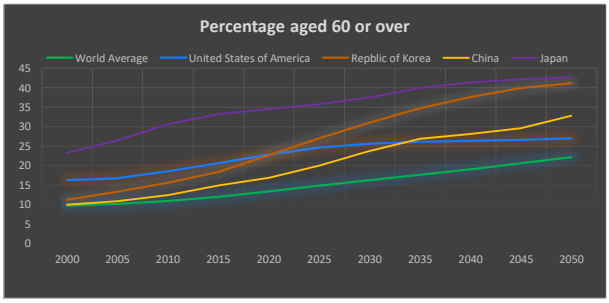
ACTIVE AND ASSISTED LIVING PROGRAMME
ICT for ageing well.

The primary goal of AAL solutions is to extend the time which elderly people can ***live independently*** in their preferred environment using ICT technologies for personal healthcare.

Ambient Assisted Living Healthcare Frameworks, Platforms, Standards, and Quality Attributes
Mukhtiar Memon,* Stefan Rahr Wagner,* Christian Fischer Pedersen, Femina Hassan Aysha Beevi, and Finn Overgaard Hansen, Sensors (Basel). 2014 Mar; 14(3): 4312–4341

Demographic Data

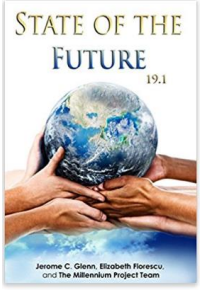
- Aged population is rapidly increasing (2012 UN data)
  - In Korea, 25% by 2022; 33% by 2034; 42% by 2050
  - World average, 15% by 2025; 22% by 2050
- The US population aged **65 and older** is expected to **double** by 2050; the population **over age 80** will **triple.**



Source: UN, retrieved from http://data.un.org/Data.aspx?q=aged+over+60&d=PopDiv&f=variableID%3a33

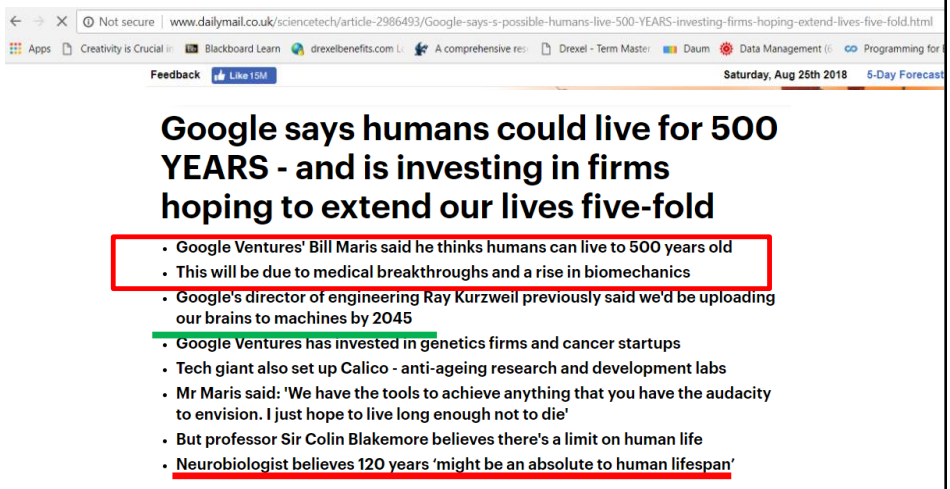
National Geographic Magazine (May 2013)

According to the Book



In 2050, the average life span will be **130 years old.**
(*State of the Future*, Jerome C. Glenn and Elizabeth Florescu, 2017)

According to the Google!



Not secure | www.dailymail.co.uk/sciencetech/article-2986493/Google-says-s-possible-humans-live-500-YEARS-investing-firms-hoping-extend-lives-five-fold.html

Apps | Creativity is Crucial | Blackboard Learn | drexelbenefits.com | A comprehensive res | Drexel - Term Master | Daum | Data Management | Programming for

Feedback | Like 15M | Saturday, Aug 25th 2018 | 5-Day Forecast

Google says humans could live for 500 YEARS - and is investing in firms hoping to extend our lives five-fold

- Google Ventures' Bill Maris said he thinks humans can live to 500 years old
- This will be due to medical breakthroughs and a rise in biomechanics
- Google's director of engineering Ray Kurzweil previously said we'd be uploading our brains to machines by 2045
- Google Ventures has invested in genetics firms and cancer startups
- Tech giant also set up Calico - anti-ageing research and development labs
- Mr Maris said: 'We have the tools to achieve anything that you have the audacity to envision. I just hope to live long enough not to die'
- But professor Sir Colin Blakemore believes there's a limit on human life
- Neurobiologist believes 120 years 'might be an absolute to human lifespan'

Aging Outstrips All Other Risks

"Aging is by far the best predictor of whether people will develop a chronic disease like atherosclerotic heart disease, stroke, cancer, dementia or osteoarthritis," Dr. James L. Kirkland, director of the Kogod Center on Aging at the Mayo Clinic, said in an interview. "Aging way outstrips all other risk factors."

https://well.blogs.nytimes.com/2016/02/01/pursuing-the-dream-of-healthy-aging/?_r=1

Alzheimer's Disease in the USA (2018)

https://www.alz.org/alzheimers-dementia/

5.7 MILLION AMERICANS ARE LIVING WITH ALZHEIMER'S

BY 2050, THIS NUMBER IS PROJECTED TO RISE TO NEARLY 14 MILLION

ALZHEIMER'S DISEASE IS THE 6TH LEADING CAUSE OF DEATH IN THE UNITED STATES

EVERY 65 SECONDS, SOMEONE IN THE UNITED STATES DEVELOPS THE DISEASE

1 IN 3 SENIORS DIES WITH ALZHEIMER'S OR ANOTHER DEMENTIA

IN 2018, ALZHEIMER'S AND OTHER DEMENTIAS WILL COST THE NATION $277 BILLION

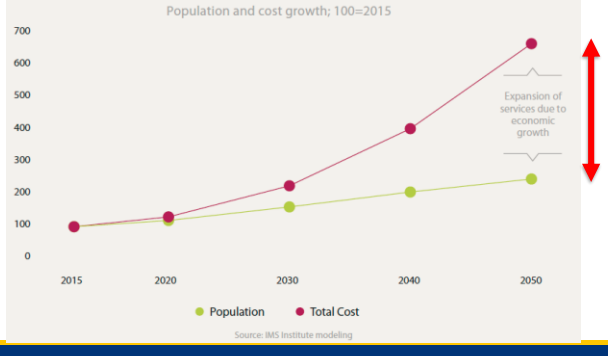
BY 2050, THESE COSTS COULD RISE AS HIGH AS $1.1 TRILLION

EARLY AND ACCURATE DIAGNOSIS COULD SAVE UP TO $7.9 TRILLION IN MEDICAL AND CARE COSTS

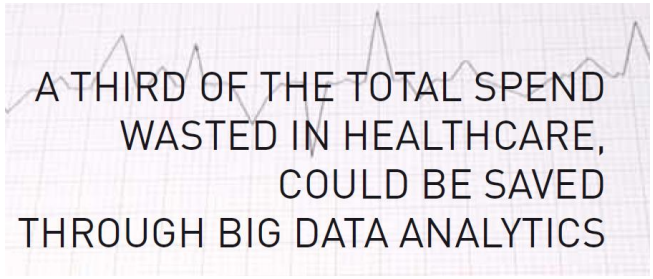
Aging populations and Economics Consequences

(IMS Institute, 2014)

- 18% of US GDP goes to healthcare (2017, www.cms.gov)
- Costs in 2050 would be **6.6 times larger** than the costs in 2015.
- About **one-third of that increase can be attributed to the direct impact of the population over the age of 65**.



Big Data Analytics for Healthcare Cost Reduction



(The Age of Data-Driven Medicine, Across Technology, http://pivotal.io/agile/white-paper/the-age-of-data-driven-medicine)

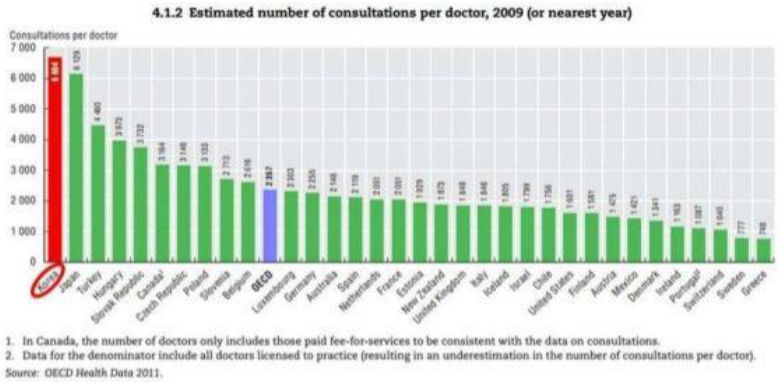
Healthcare Costs & Preventable Diseases

75% of healthcare costs are spent on *preventable chronic* diseases!

(Center for Disease Control & Prevention, 2009)

Short Consultation Time

- The consultation time for patient by doctor is too short
- Doctors in Korea consult the largest #patients in the world
  - 2.2 doctors per 1000 people



Source: http://www.slideshare.net/ahmedrj/jpg-16962441

Why Smart Aging?

- **Aged society results in:**
  - High medical cost
  - Reduction of productive population
  - Low economic development crisis
- **Big data technology and analytics (BDTA)**
  - Digital healthcare technology: data generation in 24*365
  - BDTA enables revolution to healthcare paradigm and approaches

Why Smart Aging?

- **Medical Paradigm Shift**
  - From disease/treatment to prevention
  - Personalized medicine trend
  - Patients become proactive
    - Find information and treats themselves

Categories of Smart Aging Projects

- Smart aging at the *individual* level (home, work)
- Smart aging in the *community*
- Smart aging at the *national* level

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Healthcare Data

- **EHR data**
- **Patient demographic data**
- **Personal vital data history**
- **Clinical notes**
- **Lab test results**
- **X-ray image**
- **MRI**
- **ECG data**
- **Disease progression data**

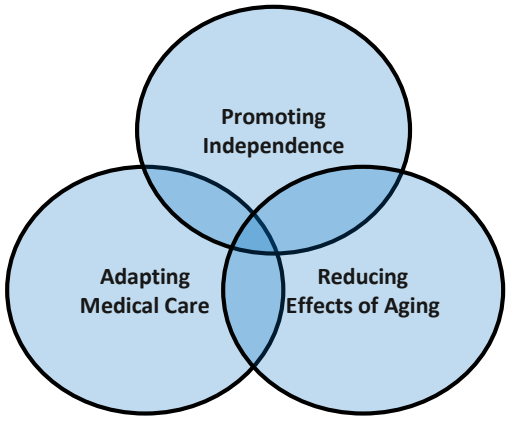
- **Wearable data**
- **Physical: (heart rate, respiratory rate, bp, etc)**
- **Chemical: (glucose, lactate, potassium, etc)**
- **Behavioral: (walks, body, sleeping, etc)**
- **Medication data**
- **Pharmaceutical data**
- **Gene banks data**
- **Personal genomic data**

- **Patient behavioral data**
- **Video surveillance data**
- **Medical ontologies**
- **Medical procedure data**
- **Insurance claims**
- **Nutrition data**
- **Patient social media interaction data**
- **Telemetry data**

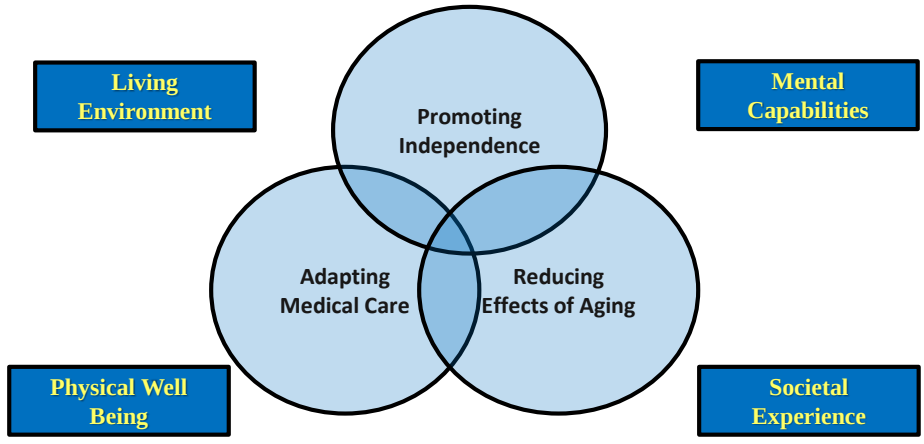
V's of Healthcare Big Data

- Volume: Huge amounts of data need to be stored
- Velocity: Data is being rapidly created, moved or accessed
- Variety: There are many different types of sources and data types
- Veracity: Quality of some data may not be trustworthy (accurate)
- Volatility: Some data changes more often than others
- Vulnerability: Some data should be protected and secured
- Visualization: Data should be presented effectively and clearly to the stakeholders
- Value: Produce a meaningful ROI

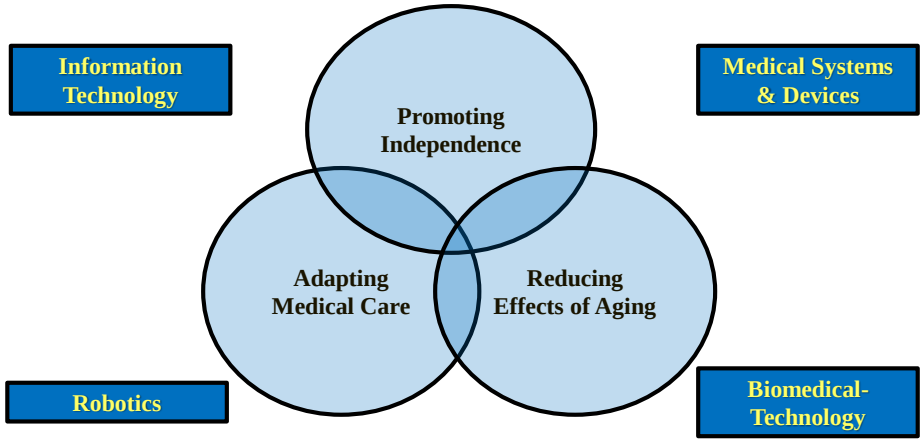
Smart Aging Concerns



Smart Aging Areas of Concern



Smart Aging Technology Focus



Smart Aging Topics

Promoting Independence

- **Remote monitoring and alert Systems for the home**
- **Human-care robots**
- **IT personal assistant**
- **Transportation syst.**
- **Medication adherence**
- **Self management**
- **End of life care**

Adapting Medical Care

- **Wearable sensors**
- **Disease prevention & prediction**
- **Access to medical IT**
- **Genetic technologies**
- **Personalized medicine**
- **Bio-signal interface**
- **Brain-computer interface**

Reducing Effect of Aging

- **Sustaining cognitive capability**
  - Mental health
  - Pharmaceuticals
  - Community systems
- **Physical capability**
  - Life styles
  - Medical suit
- **Social Media**
- **Health literacy**

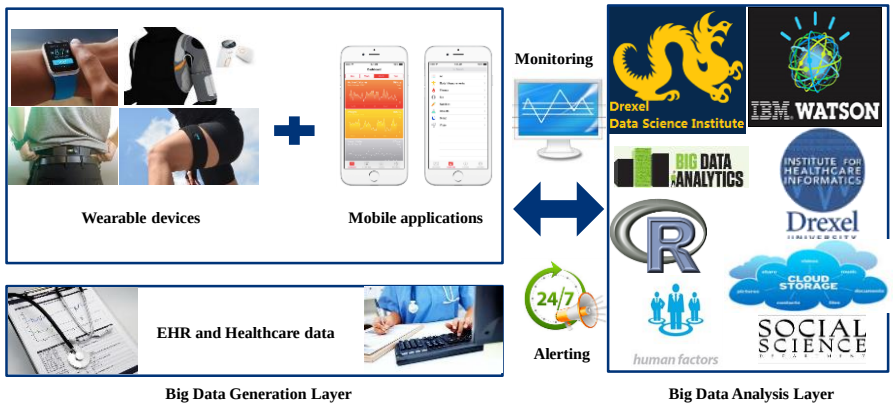
Components of Smart Aging Technologies

1) **Wearable devices and IOT**
2) **Smart phone & Mobile health care**
3) **BioMedical & Healthcare Informatics**
4) **Big Data Technology and Analytics (Cloud, ML, DM, Robotics)**
5) **Human Factors & Cognitive Acceptance**

Use Cases of Big Data Analytics in Smart Aging

- Translating sensor data into actionable knowledge
- Real-time monitoring and alerting
- Predictive analytics in readmission analysis, disease prediction and prevention
- Precision healthcare – match treatments to individual patients
- Telemedicine support
- Epidemic control
- Computational systems biology, genomics

Integrating Components of Smart Aging Technologies



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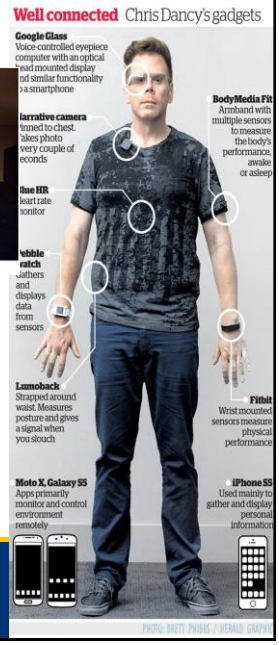
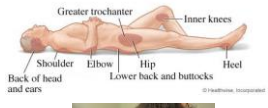
"The Most Connected Man on Earth"

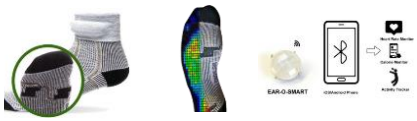
He utilizes **up to 700 sensors**, **devices, applications, and services** to track his real-time data about his life, analyze, and optimize his life from calorie intake to his spiritual well-being.

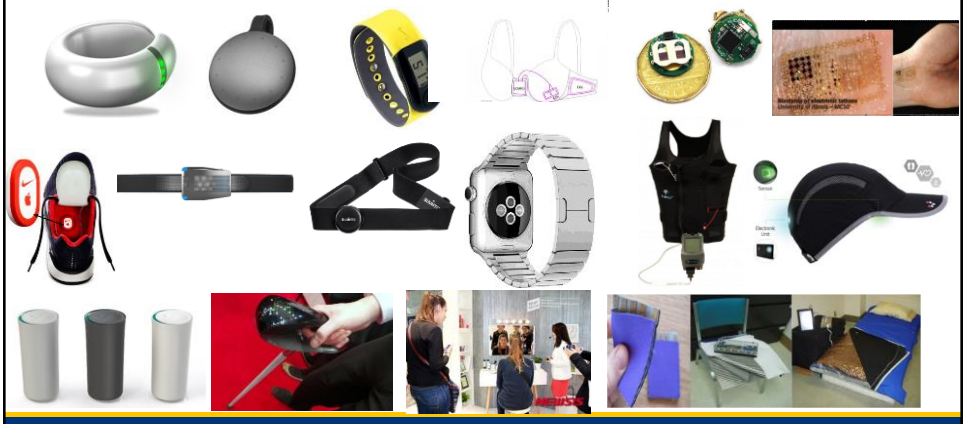
http://www.chrisdancy.com



WEARABLE SENSORS



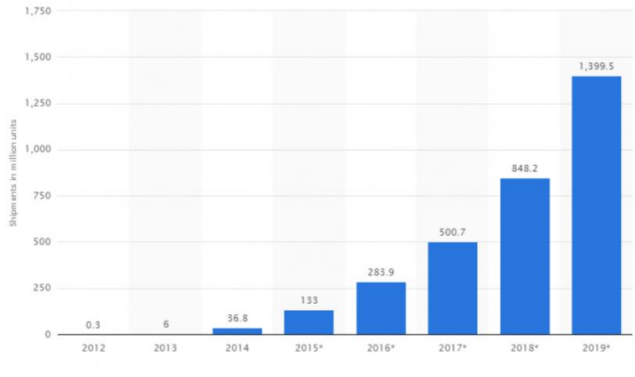




SMART WEARABLE DEVICE SHIPMENTS

Smart wearable device unit shipments worldwide from 2012 to 2019 (in millions)

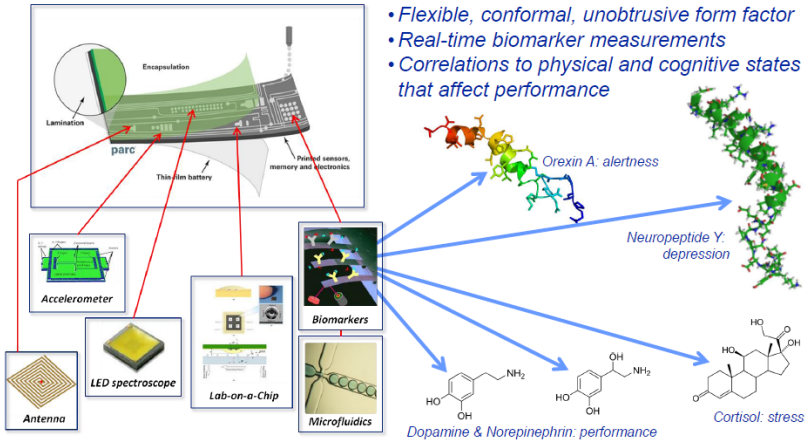
This statistic shows global shipments of smart wearable devices from 2010 to 2019. In 2014, smart wearable device shipments worldwide reached 36.8 million units.



Source: Statista.com

Next-Gen Wearable Sensors

- Real-time physiological monitoring of body chemistries



- *Flexible, conformal, unobtrusive form factor*
- *Real-time biomarker measurements*
- *Correlations to physical and cognitive states that affect performance*

Body chemistries and signature analysis through analytics will enable a wealth of physiological and cognitive assessments not previously possible

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(Source: Hironobu Takagi, IBM Research 2017)

Availability of Wearable Devices

Pro

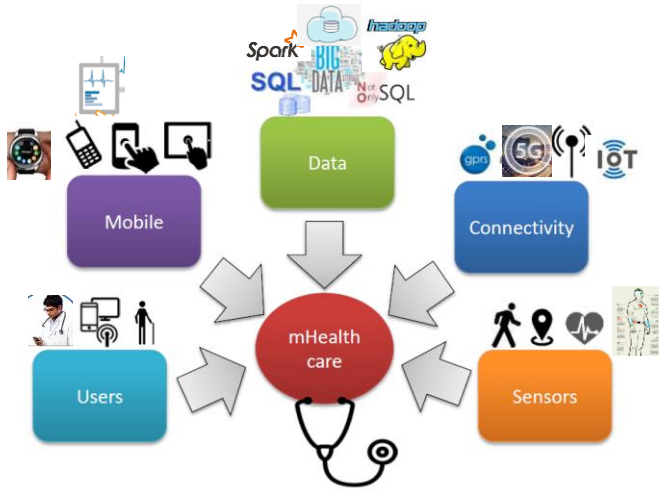
- Miniature
- Light
- Powerful
- Low-cost
- Wireless

Con

- Battery
- Reliability (noise filtering)
- Security
- Acceptance
- Lack of standards

Analytical work required to turn wearables' measurement data into actionable knowledge!

Mobile Health (mHealth)



Smart Phone Capabilities

https://www.slideshare.net/DavidLeeScherMD/keys-to-building-a-successful-mobile-health-strategy

Smart Phone is a Medical Device!

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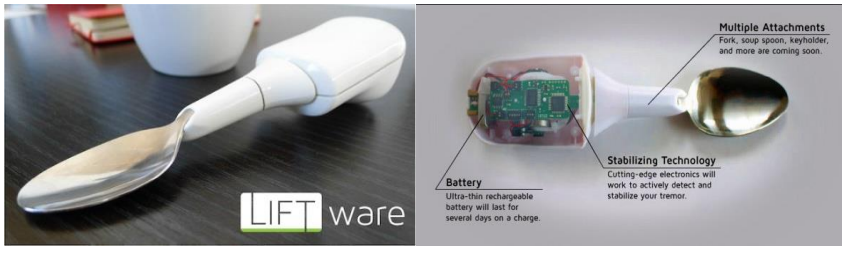
GOOGLE LIFTWARE

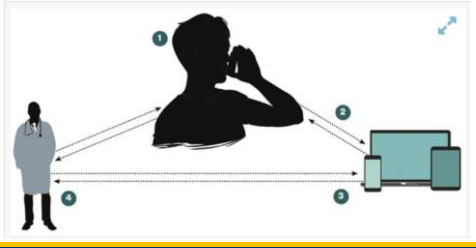
- **Liftware** uses stabilizing technology to prevent spilling for people with hand tremor or **Parkinson's disease**
- Can be connected to spoon and fork



Source: https://www.liftware.com/

SMART INHALER FOR ASTHMA

- **Inhaler + Sensors:** use sensors and Bluetooth technology to detect inhaler use, remind patients when to take their medication and gather data to help guide care
- Track inhaler use and provide patients with personalized feedback
- An example of Medicine + Technology



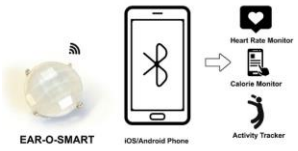
FUJITSU SMART CANE

- For the elderly, to track location, heart rate, and temperature. It even send email alerts if it thinks the user has fallen down.

Source: http://www.pcmag.com/article2/0,2817,2416129,00.asp

EAR-O-SMART (EARRING)

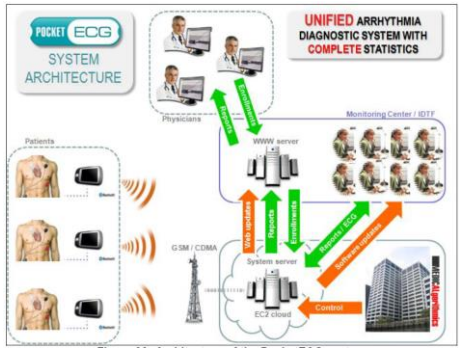
- The world's first smart earring which can monitor your heart rate, calories, and activity level.
- Ear-o-smart connects to your smartphone and allows you to monitor a wide range of fitness data



Source: http://earosmart.com/

POCKETECG IN EUROPEAN EHEALTH PROJECT

- A next generation mobile arrhythmia diagnostic system with complete statistics.
- Automatically interprets the ECG in real-time and streams all annotations and the full-disclosure signal to a monitoring center



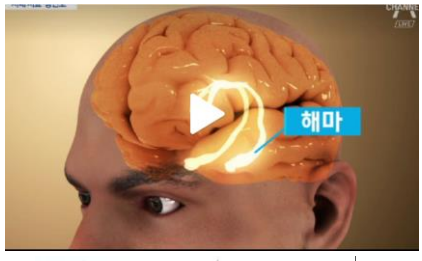
http://ehealthmonitor.eu

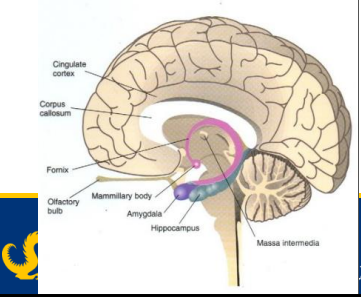
SMART TATOO

- Self-diagnosing cancers
- (ETH Zurich) 2018.05.01.

DELAYING DEMENTIA

- Curing Alzheimer's disease with synapse Hippocampus area
- (ETH Zurich) 2018.05.01.





COAGMAX®

- CoagMax® is the first-in-class **PT/INR monitor (Microvisk)**
  - to perform as **blood-glucose testing at home**.
  - to check whether **medicine to prevent blood clots is working**
  - to monitor how drugs may be affecting their blood status.
  - To check whether a surgery involving bleeding can be safe
- Uses **Micro Electro Mechanical System (MEMS) chip**, embedded on a disposable SmartStrip

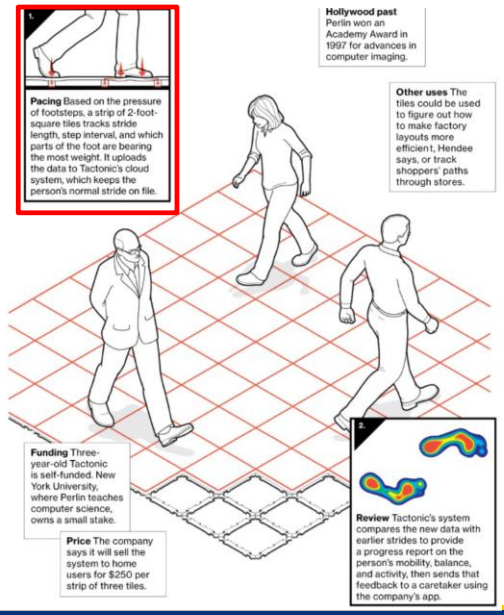
CoagMax® from Microvisk
A revolution in point-of-care coagulation monitoring

Source: http://www.microvisk.com/coagmax-2/

Floor Tiles That Can Monitor the Health of the Elderly

A strip of pressure-sensitive floor tiles made of plastic evaluates a walker's health based on footstep patterns. The tile system's cloud-based analytics can provide health updates via smartphone and assist caretakers for the elderly.

Tactonic, which plans to start selling IntelliMat tiles on its website later this year, is refining them to track arthritis, joint weakness, and Parkinson's disease. Beyond in-home care, the tiles are valuable to hospitals and physical therapists.



https://www.bloomberg.com/news/articles/2014-03-20/intellimat-flooring-measures-health-based-on-footstep-patterns

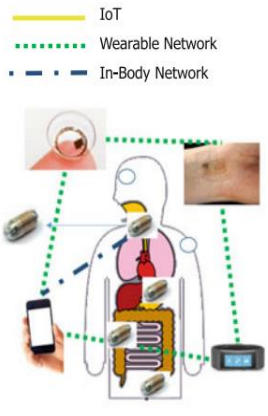
Mobile Health Trends

- **Wearable sensors become reliable and diverse**
- **Cloud-based smart services become norm**
- **Telemedicine will be in rise**
- **IOT-driven health apps will be popular**
- **Edge analytics are increasing**
- **Increasing use of AI (ML, Robotics, Chatbots, Google DeepMind, IBM Watson, etc)**
- **Appearance of blockchain use cases in medical records and services**

Source: Healthcare Mobile applications: Trends to watch out for in 2018
http://mhealth-sujeetkatiyar.blogspot.com/

SMART HEALTHCARE MONITORING SYSTEMS

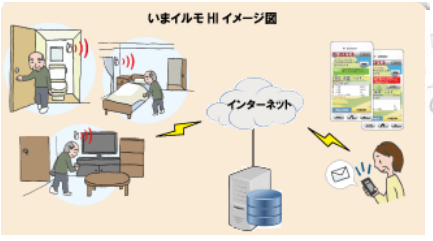
A Network of interconnected sensors



Big Healthcare Data Analytics: Challenges and Applications. C. Lee, Z. Luo, K.Y. Ngiam, et al., in Handbook of Large-Scale Distributed Computing in Smart Healthcare, 2017.

"IMAIRUMO HI"

- A monitoring aid system in Japan.
- A platform using robot technologies of fall detection sensors and external communication functions, which are useful for nursing care at private homes.



Source: http://robotcare.jp/

Apps Related to Smart Aging

ResearchKit

- Parkinson's mPower Study App
- EpiWatch Epilepsy Tracking App

- Future Mirror App
- MyFitnessPal

Parkinson mPower Disease App

- Track symptoms of **Parkinson** disease, review trends and share this information with researchers.
- Balance, speed of walking, general dexterity from IOS accelerometer and other sensor data

Parkinson mPower study app 17+

Sage Bionetworks, a Not-For-Profit Research Organization

4.4, 5 Ratings

Free

EpiWatch App

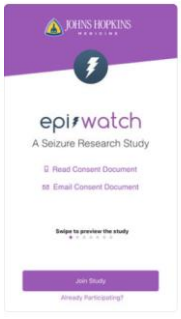
- Track their seizures, heart rates, potential **seizure** triggers, medications, and share the data with Johns Hopkins researchers

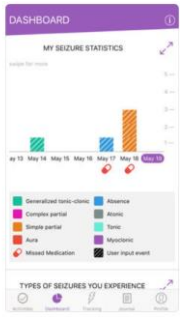
EpiWatch 12+

Johns Hopkins Digital

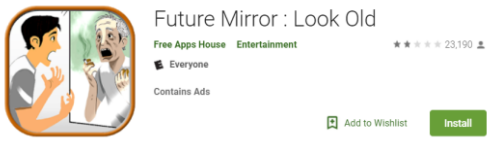
4.2, 5 Ratings

Free





FUTURE MIRROR APP, DEVICE, AI MIRROR



MyFitnessPal App

MyFitnessPal Mobile

Track your health from anywhere, anytime.

MyFitnessPal

iPhone rating: ★★★★★

Android rating: ★★★★★

Our web and mobile apps sync automatically, so your diary is always up to date.

- The most popular calorie-counting, food tracking app
- Over 85M users
- Over 5M foods in the database
- Save eaten foods, barcode scanning, and set nutrition goals

AI-Based Medical Devices/Systems Related to Smart Aging

- AI Doctor for IDX-DR
- Google DeepMind
- Med-Pod
- Qualcomm Challenge: Tricorder
- IBM Watson

AI DOCTOR

HTTPS://WWW.EYEDIAGNOSIS.NET/IDX-DR

- First AI-based medical device (approved by FDA, 2018.04.11)
- IDx-DR is an AI diagnostic system that autonomously analyzes images of the retina for signs of diabetic retinopathy
- Give diagnosis in 1 min with 90% accuracy

GOOGLE'S DEEPMIND FOR EYE DISEASES

- Analyzes 3D scans of the retina, identifies dozens of common eye diseases and then recommends the treatment.
- Can detect over 50 eye diseases as accurately as a doctor.
- Made the same recommendation more than 94% of the time.

https://www.theverge.com/2018/8/13/17670156/deepmind-ai-eye-disease-doctor-moorfields

Ultimate Futuristic Smart Health Device

Two Winners of QualComm Challenge

(1) Final Frontier Medical Devices was announced the highest performing team and received $2.6M (April 12, 2017) (https://tricorder.xprize.org/teams)

THE DEVICE

The system pulls together data from a patient's personal and family medical history, physical exam, and multiple sensors to make a quick and accurate assessment.

THE TEAM

- Family team led by brothers Dr. Basil Harris, an emergency medicine physician, and George Harris, a network engineer
- Basil Leaf Technologies
- From Pennsylvania

Two Winners of QualComm Challenge

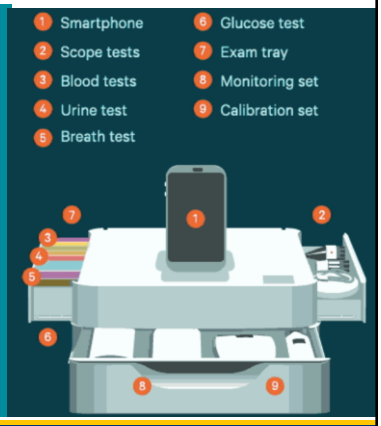
(2) Dynamical Biomarkers Group received $1M for 2nd place. (April 12, 2017) (https://tricorder.xprize.org/teams)

THE DEVICE

The system incorporates innovative technologies for artificial intelligence, physiologic signal analysis, image processing, and biomarker detection in a user-friendly process.

THE TEAM

- Multidisciplinary team of clinicians, scientists, and engineers
- Sponsored by HTC
- From Taiwan and Massachusetts

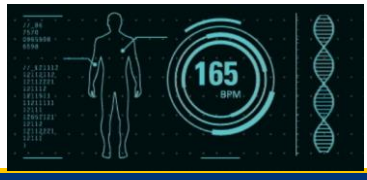


Two Winners of QualComm Challenge

(https://tricorder.xprize.org/teams)

Using these devices, the average person—with no medical training—will be able to accurately self-diagnose at home.

Both devices aim to diagnose 10 core health conditions:



Additionally, both teams chose three elective health conditions to address:

DxtER
by Final Frontier Medical Devices
- Mononucleosis
- Pertussis (whooping cough)
- Hypertension

DeepQ Kit
by Dynamical Biomarkers Group
- Melanoma
- Shingles
- Hypertension

Ultimate Futuristic Smart Health Device

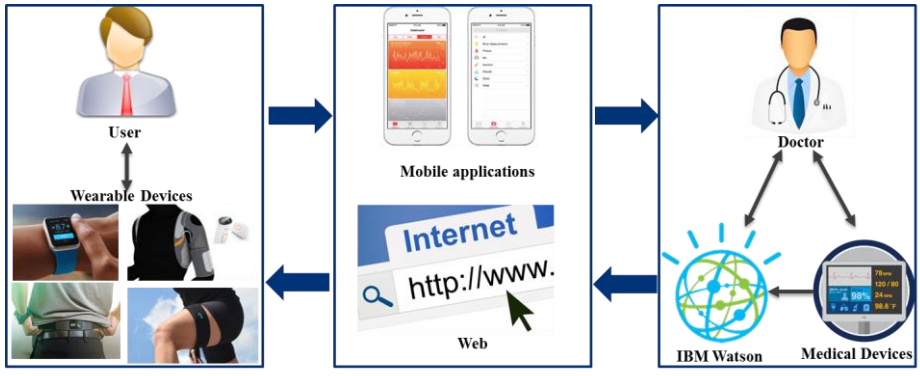
Med-Pod:

- A home-hospital with various sensors, medical devices, and 3D printers that produces/receives medicines
- Possibly remote operations

Watson

Source: http://www.mhealthtalk.com/moores-law-and-the-future-of-healthcare/

Smart Aging with Watson

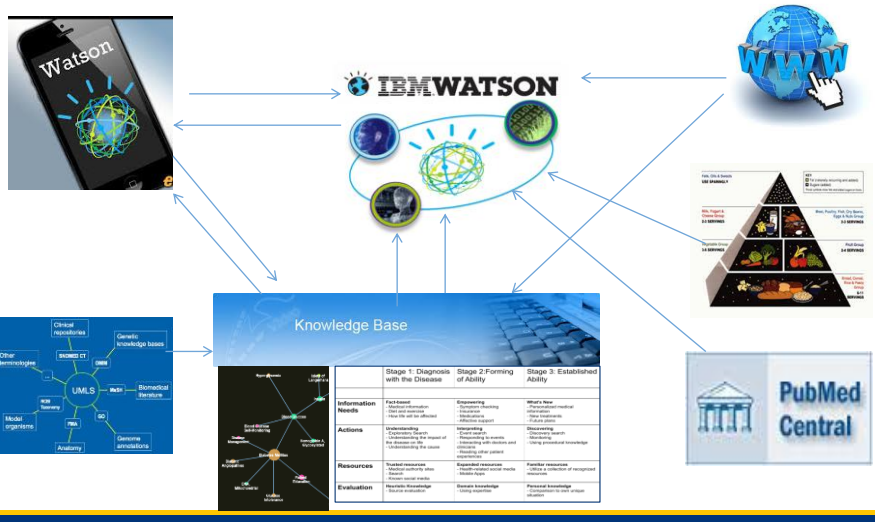


Types of wearable devices: garments, hats, gloves, wrist bands, belts, socks, shoes, eyeglasses, contact lens, smartwatches, headphones, smartphones, etc.

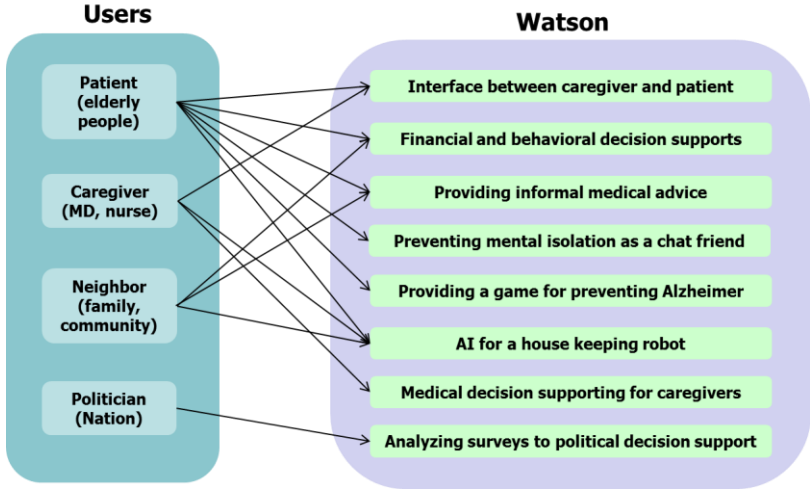
Mobile applications and websites are places that gather data inputted by users or generated by wearable devices.

Doctors interact with Watson and medical devices. Watson analyzes user data and send feedback to mobile applications and/or websites.

MOBILE APPS TO WATSON



Use Cases of Watson for Smart Aging



Bloomberg LP [US] | https://www.bloomberg.com/view/articles/2018-08-24/ibm-s-watson-failed-against-cancer-but-a-i-still-has-promise

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Technology & Ideas

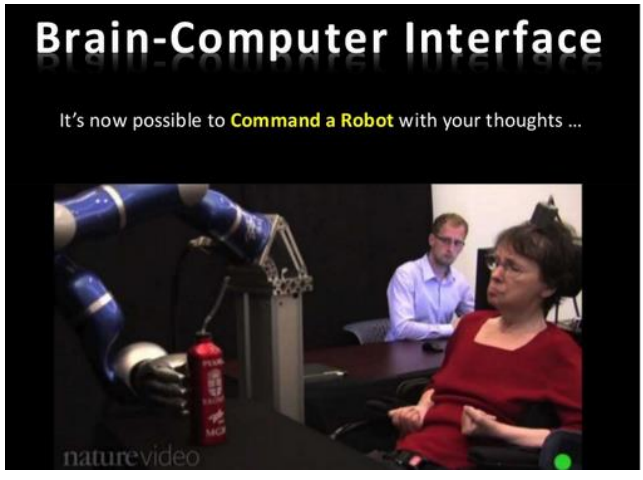
IBM's Watson Hasn't Beaten Cancer, But A.I. Still Has Promise

The company made bold claims that haven't yet panned out. But someday artificial intelligence could crack the code of individualized diagnosis and treatment.

By Faye Flam
August 24, 2018, 11:00 AM EDT

- "The medical website STAT reported that …. doctors who had tried to use Watson to help them design treatment complained that the system wasn't ready to practice medicine"
- "But there are parts of medical intuition that can't be computerized."
- (An IBM spokeswoman, Christine Douglass, said in response to recent news coverage of Watson's cancer venture: "The opportunity for A.I. in health care is still nascent, but we are proud to be pioneers in this arena.")

BRAIN-COMPUTER INTERFACE



Source: http://www.mhealthtalk.com/moores-law-and-the-future-of-healthcare/

Thought Controlled Computing

The flagship product, MindWave, is a headset that can log into your computer using just your thoughts. Researchers recently used the EEG headset to develop a toy car that can be driven forward with thought.

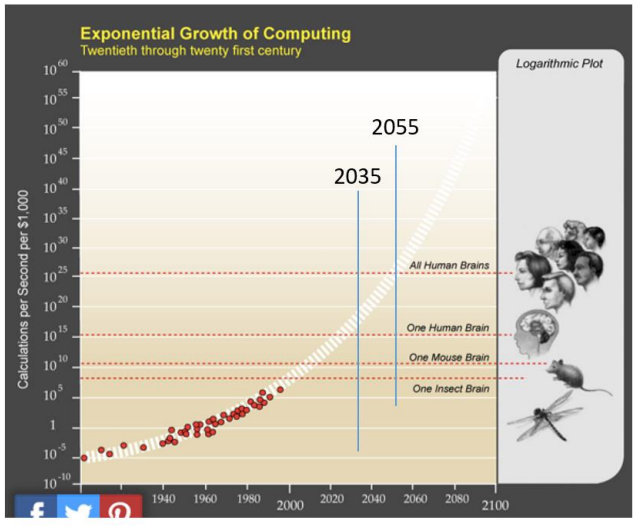
NeuroSky's smart sensors can also track your heart rate and other bodily metrics and can be embedded in the next generation of wearable devices.

"We make it possible for millions of consumers to capture and quantify critical health and wellness data," Yang (CEO of Softbank) said. Softbank is the funder.

[Source: http://venturebeat.com/2013/11/04/next-step-for-wearables-neurosky-brings-its-smart-sensors-to-health-fitness/]

DREXEL UNIVERSITY College of Computing & Informatics

Computing with Brain

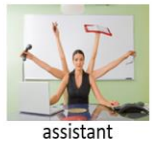


Source: Cognition as a service, IBM, 2016

IBM Cognitive Tools for People by 2035

	Task & World Model/ Planning & Decisions	Self Model/ Capacity & Limits	User Model/ Episodic Memory	Institutions Model/ Trust & Social Acts
Tool	+	-	-	-
Assistant	++	+	-	-
Collaborator	+++	++	+	-
Coach	++++	+++	++	+
Mediator	+++++	++++	+++	++


tool


assistant

collaborator

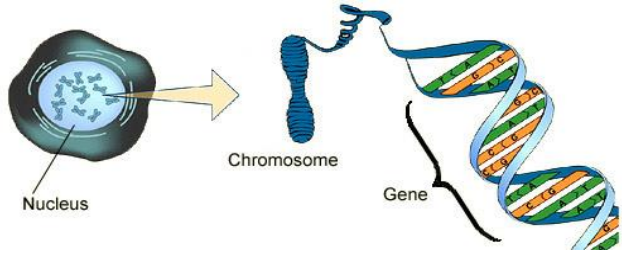

coach


mediator

Source: Understanding Cognitive Systems, IBM, 2016

Biomedicines and Genetics

- TAME medicine
- Telomere
- CHRSPR
- 3D and 4D printing of Organs



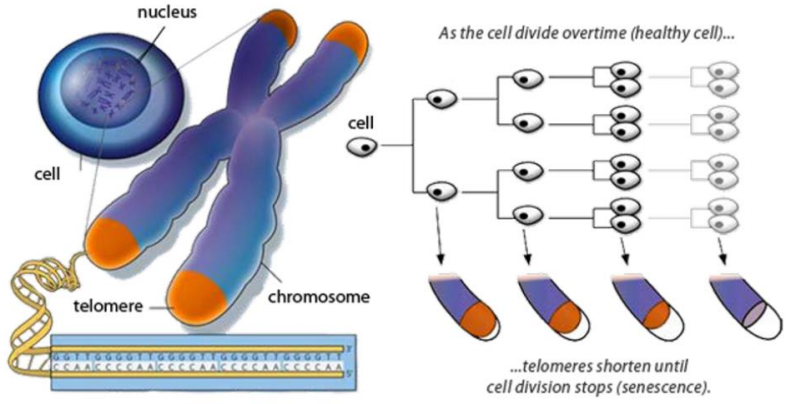
TAME

Source: https://www.afar.org/natgeo/

- **T**argeting/Taming **A**ging with **Me**tformin (TAME)
  - **Metformin** : a diabetic medicine for Type 2 Diabetics
- **A new paradigm in aging research**
  - An anti-aging drug
  - An effort of using a medicine against all the age-related diseases simultaneously, instead of cancer, heart disease or Alzheimer at a time
- **Einstein Hospital** project funded by AFAR (American Federation for Aging Research)
  - **FDA approved 3000 human volunteers** aged over 70-80 years old

Telomeres and Aging – Nobel Science for Anti-Aging

Telomeres are the end sections of each of our chromosomes



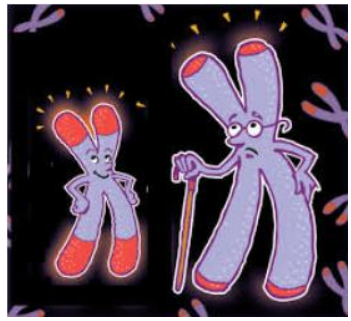
A telomere is a region of repetitive nucleotide sequences at each end of a chromosome

https://theiss.care/telomeres-and-aging/

TELOMERE

- **The longer your telomeres, the longer you will live**

Elizabeth Blackburn, Carol Greider and Jack Szostak received the 2009 Nobel Prize!



- ***Can the Genetics artificially extend the length of Telomere?***

CRISPR

- *Genome-editing technology*
- Science's 2015 Breakthrough of the Year, Nature (March 10, 2016), Time Cover, June 23, 2016

CRISPR

- *Replace damaged genes with normal genes*
- May promise "gene therapy" for a range of diseases
- CRISPR holds the promise of doing so with unprecedented simplicity, speed and precision.

What the CRISPR experiments mean for humanity?

CRISPR

Can CRISPR extend the length of Telomere?

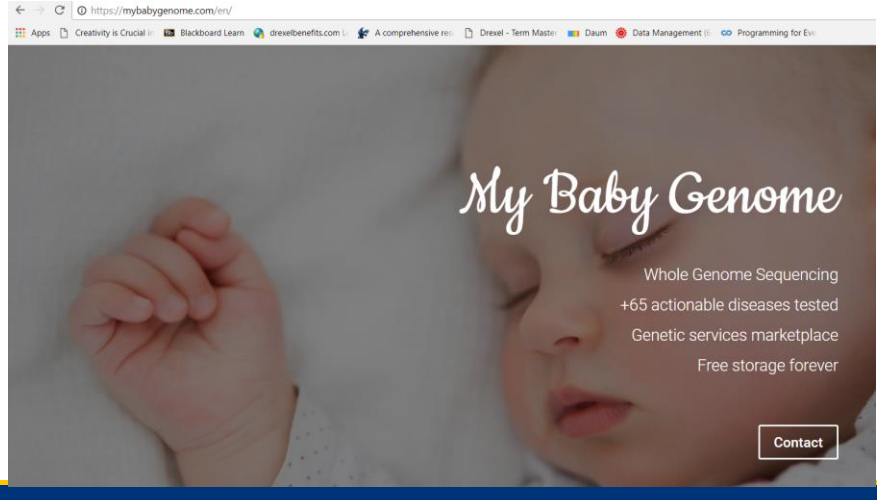
What the CRISPR experiments mean for humanity?

CRISPR

(The Economist, Aug 22, 2015)

MYBABYGENOME.COM

- Whole Genome Sequencing against 65+ actionable diseases



CRISPR INVENTORS

Jennifer Doudna Emmanuelle Charpentier Feng Zhang

CARIBOU BIOSCIENCES

Intellia THERAPEUTICS

CRISPR THERAPEUTICS

editas MEDICINE

CRISPR AND ANGELINA JOLIE

THE COST OF GENE SEQUENCING

- 2001: $100M
- Illumina: less than $1,000
- 23andme: ~$100

23andMe DNA Test Ancestry Personal Genetic Service - includes at-home saliva collec...
1413
$99.00 prime

National Geographic DNA Test Kit: Geno 2.0 Next Generation (Ancestry) - Powered by ...
57
$69.95 prime

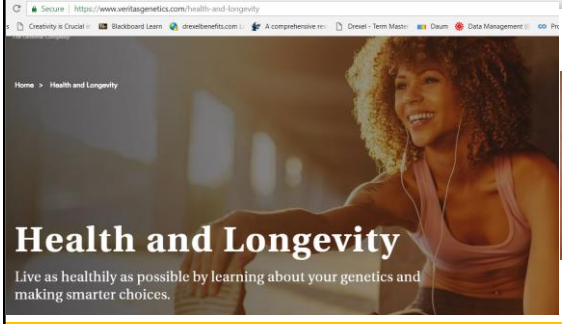
Defy Your DNA Program DNA Testing
$389.00

5Strands | Affordable Allergy & Intolerance Deluxe Test | at Home Environmental & F...
8
$154.00 prime

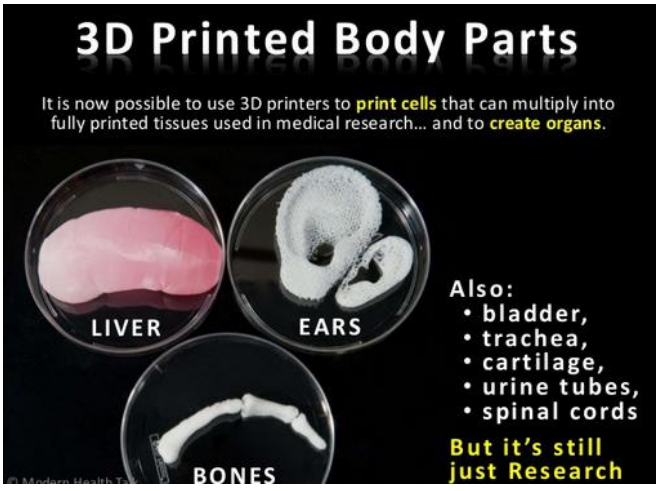
Ad feed

VERITAS GENETICS

- Costs $200~$300 for genetic report on various diseases



3D PRINTING

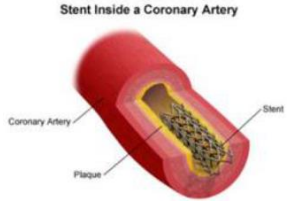


Source: http://www.mhealthtalk.com/moores-law-and-the-future-of-healthcare/

4D PRINTING

- **4D Printer = 3D Printer + Smart materials**
  - **with transformation abilities**
- **Healthcare applications:**
  - **Cardiac Tube/Stent**
  - **Artificial Limb**
  - **Nano robots for chemotherapy**

http://www.technologyreview.com/article/401750/electroactive-polymers/



http://www.nhlbi.nih.gov/health/health-topics/topics/stents

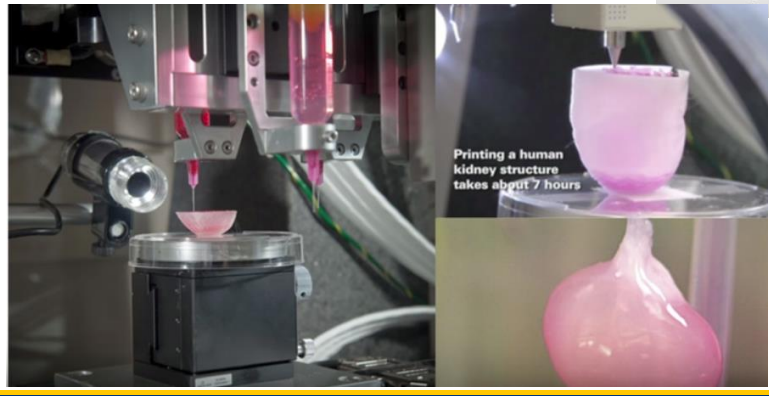
PRINT ORGANS AND GROW

Anthony Atala, MD

Dr. Anthony Atala, Wake Forest University, NC, USA

Can we grow organs instead of transplanting them?

Print Kidney using 4D printer and Grow it



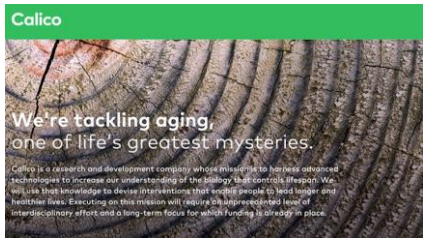
SMART HEALTH PROJECTS

- Google
- MIT AgeLab
- Drexel

Source: http://healthspancampaign.org/2015/04/28/dr-nir-barzilai-on-the-tame-study/

GOOGLE'S CALICO

- In 2013, Google founded Calico, focusing on aging and age-related diseases.
- Announced a **$1.5bn** partnership with pharmaceutical company, AbbVie, to accelerate the discovery, development and commercialization of age-related conditions such as neurodegeneration and cancer.



Source: http://www.ft.com/cms/s/041e8e66-5503-11e4-b616-00144feab7de,Authorised=false.html?_i_location=http%3A%2F%2Fwww.ft.com%2Fcms%2Fs%2F0%2F041e8e66-5503-11e4-b616-00144feab7de.html&_i_referer=http%3A%2F%2Fbionicly.com%2F8-examples-google-moving-digital-health%2F#axzz3HnLsEOni

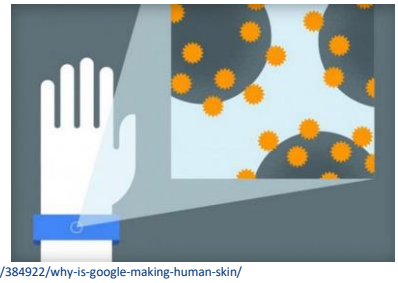
GOOGLE'S CANCER AND HEART ATTACK-DETECTING PILL (SINCE 2014)

- Google X research lab is developing a **nanoparticle** that attach to and detect other molecules inside the body
- It could ***identify cancers, heart attacks and other diseases before they become a problem***.
- The idea is that patients will swallow the pill. Then, a **wearable device (e.g., smart wristband)** could use their **magnetic cores to gather information about the disease.**

Source: http://www.wsj.com/articles/google-designing-nanoparticles-to-patrol-human-body-for-disease-1414515602

GOOGLE'S SYNTACTIC SKIN

- By Google X
  - In order *to detect the light coming from the nanoparticle* pills, Google started making synthetic skin.
  - made like the same as real skin with the same **autofluorescence** and **biochemical components**.



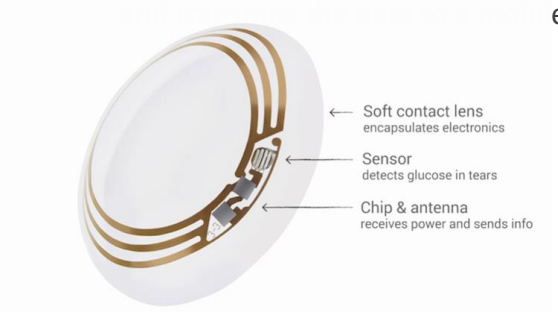
Source: http://www.theatlantic.com/video/index/384922/why-is-google-making-human-skin/

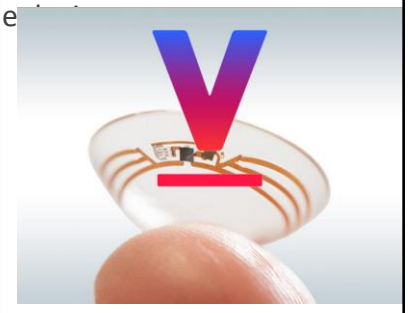
GOOGLE'S VERILY

- A spinoff from Google[X] (2015)
- Focused on using technology to better understand health, as well as prevent, detect, manage disease, and live longer
- **Understand diseases at a personal level**
- **https://verily.com/**

GOOGLE'S SMART CONTACT LENS

- Google X is developing a smart contact lens for people with ***diabetes***
- Partnering a pharmaceutical company, Novartis.
- *Measures blood sugar levels directly from the tear fluid*

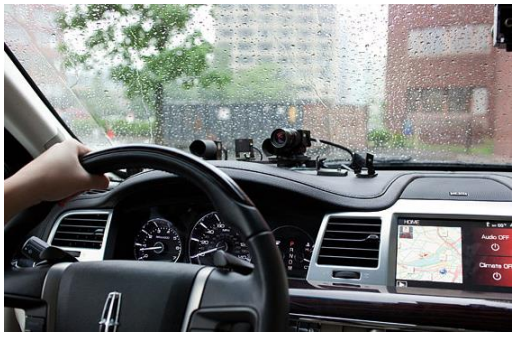




ource: http://www.forbes.com/sites/leoking/2014/07/15/google-smart-contact-lens-focuses-on-healthcare-billions/

MIT AgeLab

- **AwareCar: help elderly drive safely**
  - Uses on-board eye-tracking cameras to measure the effects of fatigue and distraction
  - Sensors measure heart and breathing rates.



Source: http://agelab.mit.edu/awarecar
Source: http://www.ft.com/intl/cms/s/2/1fed1eee-b34b-11e0-9af2-00144feabdc0.html

MIT AgeLab

- **Smart Trash Can:** to keep track of usages by elderly
  - Uses RFID antennas to tag objects in a kitchen.
  - Senses when items have been used or thrown out – letting distant family members or caregivers look out for unusual eating behaviors.

Source: http://www.ft.com/intl/cms/s/2/1fed1eee-b34b-11e0-9af2-00144feabdc0.html

MIT AgeLab

- **AGNES (Age Gain Now Empathy System):**
  - A suit to experiment what it feels like to age
  - Feels visual, flexibility, dexterity and strength of a **person in their mid-70s**.

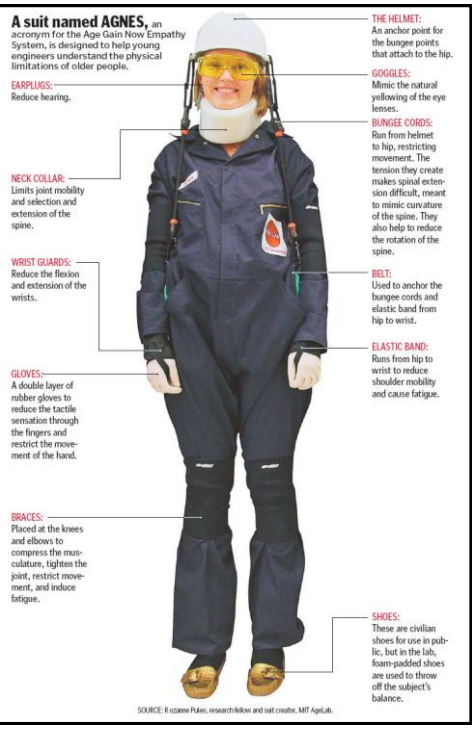
Source: http://agelab.mit.edu/agnes-age-gain-now-empathy-system

MIT AgeLab

- **AGNES(Age Gain Now Empathy System)**
- **Video link: (1.31)**

https://www.youtube.com/watch?v=czuww9rp5f4

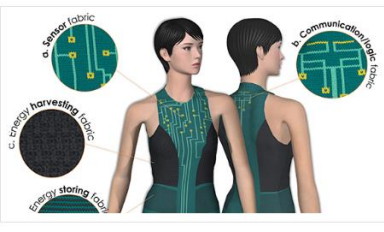
Source: http://agelab.mit.edu/agnes-age-gain-now-empathy-system



Shima Seiki Haute Wearable Sensor Lab

(Director: Dr. Genevieve Dion)

- **Develop** Knit-based wearable sensors using 3-D computerized knitting systems
- **Demo:** http://www.drexel.edu/excite/research/shimaSeiki/



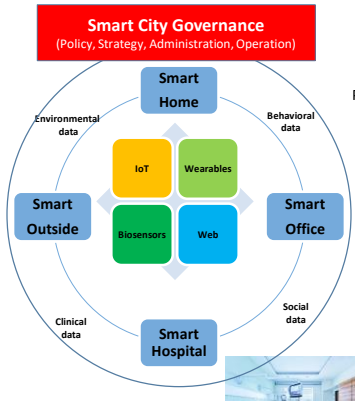
Digital Colleagues for Smart Aging

- **Goal:** Augment human performance when physical and/or cognitive limitations exist. (**Expert colleague**, **personal work assistant**, **personal digital health coach**)
- **Approach**: Wearable and environmental sensors feed an intelligent *Digital Colleagues* that recommends accommodations and strategies.

Smart Health Enabled Smart City

Activity Tracking
Remote Patient Monitoring
Personalized Health Assistance
Food Consumption Monitoring

Smart City Enablers
Medical Facilities Hotspotting
Real-Time Traffic Monitoring
Air Quality Monitoring



Activity Tracking
Prevention of Being Sedentary
Psycho-social Mental Health Improving
Peer-Interaction System

Real-Time Vital Monitoring
Adaptive Treatment Planning
Prescription Adherence Improving
Wait-Time Management
Readmissions Management
Genomic Analysis

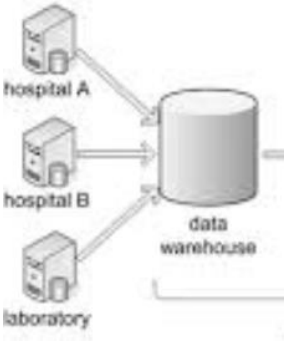
Watch out Smart Healthcare Technologies

- Smart skin patch for Parkinson's disease
- Smart skin for robots that can sense/pass pressure, temperature, moisture, and feeling
- Happiness measuring wearables (Hitachi)
- 3D printing medicines (Aprecia) and 4D human parts
- Wireless implantable medical devices
- 5G comm. Tech. and augmented reality
- Molecules that extend lifespan

(**U.S. Patent No. 8,642,660 is the most-cited discovery by Thomson Reuters IP & Science)**

HEALTHCARE DATA WAREHOUSES

- DWs store refined structured data to the relational databases
  - Consolidated data
  - Conformed data
  - Cleaned data
  - Basis of BI and descriptive analytics
  - Proved its value as "the system of records"
- DWs are still important and necessary



RECENT DEVELOPMENTS IN DWS

(a) The cloud
- Redshift

(b) Big data technology such as HDFS, Hadoop, Spark
- Using Hadoop for ETL and Cold storage

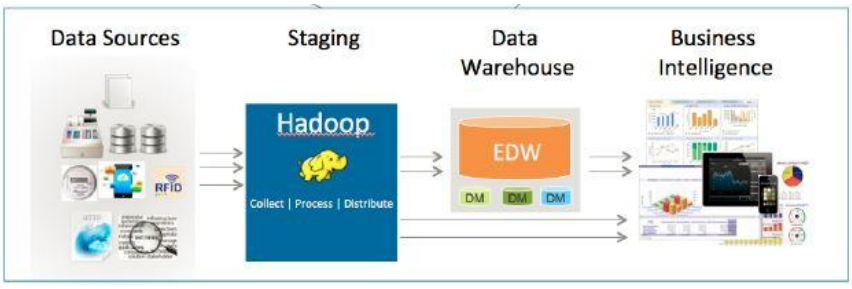
(c) Big data, especially unstructured data
- Development of data lake

(d) New applications (real-time)

Coexistence of DWs, big data, data lake in an enterprise architecture.

Using Hadoop in DW Environment (I)

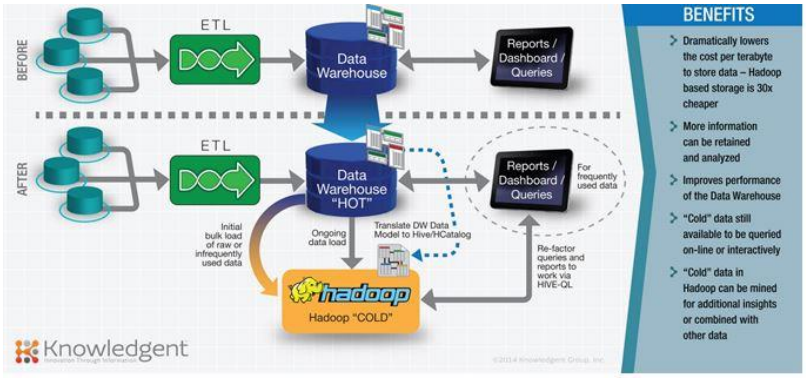
- Use cases of Hadoop in DWs:
  - **To replace/support ETL /ELT processing as a front-end to the DW**
  - **To store the data in HDFS and to directly process raw data**



Source: 5 Steps to Offload your Data Warehouse with Hadoop, Syncsort

Using Hadoop in DW Environment (II)

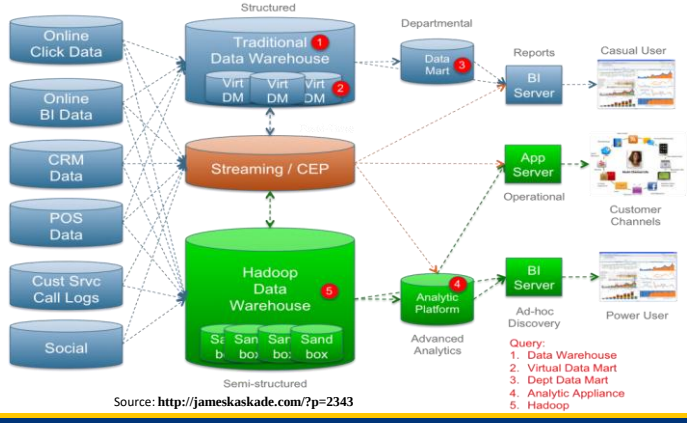
- Use cases of Hadoop in DWs:
  - **To offload (archive) cold data from the DW (cloud) in the back-end**



Source: http://www.novetta.com/2015/02/why-you-should-offload-your-data-warehouse-to-hadoop/

Using Hadoop in DW Environment (III)

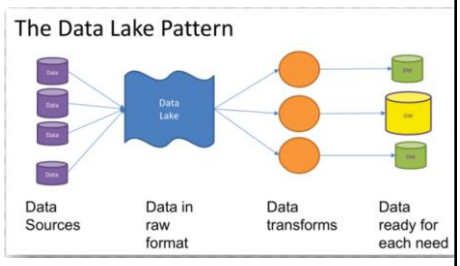
- Use cases of Hadoop in DWs:
  - **To extend EDW as an analytic platform**



Source: **http://jameskaskade.com/?p=2343**

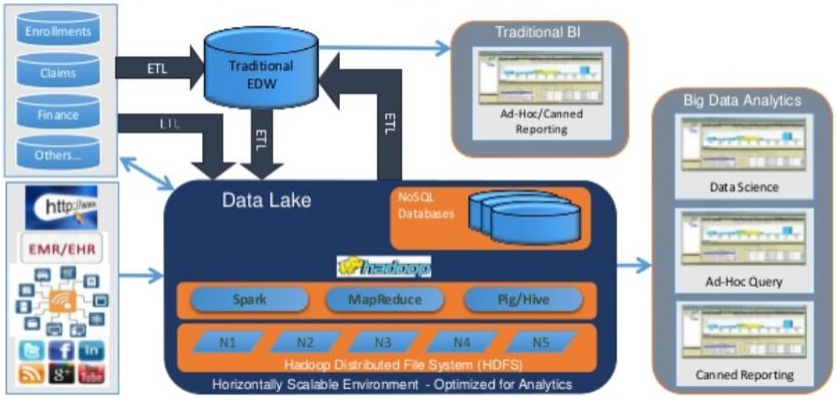
The Data Lake

- A data lake is a storage repository that holds a vast amount of *raw data*
- Collect everything--Stores both unstructured, structured, and stream data
  - Assume all data has value-someday.
- Multiple points of access- allow refining, exploration, and enrichment of data
- Flexible access- across shared infrastructure
- Data lakes work effectively with DWs



Data Lake Reference Architecture

(Joe Caserta, Caserta.com)



https://www.slideshare.net/CasertaConcepts/incorporating-the-data-lake-into-your-analytic-architecture

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- Smart Aging Definition, Needs, Backgrounds
- Components of Smart Aging Technologies
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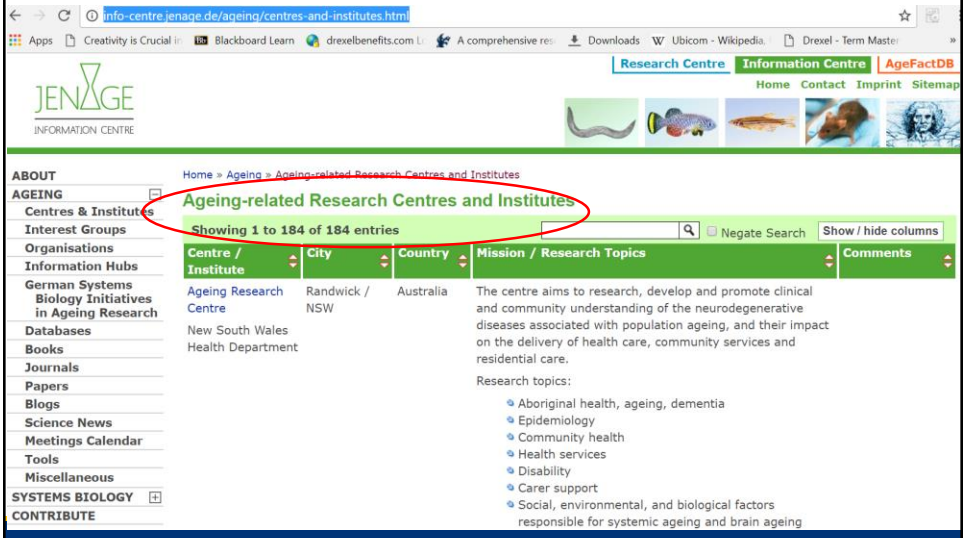
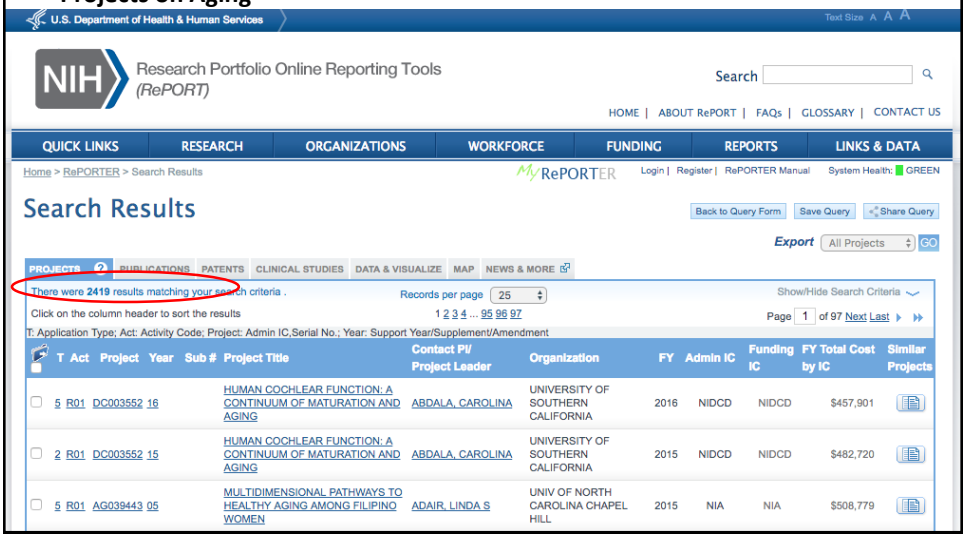
  - Mobile Healthcare
  - Apps
  - AI-based Devices/Systems
  - Biomedicine and Genetics
  - Google/MIT/Drexel Projects
  - Healthcare Data Warehouses
  - Data Lake
- **NIH Projects and Text Mining Results**
- Suggestions and Research Topics
- Summary

Research Centers & Institutes on Aging



NIH-funded Research Projects on Aging

- https://projectreporter.nih.gov/
  - **2419 funded projects in 2015 - 2017 whose titles or abstracts contain "aging".**
- **Projects on Aging**



NIH-funded Research Centers on Aging (2014)

- **Two new centers**
  - Brandeis University, Boston Roybal Center
  - Johns Hopkins University, Johns Hopkins Roybal Center
- **Existing 11 centers**
  - University of Alabama at Birmingham, Roybal Center for Translational Research on Aging and Mobility
  - Weill Medical College of Cornell University, Cornell Roybal Center
  - National Bureau of Economic Research, Behavior Change in Health and Saving
  - Oregon Health & Science University, Oregon Roybal Center for Translational Research on Aging
  - Princeton University, Princeton Center for Translational Research on Aging
  - University of Illinois at Chicago, Midwest Roybal Center for Health Promotion and Translation
  - University of Pennsylvania, Penn Roybal Center on Behavioral Economics and Health
  - University of Southern California, Roybal Center for Health Decision Making and Financial Independence in Old Age
  - University of Southern California, Roybal Center for Health Policy Simulation
  - University of Washington, Northwest Roybal Center
  - Yale University, New Haven, Center for Study of Networks and Well-Being

Source: http://www.nih.gov/news/health/nov2014/nia-12.htm

NIH-funded Research Projects on Aging (2015-2016)

- https://projectreporter.nih.gov/
  - Searched for projects funded in 2015 - 2017 whose titles or abstracts contain "smart aging".
- **Projects on Smart Aging**
  - [2015, 2016] SOCIAL ACTIVITY NETWORKS AND THE MOBILITY OF LOWER LIMB AMPUTEES (VPSHS)
  - [2015, 2016] COLLABORATIVE RESEARCH: QUADRUPEDAL HUMAN-ASSISTIVE ROBOTIC PLATFORM (UAT)
  - [2015, 2016] PATHWAYS TO LUTS PREVENTION: A MODEL FOR PUBLIC EDUCATION, BEHAVIORAL SKILLS, AND EARLY DETECTION (UAB)
  - [2015, 2016] SMART HAND (U of Nebraska)
  - [2015, 2016] SMART TECHNOLOGIES FOR HEALTH ASSESSMENT AND ASSISTANCE (Washington SU)
  - [2015] SMART ENVIRONMENT TECHNOLOGY FOR LONGITUDINAL BEHAVIOR ANALYSIS AND INTERVENTION (Washington SU)
  - [2015] SPATIAL SEGREGATION OF CELL FUNCTIONING DURING CELL MOTILITY (PITTSBURGH)
  - [2015] SMART TELEVISION AND EXERCISE PROMOTION FOR INDEPENDENT LIVING FACILITIES (KBI)

NIH-funded Research Projects on Aging (2016-2017)

- **Projects on Smart Aging**
  - [2016] SMART RESIDENTIAL CARPET FOR PROMOTING AGING IN PLACE (BIOSENSICS, LLC)
  - [2016] MANAGING DEMENTIA THROUGH A MULTISENSORY SMART PHONE APPLICATION TO SUPPORT AGING IN PLACE (Wright State University)
  - [2017] AGING AND MECHANISMS OF AGING-RELATED DISEASE (KEYSTONE SYMPOSIA)
  - [2017] ROCK STEADY- A MOBILE, GAMIFIED VESTIBULAR REHABILITATION THERAPY APP FOR OLDER ADULTS WITH COMPLAINTS OF DIZZINESS (BLUE MARBLE REHABILITATION, INC.)

Strategic Directions of NIH Projects

- Understand aging process and its impact on the **prevention, progression, and prognosis** of disease and disability.
- Understand the effects of **behavioral, psychological, and social factors** in aging
- Improve **well-being and independence** of adults as they age
- Support for **smart technologies** for assessment, monitoring, and assistance
- Support the **infrastructure and resources** for quality research.
- **Disseminate information** to the public, medical and scientific communities, and policy makers

Data-driven Analysis of Smart Aging Related Websites

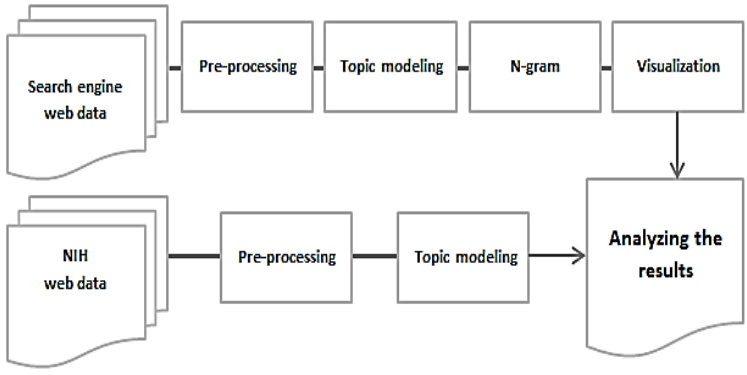
Crawled Smart Aging Web Documents

- From the list of organizations that received funding from the ***National Institutes of Health (NIH)***
- *The 4,500 webpages*

- From the URLs were crawled from ***Web search engines*** **such as Google, Yahoo, and Bing**
- *The 3,760 web* pages

Data-driven Analysis of Smart Aging Related Websites

– LDA, a topic modeling technique, is applied to find topics and topical terms



Contents Analysis of Web pages by Search Engines

Topic Analysis of Smart Aging

The range of topics were extracted from 3,760 web pages.

A result of LDA topic modeling analysis

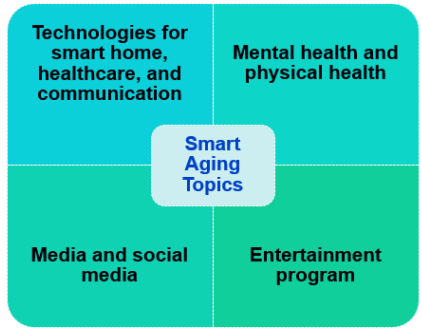
1	0.2697 smart home aging people life health time age family senior smart_aging service smart_home day own datum
2	0.06131 reply question people chronology feb time post article pm thanks blog jon game lot answer comment profile s
3	0.05193 smart smart_ageing ireland event book universal_design people innovation housing service smart_aging awar
4	0.04972 cognitive view brain study memory google cognitive_function dementia vol google_scholar scopus publisher in
5	0.0308 water aging figure day november polymer coating body age healthy exercise effect study kathy_gottberg ph
6	0.02194 technology smart_home elderly smart adult patient google_scholar research google health social life primary h
7	0.0203 smart season max episode control kaos agent chief series maxwell_smart tv maxwell film siegfried adams dc
8	0.01938 tohoku_university tohoku smart_gesture smart asus university_department window driver pm am student as
9	0.01733 smart android app phone google device smart_filter filter english smart_filters smart_tv file parent filter_mask
10	0.0166 smart smart_meter smart_grid energy technology utility meter action friendly_format printer_friendly permalir

smart_aging_topics

Contents Analysis of Web pages by Search Engines

A result of Smart Aging topics analysis

Topics	Weights
Topic 1 **Smart Home**	*0.2697*
Topic 2 **Entertainment and Social Media**	*0.06131*
Topic 3 **Smart Aging Innovation Housing Design**	*0.05193*
Topic 4 **Cognitive Ability**	*0.04972*
Topic 5 **Physical Health**	*0.0308*
Topic 6 **Smart Home Technology**	*0.02194*
Topic 7 **TV Programs**	*0.0203*
Topic 8 **Smart Aging Research Center**	*0.01938*
Topic 9 **Smart Aging Devices and Applications**	*0.01733*
Topic 10 **Smart Grid Technology**	*0.0166*



Contents Analysis of NIH Smart Aging Related Websites

A content analysis of 4,500 web pages of the NIH funded organizations' websites related to smart aging

A result of LDA topic modeling analysis

1	0.12241	health research social aging study national center adult project life university roybal_center public time pl
2	0.02751	nursing washington uw gift degree_program community_impact university uw_nurse nursing_research re
3	0.01587	health health_research ihrp uic illinois chicago policy contact_us roybal_center research_core methodology
4	0.01555	health research_center family global_aging programs data_toolbox us us_people policy aging_data retire
5	0.01552	student nursing disability nursing_student program financial_support master clinical school current_studen
6	0.01546	art brandeis graduate rabb_school sciences boston_roybal social active graduate_student active_lifestyle
7	0.01406	network_science yale network social_network us roybal_center yins sponsor corporate_partnership partn
8	0.01272	princeton public health economics wellbeing princeton_university public_affairs wilson_school woodrow_wils
9	0.01264	aging phd johns_hopkins johns md eba pepper_center adult center health scholars_program pepper_sch
10	0.01237	pm vpd monday thursday behavioral behavioral_economics calendar april october march september ma
11	0.01062	princeton_university project princeton age child respondent swb people elderly cognitive human drm inco
12	0.01048	palliative palliative_medicine geriatrics weill_cornell clinical_care cornell_medicine aging patient medical_edu
13	0.01014	applied applied_gerontology cognitive research adult mobility alabama driver_research senior_driver uab_
14	0.0097	nber working_paper nber_working health paper retirement financial social_security economic aging econo
15	0.00849	health future program health_policy roybal_center future_elderly physical_activity elderly_model policy_sir

smart_aging_nih_topics

Contents Analysis of NIH Smart Aging

A result of Smart Aging Research Activities

Topics	Weights
Topic 1 Behavior and Social Sciences Research of Aging	0.12241
Topic 2 Nursing Research	0.02751
Topic 3 Research on Health and Aging	0.01587
Topic 4 Global Aging Health and Financial	0.01555
Topic 5 Nursing and Clinical Science	0.01552
Topic 6 Extramural Activities	0.01546
Topic 7 Social Network Study	0.01406

Topics	Weights
Topic 8 Economics and Well-being	0.01272
Topic 9 Center on Aging and Health (COAH)	0.01264
Topic 10 Behavioral Economics and Health	0.01237
Topic 11 Human Cognitive	0.01062
Topic 12 Geriatrics and Palliative Care	0.01048
Topic 13 Gerontology Research	0.01014
Topic 14 Health Economics Financial of Aging	0.0097
Topic 15 Physical Activities for Elderly People	0.00849

Contents Analysis of NIH Smart Aging Related Websites

Analysis results

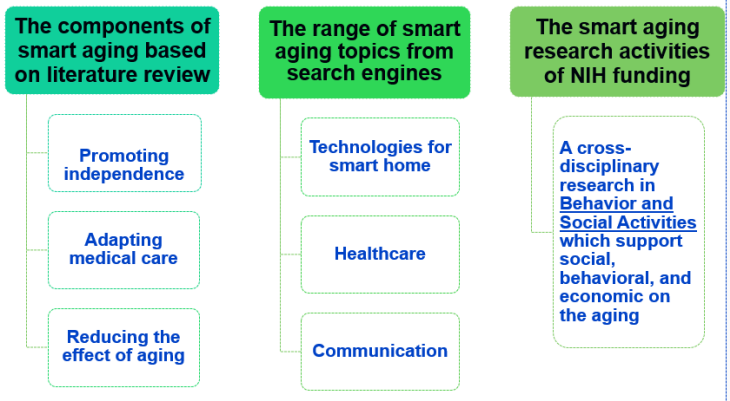
of the research activities on smart aging

Funded by National Institutes of Health (NIH) were concentrated on cross-disciplinary research in:

- Behavior and social activities
- Brain and mental functions
- Biological aging
- Nursing
- Healthcare
- Extramural activities

Thematic Structure of Smart Aging

The overall thematic structure of smart aging by content analysis to identify major issues and future directions of smart aging.



Thematic Structure of Smart Aging

Smart Aging topics analysis	Smart Aging research activities
Behavior and Social • Human Cognitive/ Brain Functions • Entertainment program for Aging **Technologies** • Smart Home Technology • Social Media • Smart Aging Innovation Housing Design • Smart Aging Devices and Applications • Smart Grid Technology and Applications / Smart City • Information Technology **Medical Care** • Aging Physical Health • Aging Mental Health	**Behavior and Social** • Global Aging Health and Financial • Extramural Activities • Social Network Study • Economics and Financial of Well-being • Behavioral Economics and Health • Human Cognitive **Medical Care** • Health and Aging • Nursing and Clinical Science • Geriatrics and Palliative Care • Physical Activities for Elderly People • Gerontology Research

Areas of Smart Aging

The literature review show that the scholarly community focus mainly on aspects of smart aging such as Technologies, Aging Medical Care, and Behavior and Social.

The range of smart aging topics of datasets collected from search engines encompasses a broader perspective such as entertainment program and social media, along with medical science, smart aging innovation technologies & products, and information security.

The research activities of NIH funded projects include Behavior and Social, and Medical Care. Specifically, they were concentrated on cross-disciplinary research in behavior and social activities which support social, behavioral, and economic on the aging. Other research activities on aging are brain and mental functions, biological aging, nursing, healthcare, and extramural activities.

More Details on Topic Analysis on Smart Aging

Data & Knowledge Engineering 115 (2018) 68–79

Contents lists available at ScienceDirect

Data & Knowledge Engineering

journal homepage: www.elsevier.com/locate/datak

The landscape of smart aging: Topics, applications, and agenda

Il-Yeol Song [a,*], Min Song [b], Tatsawan Timakum [b], Su-Ryeon Ryu [c], Hanju Lee [c]

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[b] Department of Library and Information Science, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, South Korea
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- NIH Projects and Text Mining Results
- **Research Topics and Suggestions**
- **Summary**

Evaluation of Smart Aging Devices

1. Ease of use
   - Ease of control, intuitive display,
   - Multi-interaction mode (voice, text)
2. Privacy and security
3. Affordability
4. Design/UX: stylish, attractive to younger people or older people?
5. Lovability
6. Architecture
7. Features and Functions
8. Accuracy

Source: http://www.digitalistmag.com/industries/healthcare/criteria-iot-smart-aging-devices-03164708

Challenges and Opportunities

Challenges

- Multidisciplinary research
- Sensor data integration
- Security and privacy
- Big data mgmt and cloud
- Big data analytics
- Real-time data mgmt
- Usability and UX
- Telemedicine
- Law, ethics, social bias, etc
- Connect with smart cities

Opportunities

- Applications of big data analytics to integrated EHR data
- Improvement in chronic disease prevention and quality of life
- Proactive and effective healthcare environment
- Cost-saving

Research Topics (I)

- Automatic standardization of medical terms
- Common sensor data management protocol and platform
- Turning wearables' measurement data into actionable knowledge
- Metadata management in smart aging environment
- Taxonomy and Ontology of wearables for interoperability
- Human factor studies on wearables and their acceptance by elderly
- Smart Elderly Monitoring systems through Automatic Activity Recognition and Prediction using Smartphones
- Real-time data-driven monitoring system for human behaviors

Research Topics (II)

- Automatic analysis of time series data from multiple sensors
- Using AI systems for real-time monitoring system for adults
- Applications of big data analytics for Precision healthcare
- Comprehensive risk assessment analytic tools for Elderly
- Digital personalized health advisor/app/genetic tools
- Modeling and Developing Cognitive Assistant and then Mediator for Smart Aging

Suggestions

1. A sense of urgency
2. Development of a silver economy and community
3. Support the start-ups by senior for seniors
4. Technology-based innovations with human factors
5. Revision/agreement of privacy law on medical data and use of wearable devices
6. Adoption of prevention and diagnosis technology
7. Funding innovation for healthy and smart aging technologies
8. Utilization of existing services/technologies
9. Focusing on your own strengths
10. Support convergence (ICT+SW+Bio+Nano+Neuro+Genetics+)
11. Strategic collaboration: government, business, academia, technology for R&D as well as and Education

Summary

1. Aging is an urgent social issue
2. Technologies are driving new paradigms in healthcare
   - Wearables, IOT, Big data technologies, AI, analytics and computational biology, Biomedicine, Genome editing, 4D printing of organs, NANO, CRISPR, blockchains
3. The major success factors include increasing adoption of wearables by patients and medical professionals and removing associated hassle factors.
4. Smart aging projects need a team work
5. Strategic collaboration: industry, academia, technology for R&D, education as well as Government policies and laws
6. Security and privacy would be even more critical in the future
7. Challenges and opportunities are immense

Last Word!

You will live longer than you think!

Take Actions