PTC'21
NEW REALITIES
17-20 JANUARY 2021

Empirical analysis of value creation: Identifying needs, opportunities, knowledge, technologies behind AI powered solutions to support independent elderly living

Yuan Fei [1]

Kumiko Miyazaki [2]

Santiago Ruiz-Navas [3]

1. Beijing University of Technology
2. Ritsumeikan Asia Pacific University
3. Waterloo University

PACIFIC
TELECOMMUNICATIONS
COUNCIL

Content

- **1. Introduction**

- **2. AI to support Elderly Independent Living**

- **3. Scientometric anlalysis to support Elderly Independent Living**

- **4. Descriptive analysis of the knowledge and technology structures of AI solutions to support EIL**

- **5. Conclusions and implications**

1. Introduction

- Starting from 2012, the 3rd AI boom has promised innovations to improve the Quality of Life of the elderly population

- The world's population is aging, and the population over 65 is growing faster than all other age groups.

- According to the World Bank, many developed countries, such as Sweden, Ideland, Finland, Japan, Germany entered the ageing society.

- According to Bloom, Canning, Fink by 2050 almost all countries will face severe pressure of population ageing and independent living care of the elderly has become one of the key issues in economic and social development

Developments in AI

- 1st phase 1950s ~ 60s   basic research on AI

- 2nd phase 1980s   MITI funds the 5th generation computer project.(57bn yen)   Growing use of expert systems.   Knowledge based systems (eg. Research at Schlumberger)

- 3rd phase, a revival in interest in AI. Alpha Go won against the world champion. This boom has been enabled by developments in other tech. Such as big data, Deep learning, Machine learning, Sensors, Faster processing speed. (neural network 19 x 19 x 48)

- Applications in healthcare   (medical diagnosis, treatment), assemblying (robots), virtual assistants, marketing and sales, weather forecast automated navigation, etc. The co. acquired by Google called Boston Dynamics launched a robot in 2016 Feb. based on deep learning.   Banks back office work or answering customer query, AI   used in analyzing claims data at Honda,

  the Jp gov just announced it will use AI for match making

- Publication trends are similar based on a search of

- Artificial Intelligence, on the right. AI related technologies on the left. 34% of publications concentrated in the recent 4 years

発行年別AI関連研究論文数の推移

各年での"artificial intelligence"を含む
論文数

"artificial intelligence"の検索条件
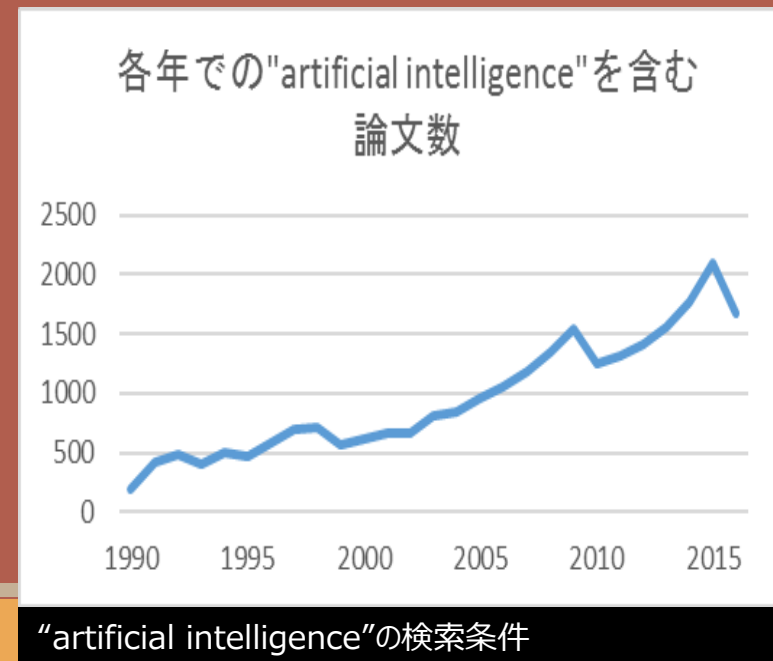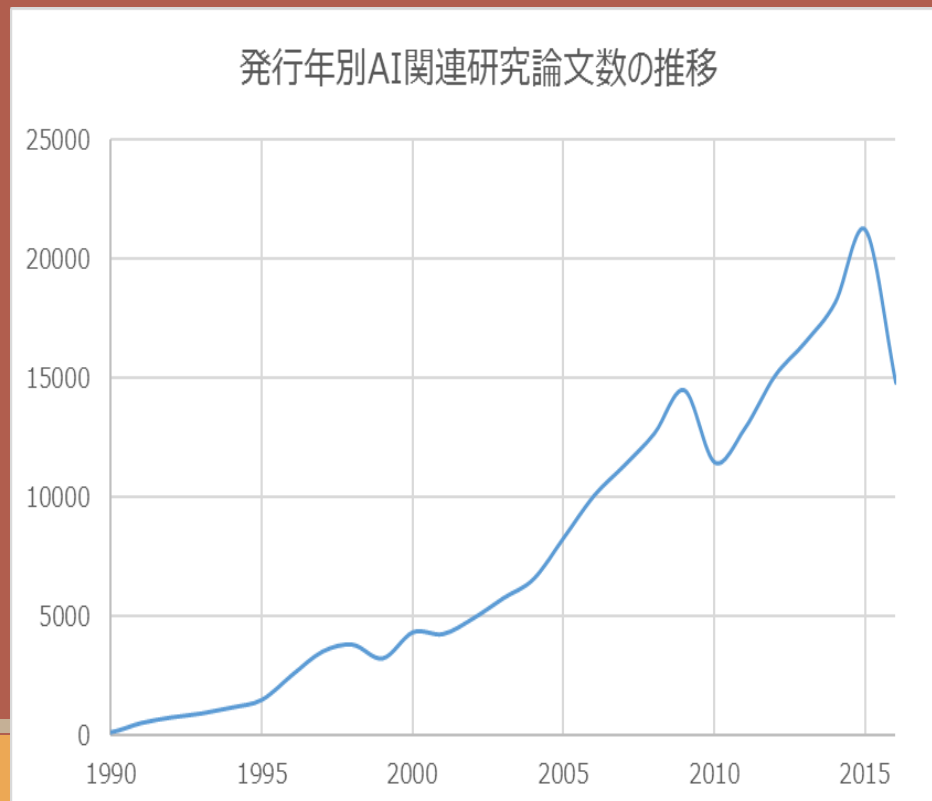
2. Enablers of EIL(elderly independent living)

1. EIL is supported by numerous services and technologies that take care of the elderly's emotional and physical health. Eg. Care services supporting ADL, nursing, transportation, social services, and health monitoring, personalized medicine.

2. **Core input, Data**

3. **AI,   together with other technologies, such as sensor networks, cognitive computing, machine learning provides possible solutions for EIL**

4. **Demand for elderly care products and services is growing faster than supply, generating high service costs and less ability to personalize care.**

5. Collaborative, interdisciplinary innovation

Researh Questions we aim to address

- What are the opportunities of AI solutions being disclosed in scientific papers to help elderly independent living?

- How is the country-level scientific strengths and research foci underlying the AI related emerging technologies supporting Elderly Independent living?

- What are the challenges and issues disclosed in those AI solutions to help the elderly independent living?

Characteristic of Innovation in digital age
Core input DATA

Innovation relies on usage of data from various sources

Challenges such as achieving a balance between respecting elderly's privacy and monitoring their data to better serve them

Challenges of AI powered innovations

Core input DATA

 AI covers many disciplines and their solutions can be delivered as AI powered intangible software or tangible hardware. It requires identification of cross disciplinary AI solutions

AI, Machine learning requires large numbers of observations, although recently research on less data usage is taking place.

It requires a review and comparison of elderly in different context with diverging needs, taking advantage of the knowledge underlying AI technologies

2. AI to support EIL

1 Technologies, solutions to help the elderly stay at home in older years instead of a nursing home is a positive and empowering concept

2. AI technologies, together with other assistive technologies improve the independence of the elderly and help them to live at home

3. **Emergency situations, such as slip and fall can trigger a serious medical conditions in the elderly. By getting in-house assistance by AI can ensure that the activities of daily living are met efficiently and safely by the elderly. AiCare uses machine learning and wearable sensors**

4. Healthcare providers are starting to offload certain elderly care service to AI, AI enabled solutions for telemedicine and telecare will have a big impact on caregiving services. (Sanyal)

5 AI is used by researchers to do research on anti-aging to understand the process of ageing. Insilico Medicine is a drug development company which uses deep learning for age related drug discovery. .

3. Scientometric Analysis Of AI Technologies to Support Elderly Independent Living

- Scientific output: **3683** literature on emerging technology in 3rd AI Boom

- Keywords: AI technology and aging-related terms

Number of papers on AI to support Aging 2012-2019
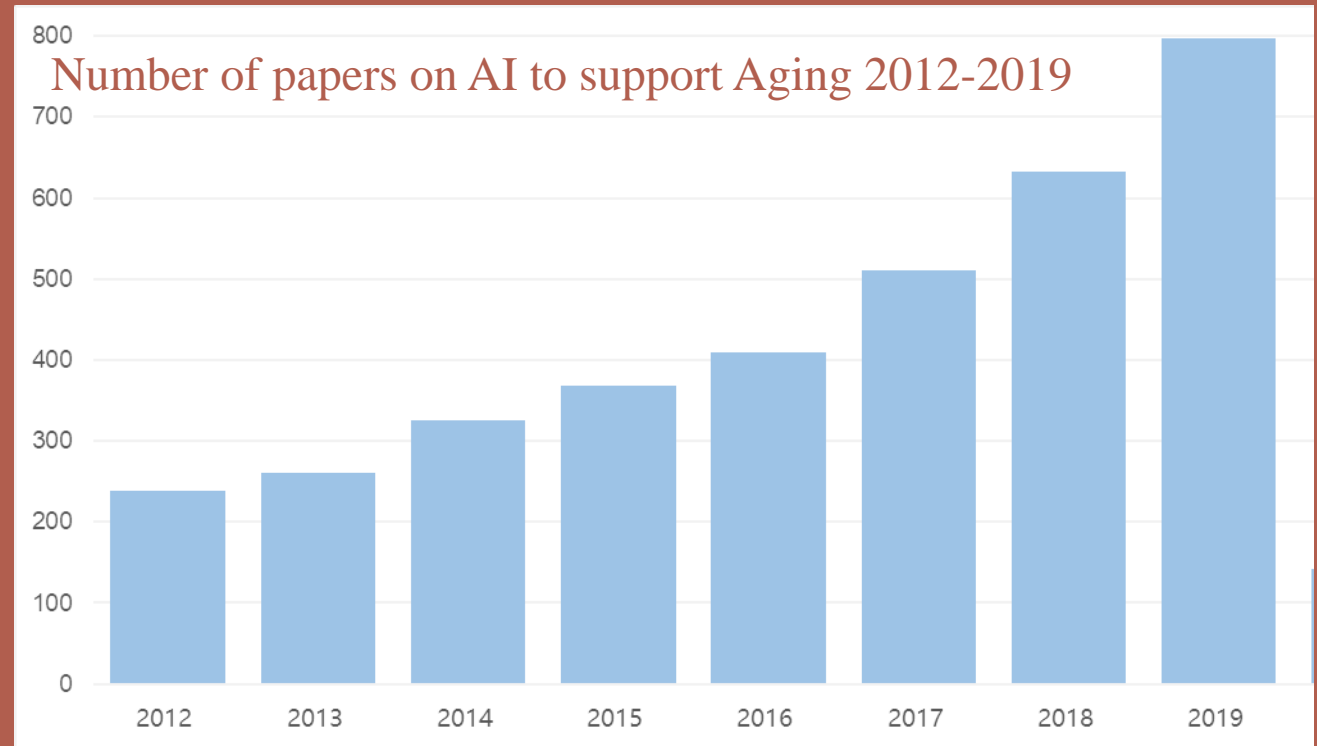
# The Cooperative Network of Research Institutions

- Major research institutions in the United States cooperate closely with each other

- Only a small number of research institutions in Europe and Asia appear with a cooperative connection in the network

- American institutions having more research output occupy a major position, while other research institutions cooperate with each other and American institutions
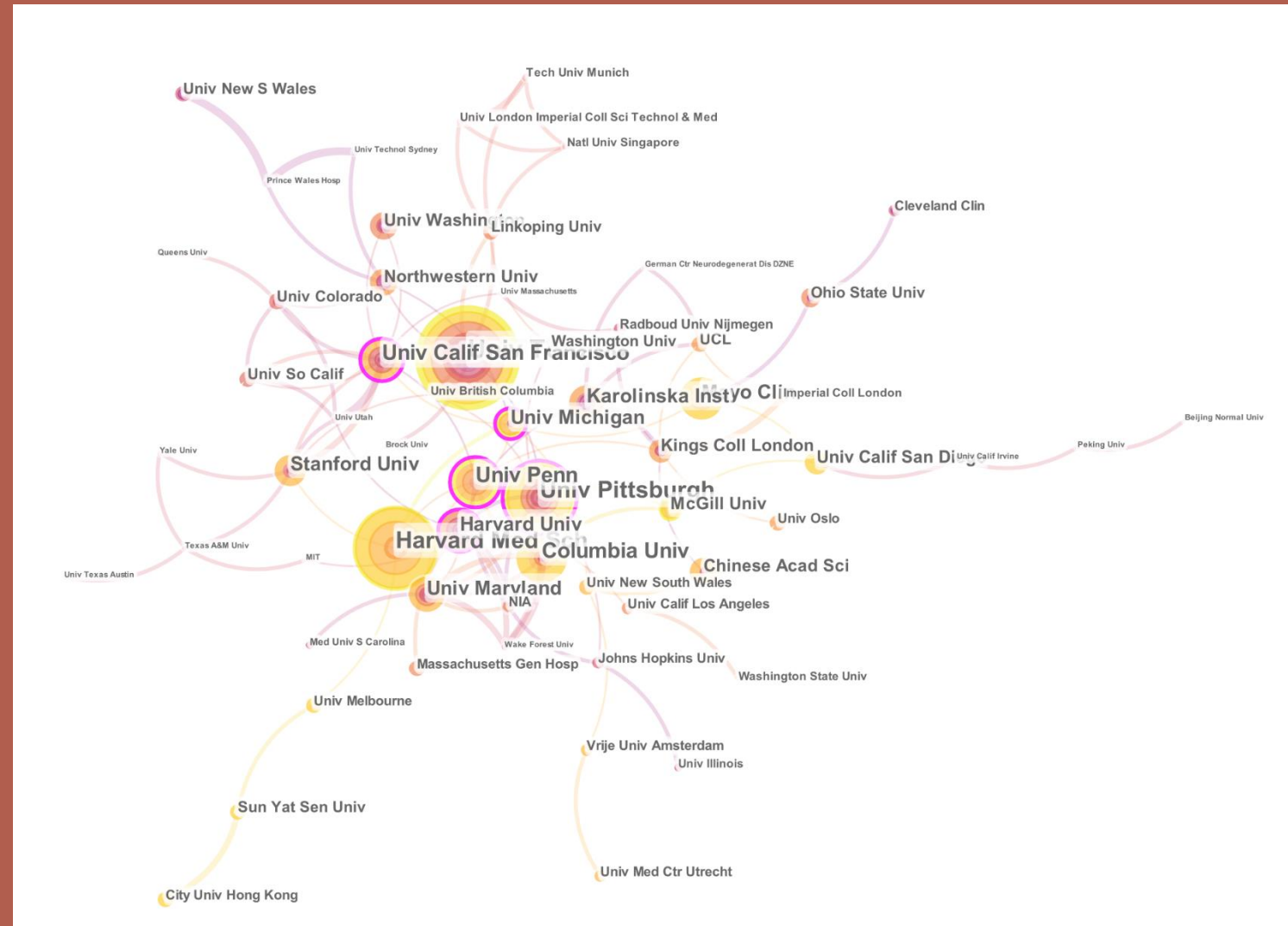
Top 10 Research Institutions By The Number of Publications

- Most institutions are universities that have a leading position in both AI and medical research

- Institutions with interdisciplinary capabilities have the research and innovation potential to meet the interdisciplinary issue of elderly independent living

- US has a leading position

- Emerged in Europe and Asia

Top research institutions


Legend: Number of Publications
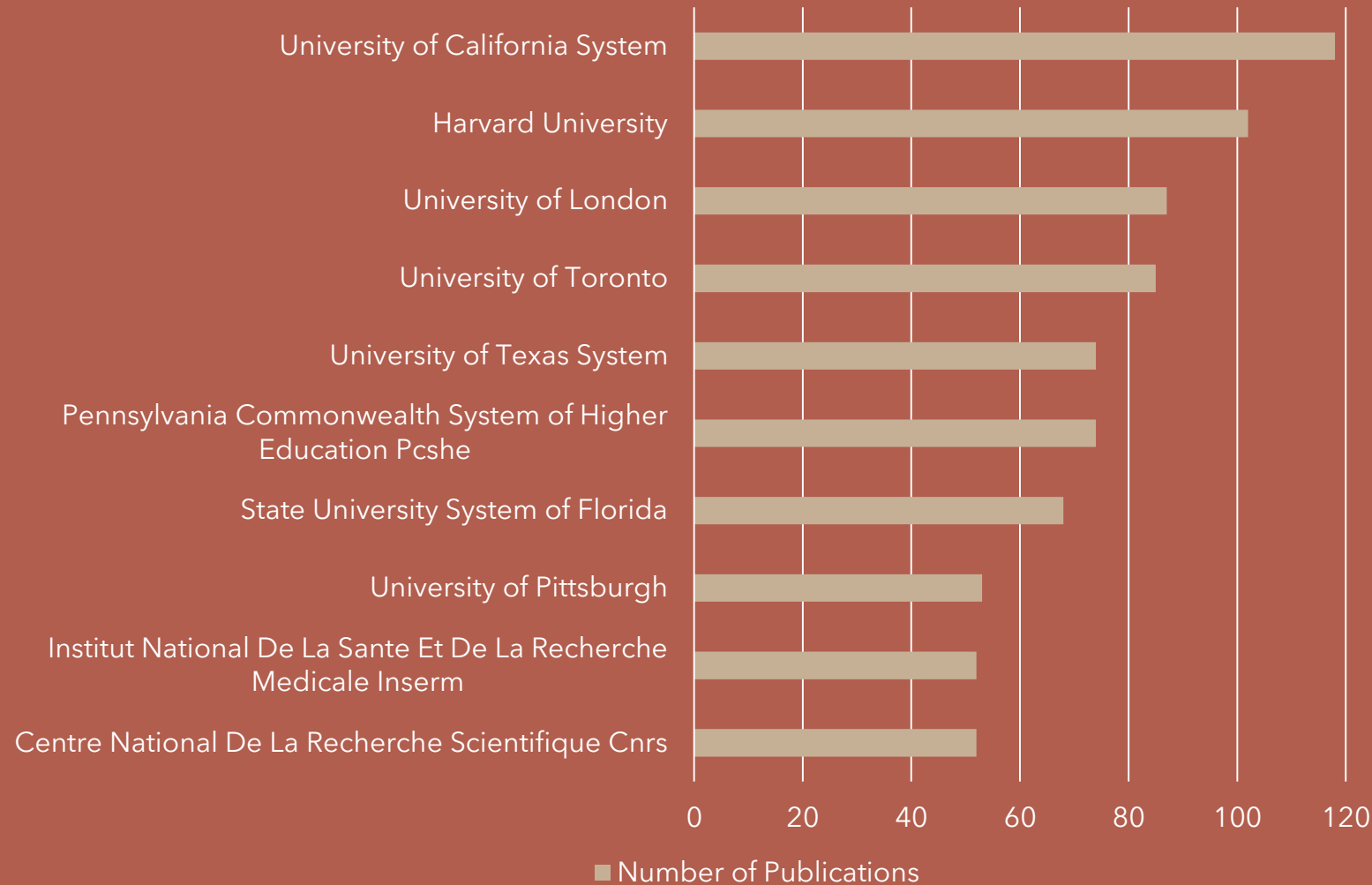
The Cooperative Network of Nations

- The nodes connect each other but with no obvious small cluster, the cooperation and exchanges between countries are very close

- No country is separate from the world and carrying out independently

- The number of US publications is large with many achievements, but its influence on the cooperation of countries around the world does not occupy a leading position

- US, UK, Canada, Japan are highly intermediary countries with active international cooperation

The cooperative network (US excluded)

The cooperative network (US included)

Core Players in the research of AI Tech to support ADLs

- Core players: the United States, the United Kingdom, Canada, Australia, France, Japan, and South Korea

- The United Kingdom and Canada are in a leading position in the research field with more international influence

- Not all countries with high volume publications are at the forefront: Japan and France with high influence, but Italy and Germany attention differs from the focus of global researchers

- Japan, France, and South Korea have not published many articles, but their research results have a greater impact

- China's attention to using AI to deal with the aging problem is emerging, but the outputs of technological innovation did not match with the actual needs of an aging society
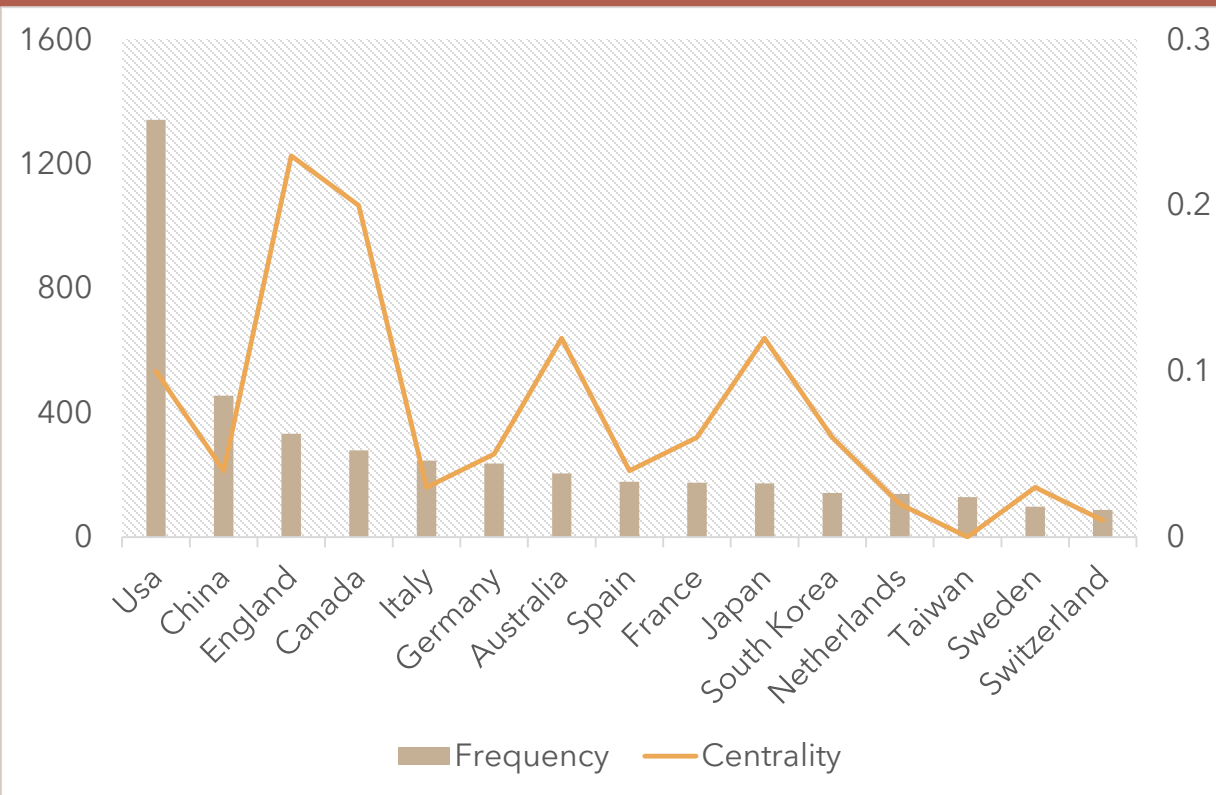
Visualizing Research Foci of AI To Support Aging (7 clusters)
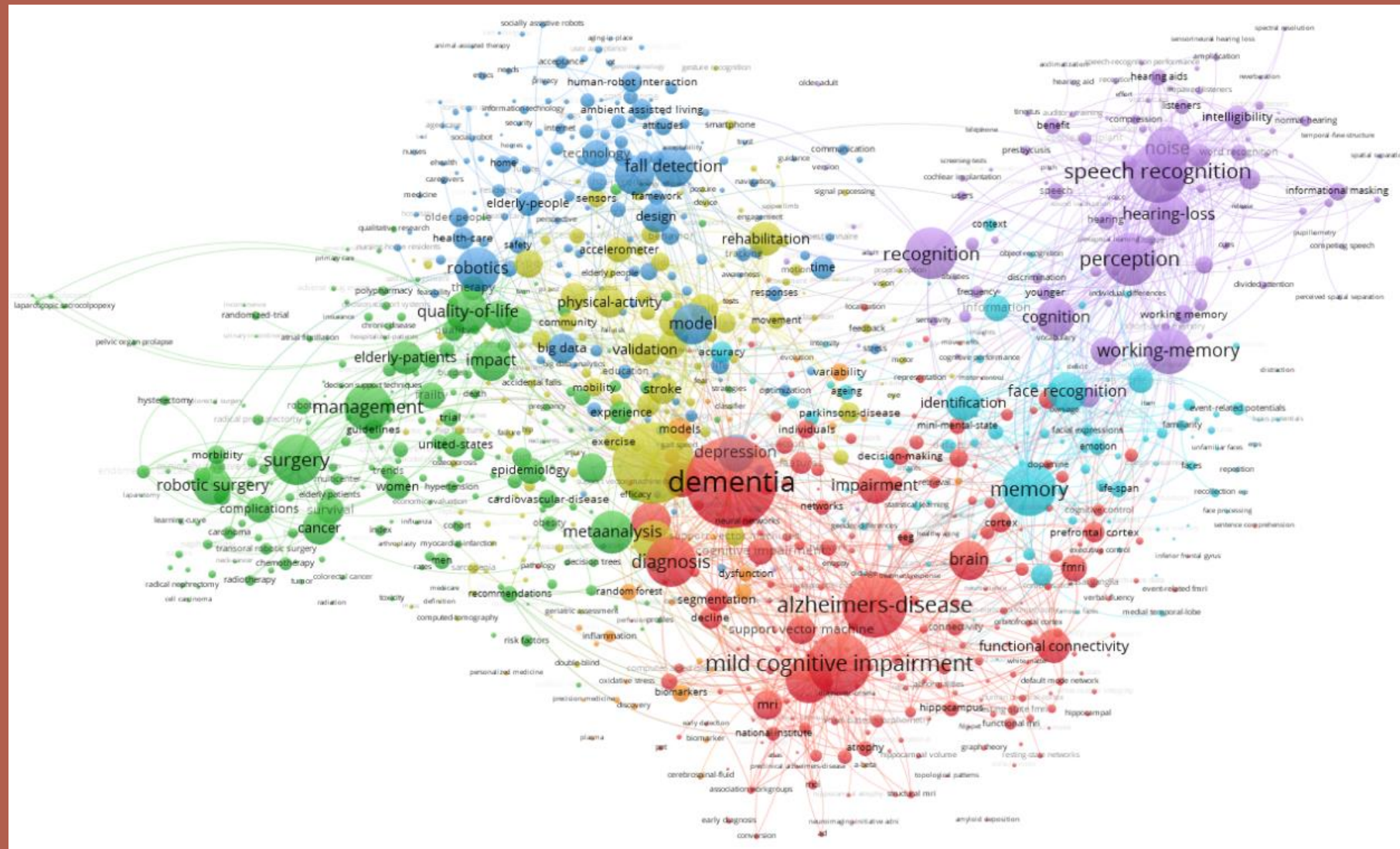
Visualizing Research Foci of AI To Support Aging (7 clusters)

Classifications	Example of Technology Application
Cluster 1(red): brain functions of the elderly	AI Detect Alzheimer's Disease in Brain Scans Six Years Before a Diagnosis
Cluster 2(green): Diagnosis and treatment of disease	use AI to detect early signs of lung diseases
Cluster 3(blue): Behavior Surveillance	Artificial Intelligence Detect and Prevent Senior Falls
Cluster 4(yellow): Disease prediction and assessment	Prediction of fatty liver disease using machine learning algorithms
Cluster 5(purple): Speech recognition and hearing-aid	Use AI to Program Cochlear Implants
Cluster 6(Aqua): facial recognition	Face recognition assists the cognitive function of the elderly
Cluster 7(orange): Algorithm application	Random forest algorithm assists diagnosis of diseases

Visualizing the co-citation of literature on AI to support aging
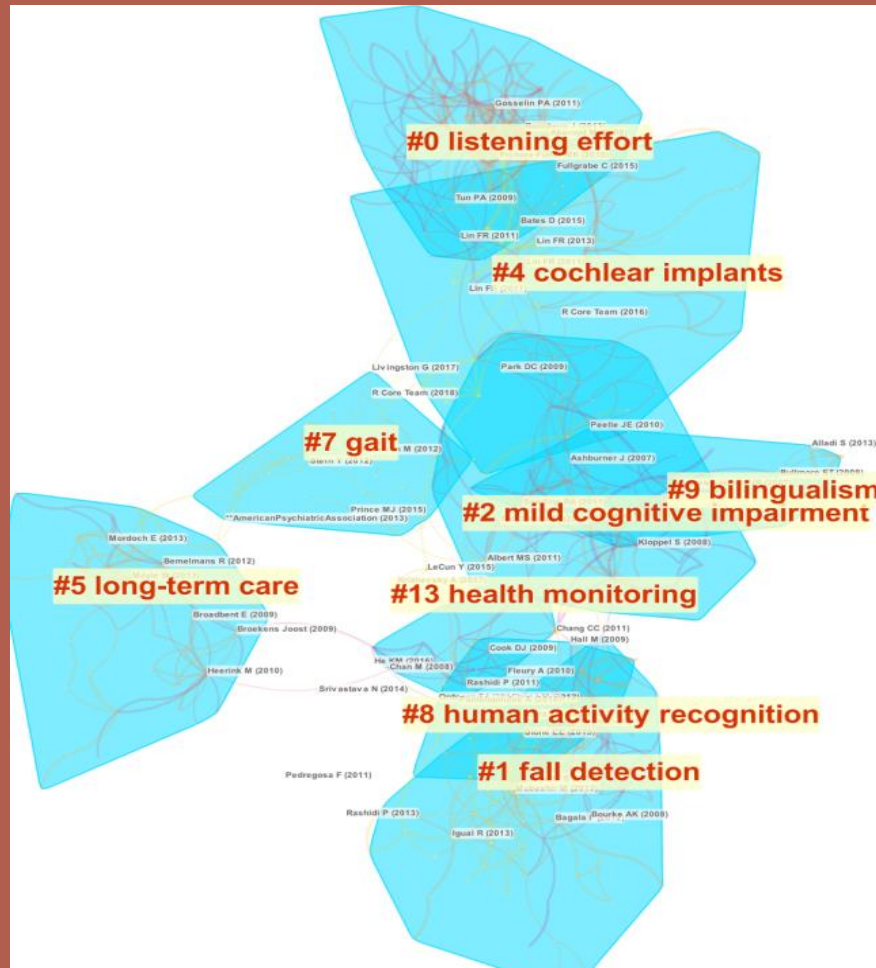
- **8 Highlights**: Fall detection, behavior recognition, cochlear implants, auditory and motor function, mild cognitive impairment, gait, health monitoring, and long-term care

- Researchers mainly focus on hearing-aid, behavior-assist, cognitive enhancement, using AI technology to solve the elderly independent living difficulties, to a certain extent, to replace the simple human caregiving

- Cognitive function, assisted care, and recognition techniques are among the most prominent keywords that have remained the focus of scientist research in the 3rd boom of AI

4. Descriptive analysis of the knowledge and technology structure of AI solutions to support Elderly independent living

- Objective: Identify how AI is being used to support Elderly independent living.

- Method:
  - Retrieving the scientific publications – using Web of Science, retrieved 4274 documents for the period 2012-2020.
  - Author keyword preprocessing – enhanced by DBpedia and Wikipedia to classify keywords as technologies and disciplines
  - Creating keyword co-occurrence network
  - Analysis of knowledge and technology structure for 2019.

Descriptive analysis of the knowledge and technology structure of AI solutions to support Elderly independent living

Results

- Network of 348 nodes and 1551 edges
- 17 clusters
- Three top clusters selected by their betweenness centrality,
- Clusters 12,14 and 4

Cluster	Description
12	Machine learning and sensors to solve quality of sleep, improve life quality and stroke care.
14	Machine learning, IoT, Smart houses and wearables to solve healthy aging.
4	Machine learning, health economics. Physical activity, vaccination and hearing aids to treat conditions such as carcinoma, brain injury and chronic kidney diseases

5. Conclusions

- Scientometric analysis on AI to support EIL in this paper has illustrated the national and regional research development, cooperation, and hot topics in the field of emerging AI technology for elderly ADLs

- Proposed six steps to provide a descriptive analysis of knowledge and technology structure of AI solutions to help the Elderly independent living using scientific publications

5. Conclusions

- Analyzed scientific documents related to AI solutions to support aged adults' independent living and provided a descriptive analysis of the more central solutions identified for the year 2020

- Resulted in the identification of solutions based on technical and healthcare disciplines to attend elderly living issues such as illness, quality of sleep and quality of life

- Provided an initial application of how annotating author keywords using metadata from external knowledge sources such as Wikipedia and DBpedia can facilitate the analysis of the knowledge and technology structure of a dataset of scientific publications

5. Implications

- From this analysis, we suggest actors interested in developing solutions for supporting elderly independent living to pay attention to foster interdisciplinary work and what it entails.

- We can point out that solutions to support elderly independent living require the integration of knowledge from various disciplines, services and products such as machine learning, sensors, data analysis and sociology and healthcare

References

[1] D. E. Bloom, D. Canning, and G. Fink, "Implications of population ageing for economic growth," Oxford Rev. Econ. Policy, vol. 26, no. 4, pp. 583–612, 2010.

[2] C. Siegel, A. Hochgatterer, and T. E. Dorner, "Contributions of ambient assisted living for health and quality of life in the elderly and care services - a qualitative analysis from the experts' perspective of care service professionals," BMC Geriatr., vol. 14, no. 1, p. 112, Dec. 2014.

[3] S. Sanyal, "How Is AI Revolutionizing Elderly Care," Forbes, 2018. [Online]. Available: https://www.forbes.com/sites/shourjyasanyal/2018/10/31/how-is-ai-revolutionizing-elderly-care/#2af4177e07d6. [Accessed: 12-Feb-2019].

[4] AiCare, "AiCare – Intelligent Senior Care," AiCare, 2020. [Online]. DAvailable: https://aicare.co/.

[5] K. Miyazaki, R. Satou, and S. Ruiz-Navas, "Evolutionary Path of Development of Artificial Intelligent (AI) and Patterns of Knowledge Convergence over the Second and Third AI Booms," STIPM., vol. 4, no. 3, pp. 125–142, 2019.

[6] S. R. Ruiz-Navas and K. Miyazaki, "Developing a framework to track knowledge convergence in 'big data,'" Int. J. Technol. Intell. Plan., vol. 12, no. 2, p. 121, 2018.

[7] OECD., K. OECD Science, Technology and Innovation Outlook 2018. OECD Publishing, 2018.

Thank you so much!