



Applications of Distributed Artificial Intelligence and Swarm Intelligence in Medicine

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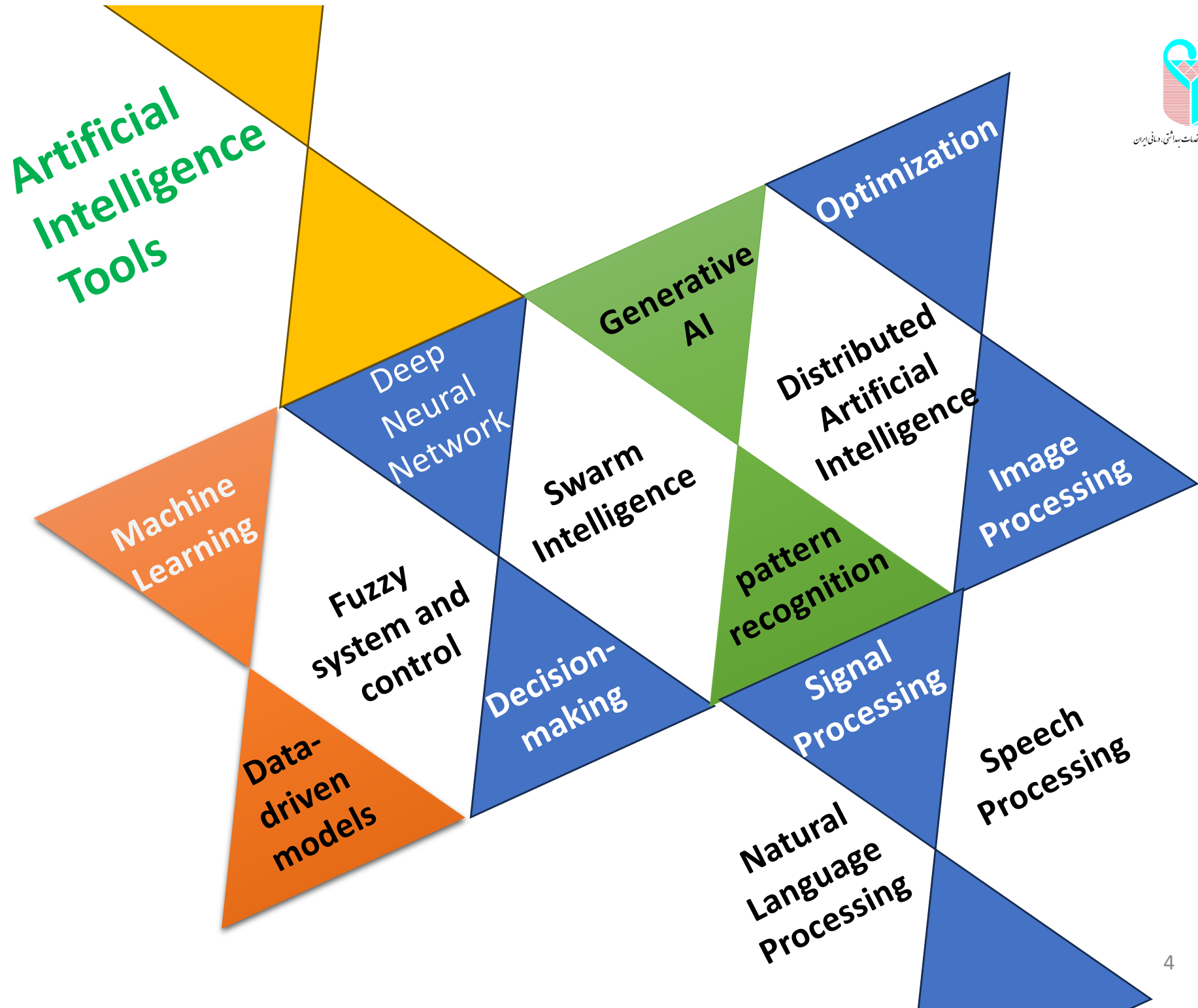
سوره الفجر



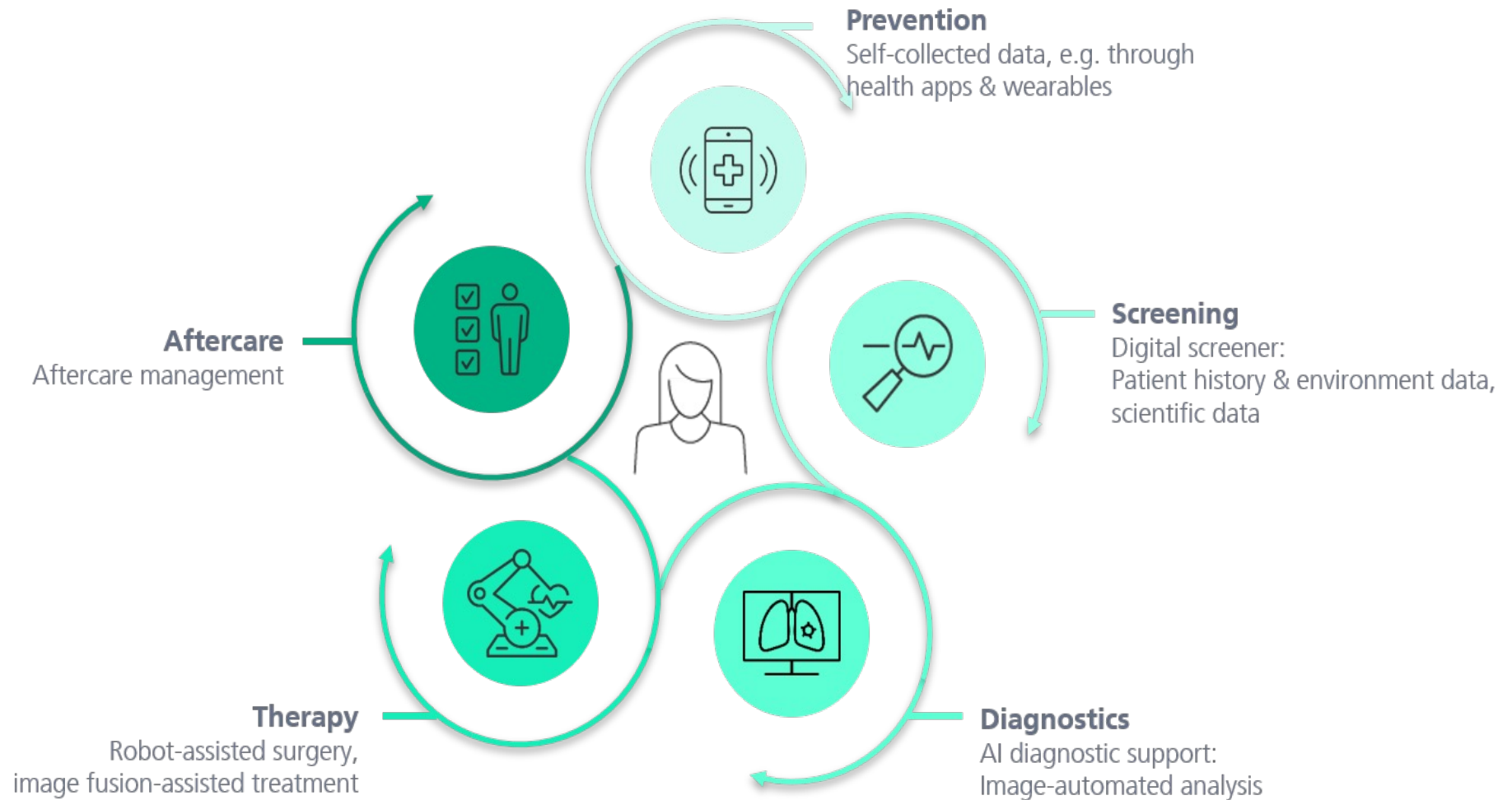
عنوان دوره آنلاین:
هوش مصنوعی در پزشکی با رویکرد بالینی
Online Course: Artificial Intelligence in
Medicine with Clinical Approach

Course Topics	عناوین بیست و چهار جلسه	تاریخ جلسات
Artificial Intelligence (AI) in medicine	معرفی هوش مصنوعی در پزشکی	۲۸ بهمن ۱۴۰۲
AI and Fuzzy systems and its applications in medicine	هوش مصنوعی و سیستم های فازی در پزشکی	۵ اسفند ۱۴۰۲
Machine Learning and its applications in medicine	یادگیری ماشین و کاربردهای آن در پزشکی	۱۲ اسفند ۱۴۰۲
Evolutionary systems and its applications in medicine	الگوریتم های بهینه سازی تکاملی و کاربردهای آن در پزشکی	۱۹ اسفند ۱۴۰۲
Neural networks and deep neural networks in medicine	شبکه های عصبی و شبکه های عصبی عمیق در پزشکی	۲۵ فروردین ۱۴۰۳
Application of AI in Early Detection of Disease	کاربرد هوش مصنوعی در تشخیص زودهنگام بیماری ها	۱ اردیبهشت ۱۴۰۳
Swarm Intelligence and multi-agent/swarm in medicine	هوش ازدحامی، سیستم های چند عامله/ازدحامی در پزشکی	۸ اردیبهشت ۱۴۰۳
Application of AI in Cancer	کاربردهای هوش مصنوعی در سرطان	۱۲ اردیبهشت ۱۴۰۳
Application of AI in surgery	کاربردهای هوش مصنوعی در جراحی	۲۹ اردیبهشت ۱۴۰۳
Applications of AI in Neurology	کاربردهای هوش مصنوعی در مغز و اعصاب	۵ خرداد ۱۴۰۳
Application of AI in Internal Medicine	کاربردهای هوش مصنوعی در پزشکی داخلی	۱۲ خرداد ۱۴۰۳
Applications of AI in cardiovascular	کاربردهای هوش مصنوعی در قلب و عروق	۱۹ خرداد ۱۴۰۳
Applications of AI in Breast Disease	کاربردهای هوش مصنوعی در بیماری های پستان	۲۶ خرداد ۱۴۰۳
Application of AI in Ophthalmology	کاربردهای هوش مصنوعی در چشم پزشکی	۲ تیر ۱۴۰۳
Application of AI in Nephrology	کاربردهای هوش مصنوعی در نفرولوژی	۹ تیر ۱۴۰۳
Application of AI in Otorhinolaryngology	کاربردهای هوش مصنوعی در گوش و حلق و بینی	۱۶ تیر ۱۴۰۳
Application of AI in Gynecology and obstetrics	کاربردهای هوش مصنوعی در زنان و مامایی	۲۳ تیر ۱۴۰۳
Application of AI in pediatric medicine	کاربردهای هوش مصنوعی در پزشکی اطفال	۳۰ تیر ۱۴۰۳
Application of AI in anesthesia	کاربردهای هوش مصنوعی در بیهوشی	۶ مرداد ۱۴۰۳
Application of AI in emergency medicine	کاربردهای هوش مصنوعی در پزشکی اورژانس	۱۳ مرداد ۱۴۰۳
Applications of artificial intelligence in orthopedics	کاربردهای هوش مصنوعی در ارتوپدی	۲۰ مرداد ۱۴۰۳
Application of AI in pain management	کاربردهای هوش مصنوعی در مدیریت درد	۲۷ مرداد ۱۴۰۳
Application of AI in pharmacology	کاربردهای هوش مصنوعی در داروسازی	۳ شهریور ۱۴۰۳
Application of AI in dentistry	کاربردهای هوش مصنوعی در دندان پزشکی	۱۰ شهریور ۱۴۰۳



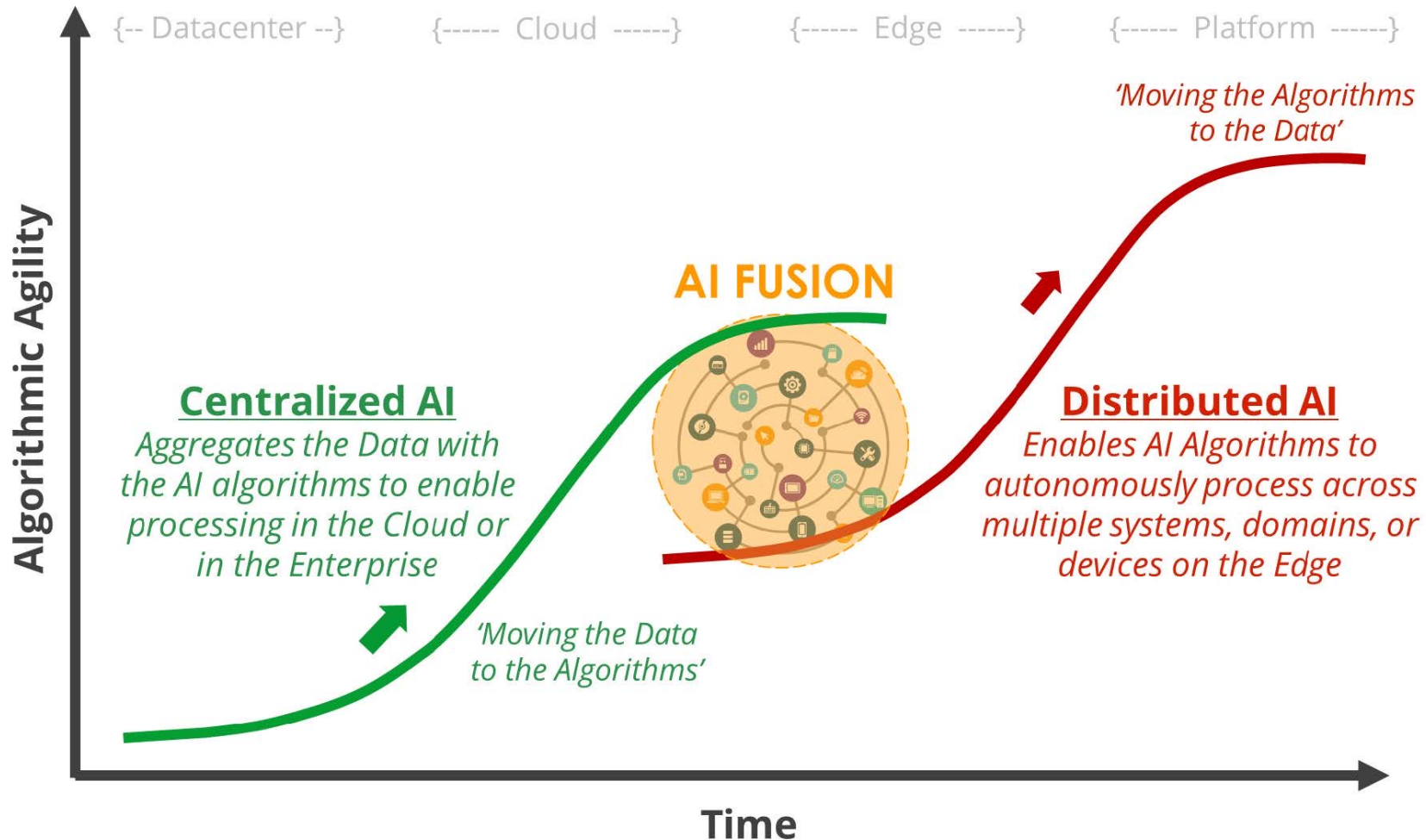


The digital patient journey



Distributed Artificial Intelligence

dedicated to the development of distributed solutions for problems



Distributed Artificial Intelligence

dedicated to the development of distributed solutions for problems

It is for solving complex learning, planning, and decision-making problems.

parallel and large-scale computing and spatial distribution of computing resources.

DAI systems consist of agents of autonomous learning processing, which are usually distributed on a very large scale.

DAI nodes can operate independently and partial responses are integrated, often asynchronously, through communication between nodes.

DAI systems do not require all relevant data to be collected in one place.



Fig. 1- Illustration of service AI



Distributed Artificial Intelligence

Swarm Intelligence



Swarm Intelligence

- Swarm intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial.

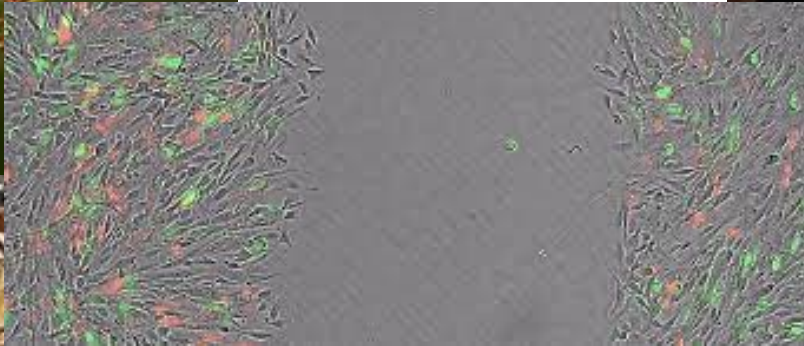
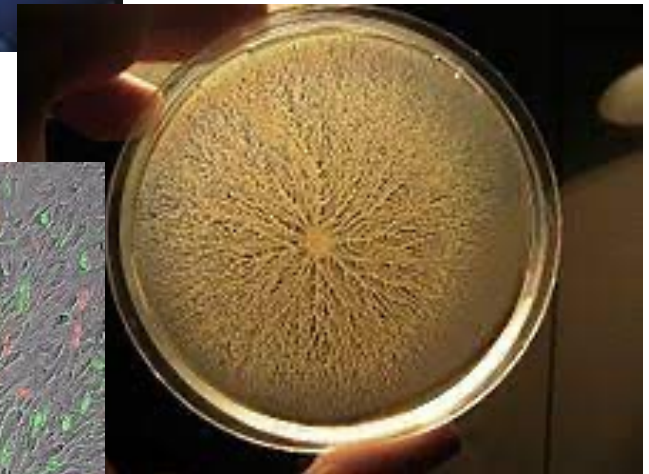
work together to achieve a common goal

SI systems consist typically of a population of simple agents interacting locally with one another and with their environment.

Agents follow very simple rules, and there is no centralized control, interactions between agents lead to emergence of "intelligent" global behavior



Examples



Benefits of SI

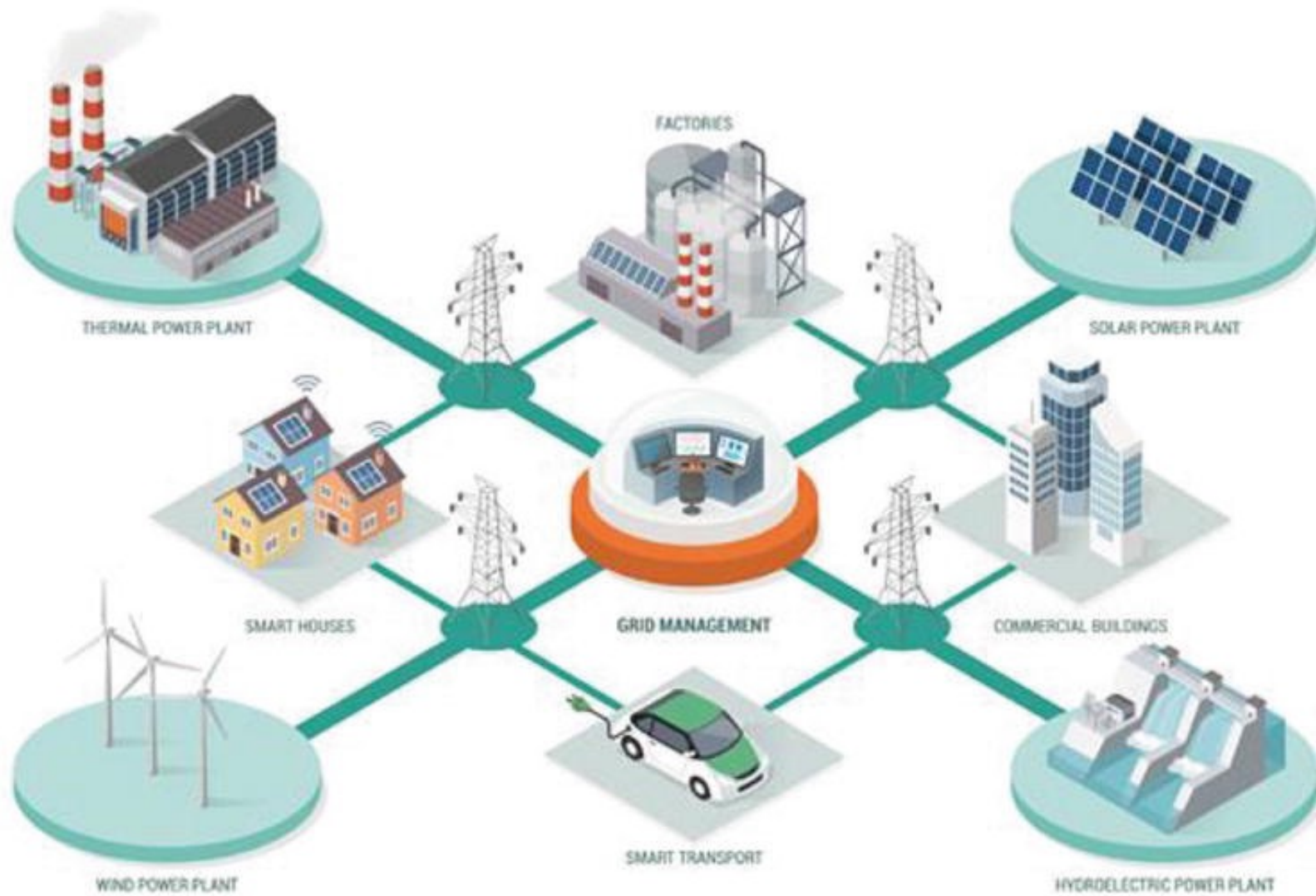
- Flexibility and adaptability.
- coping with external challenges and internal disturbances
- Agents may have different and possibly imperfect capabilities. Through synergy, the individuals will be able to cover each other's weaknesses and reinforce each other's strengths achieving challenging tasks.
- SI systems are scalable and may include a few to millions of individuals thanks to their decentralized decision-making.
- scalability, confidentiality, decentralization, flexibility

Multi agent systems

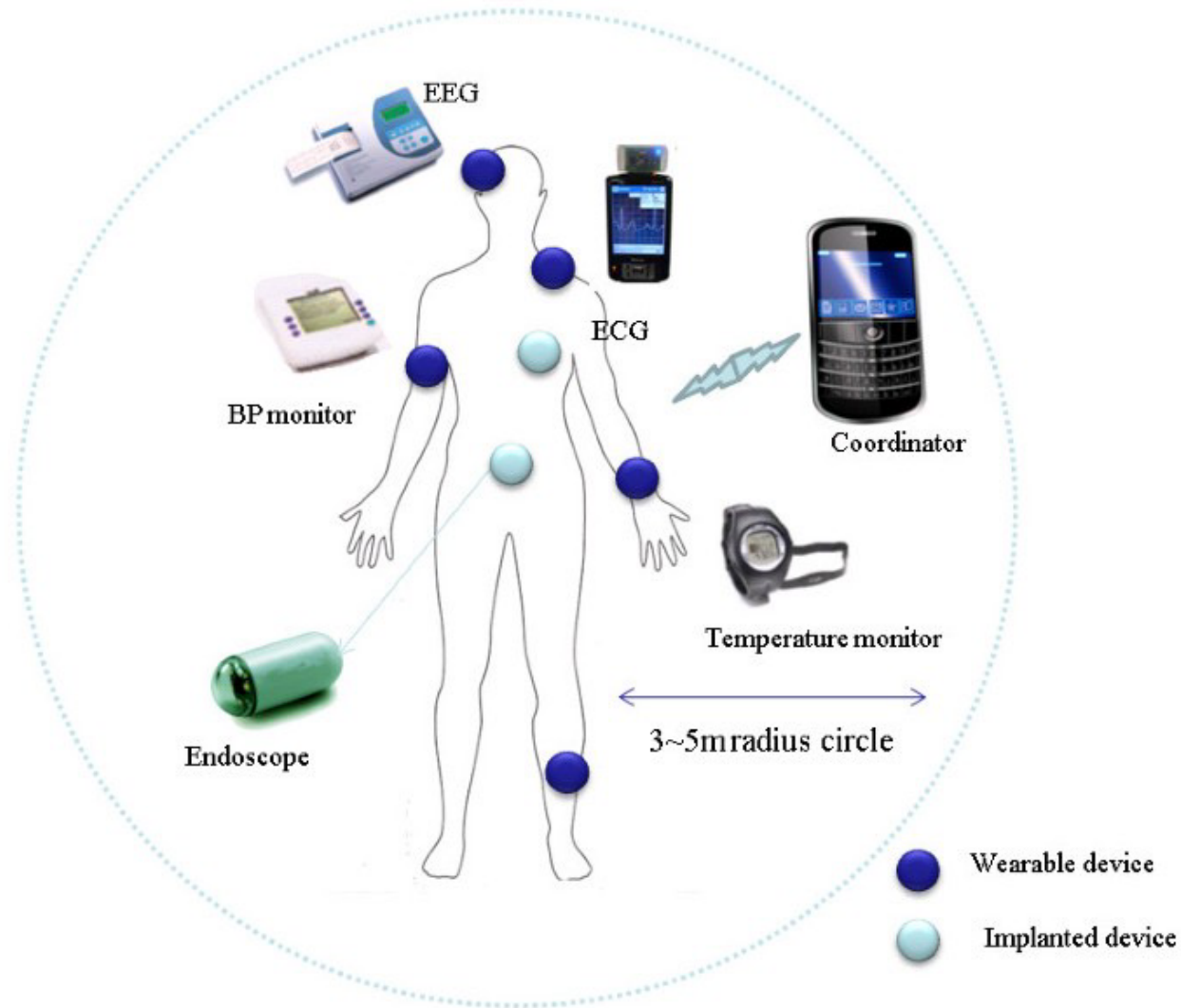
- A self-organized system composed of group of agents or humans and agents that interact with each other and the environment to achieve goals.



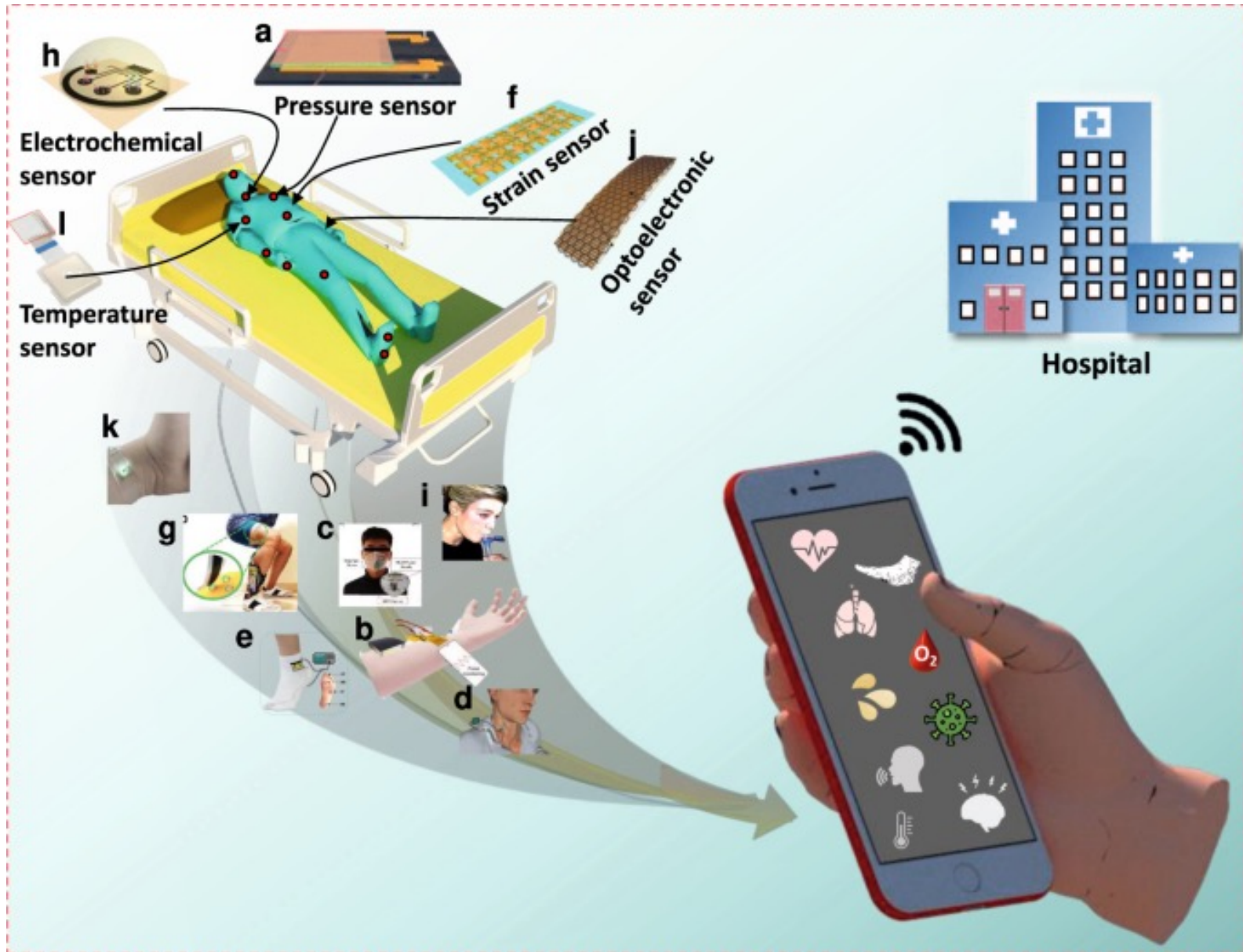
system of systems

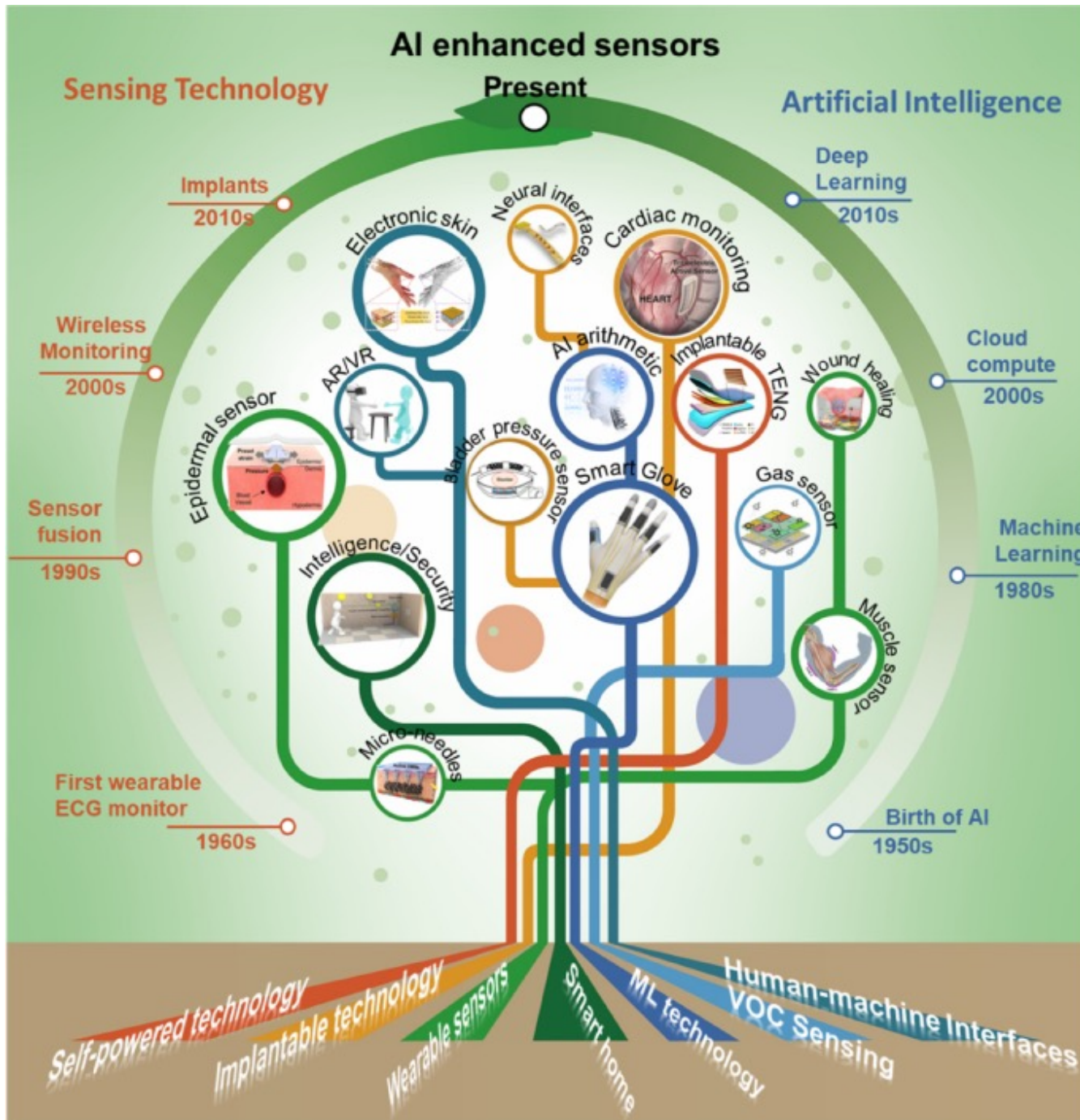


Body Area Network



Telehealth

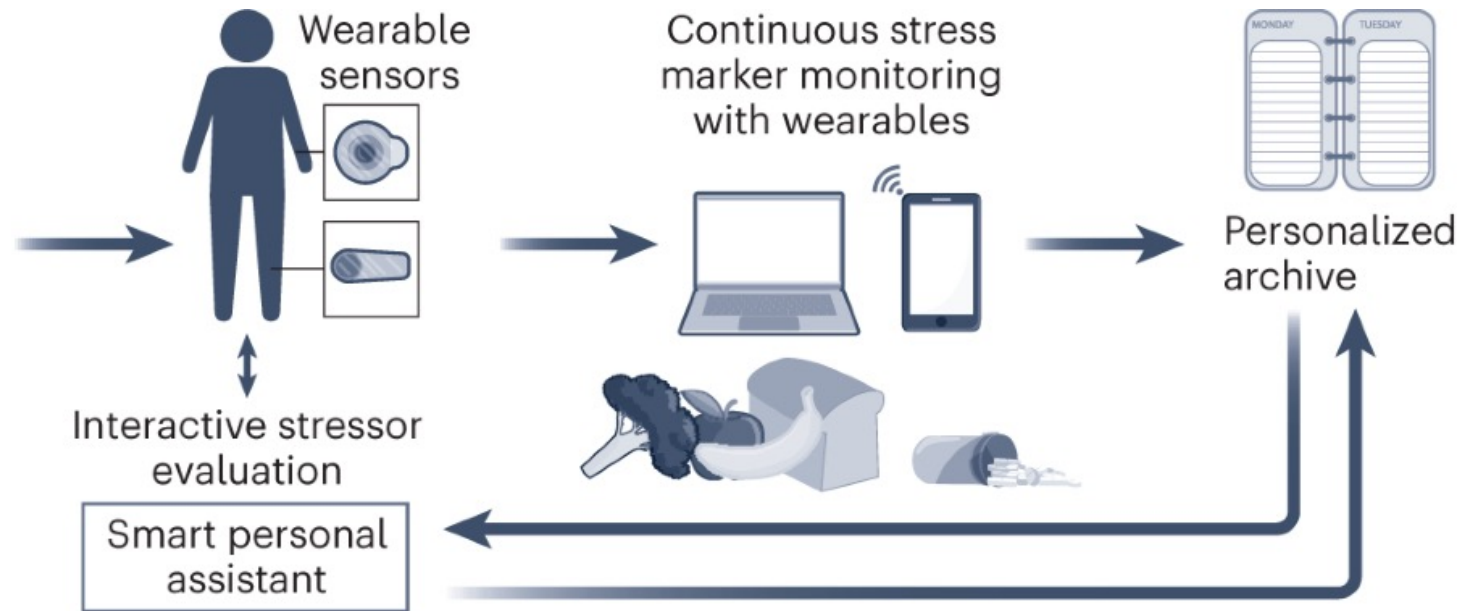




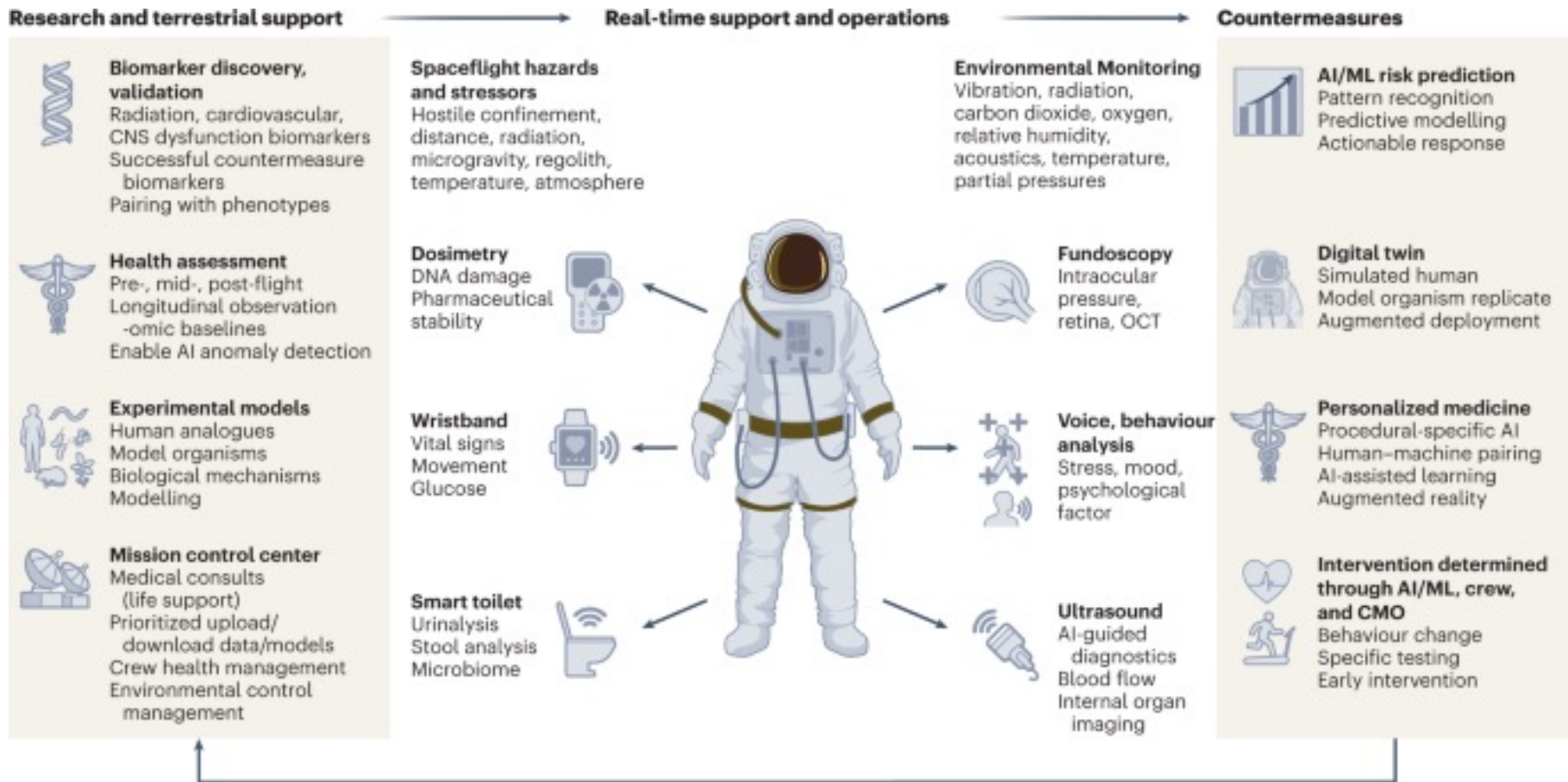
Stress Monitoring



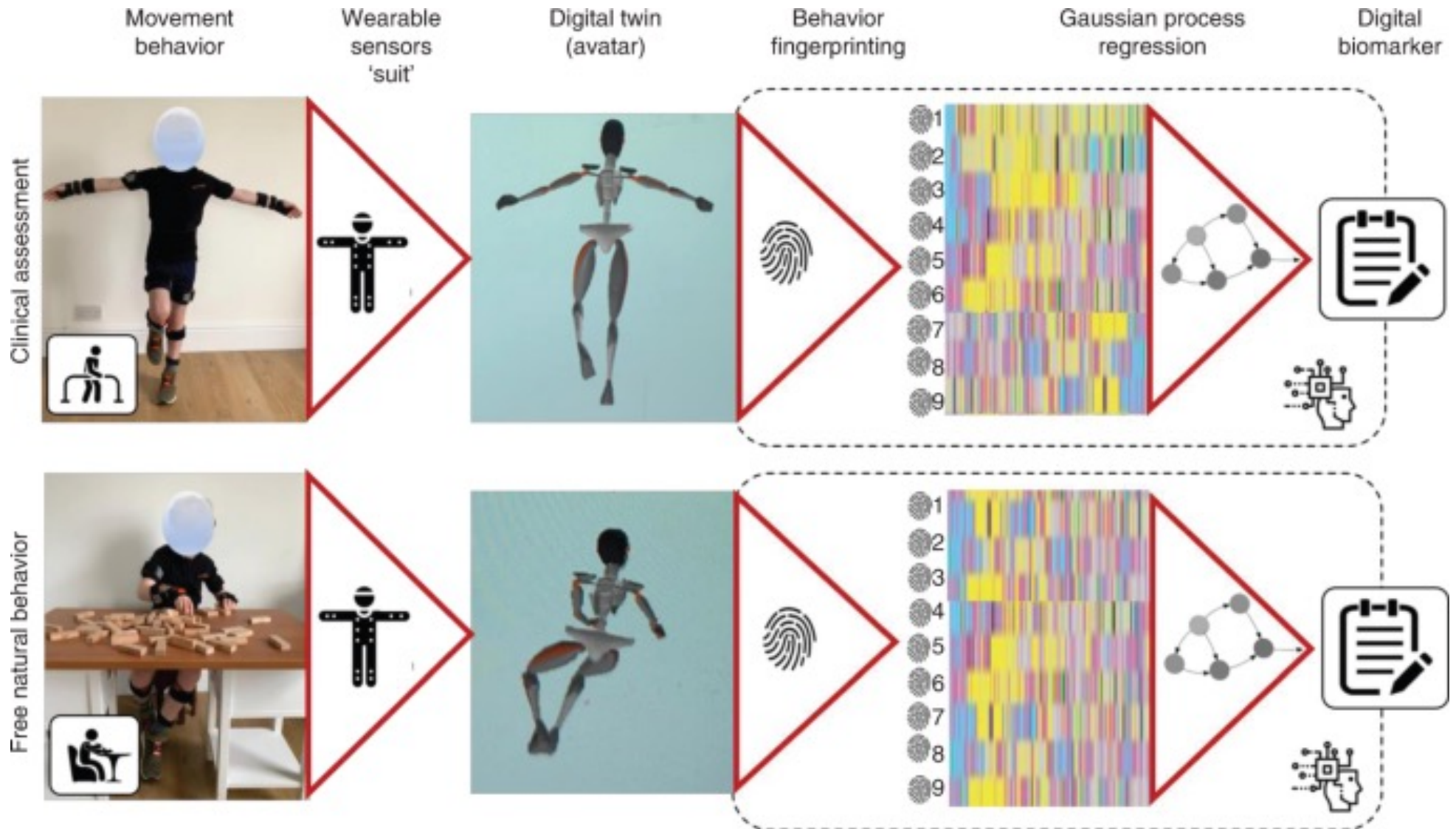
Daily activities embedded with stressors



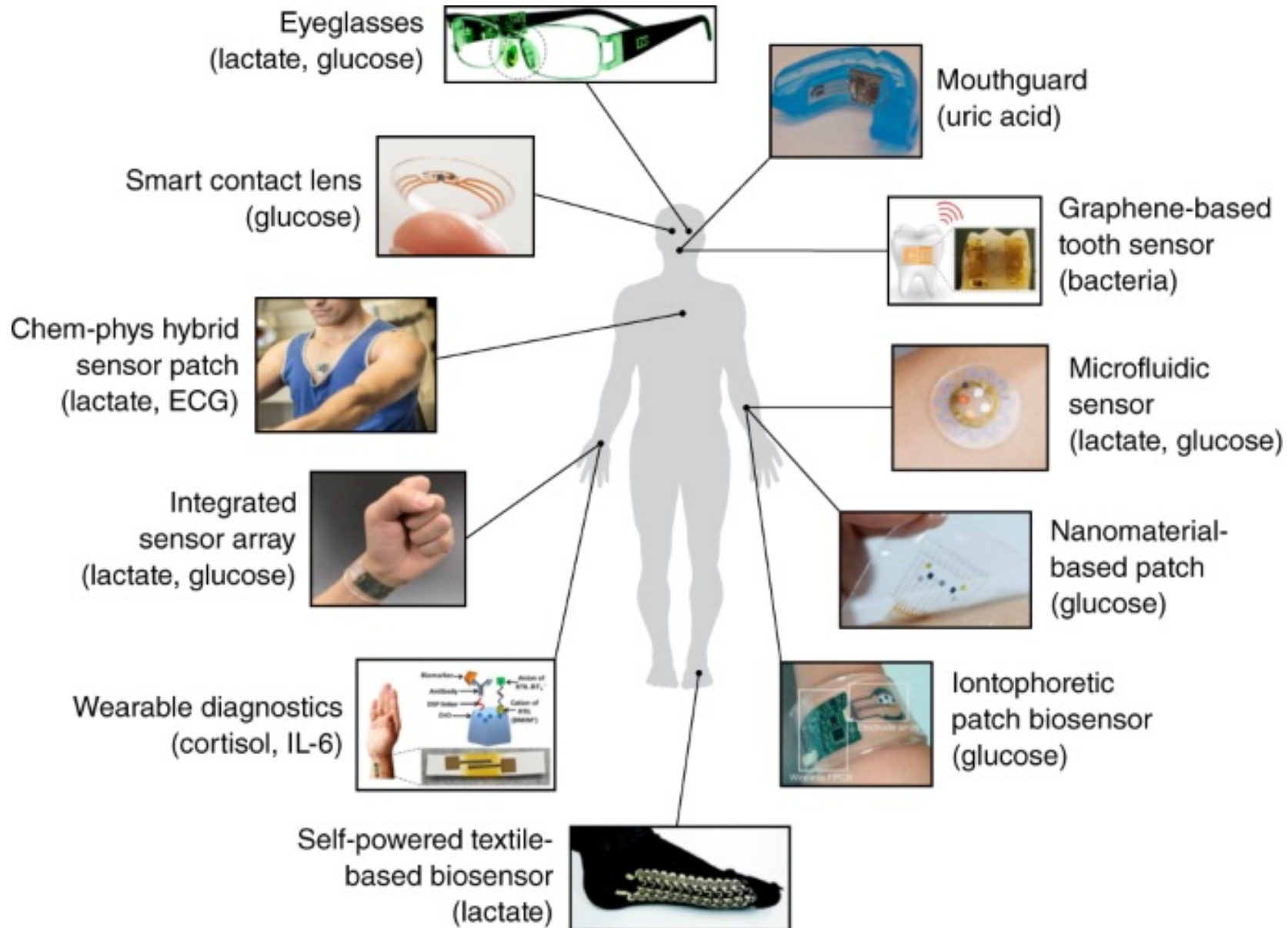
Precision Health Space



Muscular Dystrophy

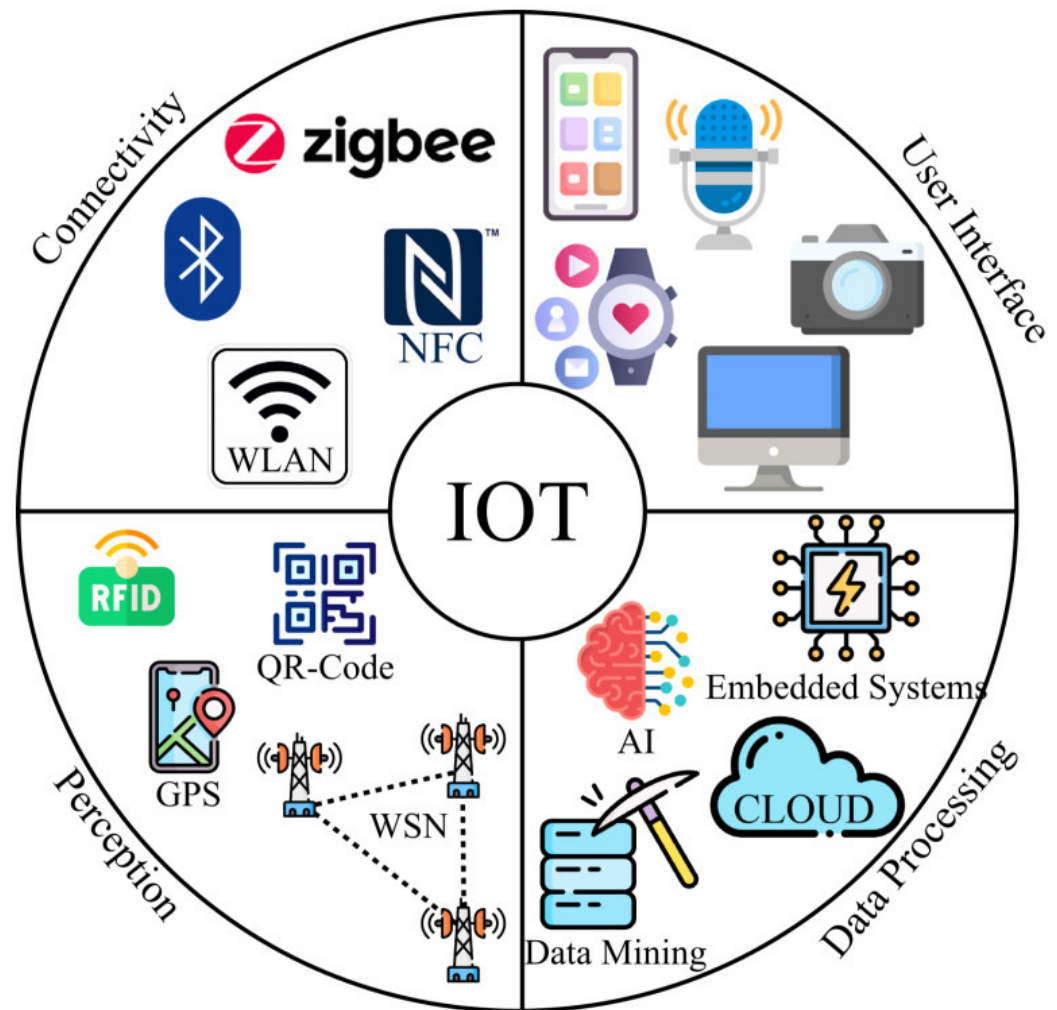


Wearable Health Tools



Internet of Things

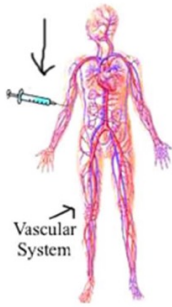
- IoT is based on technologies such as cloud computing, wireless sensor networks (WSNs), radio-frequency-identification (RFID) devices.



Medical Swarm robotics

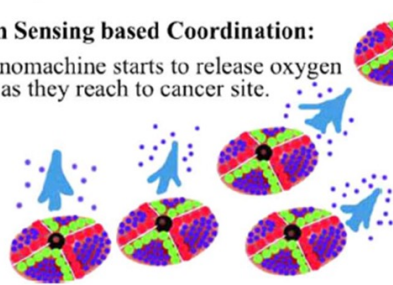


Injection of Nanomachine



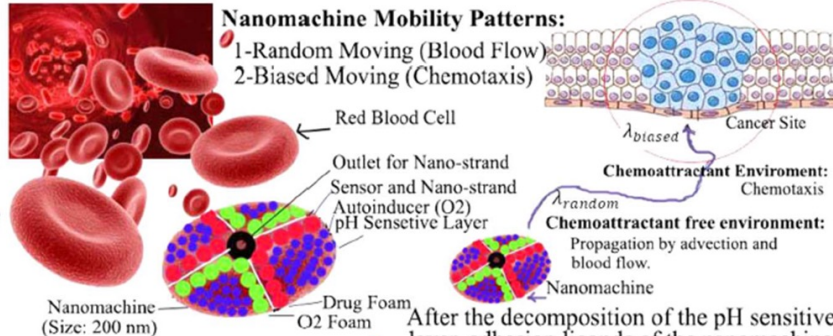
Quorum Sensing based Coordination:

Each nanomachine starts to release oxygen as soon as they reach to cancer site.



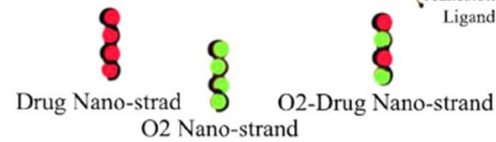
Nanomachine Mobility Patterns:

- 1-Random Moving (Blood Flow)
- 2-Biased Moving (Chemotaxis)

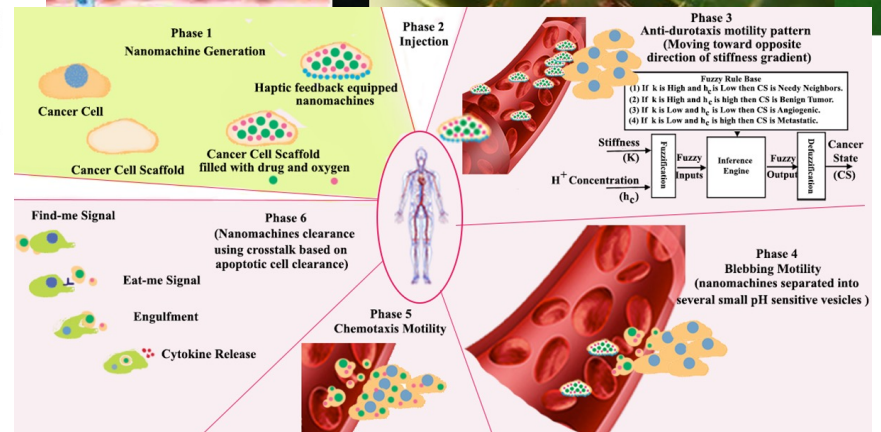


After the decomposition of the pH sensitive layer, adhesion ligands of the nanomachine are appeared and nanomachine turns into a porous structure. Then based on the cancer state (FIS output), different nano-strands are released into cancer cells.

Types of nano-strands:

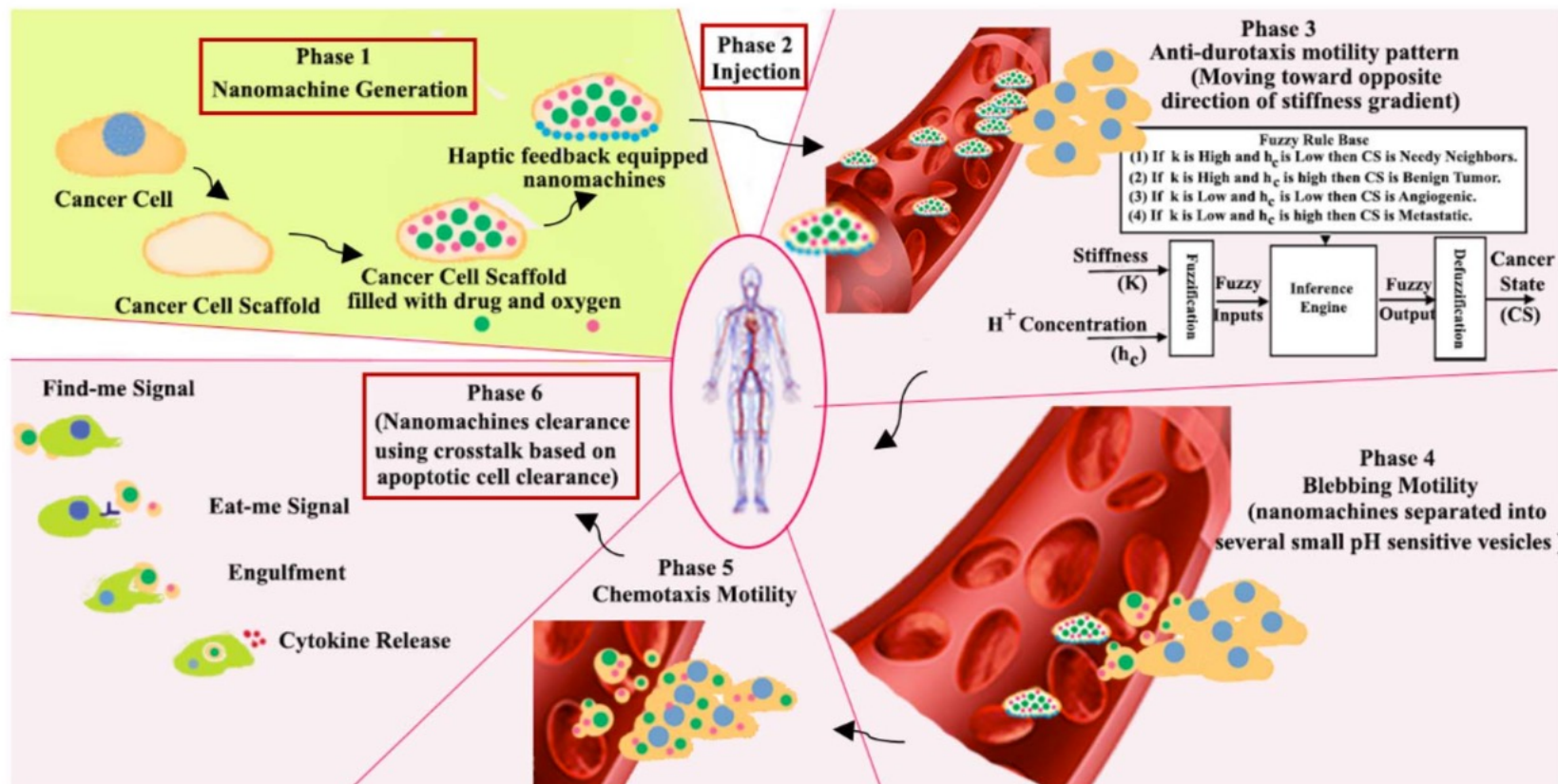


Cancer

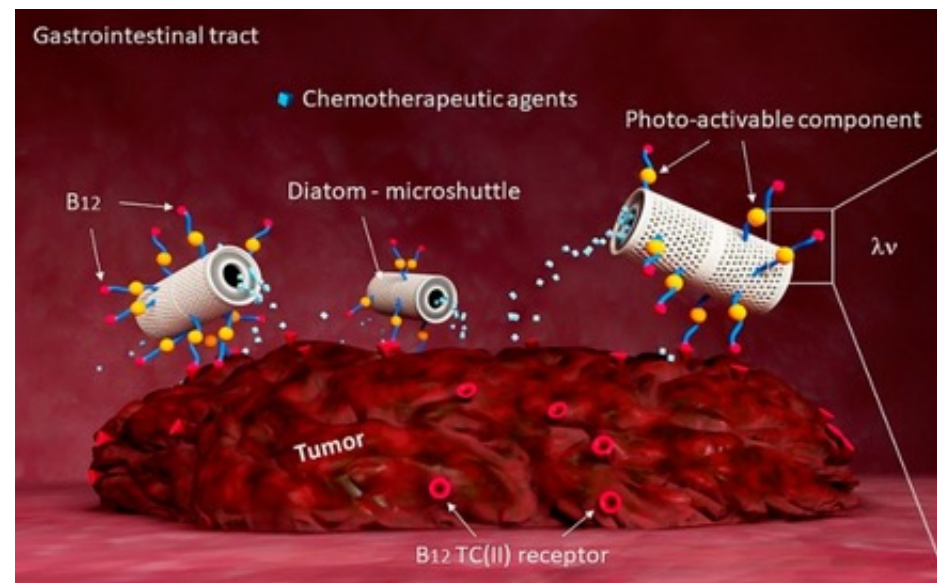


Target Convergence Analysis of Cancer-Inspired Swarms for Early Disease Diagnosis and Targeted Collective Therapy

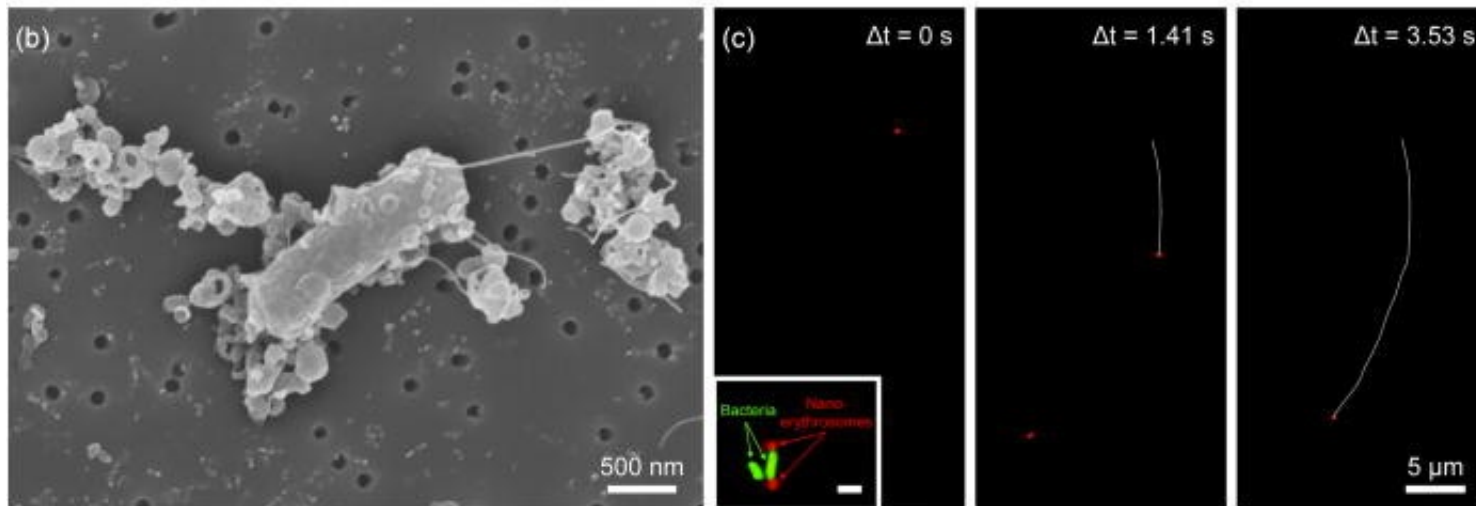
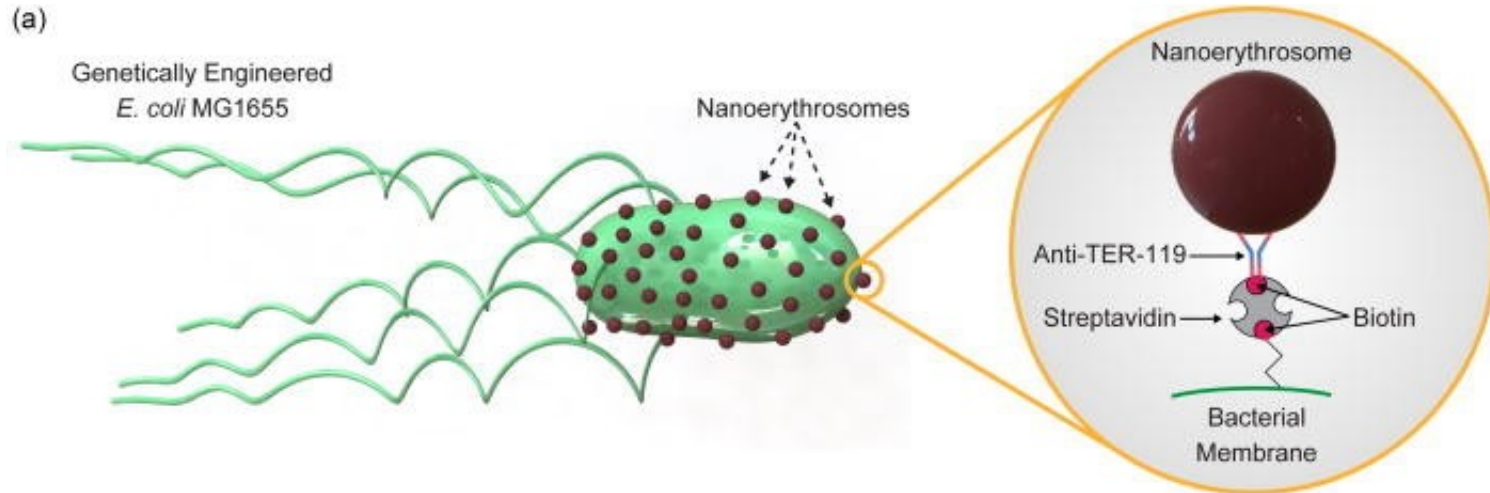
Nasibeh Rady Raz^{ID} and Mohammad-R. Akbarzadeh-T.^{ID}, *Senior Member, IEEE*



- Biohybrid diatomite microswimmer drug delivery system.
- Diatom frustule surface functionalised with photoactivable molecules (orange spheres) linked to vitamin B-12 (red sphere) acting as a tumor-targeting tag.
- The system can be loaded with chemotherapeutic drugs (light blue spheres), which can be selectively delivered to colorectal cancer cells. In addition, diatomite microparticles can be photoactivated to generate carbon monoxide or free radicals inducing tumor cell apoptosis.



Biohybrid bacterial microswimmers



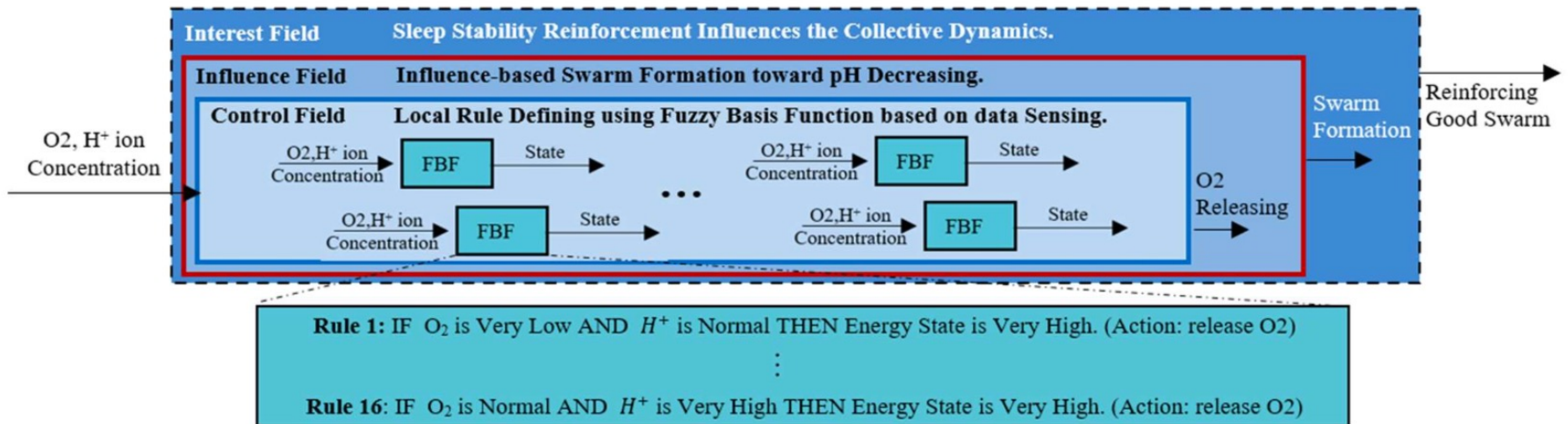
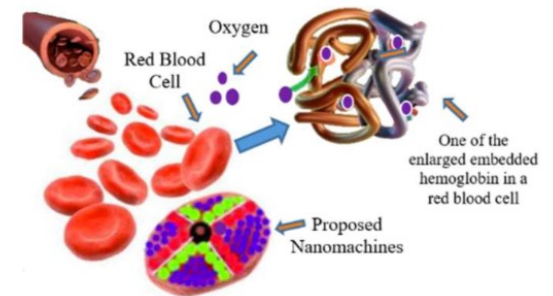
Influence-Based Nano Fuzzy Swarm Oxygen Deficiency Detection and Therapy

Publisher: IEEE

Cite This

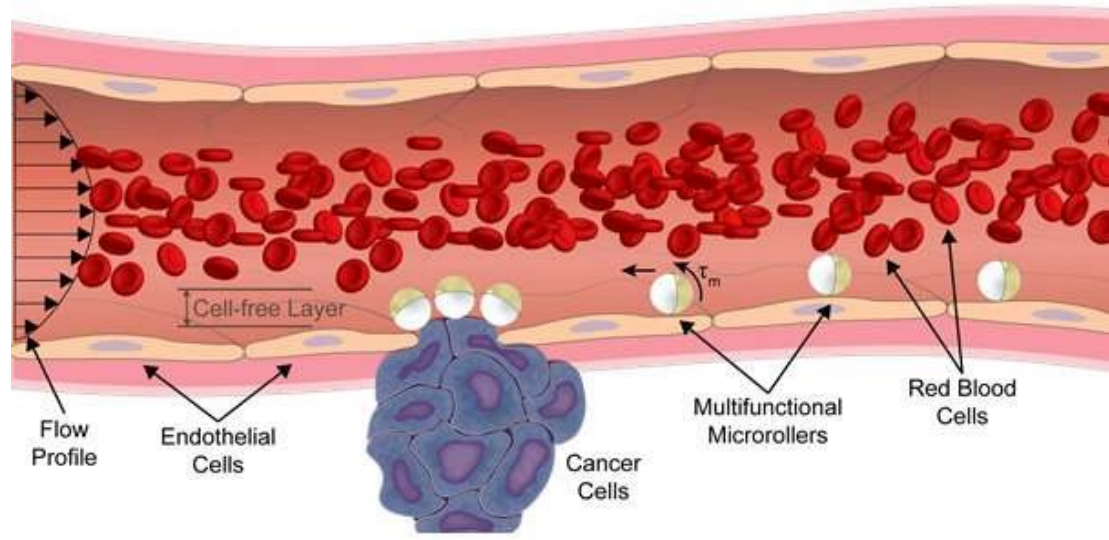
PDF

Nasibeh Rady Raz  ; Mohammad-R. Akbarzadeh-T.  ; Saeed Setayeshi



N. R. Raz, M. -R. Akbarzadeh-T. and S. Setayeshi, "Influence-Based Nano Fuzzy Swarm Oxygen Deficiency Detection and Therapy," in *IEEE Transactions on Systems, Man, and Cybernetics: Systems*,

- Swarm-robot that resembles a **white blood cell** traveling through the circulatory system. It has the shape, the size and the moving capabilities of leukocytes.
- The team took inspiration from white blood cells, the task force of the immune system, as they are the only motile cells in the blood stream.



Multifunctional surface micro-rollers for targeted drug delivery in physiological blood flow, Sci Robot, 2020 May 20;5(42).

Swarm-Fuzzy Rule-Based Targeted Nano Delivery Using Bioinspired Nanomachines

Nasibeh Rady Raz^{ID} and Mohammad-R. Akbarzadeh-T.

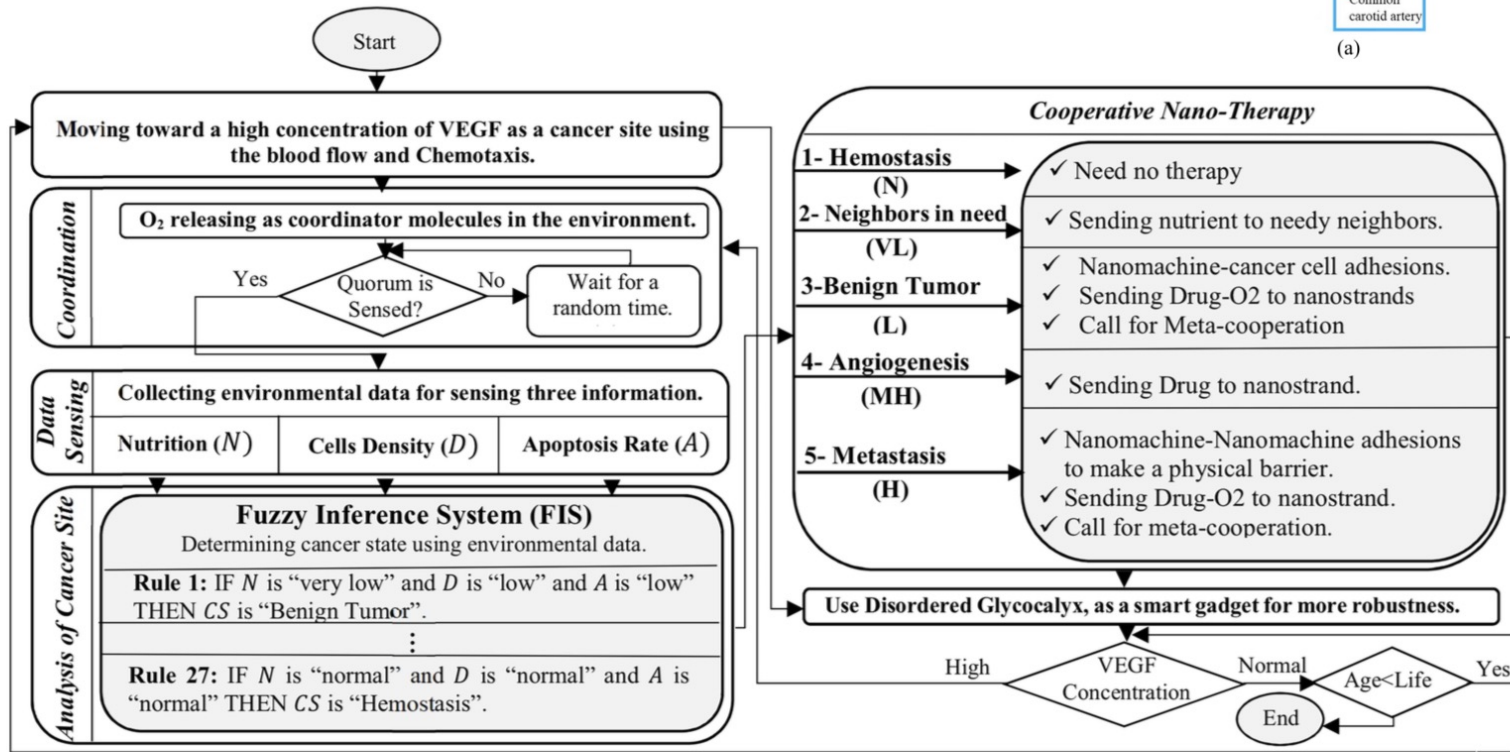
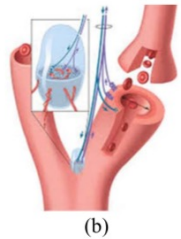
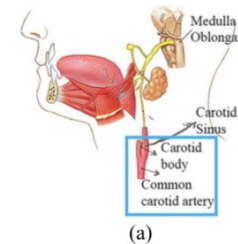


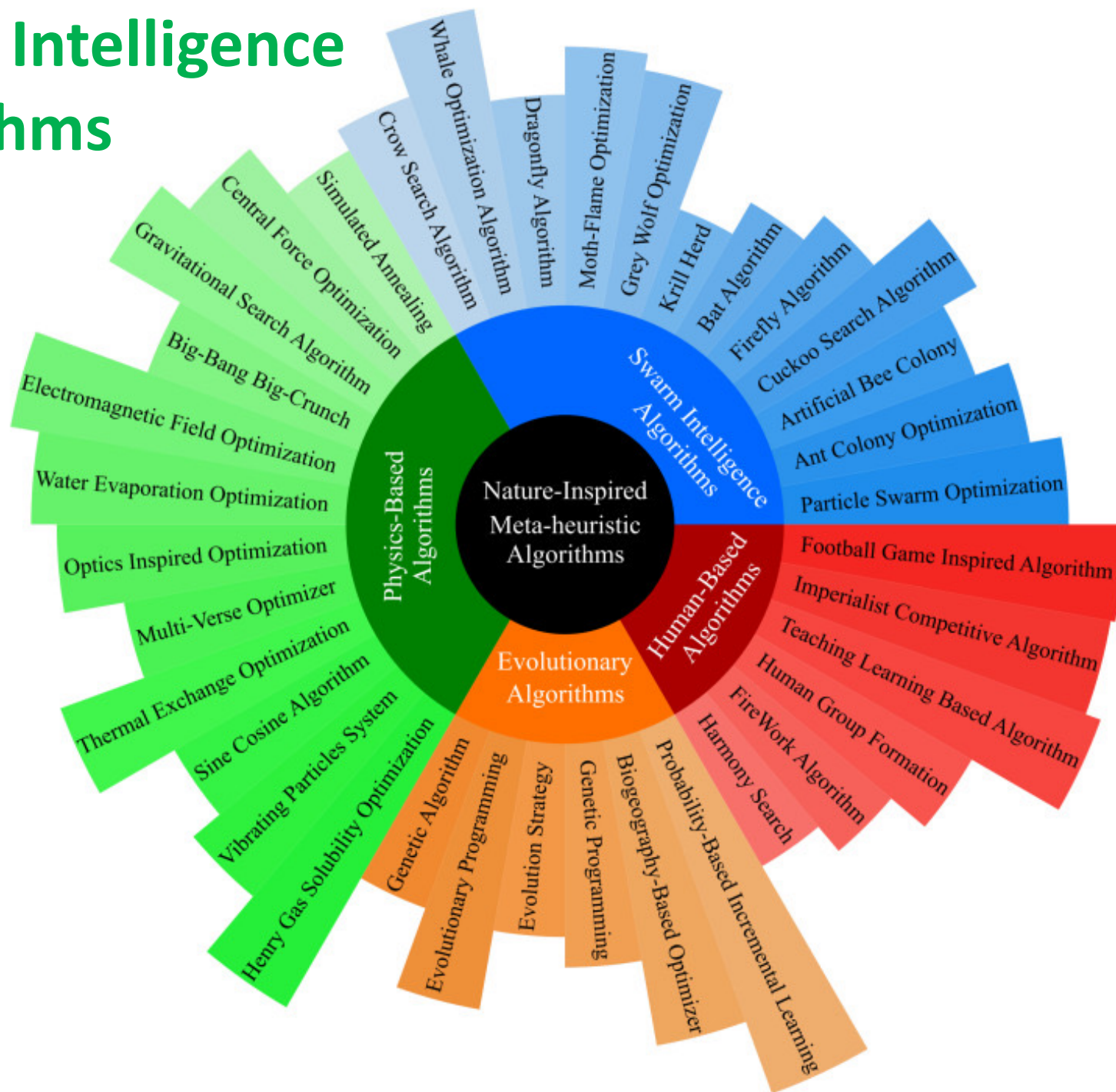
Fig. 4. The proposed block diagram for FCBN.

Medical Data Mining

- Data mining refers to the task of exploring useful and interesting patterns and associations in voluminous data.



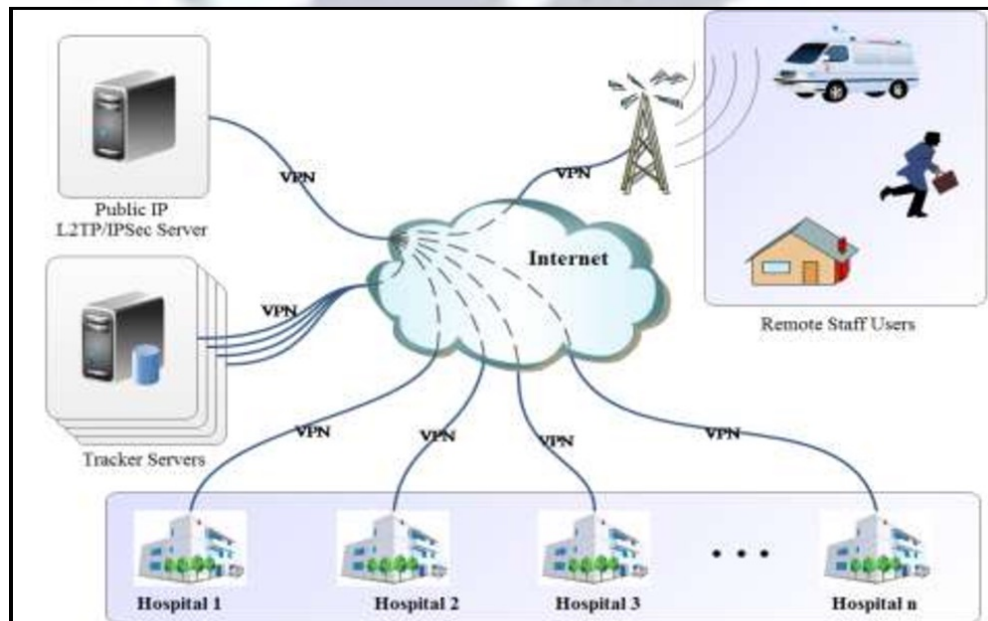
Swarm Intelligence Algorithms





Building Trust in Medical Use of Artificial Intelligence – The Swarnn Learning Principle

- Medicine is inherently decentralized and medical data are usually stored and handled at the production sites, the locally available data for any kind of medical problem are usually insufficient for optimally training AI-based models.



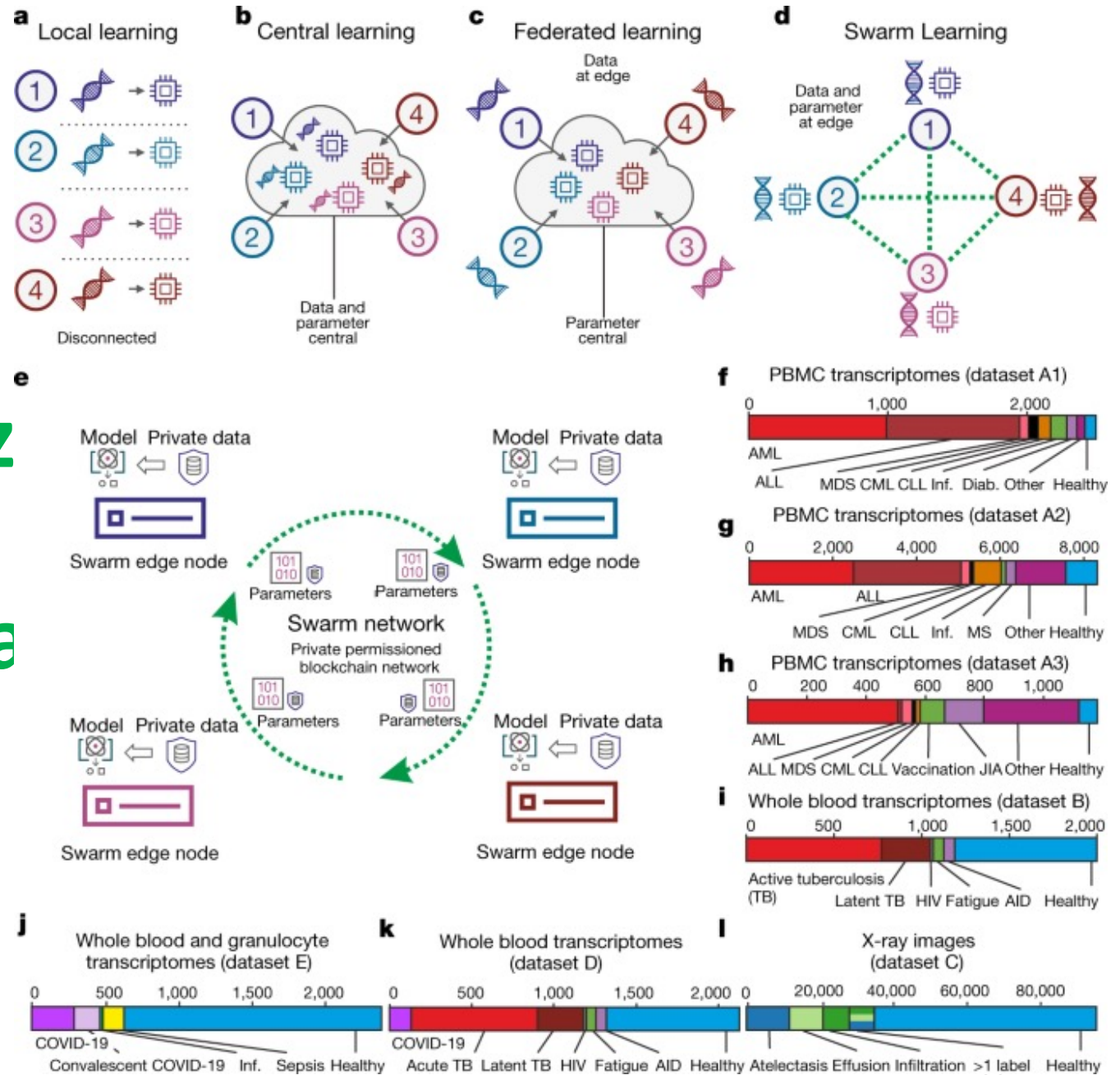
Swarm Learning

- Swarm Learning opens doors to new opportunities for collaboration and innovation in clinical research while maintaining patient privacy and no centralized repository.



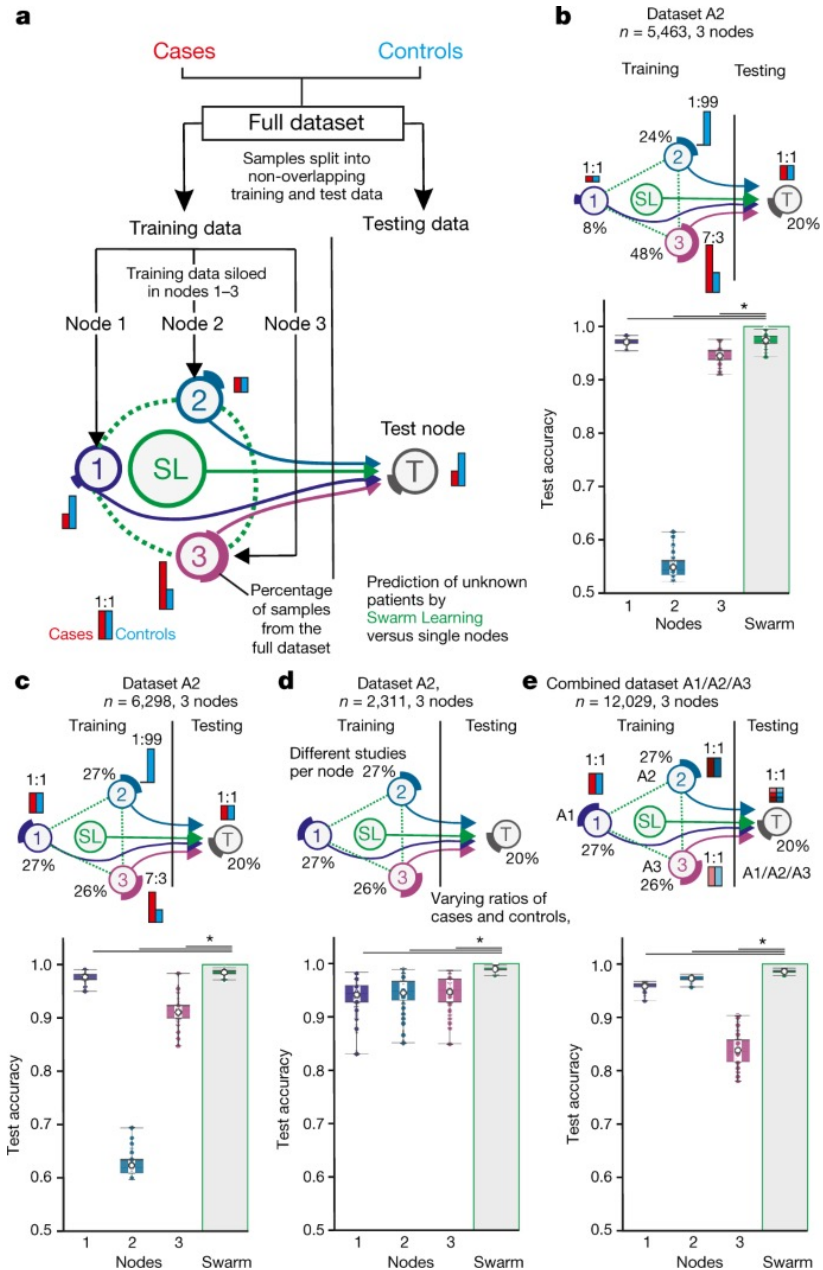
دانشگاه علوم پزشکی و خدمات بهداشتی، همدان، ایران

Swarm Learning for decentralized and confidential clinical machine learning



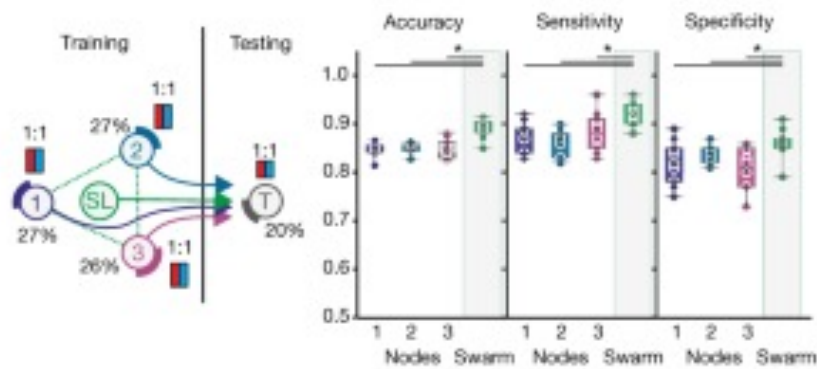
Nature volume 594, pages265–270 (2021)

Swarm Learning predicts leukaemias

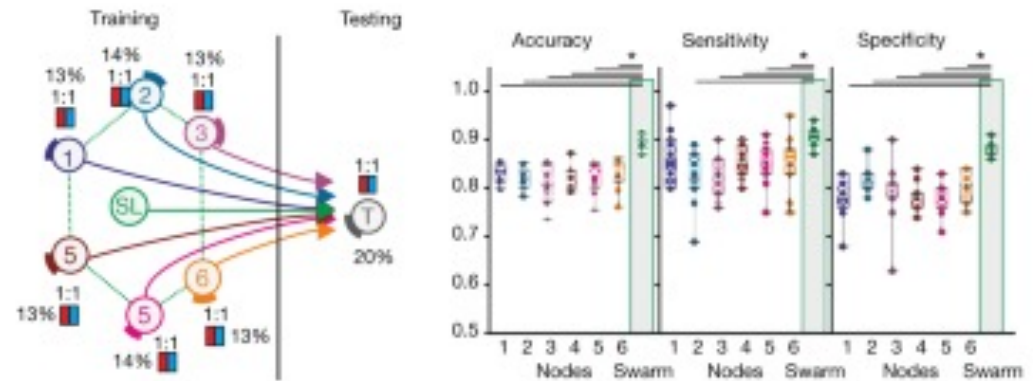


Swarm Learning to identify tuberculosis

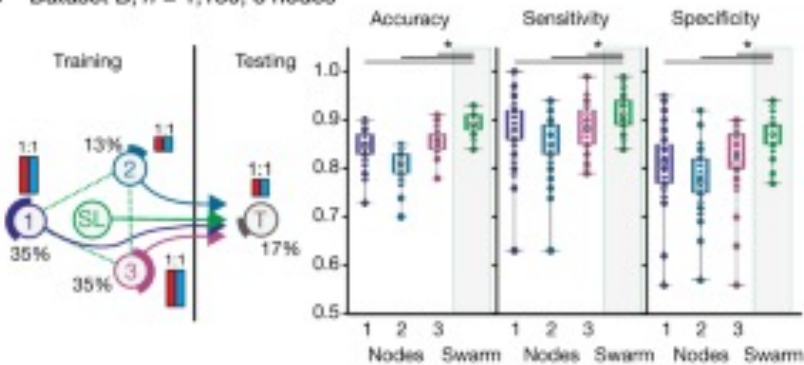
a Dataset B, $n = 1,550$, 3 nodes



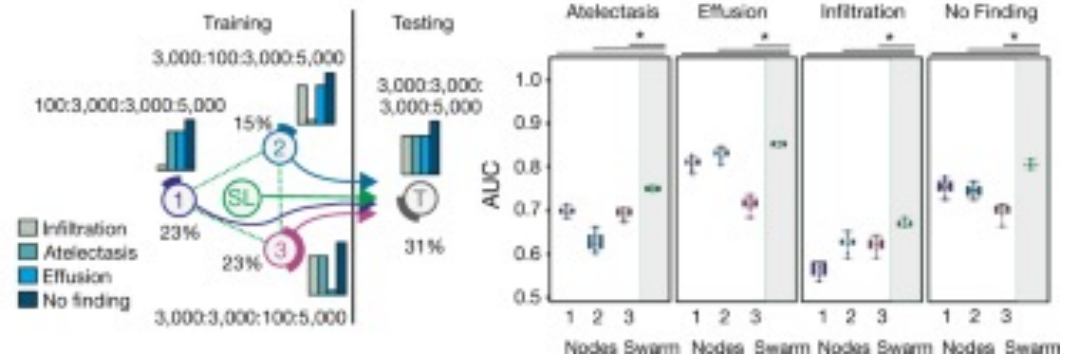
b Dataset B, $n = 1,550$, 6 nodes



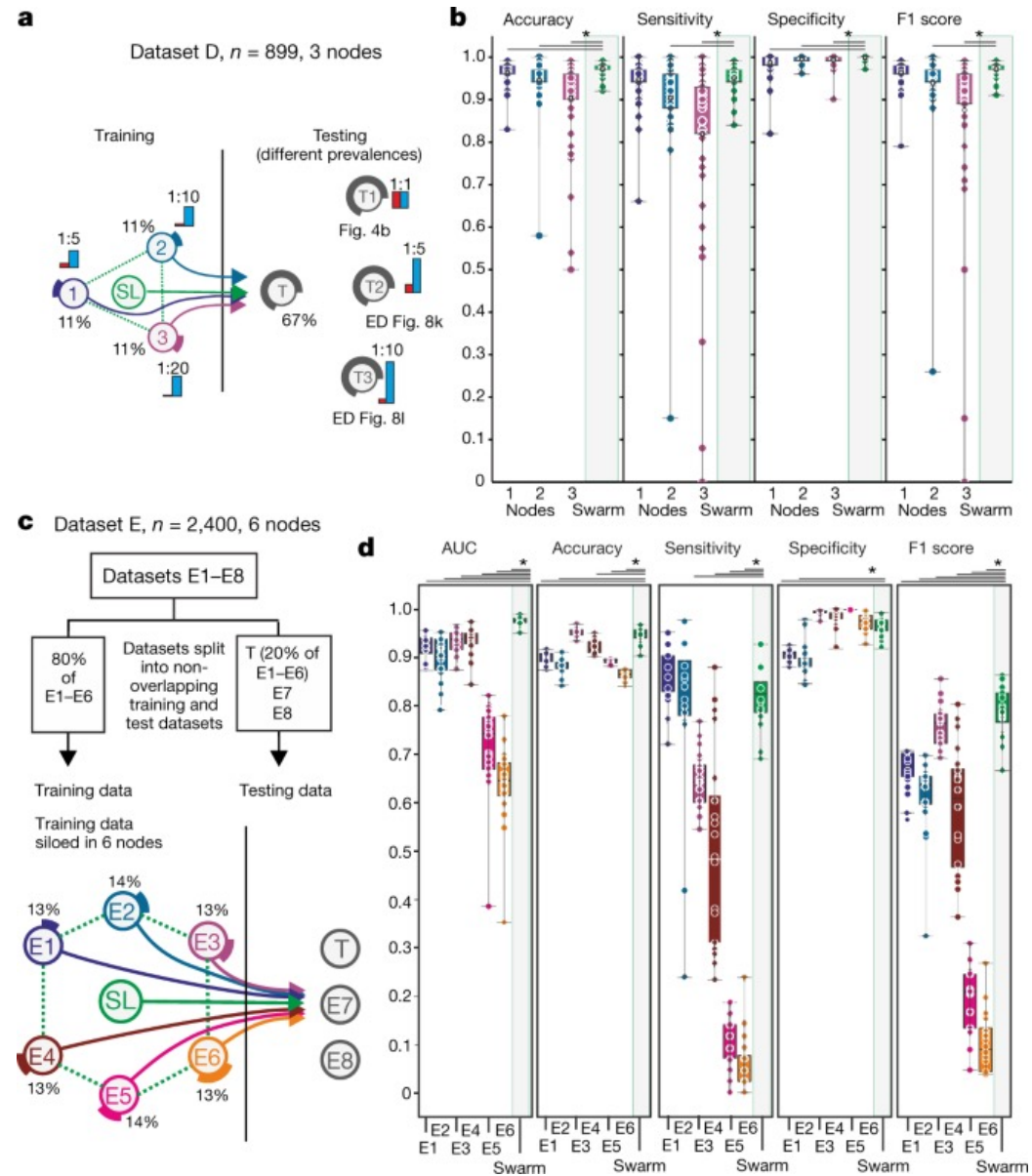
c Dataset B, $n = 1,150$, 3 nodes



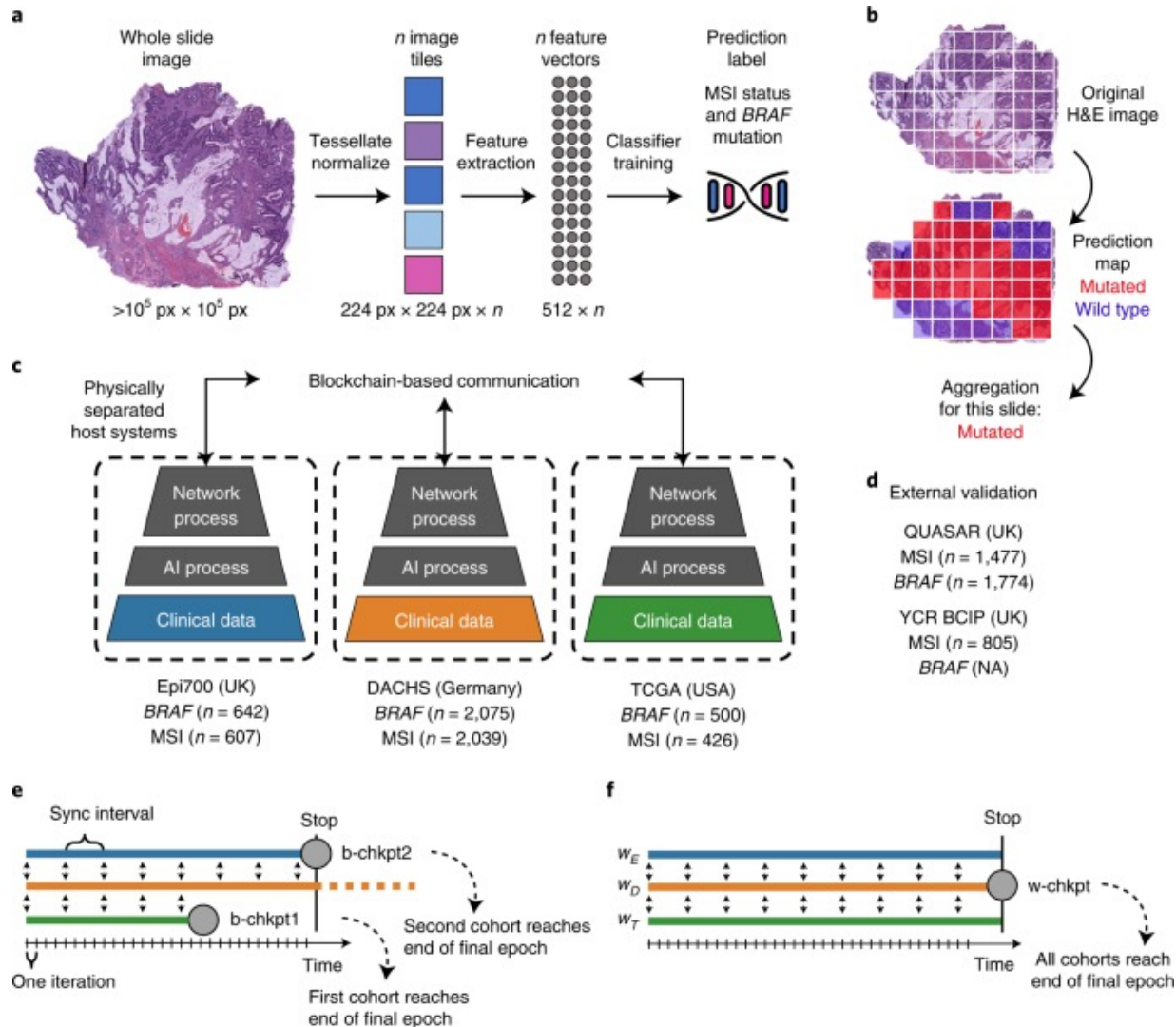
d Dataset C, $n = 47,300$, 3 nodes



Identification of COVID-19



Swarm learning for decentralized artificial intelligence in cancer histopathology

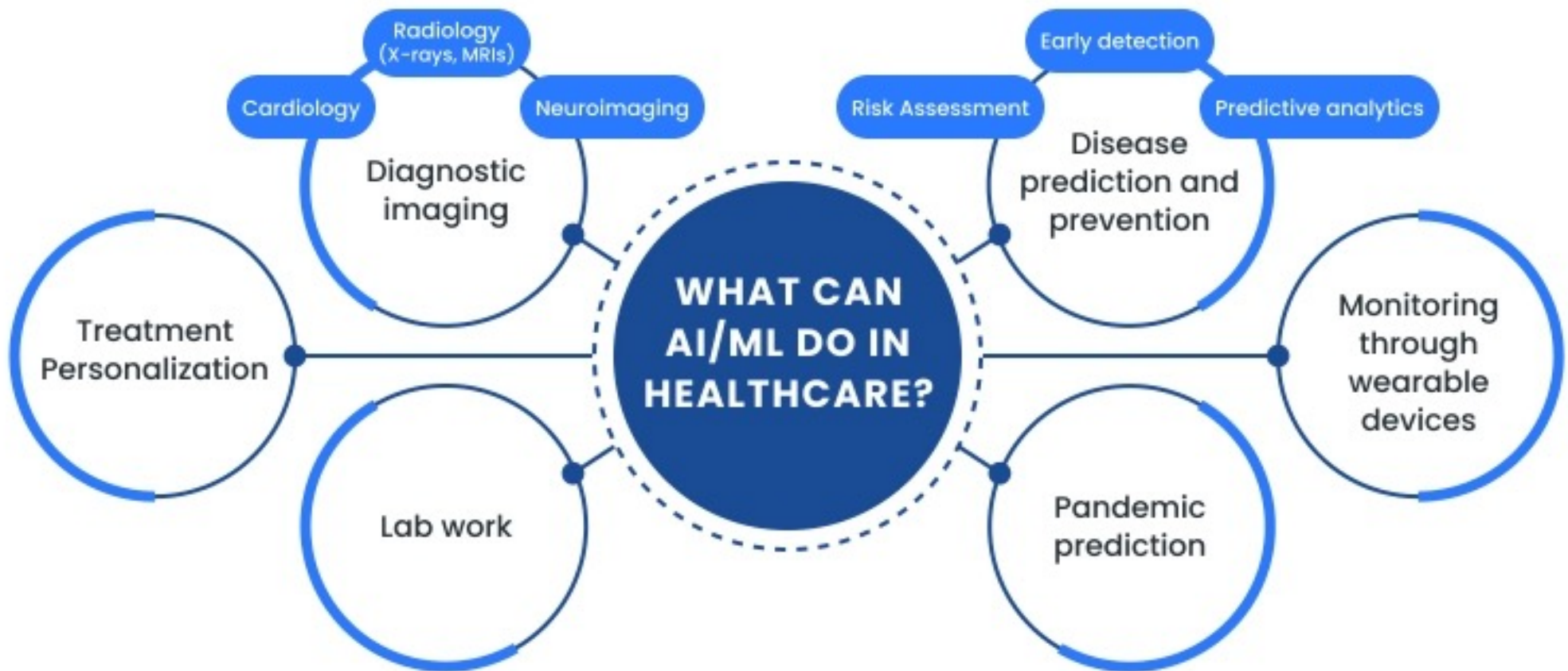


Challenges and Ethical Considerations

data privacy,

potential biases in datasets

interpretability of algorithms,



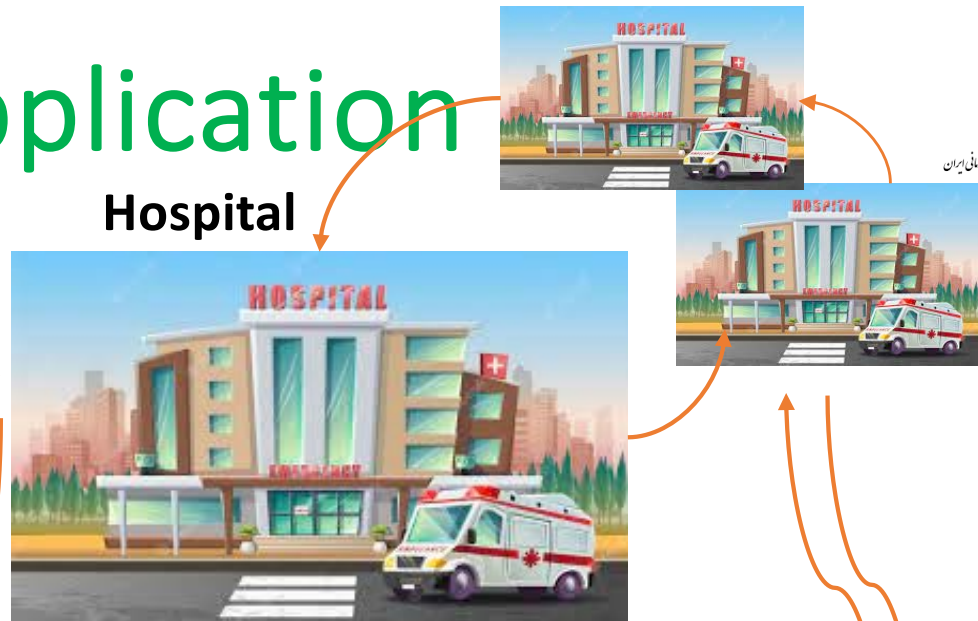
Note that!!

- AI may not replace human doctors.
- Since doctors are trained to not only diagnose and treat diseases but also to provide emotional support to patients.
- AI cannot replace the empathy and compassion that doctors bring to their work.



8-AI Medical Application

Prevention	Screening
Early Detection	Diagnosis
Recurrence Prediction	Critical Decision Making
Treatment Selection and Analysis	Mortality and Morbidity Prediction
Triage	...



Hospital



In the Hospital

Pre Hospital



Doctor



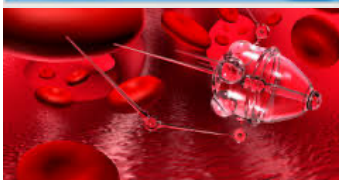
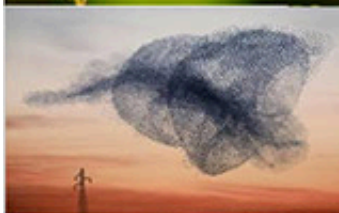
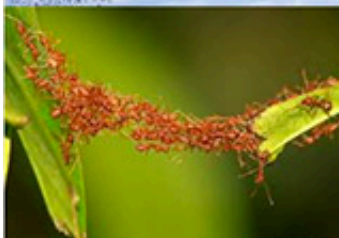
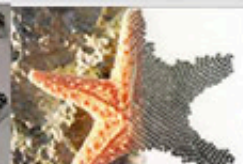
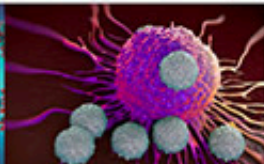
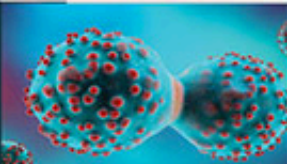
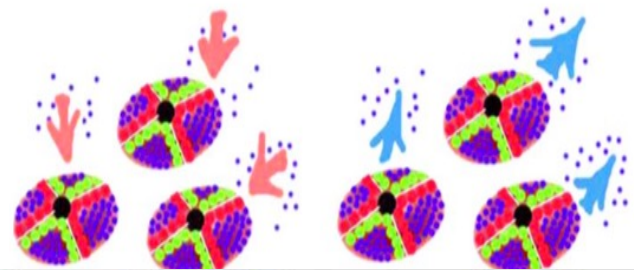
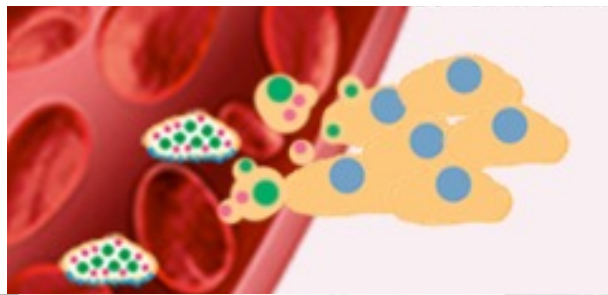
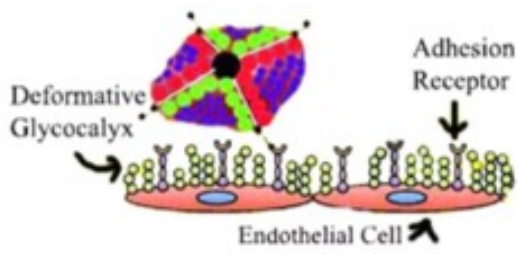
Patient



Home



Post Hospital at Home



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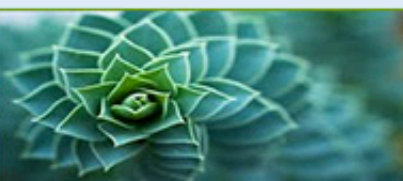
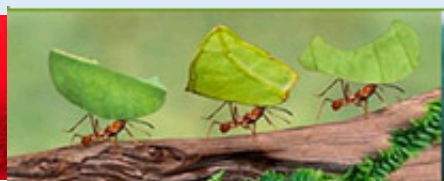
MA, Ph.D., and Postdoc in Artificial Intelligence and Robotics

Website: <http://radyraz.student.um.ac.ir/>

Email: radyraz.n@iums.ac.ir , radyraz@mail.um.ac.ir,
radyraz@yahoo.com

Research Interest:

Artificial Intelligence, Artificial Intelligence in Medicine, Complex Systems, Biomimicry, Cognitive Science, Swarm Intelligence, Nanomedicine, Targeted Drug Delivery, Early Detection of Disease, Swarm Nano Robotics, Cancer Research, Fuzzy Logic and Control, Soft Computing, Neural Networks, Machine Learning, Multi-agent Systems, Distributed Decision Making, Biomarkers, Biophysics, Nature Inspired Algorithms, Computational Cellular/Molecular Biology, Protein Folding



Artificial Intelligence for Good (AI for Good)