

Chapter IX

AI and Advanced R&D for Longevity Research

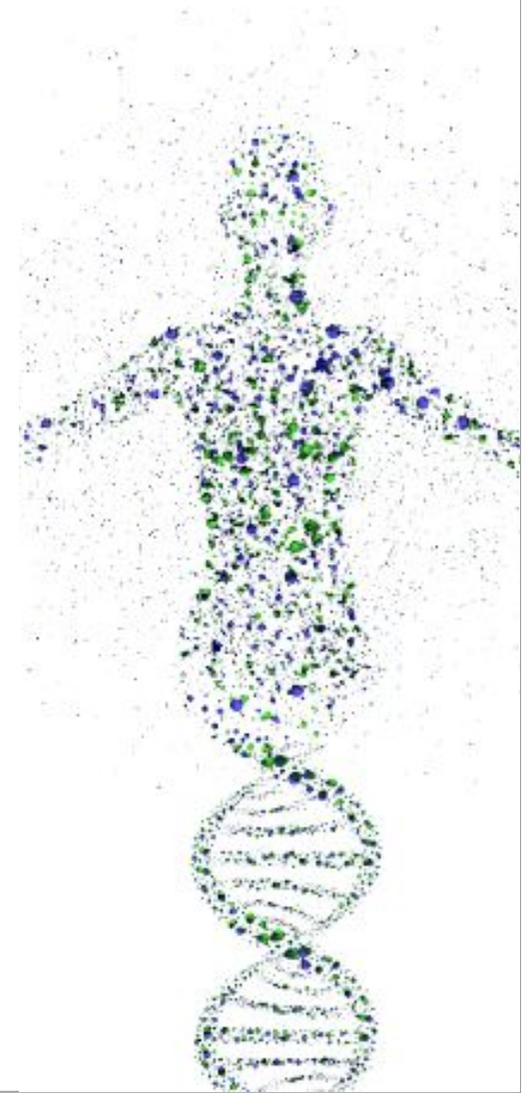
“ We have the means right now to live long enough to live forever. ”
~Ray Kurzweil

The following chapter describes the manner in which these technologies combine to form an industry.

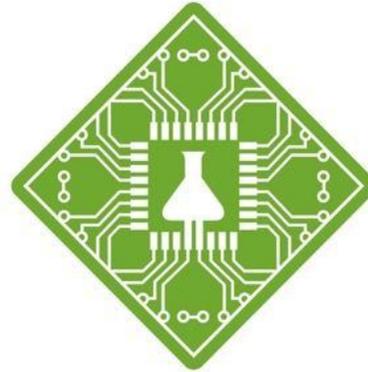
But any industry worthy of the Industrial Revolution title must have some form of automation or technological optimisation, and a system of finance behind it.

This chapters examines how AI and blockchain technology form the engine of the future industry, and touches upon some novel financial systems.

“I see a bright future for the biotechnology industry when it follows the path of the computer industry, the path that von Neumann failed to foresee, becoming small and domesticated rather than big and centralized. ” ~Freeman Dyson



AI Companies in Longevity



INSILICO MEDICINE



Atomwise
Better medicines faster.

Atomwise



BioAge

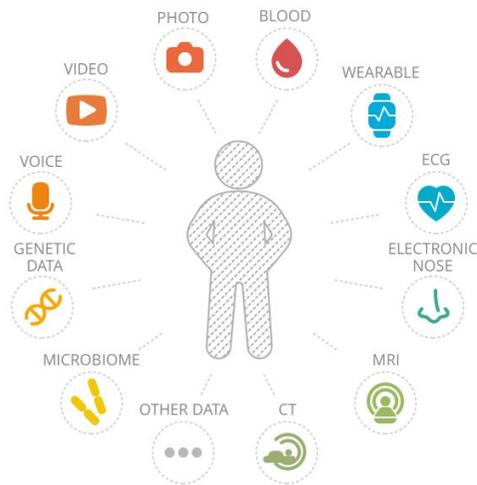
Insilico Medicine Aging.AI 2.0



INSILICO MEDICINE

One of the most promising projects developed by Insilico Medicine is called Aging.AI 2.0, which is an AI-empowered platform integrating multiple predictors of clints age and used to track changes of health over time and optimize clints lifestyle.

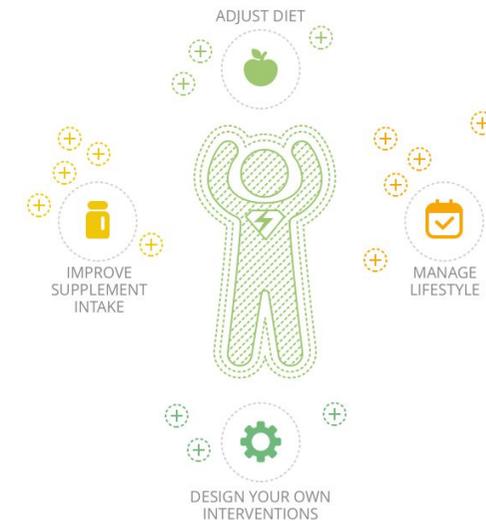
<http://young.ai/>



Track your age
at every level!



See what makes you
younger or older!



Stay young!

Insilico Medicine



INSILICO MEDICINE

Insilico Medicine's mission is to extend healthy longevity through innovative AI solutions for drug discovery and aging research. Insilico Medicine is committed to transforming the pharmaceutical industry with next-generation artificial intelligence. They are developing new tools for drug discovery and repurposing, biomarker development and pursuing novel strategies for rapid validation. Their projects combine advances in genomics, big-data analysis, deep learning and reinforcement learning.

Insilico Medicine and Biotime announced in 2016 the launch of a beta version of Embryonic.AI, an artificially intelligent system for analyzing the embryonic state of human cell samples using gene expression data.

Insilico established in 2017 a collaboration with GSK to discover novel biological targets and molecules. As a first stage of the collaboration, GSK will evaluate Insilico's technology in the identification of novel biological targets and pathways of interest to GSK.

In 2018 a collaboration occurred between Insilico Medicine and Juvenescence AI Limited, which is a drug development and artificial intelligence company focused on ageing and age-related diseases. Juvenescence AI combines advances in artificial intelligence with classical development expertise in order to prioritize and develop compounds from Insilico Medicine, Inc.'s end-to-end automated drug discovery pipeline through to clinical proof of concept.

By using AI and deep learning, the company can analyze how different compounds will affect certain cells, determine what drugs can be used to treat the symptoms, and any possible side effects that may occur.

Even though it's only been around a few years, Insilico has already been named by NVIDIA as one of the 5 top AI companies. With R & D resources spread out across the globe in the UK, Russia, and Belgium and a backing of \$14 million behind it.

Sources: https://www.eurekalert.org/pub_releases/2017-08/imi-iec081417.php
<https://www.businesswire.com/news/home/20180205005024/en/Insilico-Medicine-Juvenescence-Announce-Drug-Candidate-Joint>



Atomwise is the creator of AtomNet, the first Deep Learning technology for novel small molecule discovery, characterized by its unprecedented speed, accuracy, and diversity.

Today, drug-resistant bacteria and pandemic viruses threaten to send us back to the time of plague and smallpox. Persistent, neglected diseases remain a dark spot on our collective conscience. And while we're all living longer, diseases of aging like Alzheimer's still have no cure. Atomwise has the unique ability to research hundreds of millions of potential medicines rapidly, making it fundamentally easier to tackle these big problems.

Atomwise's AtomNet platform uses structural information to predict binding between molecular targets and small molecules by processing millions of data points regarding successful and unsuccessful ligand-binding interactions. The company has more than 50 molecular discovery programs, including confidential projects with AbbVie Inc. and Merck & Co. Inc.

In April 2017, Atomwise started a program to motivate academic scientists to explore the drug-hunting potential of its technology. Researchers can apply to the company's Artificial Intelligence Molecular Screen (AIMS) awards program by identifying the disorder they hope to treat, and the disease-causing biomolecules they want to defeat with a drug. Successful applicants will receive 72 compounds that Atomwise predicts are most likely to work as that drug.

Atomwise has been partnering up with big pharmaceutical firms, biotechnology companies, and university research labs in an effort to speed up the discovery of new drug candidates for neurodegenerative diseases, cancer, and other disorders. In June, the startup also announced a collaboration with Monsanto to find compounds that might protect crops against pest infestations and diseases.

Source: <http://www.chematria.com/>
<http://www.4-traders.com/ABBVIE-12136589/news/AbbVie-AI-drug-discovery-company-Atomwise-raises-51M-series-A-26122374/>
<https://www.xconomy.com/san-francisco/2018/03/07/atomwise-raises-45m-to-grow-ai-driven-drug-discovery-business/>

BioAge



BioAge is committed to contribute to and support the evidence-based medical approach to a healthy lifestyle, accomplished through diet, exercise, supplementation and the use of integrative medicine.

The overall aim of the proposed staff exchange programme is to build, extend and strengthen sustainable international collaborations between the partners so as to create a knowledge base for biomarker based research related to aging, sampling techniques in the elderly and biomonitoring studies.

BioAge develop biomarkers and drugs that impact human aging by coupling genomic data with machine learning. BioAge is building a platform that doesn't require waiting for its subjects to actually age. Instead, it wants to measure biological age using signals floating in a drop of blood.

BioAge Labs raised \$10.9M in Series A financing to accelerate drug discovery for aging in 2017. BioAge is betting on the power of high-throughput human data, coupled with innovative machine learning, to substantially accelerate drug discovery for aging. The company take a hybrid experimental and computational approach to identifying the molecular signatures that drive aging, working with multiple partners in academia and industry. The funding will enable BioAge to build their team, refine and test their signatures of aging, and begin in vivo evaluation of drug candidates. Their initial targets for drug development will be specific diseases where aging is causal; however, their ultimate goal is more ambitious—to combat the suffering and disability caused by all aging-related diseases, and to restore both the quality and quantity of life that is so often lacking in old age.

Sources: <https://medium.com/@BioAge/bioage-labs-raises-10-9m-in-series-a-financing-to-accelerate-drug-discovery-for-aging-31974fcb3229>
<http://bioage.com/about.html>
<https://a16z.com/2017/07/28/bioage/>

Biomarkers of Aging

While many anti-aging interventions have demonstrated life-extending or other geroprotective effects in model organisms, practical limitations continue to hamper translation to the clinic. One problem is that the evaluation of aging changes and possible anti-aging remedies requires a comprehensive set of robust biomarkers.

Large-scale longitudinal programs like MARK-AGE have been launched to analyze changes in multiple biomarkers during aging and correlation between biological and chronological age. Several “aging clocks” able to predict human chronological age using various biomarkers have already been proposed. Methylation-based markers such as epigenetic aging clocks are currently the most accurate, while transcriptomics and metabolomics have shown to be less so.

Recent studies show that biomarkers of age-related pathologies could be used to evaluate senescence modifications based on the connection between age-related pathologies at the signaling pathway level. However, most of these biomarkers are not representative of the health state of the entire organism or individual systems and are not easily measured or targeted with known interventions.

Machine learning (ML) techniques, such as support vector machines (SVM), are routinely used in biomarker development and rapid increases in labeled data are enabling deep neural networks (DNNs). Methods based on deep architectures have outperformed classical approaches not only in image analysis, but also in solving a wide range of genomics, transcriptomics and proteomics problems.

Using Artificial Intelligence (AI), **Insilico Medicine** has developed a system that measures the biological age using readings found in a common blood test. Insilico Medicine calls it the Aging Clock, and it is based on biomarkers of aging found in our blood chemistry. Insilico Medicine says its number-crunching has yielded the most precise measure of a person’s biological age. To develop their algorithm, the company used AI techniques to analyze the blood tests of an international group of 130,000 people.

Sources: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4931851/>
<http://longevityfacts.com/ai-based-app-measures-bodys-aging-clock/>

Biomarkers of Aging

Vadim Gladyshev, Professor of Medicine at Brigham and Women's Hospital, Harvard Medical School:

"The use of the new tool to track human biological age may enable discovery of drugs and other interventions that target the fundamental process of aging, thereby delaying the onset of all chronic diseases at once, instead of targeting one disease at a time. The project has parallels with MouseAge, a tool for assessing biological age in mice, which we develop jointly with In Silico Medicine."

Insilico Medicine, Inc., a Baltimore-based company specializing in the application of artificial intelligence for drug discovery, biomarker development and aging research, announced in 2018 a publication of a research paper titled "Population-specific biomarkers of human aging: a big data study using South Korean, Canadian and Eastern-European patient populations" in The Journal of Gerontology. Insilico believe AI will transform biomarker development and drug discovery much sooner than most pharmaceutical companies and regulators expect.

In the paper, the authors present a novel deep-learning based hematological human aging clock, a biomarker that predicts the biological age of individual patients.

In 2017 the company announced the launch of the Beta 1.0 version of YOUNG.AI. The first version was publicly unveiled on September 12th, 2017 at the 4th Aging Research for Drug Discovery Forum and the Artificial Intelligence and Blockchain for Healthcare Forum in Basel, Switzerland, 11-13 of September. The beta 1.0 version features deep learned photographic and basic blood biochemistry-based predictors of age as well as the ability to track drug and supplement intake.

Sources: https://www.eurekalert.org/pub_releases/2018-01/imi-apd011118.php
https://www.eurekalert.org/pub_releases/2017-09/imi-ant091117.php

AI for Drug Discovery is Now Recognized as an Official Niche within the Longevity Research & Geroscience Community

While work being done by the companies discussed above has been progressing now for several years, the inauguration of AI for Drug Discovery and biomarker development as a legitimate niche within the broader longevity research, recognized as such by thought leaders and major players within geroscience, can be considered to have occurred in Q4 of 2017, when several leading AI for Drug Discovery companies focused on longevity research held a mini-conference at the Buck Institute for Research on Aging, the United State's most well-funded non-profit research institution devoted to aging research and the development of healthspan-extending interventions.

In a press release associated with the conference, Buck Institute CEO Eric Verdin stated: "The Buck Institute for Research on Aging generates an enormous amount of biological data, which has intriguing possibilities for combining with AI. We would like to explore synergies and invite the AI community from the Bay Area and all over the world to learn about our progress and contribute."

The min-conference featured talks by researchers from Insilico Medicine, Atomwise, Numerate, BioAge and Illumina.



AI & LONGEVITY MINI CONFERENCE
AND MEETUP @ THE BUCK INSTITUTE
FOR RESEARCH ON AGING
WITH THE CEO, DR. ERIC VERDIN

DECEMBER 14, 2017, NOVATO, CA

- ★ Get a tour of the largest biomedical research center focused on longevity
- ★ Learn about the latest research in artificial intelligence for drug discovery and biomarker development from top experts
- ★ Hear personal stories about career changes from IT to longevity research
- ★ Mingle with AI experts from the Bay Area and Silicon Valley
- ★ Learn how to get involved and contribute to aging research



Free Registration
(limited space):
goo.gl/bp8cdC



Free Books on Site
(while supplies last):
Juvenescence
Ageless Generation

HEAR THE STORIES FROM THE EXPERTS



illumina



BIOAGE

Numerate

Buck Institute Brings Insilico Medicine CEO on as Adjunct Professor to Spearhead their AI for Longevity Research Activities

Following this mini-conference, the Buck Institute also acquired Insilico Medicine's CEO Alex Zhavoronkov as an Adjunct Professor, in order to spearhead the Buck's activities in utilizing the latest advanced in AI and deep learning for longevity research.

The fact that the leading aging research foundation in the United States is devoting their time and resources towards the use of AI and deep learning for geroscience research is yet another indication that AI, machine learning and deep learning is now recognized as a legitimate niche within the broader geroscience community.

In a press release associated with the announcement, Buck Institute CEO Eric Verdin stated:

“We are incredibly excited about the potential of AI to accelerate aging research. The Buck has been at the forefront of asking the most important questions in the field. Now, with the latest in bioinformatics and artificial intelligence, and with the involvement of world-class experts like Dr. Zhavoronkov, we will finally have the tools to answer them. Fully utilizing these powerful technologies, we will dramatically increase our understanding of how aging works, and what we can do about it.”



AI for Drug Discovery in Longevity Research Reaches a New Degree of Credibility Through Frost & Sullivan's Best Practices Award

Meanwhile, in 2018, AI for Drug Discovery as a legitimate and official subsector within the broader longevity research landscape, and longevity research as a legitimate niche within the broader drug discovery landscape, attained a new degree of recognition.

This occurred when leading business consulting firm Frost & Sullivan awarded Insilico Medicine the North American Artificial Intelligence for Aging Research & Drug Development Technology Innovation Award, as part of their 2018 Best Practices Awards.

More than this, the fact that a highly respected business consulting firm like Frost & Sullivan created a specific category of award for this specific area of research and development is highly indicative of the increasing level of repute that AI in Drug Discovery for aging research is garnering from both the broader geroscience community as well as the wider drug development communities.

This new development may also serve to highlight the high degree of synergy that is possible through the convergent integration of two cutting-edge and highly innovative classes of R&D.



Insilico Medicine Earns Accolades from Frost & Sullivan

F R O S T & S U L L I V A N



INSILICO MEDICINE

2018 North American Artificial Intelligence for Aging Research
and Drug Development Technology Innovation Award

Insilico Medicine Technology Innovation Score

FROST & SULLIVAN

BEST PRACTICES RESEARCH

The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, we have chosen to refer to the other key participants as Competitor 2 and Competitor 3.

<i>Measurement of 1-10 (1 = poor; 10 = excellent)</i>			
Technology Innovation	Technology Attributes	Future Business Value	Average Rating
Insilico Medicine	9.0	9.0	9.0
Competitor 2	8.0	7.0	7.5
Competitor 3	7.0	8.0	7.5

Insilico Medicine's Future Business Value & Technology Attributes Ranking in Comparison to Top 2 Competitors

The analysis performed by Frost & Sullivan included an estimation of the winning business' future value and technology attributes. Assessing the company's technology attributes involved analyzing its industry impact, product impact, scalability, visionary innovation and application diversity, while assessing the company's future business value involved analyzing its financial performance, customer acquisition, technology licencing, brand loyalty and human capital.

As Frost & Sullivan explain in their report: "Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole"

