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Deep Genomics

About the Company

- Headquarter in Toronto: MaRS Centre, 661 University Avenue Suite 480
- What they do: develop genetic medicines using biologically accurate artificial intelligence technology
    - Focusing on the preclinical development of oligonucleotide therapies
- They have the world's first drug design system built around a molecular biology AI
- Over 30 employees with expertise in fields including automation, AI, machine learning, software engineering, genomics, molecular and cell biology, human genetics, molecular diagnostics, organic chemistry, and business
- Founder and CEO: Brendan Frey
    - PhD, FRSC
    - Led the launch of Deep Genomics in 2015
    - Is a professor of Engineering and Medicine at the University of Toronto
    - Co-Founder of the Vector Institute for Artificial Intelligence
    - Senior Fellow of the Canadian Institute for Advanced Research
- Twitter account: https://www.theglobeandmail.com/report-on-business/rob-magazine/canadas-ai-explosion-visit-three-labs-where-machines-are-being-taught-to-think-likepeople/article38336675/
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The Platform

- Genetic Medicines
    - Their platform allows them to find drug candidates with desirable properties efficiently
    - Their medicines target the genetic determinants of disease at the level of RNA and DNA
- The platform
    - On-target and genome-wide off target effect data is produced for every compound identified using the platform
    - The platform is getting better at identifying targets and compounds at an increasingly faster speed
    - It incorporates the most advanced biological knowledge and is driven by the most powerful automation technologies
    - Built using proprietary and public datasets
    - Discoveries published by other scientists and engineers are evaluated and if appropriate, are incorporated into the platform
- The work of the company has appeared in journals such a Science, Nature, Nature Genetics, Nature Medicine, Nature Methods, Proceedings of the IEEE, NIPS, Bioinformatics, RECOMB, and ISMB

Project Saturn

- Their AI platform allows for smart drug design that predicts outcomes
- Aim of Project Saturn: use the platform to evaluate over 69 million molecules against 1 million targets, *in silico*, to generate a library of 1000 compounds that are experimentally verified to manipulate cell biology as intended
- The hope is that this will become a toolkit for controlling cell biology, helping to unlock therapies with greater potential

Saturn Tech Specs

- Anticipates the universe of molecular effects achievable by antisense oligonucleotide compounds (ASOs) in reference human cells.
- Automatically identifies all ASOs that achieve a particular change, tailored to individual genotype and leveraging up to six biological mechanisms, and counting.
- Analyses over 100,000 standard RNA isoforms for altered expression, plus thousands of novel and anticipated isoforms.
- Evaluates over 69 billion ASOs against 1 million target sites in silico.
- AI components continuously improve in a closed loop, learning from both successes and failures.
- Back-of-envelope calculation of entire ASO design space: 10^50 compounds, or, mathematically, sqrt(googol)

https://www.deepgenomics.com/updates/discovering-therapies-for-neuromuscular-disorders/
Wave Life Sciences and Deep Genomics Form Collaboration to Discover Novel Therapies for Genetic Neuromuscular Disorders (April 10, 2018).

- Wave Life Sciences Ltd. (a biotechnology company that focuses on delivering transformational therapies for patients with serious, genetically-defined diseases_ and Deep Genomics announced that they will collaborating to develop novel therapies for the treatment of genetic neuromuscular disorders
    - https://www.wavelifesciences.com
- The companies will use Deep Genomics' machine learning platform to identify cause and effect relationships that are specific to neuromuscular-related targets that involve splicing regulation
- They will then analyze and test oligonucleotides against therapeutic targets within multiple genes that are associated in neuromuscular disorders
- Wave's propriety chemistry platform will then be used to validate targets and make apparent the implications of target intervention across different phenotypes

https://www.deepgenomics.com/updates/taking-on-metabolic-neurodegenerative-disorders/
Deep Genomics Takes on Metabolic & Neurodegenerative Disorders (March 26, 2018)

- In March 2018, Deep Genomics announced they are investing $10 million to expand their preclinical platform and develop therapies for metabolic and degenerative disorders
- In the next 3 years, their goal is to use its platform to unlock new anti-sense oligonucleotide therapies and advance them for clinical evaluation
- Dr. Arthur A. Levin – a leader in the field of oligonucleotide therapeutics and EVP of Research and Development at Avidity Biosciences joined the Scientific Advisory Board of Deep Genomics
- The company's belief is that oligonucleotide therapeutics will make it possible to design targeted medicines based on genomic information

https://www.utoronto.ca/news/u-t-s-deep-genomics-raises-us13-million-fund-expansion
Deep Genomics Raises $13M to Develop Genetic Medicines (Sep. 25, 2017)

- Received a $13 millions USD investment led by Khosla Ventures (one of the top Silicon Valley venture capital firms)
- The money will be used to hire a range of scientific experts
- Deep Genomics previously raised $3.7 million in a seed round in 2015

https://www.forbes.com/sites/bernardmarr/2018/11/16/the-amazing-ways-artificial-intelligence-is-transforming-genomics-and-gene-editing/#37469cae42c1

- By 2021, it is estimated that AI systems will generate 6.7 billion in revenue from healthcare globally
- AI systems make DNA sequencing and analysis faster, cheaper, and more accurate
    - Gives perspective on the particular genetic blueprint of an organism
- Genetic sequencing and analysis could also be ground-breaking for agriculture and animal husbandry
    - It can give insight into what kinds of mutations and diseases that an organism may be susceptible to in the future → this helps them think about how they can prepare for the future
- Sequencing the genome is a critical first step to understanding the human genome
    - High-throughput sequencing (HTS), the latest technology, allows the sequencing of DNA to occur in 1 day
    - This used to take a decade to do
- Machine learning is decreased the cost and making personalized medicine more possible
- Google's tool, **Deep Variant** uses the latest AI techniques to turn high-throughput sequencing (HTS) into a more accurate picture of a full genome
    - They are able to distinguish small mutations from random errors
    - Deep Learning played a big role in effectively training DeepVariant
- Deep Genomics uses its AI platform to decode the meaning of the genome to determine the best drug therapies for certain individuals based on their DNA
- Sophia Genetics is a company that hopes to use artificial intelligence to identify genetic mutations, and help doctors prescribe the best drug treatment for patients.
    - https://www.sophiagenetics.com/home.html

https://tech.economictimes.indiatimes.com/news/technology/from-agriculture-to-art-the-ai-wave-sweeps-in/66315315

- Typically, it takes several years and billion of dollars for pharmaceutical companies to bring a new drug to market
- AI holds the promise of reducing this cost and time
- It also reduces aero by decreasing the amount of guesswork
- Deep Genomics is still in its early stages
- It first compounds will be tested in clinical trials beginning in 2020

https://www.marketwatch.com/press-release/healthcare-artificial-intelligence-ai-market-rapidly-moving-to-reach-usd-12000-mn-by-2023-2018-11-13

- Deep Genomics is listed as one of the top key players in the global Healthcare AI Market

https://www.marsdd.com/magazine/robots-and-researchers-are-teaming-up-to-design-better-drugs-/?utm_medium=social&utm_source=Twitter&utm_campaign=content_promotion&utm_content=Drugs

- Deep Genomics is planning to apply their AI platform to rare Mendelian disorders (a class of inherited diseases that result from a single genetic mutation)
- They're hope is to make better medicines available to more people, more quickly
- The Ontario Institute for Cancer Research is using machine learning to develop genomic tools for early cancer detection and to categorize tumors
    - This will help doctors develop more effective treatments
- AI can also speed up the assessment of new compounds for their effectiveness, toxicity, and ability to be metabolized
    - They use pre-existing data to predict potentially new interactions
    - This helps them screen our molecules with undesired effects and prioritize effective ones
    - This takes second or minutes with AI processes, compared to months and years of experimentation
- The downside however of AI is that its ability to predict outcomes is based on the availability of high-quality data which can be difficult to come by
- Without enough data, the predictive power of AI falls
- The FEO of Deep Genomics also believes that AI can also help scientists and patients to share data more effectively

Podcast about Reprogramming the Human Genome with AI features Brendan Frey, the CEO of Deep Genomics
https://soundcloud.com/twiml/talk-012-brendan-frey-interview-reprogramming-human-genome-ai