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The rapidly growing volume and complexity of published information relevant to drug discovery provides both opportunities and challenges to innovation.

The next wave of drug innovations will be found at the intersection of scientific information and big data technologies. However, obstacles such as data and talent gaps are hindering organizations from realizing the full potential of AI and CASD.

As a specialist in scientific information solutions, CAS develops solutions like SciFinder[n] to provide scientists reliable answers in the lab and empowers organizations applying AI in their R&D programs with scientist-curated data collections, specialized technology, and custom consulting.
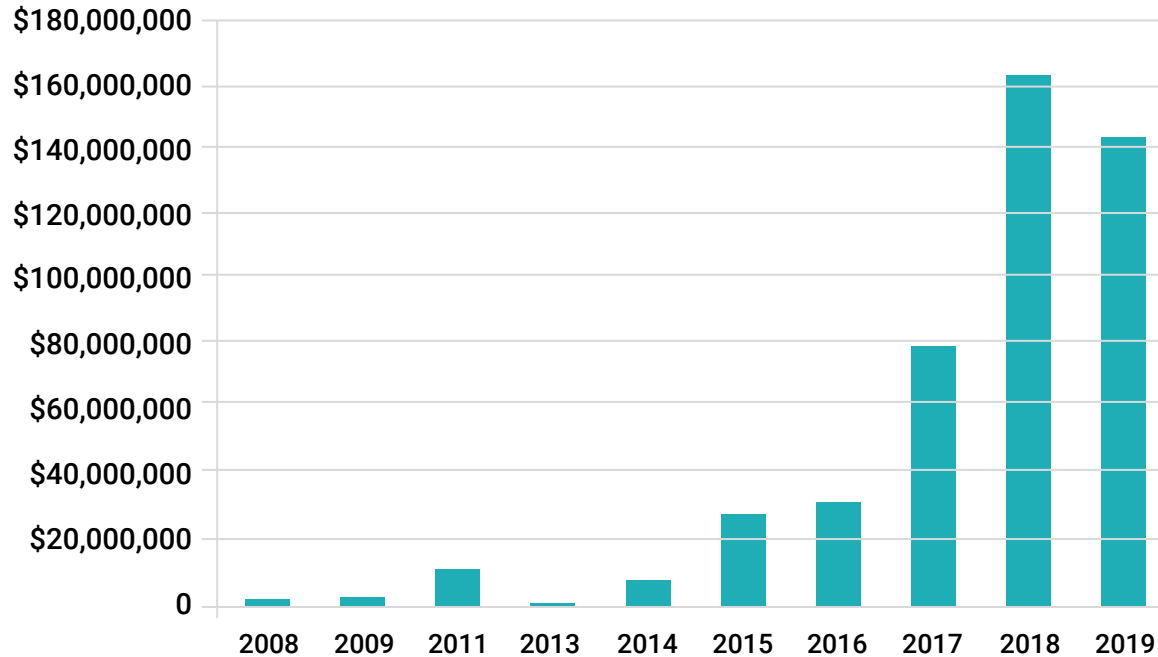
Poll Question

Agenda

1. Investment Trends

2. Biology: Target Identification

3. Chemistry: Identifying Compounds

4. Improving Clinical Trials

5. Dilemmas

6. Q&A

Investment Trends

Investment in AI companies

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Why invest in AI now?

1. Deep neural nets are **showing real progress**
2. Drug discovery **isn't getting cheaper**
3. **Explosion of data** offers intuitive use cases
4. Rote tasks, like data cleaning, **can be automated**
5. Everybody's doing it. Just wanted to make sure you're paying attention. **Hype is a toxic driver of investment**, and there's a lot of it

What tasks is AI performing?

→ Three broad categories: **Biology**, **Chemistry**, **Clinical Trials**

→ Identify disease targets and biomarkers, build confidence

→ Re-purpose existing drugs

→ Discover novel drugs

→ Design and recruit for clinical trials

→ Synthesize and analyze real world evidence

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Who wants to partner?

Benevolent AI (Janssen, AstraZeneca)

Atomwise (AbbVie, Merck)

Recursion (Takeda)

Berg Health (AstraZeneca)

Insitro (Gilead)

Numerate (Boehringer Ingelheim, Merck)

Exscientia (GSK, Sanofi)

GNS Healthcare (Amgen, Genentech)

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Don't bet the pharm just yet

→ Many of these "major, exciting, huge" **investments are not that big** and seem more defensive in nature

→ The potential benefits are **tantalizing, but aspirational**

→ AI is starting to make a difference on the margins

→ **Examples of breakthroughs**? Anyone? Anyone…?

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A rapidly evolving field with dozens of players

→ CytoReason

→ Benevolent AI

→ Berg

→ FDNA

→ Insitro

→ Data4Cure

→ Recursion Pharmaceuticals

→ Euretos

→ Precisionlife

→ Structura Biotechnology

→ Syntekabio

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A few deals to discuss...

Insitro inked a $15M deal with Gilead ($1B if it meets certain goals) to develop drugs to treat Non-Alcoholic Steatohepatitis (NASH). The goal is to identify five proteins that could be targets for novel drugs.

CytoReason signed a collaboration agreement (worth low double-digit millions) with Pfizer to map immune responses to ID disease targets and strengthen hypotheses. Details are vague, but CytoReason's tech can be useful in the development of cancer immunotherapies and drugs to treat autoimmune and neurodegenerative diseases.

Berg signed a research deal with Sanofi to use its AI data modeling to identify biomarkers associated with patient responses to seasonal flu vaccination.

Challenges

1. Assessing **what's real and what's not**. We haven't seen much in the way of results yet

2. Until value is established, changing traditional R&D approaches is going to be **a tough sell**

3. On the technical side, **data quality / value** is still questionable

4. In the end, discovery is still **limited by human knowledge**. AI can find patterns in data. But it lacks the creativity to invent

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Chemistry: Identifying Compounds

What does "identifying compounds" mean?

→ Some companies will **identify potential new uses** for existing compounds

→ Some will **design brand-new compounds**

→ Some can **predict the properties** of compounds and/or **optimize potential lead candidates**

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A few names to know...

Exscientia. The UK-based company, which specializes in small molecules, has collaborations with Celgene, GSK, Sanofi and Sunovion, and a partnership with Evotec.

Atomwise. The company claims to have 60 corporate and academic partners, including Abbvie and Merck

MoleculeNet/DeepChem. MoleculeNet is intended to serve as a practice test for algorithms that predict the properties of molecules; if an algorithm winds up predicting very different properties than the benchmark "answers," it may signal a problem with the model.

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Why is this helpful?

→ AI may be **able to see patterns** in structures or interactions that medicinal chemists may not

→ In theory, AI may be able to **speed up the process** of finding a drug candidate

→ Exscientia claims its work can **generate candidates four times as quickly** as more traditional methods

→ It may also be able to help chemists find ways to **synthesize drug candidates**

Sounds great, but…

AI needs to have something to drug in the first place

That means that a potential drug target has to be well characterized — a reasonably reliable crystal structure, for example, needs to be published.

Need to have data about potential compounds

Some databases of chemical compounds are available, but they're rarely linked with the deep clinical data that might allow…

Filling gaps in existing data sets costs money/takes time

The vast majority of well-established companies are looking for small molecule compounds

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DNDi and Atomwise: A Case Study

→ Atomwise used its **AI engine** to predict how compounds might do in a screening test. It **provided compounds for DNDi to test** as treatments for Chagas disease

→ DNDi has pursued the compounds that Atomwise picked, but **the compounds are early-stage** — more promising starting points than anything

→ Atomwise does offer **AI-based support** to develop hits (or compounds that might be hits) into lead programs

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An experiment within the experiment

→ AI offers hope to **cut costs and time** to results

→ Vendors selling improved study designs, faster and better recruitment, reduced dropout rates, and ability to incorporate real world evidence from multiple sources

→ The great hope of patients: **AI can help determine which patients are mostly likely to benefit, and inform value/pricing**

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Start-ups are popping up like dandelions, but who will survive?

A lot of players with varying levels of experience in the space:

→ **Trial design:** GNS Healthcare, Intelligencia.AI, Trials.ai. PathAI

→ **Recruiting:** Tempus, Deep 6 AI, Antidote, Mendel.ai, inato

→ **Process improvements:** AiCure, Brite Health, Saama, nQMedical

What's the use?

Tempus is taking aim at the enrollment bureaucracy in cancer trials. The goal is to create a network of providers (40 health systems, 1,800 oncologists) to ID patients and get them enrolled without lengthy contract talks.

Deep 6 AI is focused more directly in recruiting. It published a case study of its work with Cedars Sinai: Its software took less than an hour to ID 16 patients for a drug trial for pediatric heart surgery patients. Typically, it took the hospital's research team six months to find just two patients.

Brite Health has developed a platform to manage patient engagement. Sends notifications to patients, allows researchers to track engagement flags warning signs correlated with dropouts.

Real world evidence

A definition: Information collected outside of a controlled setting, such as data from patient surveys, doctor's notes, or wearable devices.

Infusing real world evidence into trials

FDA has made use of real world data a strategic priority and released a framework for using it to review new indications for existing drugs and biologics.

Synthetic control arms could accelerate research and cut costs. FDA has given approvals based on real world evidence. **A notable example is Pfizer's Ibrance for male breast cancer** — approval was based on data collected from electronic health records.

Companies such as **Aetion** and **Concerto HealthAI** (deals with Bristol Myers and Pfizer) are making inroads in establishing the value of this data.

The Dilemmas

Business Questions: Where's the beef?

1. **Is there a demonstrable benefit** of applying AI to a specific task?

2. Success stories anyone? While fluff is plentiful, **verifiable breakthroughs are rare**

3. Is AI going to **save money, or cost money**? When's the pay off?

4. What is the **cost of inaction**? The constant drip of deals is evidence that sitting on the sidelines is not an option
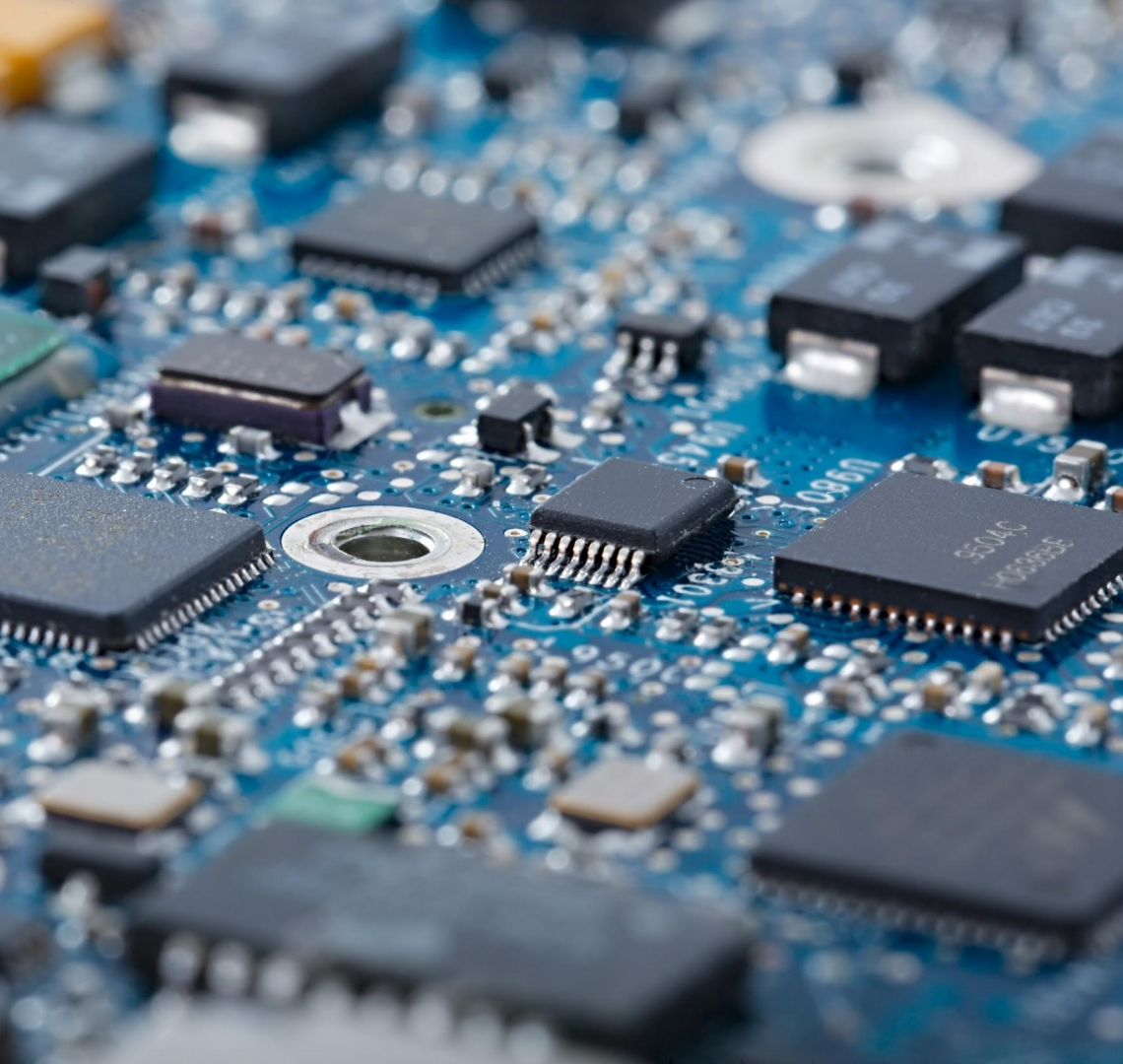
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Ethical Questions: What's in the beef?

1. Are algorithms being trained on **diverse data sets**?

2. Do algorithms need their **own clinical trials**?

3. **Is AI being used to take shortcuts** that undermine the value of the science?

4. Where do you draw the line on **real world evidence**? Is the process transparent?

What's next?

1. We appear to be reaching the **peak of the hype cycle**

2. Expect to read about **more partnerships**

3. But we also may begin to **separate winners from losers** among AI startups

4. We'll get a **clearer definition** of success

5. Will **contracts** get renewed?

Q&A

Thanks!

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