From Entrepreneurial Ecosystems to Technology Ecosystems

ESBRI Seminar on Entrepreneurial Ecosystems and Technology Ecosystems
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Erkko Autio, Imperial College Business School
with Herve Legenvre, EIPM and Ari-Pekka Hameri, UNIL

The Novel Insight We Seek

Practical insight:

- How can firms harness open-technology strategies to gain competitive advantage in general-purpose technology ecosystems?
- Where are the opportunities for new ventures?

Empirical novelty:

- Focus on ”what lies beneath”: digital infrastructures that bring the ’surface’ to life (e.g., powering platforms on the surface)
- Focus on the AI and ML technology ecosystem

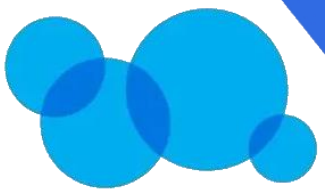
Theoretical insight:

- Demonstration how firms can drive competitive advantage through open-technology digital strategic maneuvers (OTDSIs)

Digital Infrastructures Are an Open-Technology World

TELECOM INFRA PROJECT

kubernetes



NEPHIO

PyTorch

Imperial College Business School

erkko.autio@imperial.ac.uk

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Open Technologies: Impact

Facebook released 170 new open source projects in 2019

Open Compute Project Foundation (OCP) **launched in 2011**
(open source hardware for data centres)
185 contributions from Facebook, Microsoft, ATT, Intel…
12 000 engineers contribute to OCP projects
2015: $2 billion savings and 400 000 metric tons of CO2 emissions eliminated (95 000 cars) for Facebook

Telecom Infrastructure Project (TIP)
2016: Started by Facebook to "connect the unconnected"
500+ **members**, including DT, Telefonica, Intel, Nokia, Vodafone
The CEO of **Ericsson** expects TIP to "**impact revenues**" from 2023

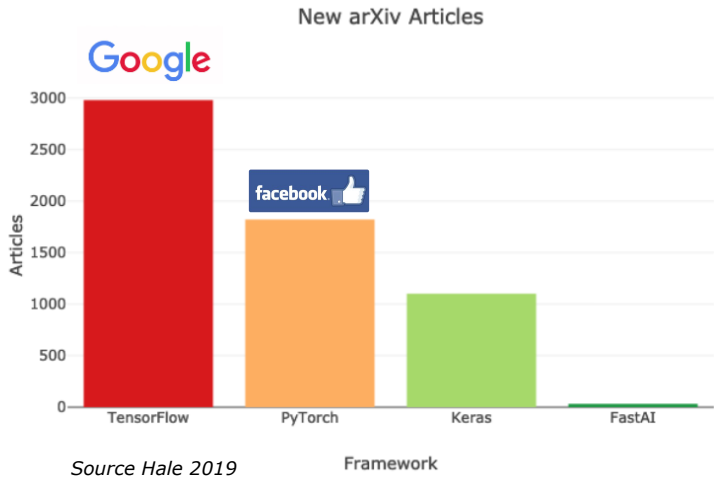
Over **9% of employees** contribute to open source

Kubernetes: De-facto standard for container orchestration that enable cloud. Donated to The Cloud Native Computing Foundation

Google supports **RISC V**, open ISA for processors

The Economist describes **RISC V** as the biggest challenger of ARM

Deep learning frameworks (AI): battle between Google and Facebook



Source Hale 2019

Welcome to the hidden world of Open-Access Digital Resources!

Open Technologies: Accessible with Highly Permissive Licensing Conditions

Open Patent Pledges
making patents freely available to the public

Standards
provide guidance on the design, use or performance of materials, products, processes, services, systems or persons. It is established by a consensus of experts and approved by a recognized body

Open-Source Software
release code under a license where the copyright holder grants users the rights to use, study, change, and distribute the code to anyone for any purpose

Open Data
are freely available to use, without restrictions from copyright or other mechanisms of control

Open Hardware
where the design is made publicly available so anyone can study, modify, distribute, make, and sell the design or hardware.

Innovation Kits
are inexpensive hardware and software packages that allow anyone to experiment with new technologies and develop proof of concepts

Open Science
makes scientific research including publications, data, equipment's and software accessible to all in society

Open Architectures
allow access to all parts of the architecture without proprietary constraints. It allows adding, upgrading, modifying and swapping components

. . . . . .

Gaps

Plenty of research on the governance of open-source software, private firms' motivations to contribute to it, and firm-level strategies to profit from open-source software

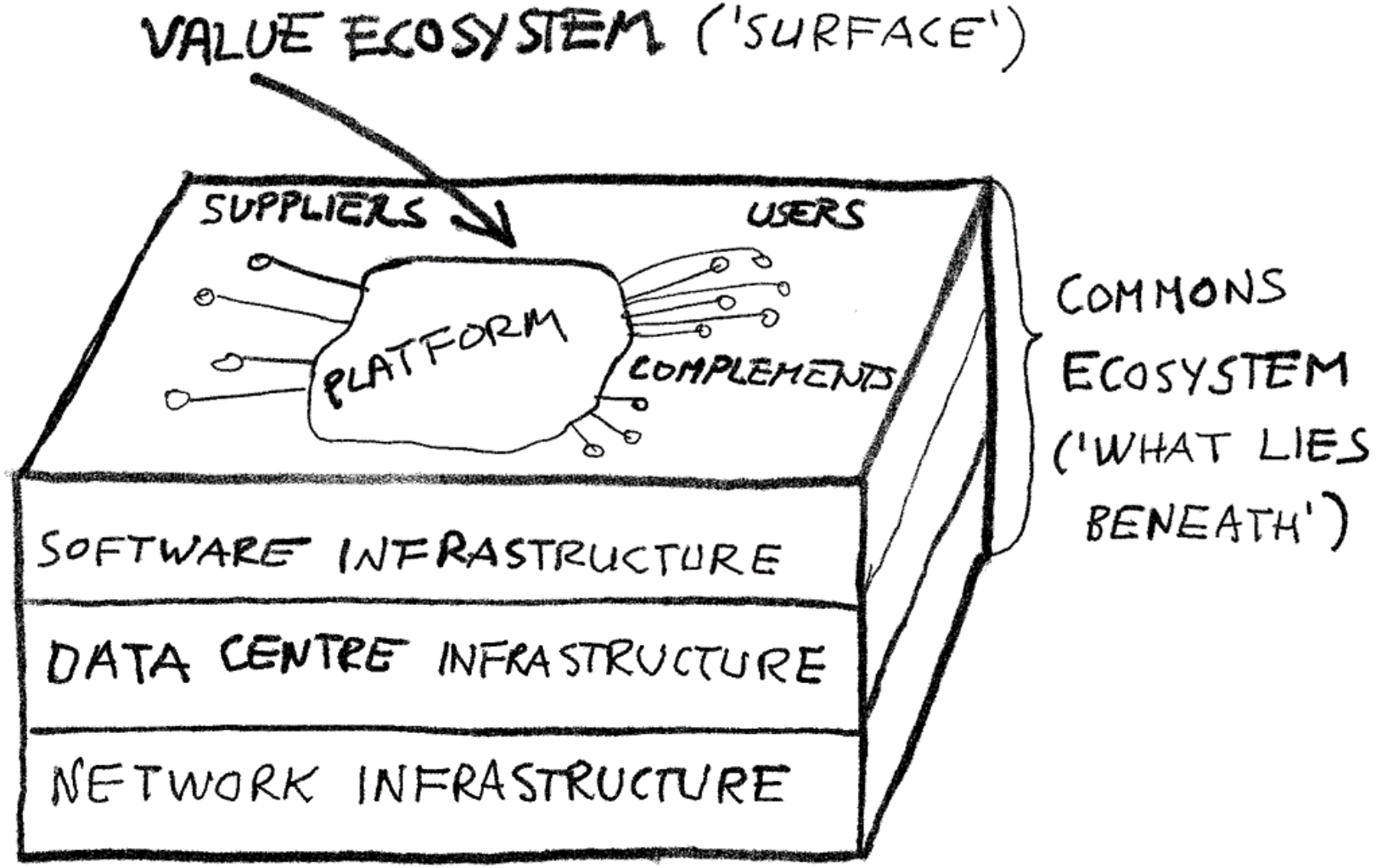
In parallel, plenty of research on innovation ecosystems and platform strategies

However, open tech and ecosystem research seldom overlap

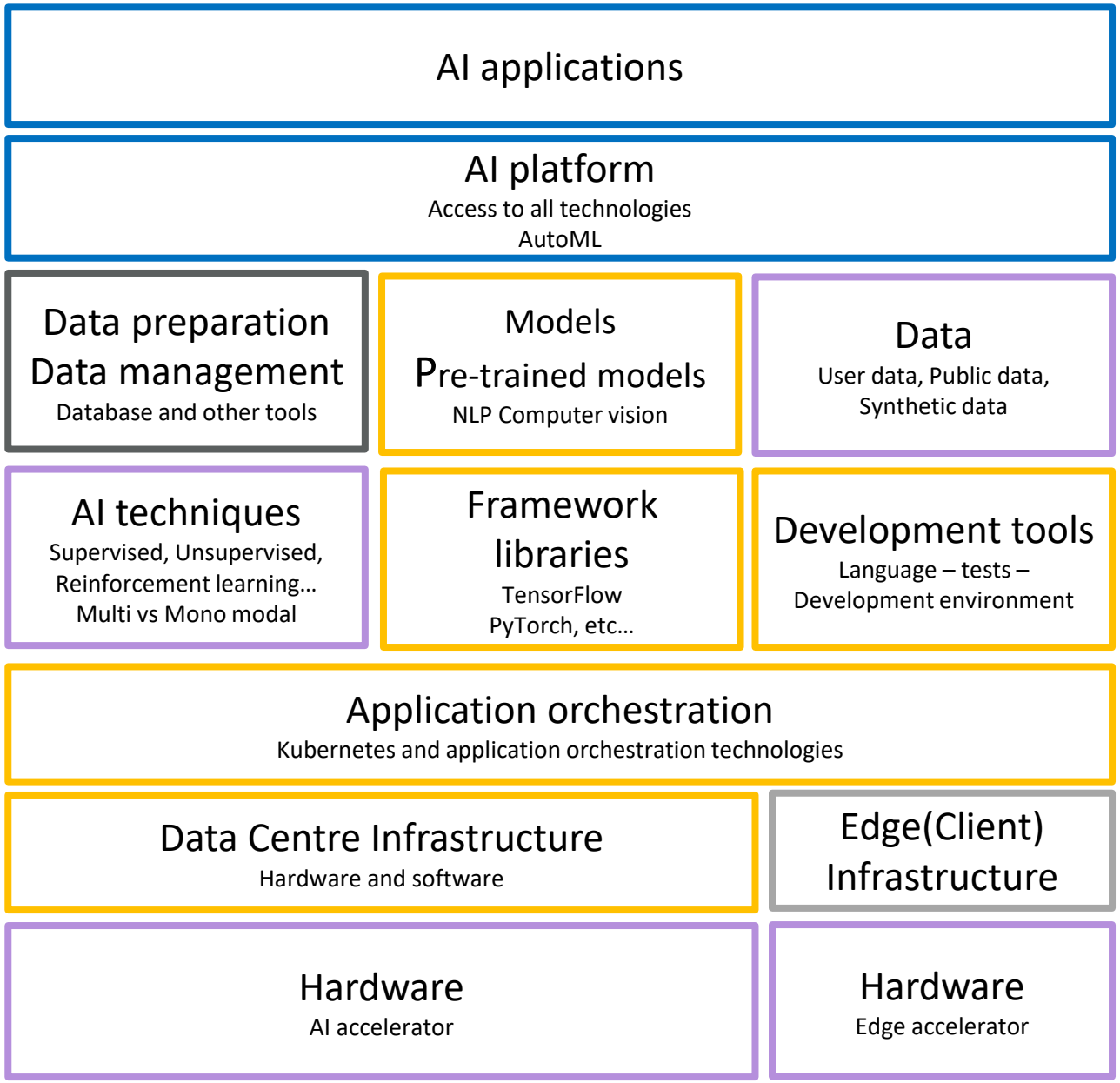
In addition, little research on:

- technology ecosystem shaping
- infrastructural innovation
- general-purpose technology ecosystems
- entrepreneurial opportunities in this context

OT Ecosystems and Platform Ecosystems



AI-ML General-Purpose Technology Ecosystem



Source: Autio, E., Legenvre, H., Hameri, A-P. 2023. Value creation and appropriation through digital strategic initiatives: Google's Open-technology maneuvers in AI and machine learning ecosystems. Working Paper, Imperial College Business School.

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“It is clear to me we are evolving from a mobile-first to an AI-first world”

Sundar Pichai, Google CEO
October 2016

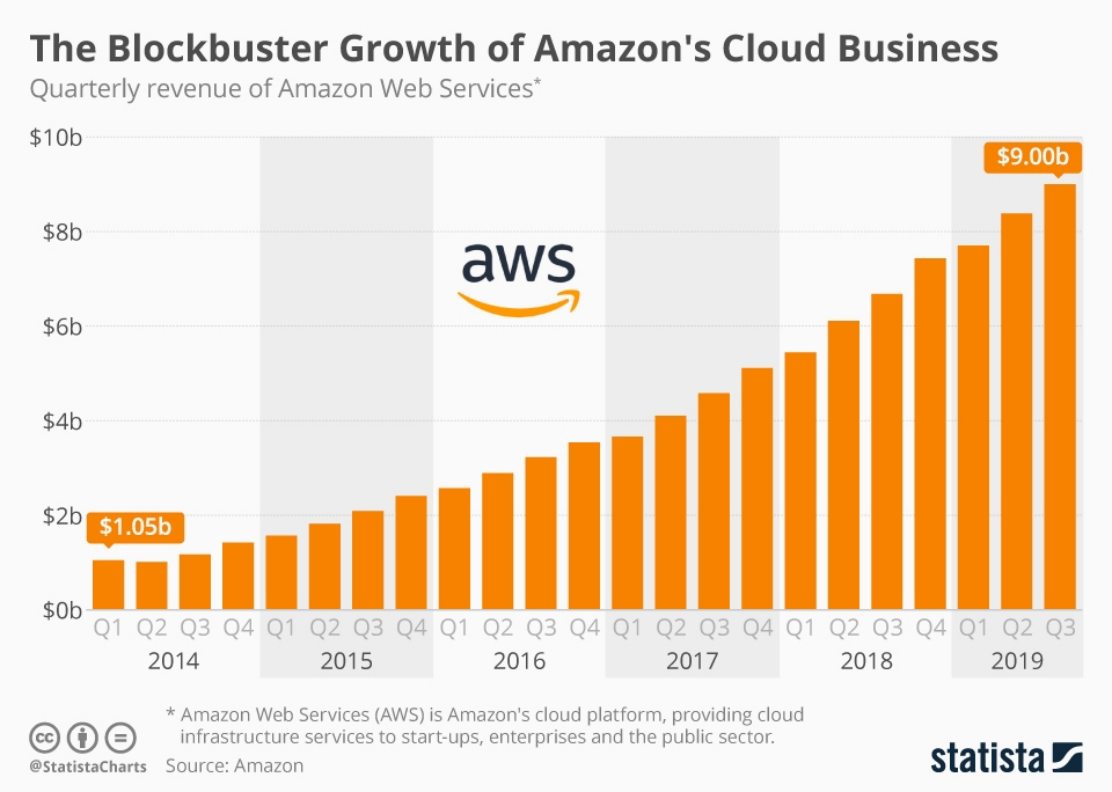
Cloud Market

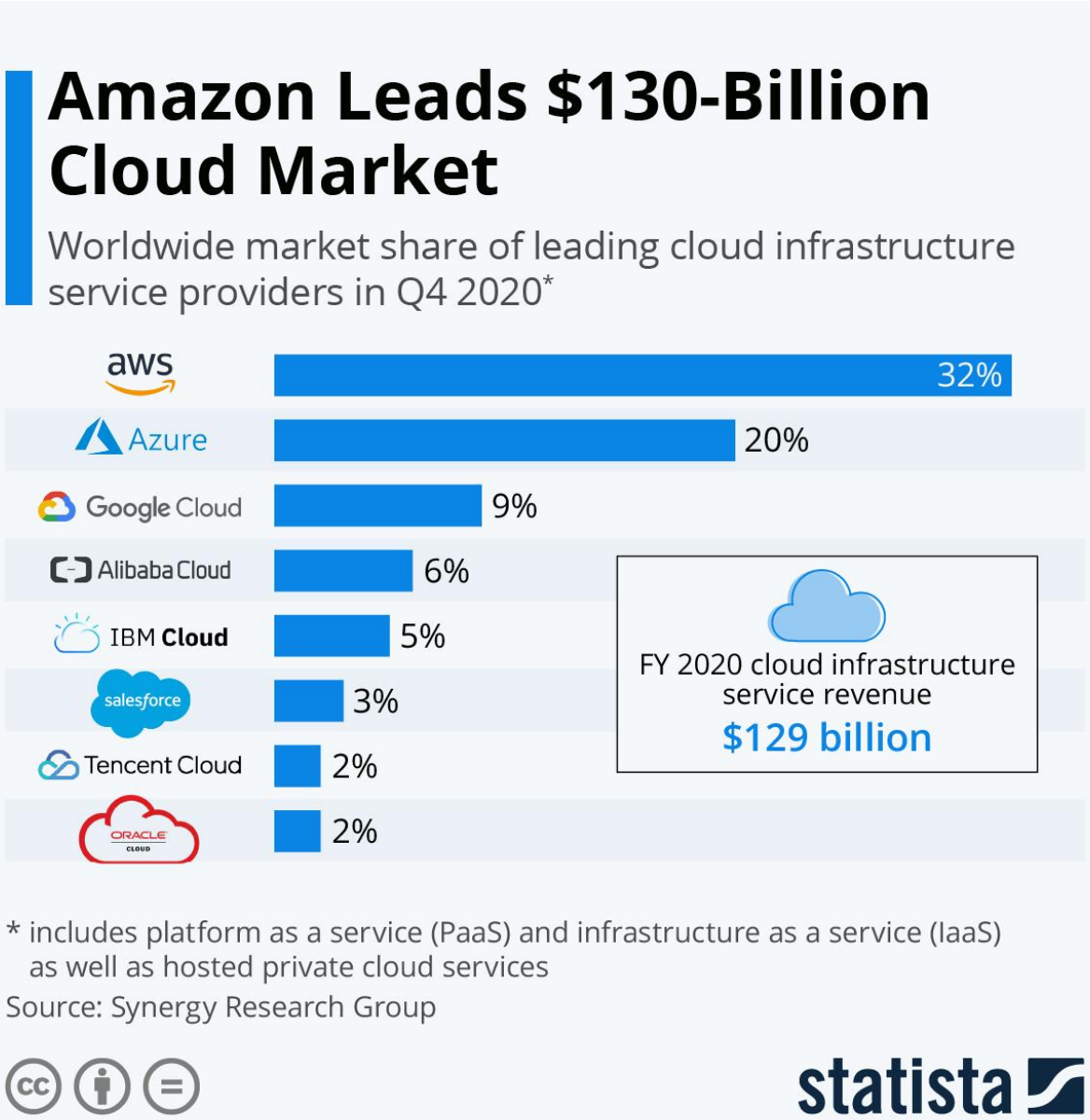
2002

***Amazon** Launches AWS, its web service that will become its cloud business*

2010

***Microsoft** launches Azure, its cloud business*
***Google** launches Google Cloud Storage*





Data Sources

Trade articles; analyst publications; blogs; press releases; conference announcements; OSS community governance (e.g., meeting notes and video recordings); OSS distributors (e.g., GitHub); video presentations and commentaries; OSS documents, technical notes, and white papers; research papers; talks and interviews with industry practitioners

Over 350 documents and sources

Iterative content analysis (‘Corley and Gioia style’), inductive coding in weekly meetings over a period of 9 months

Google OT Moves in AI Ecosystem

Move 6: Integrate AI in all Google products including Search

Move 9: Integrate AI in all Alphabet subsidiaries (automotive, health connected devices…)

Move 10: Offer an AI platform on top of the Google Cloud platform to sell AI as a service

Move 7: Release open-source data curation tool for healthcare to ease adoption of proprietary solutions

Move 5: Adopt open science and Invite academics as visiting professors, develop academic collaborations

Move 2: Release TensorFlow and unleash a massive AI ecosystem momentum in the above layers (academics, developers, complementary technologies, startups, clients)

Move 1: Release Kubernetes to challenge Amazon Web services dominance in the cloud and support future AI applications

Move 8: Develop proprietary TPUs, AI-specific processors to gain full mastery of the infrastructure and eliminate dependency on NVIDIA. Sell the TPU as a service on Google Cloud platform

AI applications

AI platform
Access to all technologies
AutoML

Data preparation
Data management
Database and other tools

ML models
Pre-trained models
NLP Computer vision

Data
User data, Public data, Synthetic data

AI techniques
Supervised, Unsupervised, Reinforcement learning…
Multi vs Mono modal

Framework libraries
TensorFlow
PyTorch, etc…

Development tools
Language – tests – Development environment

Application orchestration
Kubernetes and application orchestration technologies

Data Centre Infrastructure
Hardware and software

Edge(Client) Infrastructure

Hardware
AI accelerator

Hardware
Edge accelerator

Move 12 and 13: Collaborate with clients and develop new AI applications available on Google Cloud Platform (healthcare, supply chain..)

Move 3: Release datasets for academics, developers and clients to further fuel the AI ecosystem momentum

Move 4: Release pre-trained models to further fuel the AI ecosystem momentum

Move 11: Launch coral hardware kits and release open-source software to ease integration in client infrastructure

Open

Proprietary with open interface

Partly Open

Source: Autio, E., Legenvre, H., Hameri, A-P. 2023. Value creation and appropriation through digital strategic initiatives: Google's Open-technology maneuvers in AI and machine learning ecosystems. Working Paper, Imperial College Business School.

Herding: Momentum Through OT Releases

Releasing foundation technologies to grow developer communities

- Google's release of Borg as Kubernetes
- Building on Kubernetes' success, Google released TensorFlow
- Effect: developer community kicked off

Releasing complements to fuel applications

- Datasets – e.g., Open Images, YouTube-8M
- Customizable pre-trained models: e.g., BERT
- Effect: application development sped up

Releasing research findings

- Visiting professor program
- Publishing research papers
- Effect: speed up community growth, unblock tech bottlenecks

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Productizing AI Advances to Core Products

Monetizing in Google core products

- Using BERT to boost Google Search capabilities
- Using Multitask Unified Model (MUM) to extend search beyond text
- Impact: Enhance Google distinctiveness from competitors, expand capabilities of Google core products

Monetizing in Google cloud products

- Offering proprietary TPU in Google Cloud
- Offering proprietary pre-trained models and automation tools: e.g.,
  - » Vision API to classify images
  - » Vertex AI to manage ML models
- Impact: boost Google Cloud position

Source: Autio, E., Legenvre, H., Hameri, A-P. 2023. Value creation and appropriation through digital strategic initiatives: Google's Open-technology maneuvers in AI and machine learning ecosystems. Working Paper, Imperial College Business School.

Colonizing: Expanding Monetization Beyond

Infrastructure position + data network effects = Adjacent entry

Launching spin-outs for entry to adjacent domains

- Waymo
- Nest
- Isomorphic Labs

Isomorphic Laboratories

Facilitating AI application by customers with toolkits

- Coral
- Software for healthcare data curation

Partnerships for proprietary application development

- Healthcare applications
- Digital twins for automotive supply chains

Effect: Extend Google monetization capabilities to new domains

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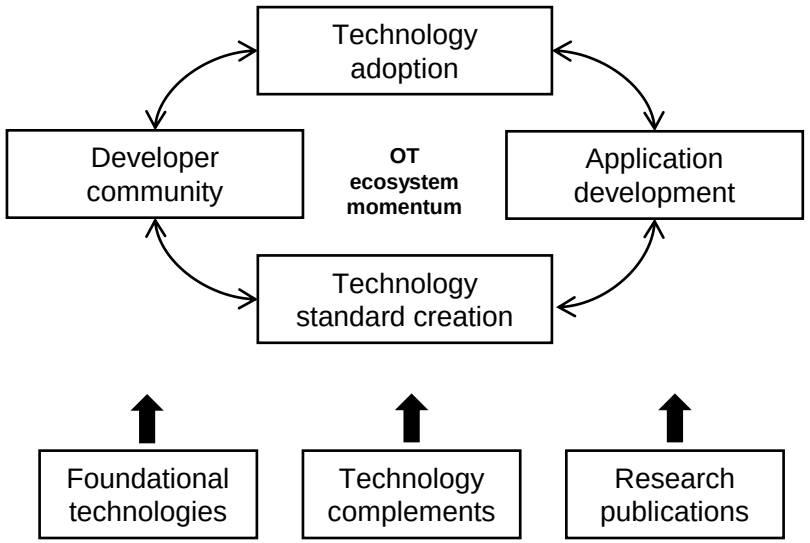
Harnessing OTs for Competitive Advantage

Herding

- Releasing foundation technologies to grow developer communities
- Releasing technology complements to drive adoption and application development
- Publishing research to facilitate and steer technology development

OT Ecosystem



AI OT advances

Productizing

Monetizing OT advances in current services

Proprietary platform	AI infrastructure
Integrating OT advances in the firm's current offerings in its platform on 'the surface'	Integrating OT advances in the firm's current offerings in its cloud operation

Infrastructural position

Colonizing

- Launching new ventures in different sectors
- Catalyzing sector-specific infrastructures for AI adoption
- Using partnerships to develop sector-specific ML services in the cloud

Harnessing ecosystem-level data network effects and infrastructure position for entry to new sectors

- New ventures exploiting ML advances in new sector settings
- Customer ability to adopt AI and ML services in new sector settings
- New sector-specific ML services offered in new sector settings

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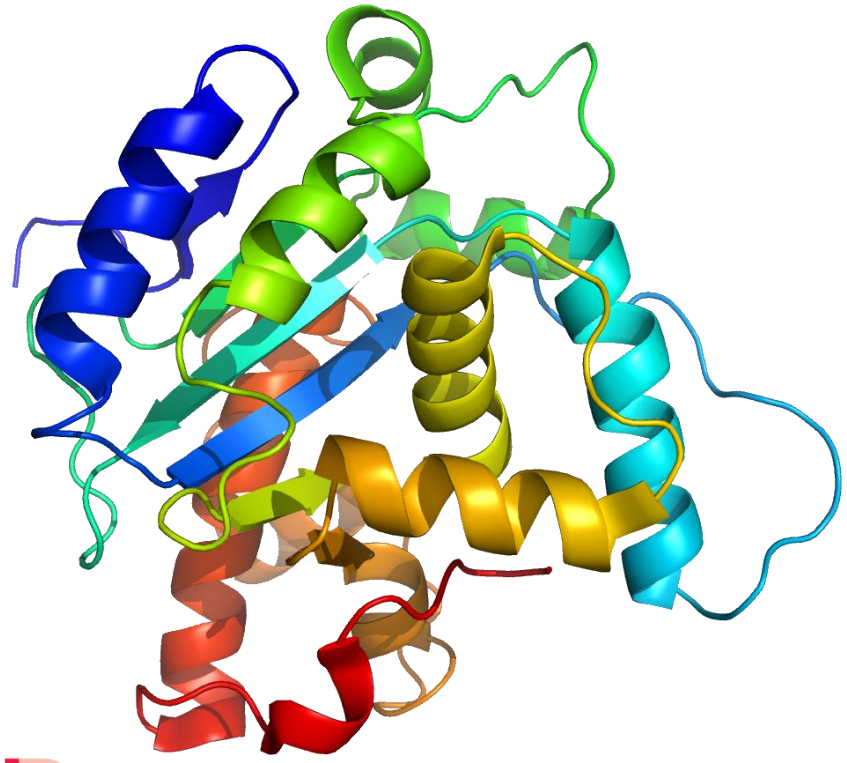
Isomorphic Laboratories



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Isomorphic Labs announces first phase of management team

New additions include Chief Scientific Officer, Chief Technology Officer, Heads of Machine Learning and People Operations

New Alphabet "bet" is focused on the use of artificial intelligence to accelerate drug discovery

LONDON, May 12, 2022 - Isomorphic Labs, a subsidiary of Alphabet, today announced the first phase of its management team. The company, established in November, was launched from Alphabet's DeepMind to build on the success of AlphaFold, DeepMind's work in protein folding that was heralded as the "Breakthrough of the Year" by *Science* and "Method of the Year" by *Nature* in 2021. Isomorphic Labs' mission is to use AI and machine learning methods to accelerate and improve the drug discovery process. The company is a pioneer in the emerging field of "digital biology" and aims to usher in a new era of biomedical breakthroughs in order to find cures for some of humanity's most devastating diseases.

Who Should Play the Game?

As such, anyone can harness open tech benefits (think MySQL, Red Hat, d2iq,...)

For ecosystem-level data network effects, strong cloud presence would appear necessary for now?

A more detailed analysis of open tech ecosystems should reveal more detail on niches that different players can occupy

OT Business Models

Support and Services

Open Core

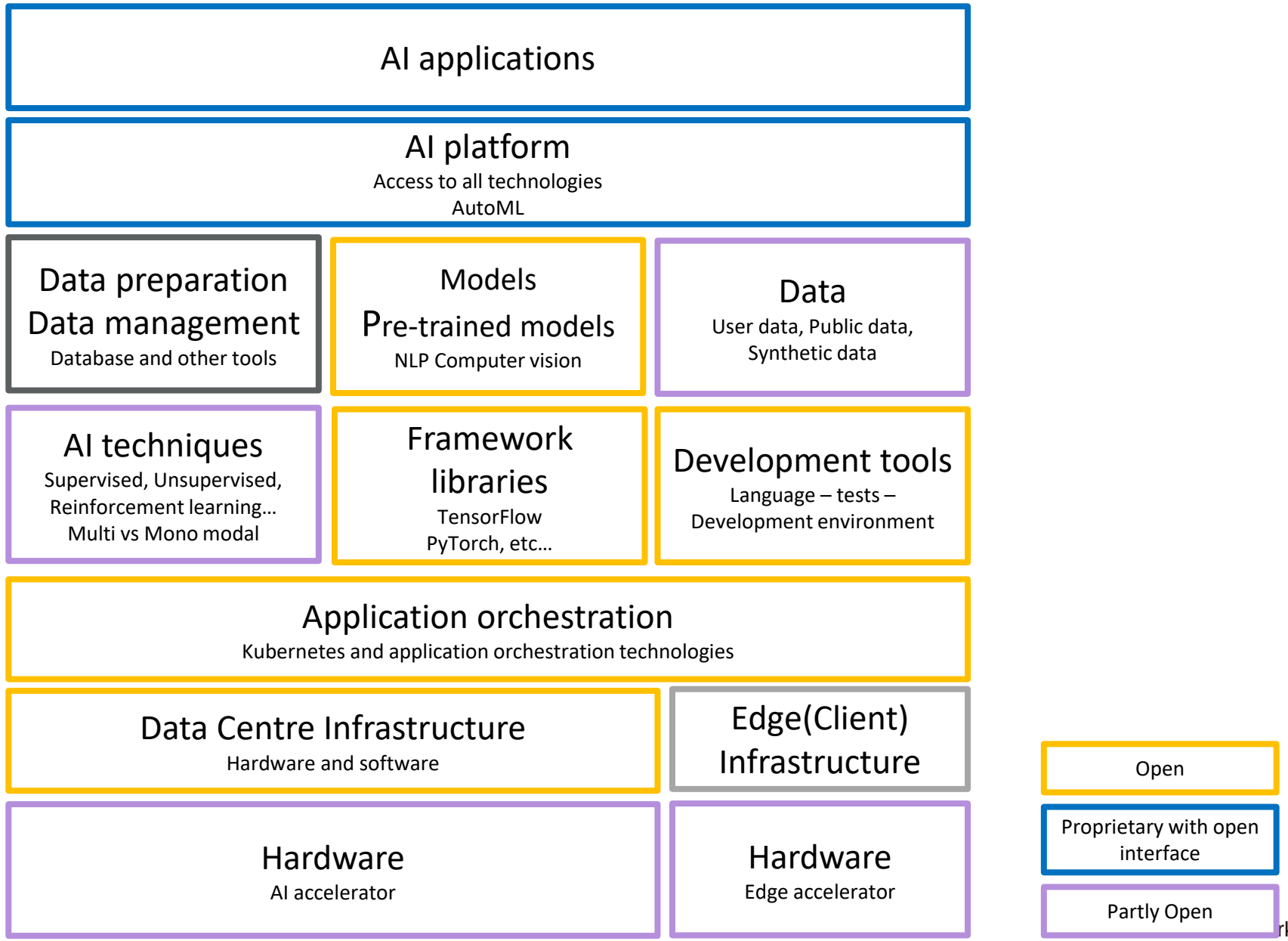
MESOSPHERE

SaaS

Hosting

elasticsearch

AI-ML General-Purpose Technology Ecosystem



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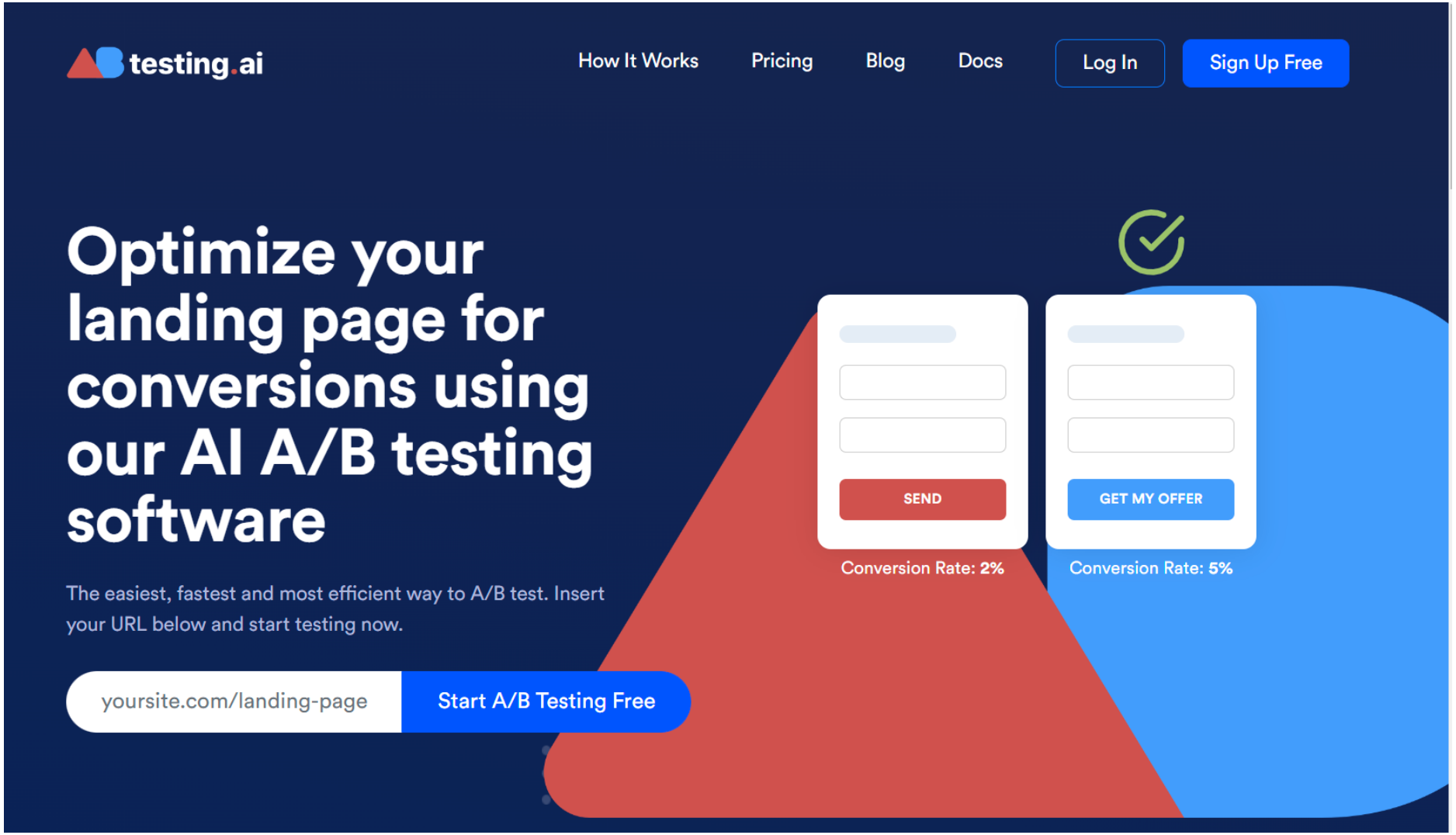
abtesting.ai



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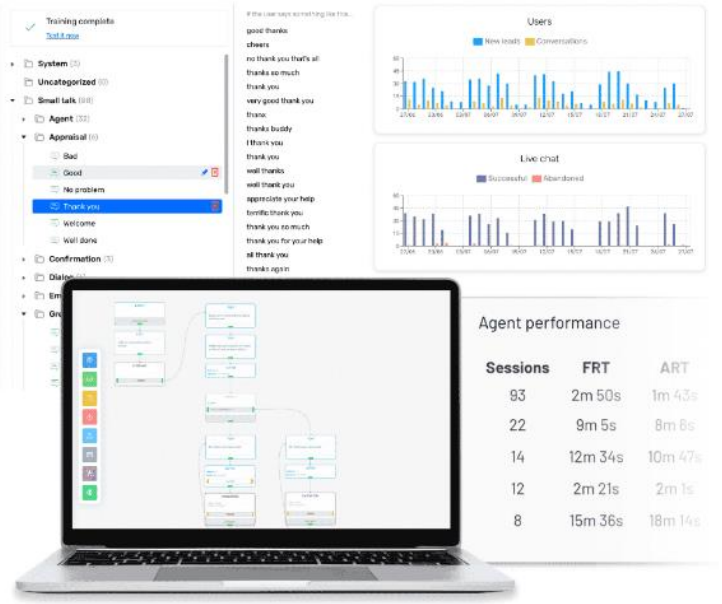
Get A Demo



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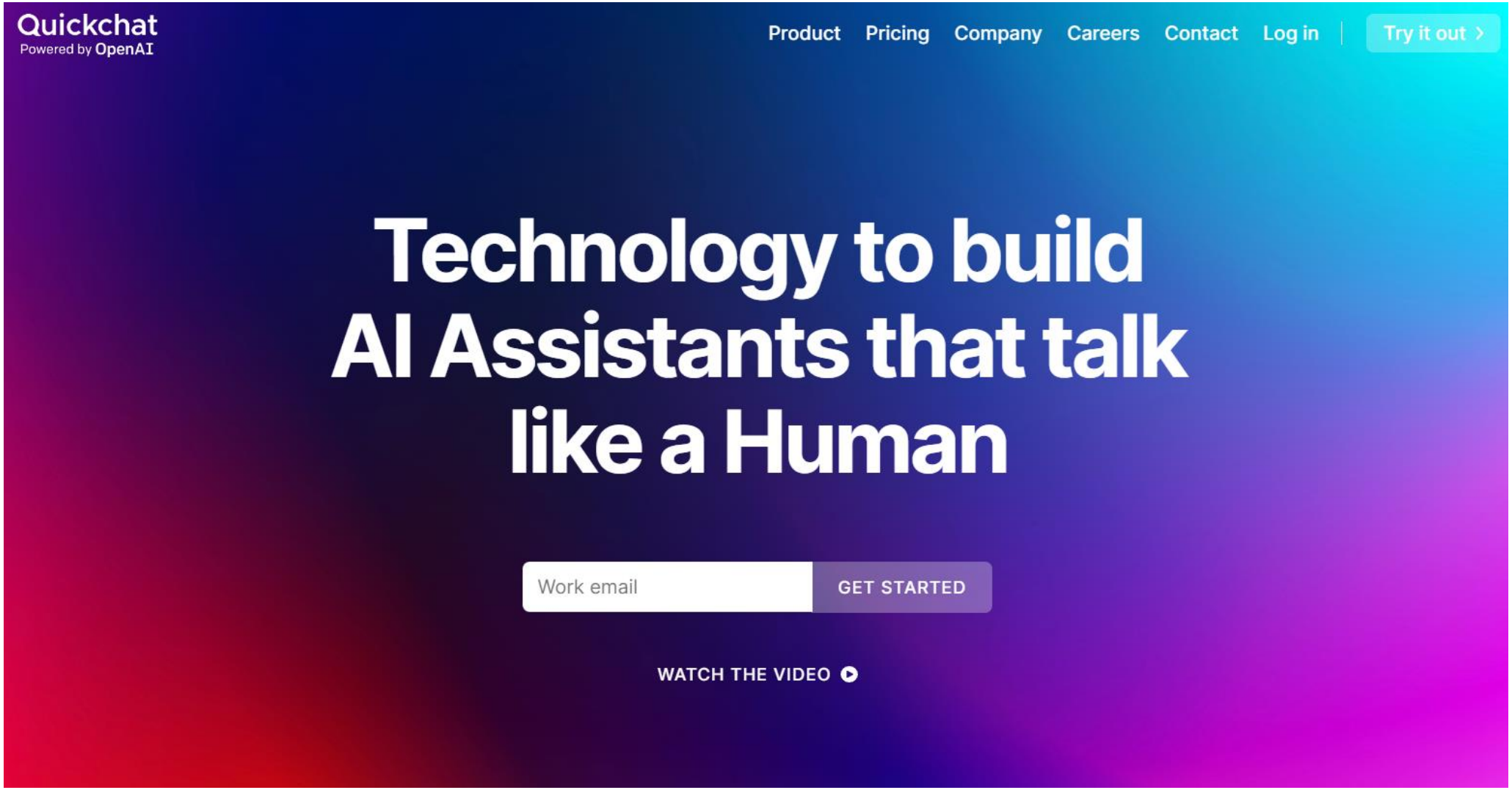
quickchat.ai



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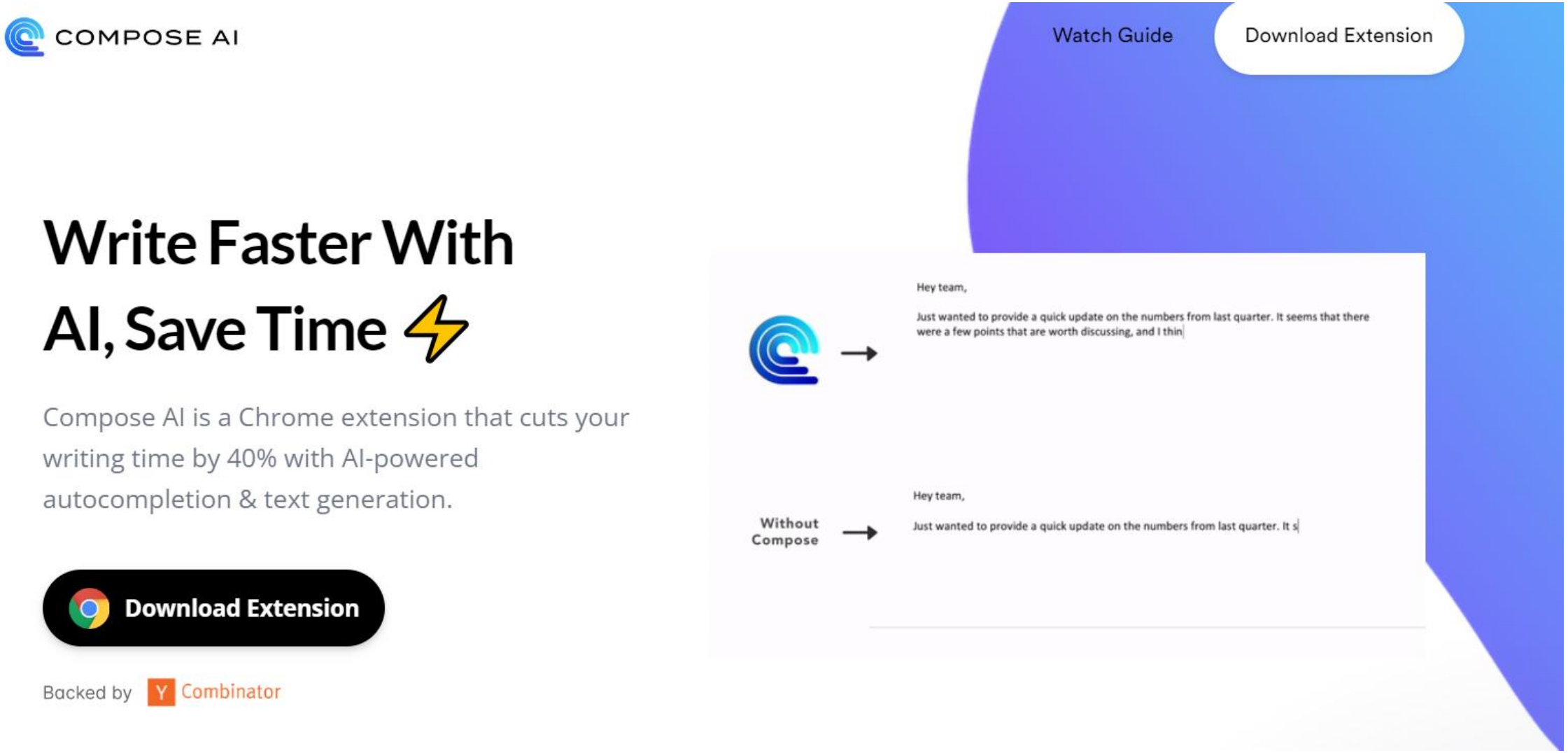
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Write Faster With AI, Save Time ⚡
Compose AI is a Chrome extension that cuts your writing time by 40% with AI-powered autocompletion & text generation.
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Backed by Y Combinator
Hey team,
Just wanted to provide a quick update on the numbers from last quarter. It seems that there were a few points that are worth discussing, and I thin
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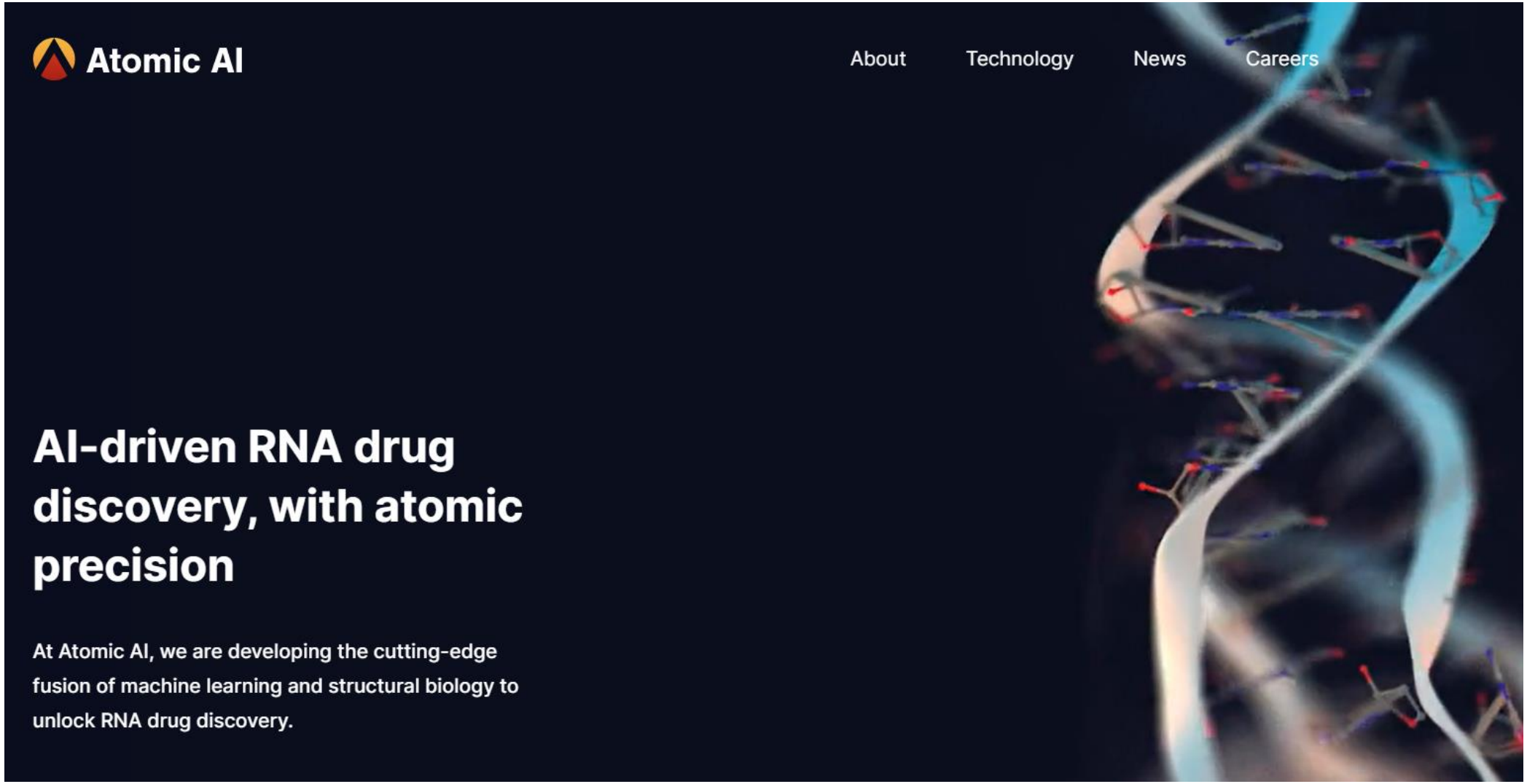
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AI-driven RNA drug discovery, with atomic precision
At Atomic AI, we are developing the cutting-edge fusion of machine learning and structural biology to unlock RNA drug discovery.

Was This an Accident?

The Guardian Newsletters

TechScape
Meta

TechScape: Will Meta's massive leak democratise AI – and at what cost?

4Chan users have posted the tech giant's new ChatGPT-style language model online, putting the future of AI at a crossroads – and opening up a whole host of dangers

Don't get TechScape delivered to your inbox? Sign up for the full article here

Alex Hern
@alexhern
Tue 7 Mar 2023 11.45 GMT

Will Meta try to put the AI chatbot genie back in the bottle? Photograph: Rafael Henrique/SOPA Images/REX/Shutterstock

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AI Chatbot Comparison

Model	Developer	Training Data	Focus	Accuracy
Chat-GPT4	OpenAI	Data prior to late 2021	Text functions	Needs careful prompting to generate more detailed responses
Bard	Google	Real-time, current research pulled from the internet	Education, business, and other fields	Expected to provide more accurate information
LLaMa	Facebook AI Research (FAIR) and Carnegie Mellon University researchers	-	More flexible than other conversational AI models like GPT-3	-