AI in medicine and drug discovery

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My own journey



https://jpvert.github.io

Who is Owkin?

Team of 200 with top data access • experts, data scientists, medical doctors, biostatisticians & computational biologists across Europe & America.

> 270 Team 60 PhDs

Thomas Clozel (CEO, M.D.) Assistant Professor in clinical oncology & former PI at Weill Cornell



33 Publications





Raised >\$255M from from leading biopharma companies (Sanofi and BMS) and venture funds (Fidelity, GV and BPI, among others) scientific journals like Nature Medicine, Nature Communications and Hepatology, NeurIPS.

33 publications in top

Scientific Advisory Board of 10 of the best specialists in their disease area, chaired by Miriam Merad (M.D., Ph.D. Mount Sinai School of Medicine, NYC)



Use AI to Discover & develop better treatments for unmet medical needs, starting with oncology. Ø

Estimated age-standardized incidence rates (World) in 2020, all cancers, both sexes, all ages

The cancer problem



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Data source: GLOBOCAN 2020 Graph production: IARC (http://gco.iarc.fr/today) World Health Organization



https://gco.iarc.fr

- 19 million new cases / year worldwide
- 10 million deaths / year (1 out of 6)
- 1/3 males, 1/4 females diagnosed before 74 in "rich" countries
- 70% of deaths in low- and middle-income countries



What is cancer?





- A growing mass, that may spread to and disrupt other organs
- Made of fast-dividing cells that look different from normal cells
- Because their (epi-)genome is abnormal

All cancers are different



All happy families are alike; each unhappy family is unhappy in its own way.

- Leon Tolstoy, Anna Karenina.





AI? = systems that *learn* to solve tasks



How Owkin will become "the" AI Biopharma

ightarrow Using AI to find the right treatment for every patient



Breaking silos: network of collaborators sharing expertise and data while preserving data privacy with federated learning

Selected academic partners







Published collaborative research

medicine

medicine	Deep learning-based classification of mesothelioma improves prediction of patient outcome. Courtiol et al. 2019
HEPATOLOGY	Predicting survival after hepatocellular carcinoma resection using deep learning on histological slides. Saillard et al. 2020
nature communications	Pan-cancer deep learning model to predict RNA-Seq expression of tumours from whole slide images. Schmauch et al. 2020
nature communications	Integrating deep learning CT-scan model, biological and clinical variables to predict severity of COVID-19 patients. Blum et al. 2021
nature	Federated learning for predicting histological response to neoadjuvant chemotherapy in triple-negative breast cancer.

Ogier du Terail et al., 2023.

Key Opinion Leaders



"Owkin is leading the use of AI for prediction and drug discovery in cancer."

Professor Fabrice André, MD, PhD Director of Research Gustave Roussy and incoming president of ESMO



"I am excited to be part of this cutting-edge research collaboration that will have a positive impact on how clinicians evaluate and treat patients."

Professor William R. Jarnigan, MD Chief of Hepatopancreatobiliary Service at Memorial Sloan Kettering Cancer Center



"Owkin were able to identify details from the histology slides that had never previously recognized as significant prognostic indicators or biomarkers of treatment decisions."





medicine

Federated learning for predicting histological response to neoadjuvant chemotherapy in triple-negative breast cancer. Ogier du Terail et al., 2023.

RlapsRisk BC

A CE-marked AI diagnostic to help pathologists and oncologists assess the risk of relapse of early breast cancer patients.



Suitable for adults with primary invasive breast cancer (ER+/HER2-) Cumulative sensitivity is significantly greater than those obtained by

standard clinical scores

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Preprocessing



Making the H&E slides Al-ready

Preprocessing occurs for every sample in the cohort. Each slide is subdivided into smaller sections called 'tiles' (~20,000 tiles)



Numerical representation of morphological aspects

An algorithm extracts the visual features from each tile and compresses and associates them to a number Ø



Interpretable AI models (deep multiple instance learning)

medicine

LETTERS https://doi.org/10.1038/s41591-019-0583-3

Deep learning-based classification of mesothelioma improves prediction of patient outcome

Pierre Courtiol^{1,8}, Charles Maussion^{1,8}, Matahi Moarii¹, Elodie Pronier¹, Samuel Pilcer¹, Meriem Sefta¹, Pierre Manceron¹, Sylvain Toldo¹, Mikhail Zaslavski¹y, Nolwenn Le Stang[®]², Nicolas Girard^{1,2}, Olivier Elemento⁵, Andrew G. Nicholson⁶, Jean-Yves Blay[®]², Françoise Galateau-Sallé^{2,8}, Gilles Wainrib^{1,4} and Thomas Clozel^{® Ja}





HE2RNA: virtual spatialization of gene expression

Nature Comms 2020 HE2RNA model Predicts gene expression patterns from routine H&E images







ARTICLE

tps://doi.org/10.1038/s41467-020-17678-4 OPEN

A deep learning model to predict RNA-Seq expression of tumours from whole slide images

Benoît Schmauch ¹⁸⁹, Alberto Romagnoni^{1,4}, Elodie Pronie^{1,4}, Charlie Saillard¹, Pascale Maillé^{2,3}, Julien Calderaro^{2,3}, Aurélie Kamoun ¹, Meriem Sefta¹, Sylvain Toldo¹, Mikhail Zaslavskiy¹, Thomas Clozel ¹, Matahi Moarii¹, Pierre Courtiol^{1,5} & Gilles Wainrib^{1,583}



HE2CD20 (exemple)



(Check for updates

Virtual gene expression spatialisation

H&E stained WSI

From biomarkers to innovative targets in Pleural Mesothelioma

Building blocks of Target Discovery Engine

- → Interpretable AI
- → Spatial prediction of clinical endpoints
- → Spatial prediction and/or measurement of molecular and cellular features
- → Computational biology
- → Expert knowledge

Discovering genes that *spatially* correlate with clinical outcomes

MesoNET Survival predictions



Nature Medicine 2019

HE2RNA virtual staining (Gene XXX)



Nature Comms 2020

Goal: "What if we target gene A in patient X ?"

Harder than standard ML (causality vs association)

How?

- Interpretable predictive models + human expertise
- Experimental data capturing causality (RCT, perturbations)
- Causal discovery theory (invariance, stability, learning causal representation)
- Your idea?

Multiscale understanding to drive Owkin's Al engines





Interested?

- Mission-driven R&D
- Interdisciplinary team (math, CS, ML, biology, chemistry, medicine)
- Values
 - Curiosity
 - Creativity
 - Care
 - Collaborate

https://owkin.com/hiring