



3 & 4 octobre 2024

Centre Prouvé - 1 Pl. de la République,
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14^E CNRC

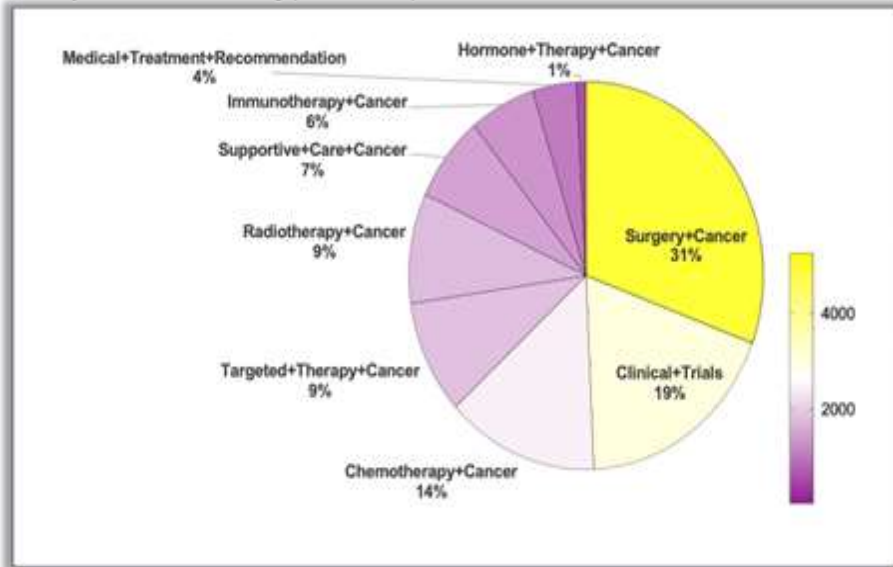
IA et aspects éthiques de cette médecine du futur

Dr Loic VERLINGUE, Lyon

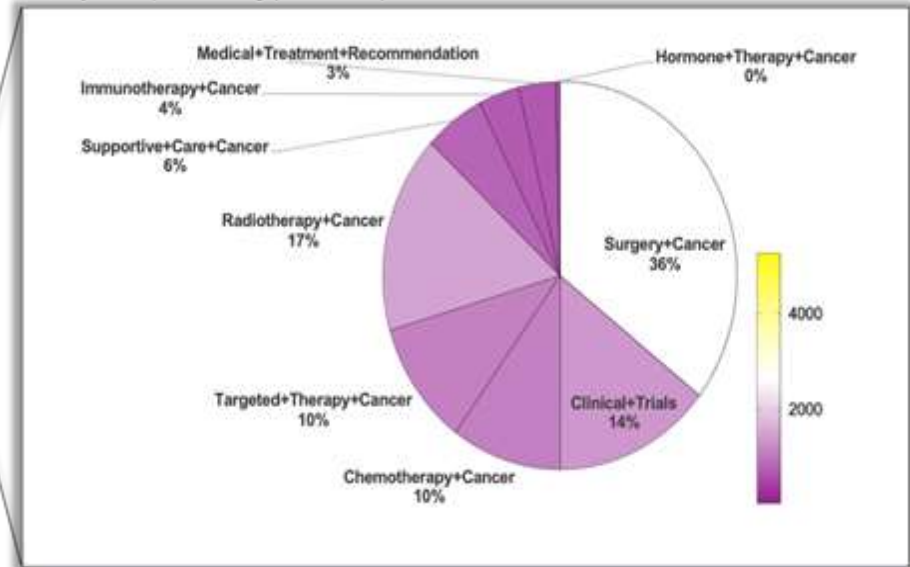


The size of the field

Query: + Machine + Learning (Total=17132)



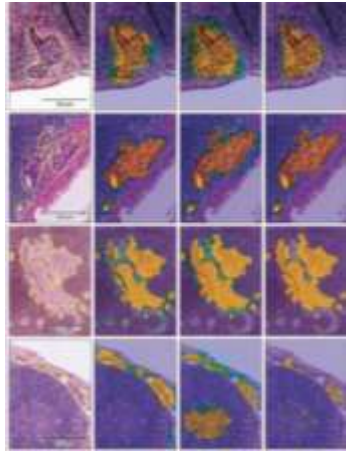
Query: + Deep + Learning (Total=7392)



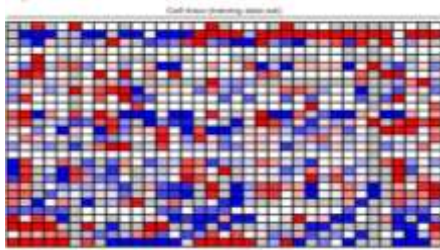
As per 2023

- 17K papers on Large Language Models were published in Arxiv;
- 263 new LLMs released !

Machine/Deep Learning application in oncology



Diagnostics



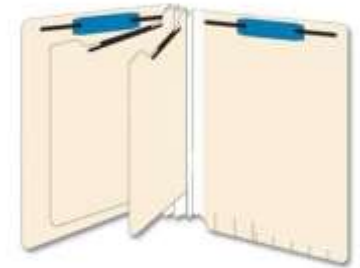
Molecular biology
& prognosis



"Here's my sequence"

The New Yorker

Drug development
& prediction



Free text &
Monitoring patients

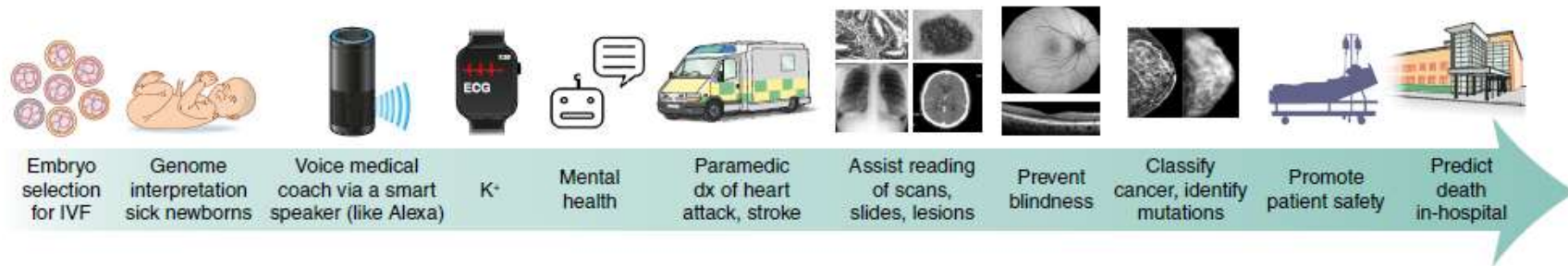
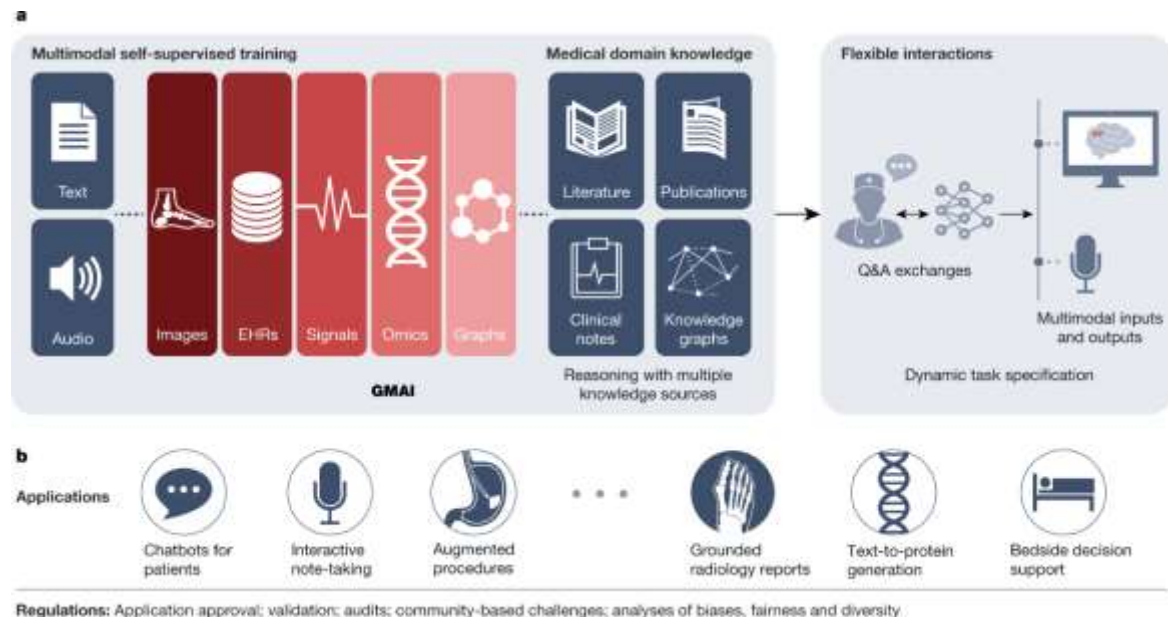


Fig. 2 | Examples of AI applications across the human lifespan. dx, diagnosis; IVF, in vitro fertilization K⁺, potassium blood level. Credit: Debbie Maizels/ Springer Nature



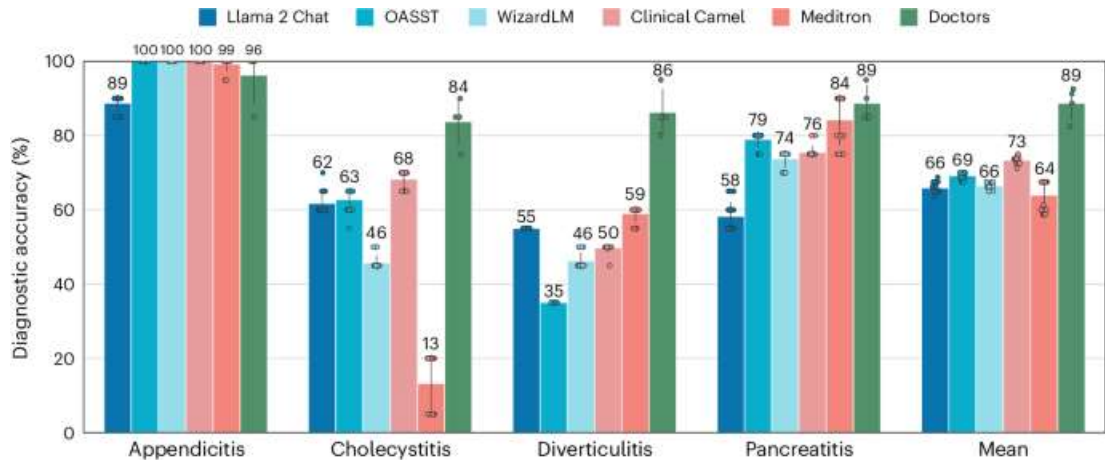
In Eric
Topol's
head



LLMs & Multi-agents for diagnosis and treatments

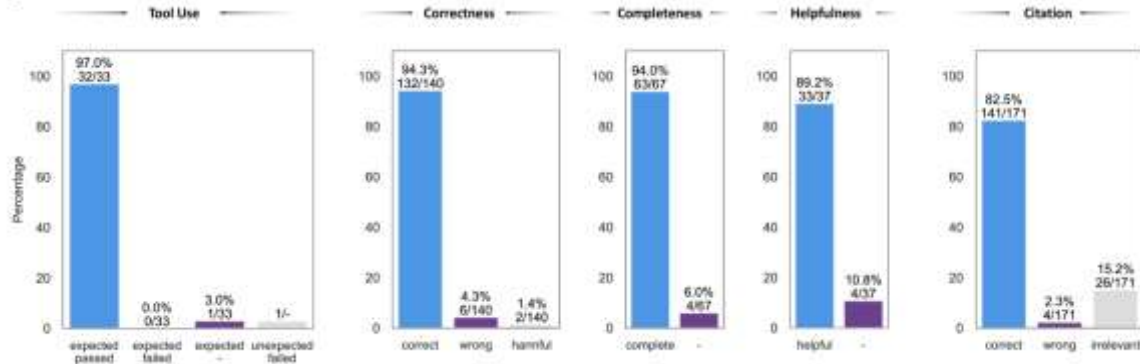
2400 patients with abdominal emergencies (appendicitis, cholecystitis, diverticulitis or pancreatitis), highlighted significant concerns due to critical errors of the LLMs (Mistral, Llama2)

<https://www.nature.com/articles/s41591-024-03097-1>

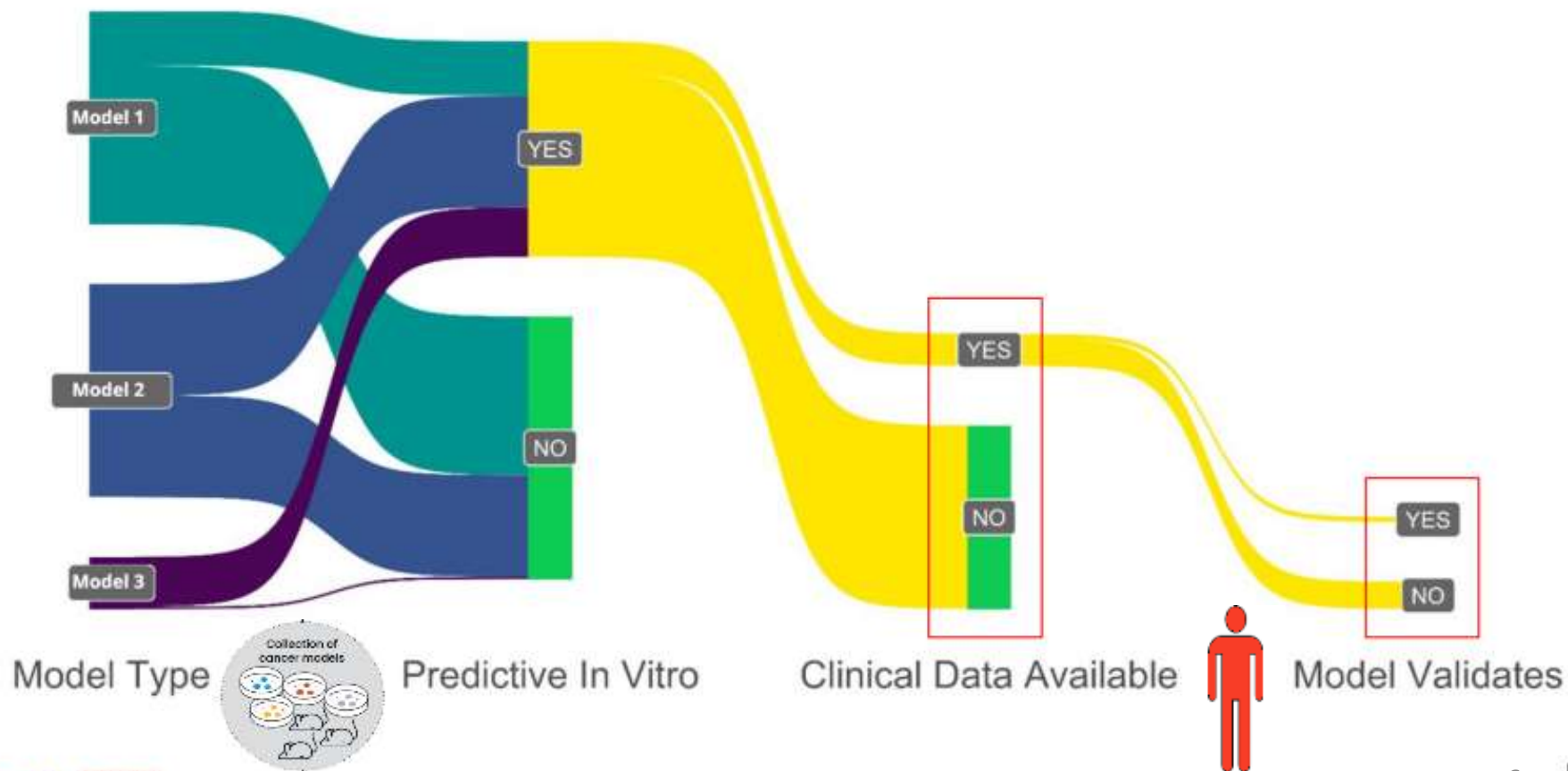


11 cases of patients with gastrointestinal cancers and reported optimistic results (GPT4)

<https://arxiv.org/abs/2404.04667>



Limited clinical genomic data is a major bottleneck



Medical data is scattered



AI has a troubled history going from R&D to clinics

- Low adoption due to lack of usefulness¹
- Logistical hurdles that slow deployment²
- Requiring clinicians to do more work, not less³
- Do not improve accuracy^{4,5}

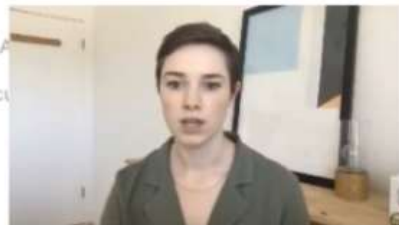
1 Elwyn, G., Scholl, I., Tietbohl, C., Mann, M., Edwards, A. G., Clay, C., ... & Frosch, D. L. (2013). "Many miles to go...": a systematic review of the implementation of patient decision support interventions into routine clinical practice. BMC medical informatics and decision making, 13(S2), S14.

2 Musen, M. A., Middleton, B., & Greenes, R. A. (2014). Clinical decision-support systems. In Biomedical informatics (pp. 643-674). Springer, London.

3 Giger, M. L., Chan, H. P., & Boone, J. (2008). Anniversary paper: history and status of CAD and quantitative image analysis: the role of medical physics and AI. Medical physics, 35(1), 1-10.

4 Kohli, A., & Jha, S. (2018). Why CAD failed in mammography. Journal of the American College of Radiology, 15(3), 535-537.

5 Cole, E. B., Zhang, Z., Marques, H. S., Edward Hendrick, R., Yaffe, M. J., & Pisano, E. D. (2014). Impact of computer-aided detection systems on radiologist accuracy. American Journal of Roentgenology, 203(4), 909-916.



Google

A Human-Centered Evaluation of a Deep Learning System Deployed in Clinics for the Detection of Diabetic Retinopathy Proceeding, Beede et al, 2020

Artificial intelligence in oncology: ensuring safe and effective integration of language models in clinical practice

Loïc Verlingue,^{a,b,*} Clara Boyer,^a Louise Olgiate,^a Clément Brutti Mairesse,^a Daphné Morel,^{b,c} and Jean-Yves Blay^a

npj | digital medicine

Published in partnership with Seoul National University Bundang Hospital

Comment



<https://doi.org/10.1038/s41746-024-01063-y>

Evaluating large language models as agents in the clinic

Nikita Mehandru, Brenda Y. Miao, Eduardo Rodriguez Almaraz, Madhumita Sushil, Atul J. Butte & Ahmed Alaa

Check for updates

The Lancet Regional Health - Europe
2024;46: 101064

Published Online 6
September 2024
<https://doi.org/10.1016/j.lanepe.2024.101064>

Evaluation!

nature medicine



Article

<https://doi.org/10.1038/s41591-024-03057-1>

Evaluation and mitigation of the limitations of large language models in clinical decision-making

Received: 26 January 2024

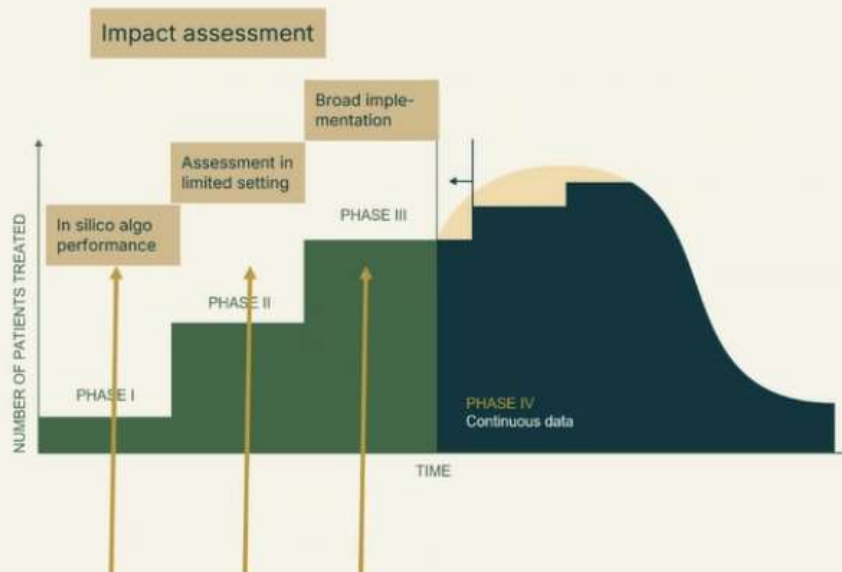
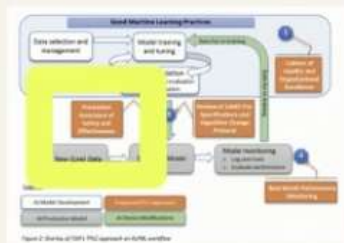
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Heger^{1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106,107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122,123,124,125,126,127,128,129,130,131,132,133,134,135,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,167,168,169,170,171,172,173,174,175,176,177,178,179,180,181,182,183,184,185,186,187,188,189,190,191,192,193,194,195,196,197,198,199,200,201,202,203,204,205,206,207,208,209,210,211,212,213,214,215,216,217,218,219,220,221,222,223,224,225,226,227,228,229,230,231,232,233,234,235,236,237,238,239,240,241,242,243,244,245,246,247,248,249,250,251,252,253,254,255,256,257,258,259,260,261,262,263,264,265,266,267,268,269,270,271,272,273,274,275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,296,297,298,299,300,301,302,303,304,305,306,307,308,309,310,311,312,313,314,315,316,317,318,319,320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,358,359,360,361,362,363,364,365,366,367,368,369,370,371,372,373,374,375,376,377,378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,398,399,400,401,402,403,404,405,406,407,408,409,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,498,499,500,501,502,503,504,505,506,507,508,509,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525,526,527,528,529,530,531,532,533,534,535,536,537,538,539,540,541,542,543,544,545,546,547,548,549,550,551,552,553,554,555,556,557,558,559,560,561,562,563,564,565,566,567,568,569,570,571,572,573,574,575,576,577,578,579,580,581,582,583,584,585,586,587,588,589,590,591,592,593,594,595,596,597,598,599,600,601,602,603,604,605,606,607,608,609,610,611,612,613,614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672,673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715,716,717,718,719,720,721,722,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754,755,756,757,758,759,760,761,762,763,764,765,766,767,768,769,770,771,772,773,774,775,776,777,778,779,780,781,782,783,784,785,786,787,788,789,790,791,792,793,794,795,796,797,798,799,800,801,802,803,804,805,806,807,808,809,810,811,812,813,814,815,816,817,818,819,820,821,822,823,824,825,826,827,828,829,830,831,832,833,834,835,836,837,838,839,840,841,842,843,844,845,846,847,848,849,850,851,852,853,854,855,856,857,858,859,860,861,862,863,864,865,866,867,868,869,870,871,872,873,874,875,876,877,878,879,880,881,882,883,884,885,886,887,888,889,890,891,892,893,894,895,896,897,898,899,900,901,902,903,904,905,906,907,908,909,910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,927,928,929,930,931,932,933,934,935,936,937,938,939,940,941,942,943,944,945,946,947,948,949,950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000,1001,1002,1003,1004,1005,1006,1007,1008,1009,1010,1011,1012,1013,1014,1015,1016,1017,1018,1019,1020,1021,1022,1023,1024,1025,1026,1027,1028,1029,1030,1031,1032,1033,1034,1035,1036,1037,1038,1039,1040,1041,1042,1043,1044,1045,1046,1047,1048,1049,1050,1051,1052,1053,1054,1055,1056,1057,1058,1059,1060,1061,1062,1063,1064,1065,1066,1067,1068,1069,1070,1071,1072,1073,1074,1075,1076,1077,1078,1079,1080,1081,1082,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1109,1110,1111,1112,1113,1114,1115,1116,1117,1118,1119,1120,1121,1122,1123,1124,1125,1126,1127,1128,1129,1130,1131,1132,1133,1134,1135,1136,1137,1138,1139,1140,1141,1142,1143,1144,1145,1146,1147,1148,1149,1150,1151,1152,1153,1154,1155,1156,1157,1158,1159,1160,1161,1162,1163,1164,1165,1166,1167,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,1196,1197,1198,1199,1200,1201,1202,1203,1204,1205,1206,1207,1208,1209,1210,1211,1212,1213,1214,1215,1216,1217,1218,1219,1220,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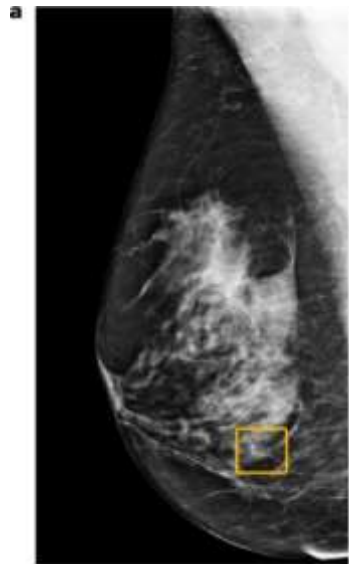
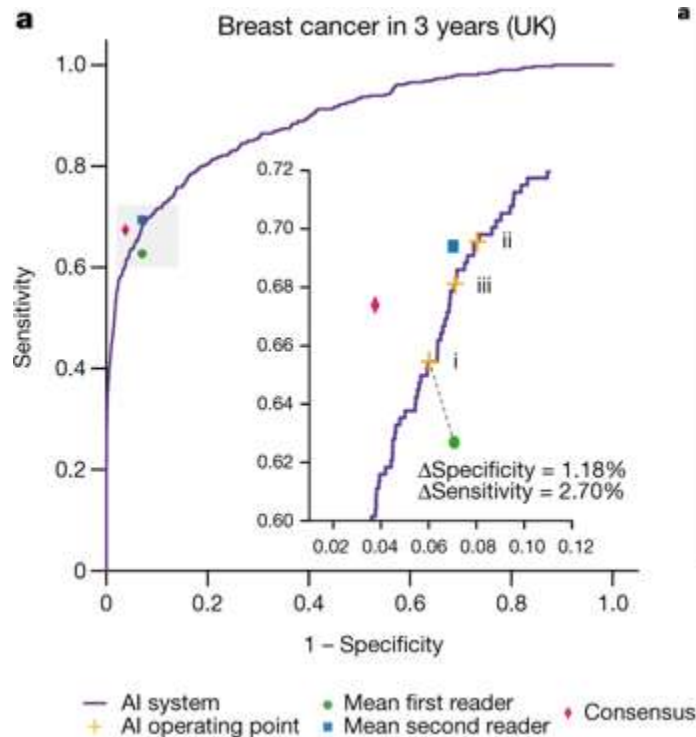
Continuous monitoring of algorithms across time



Amy Abernethy

Implementing artificial intelligence
in oncology at scale

Breast cancer screening



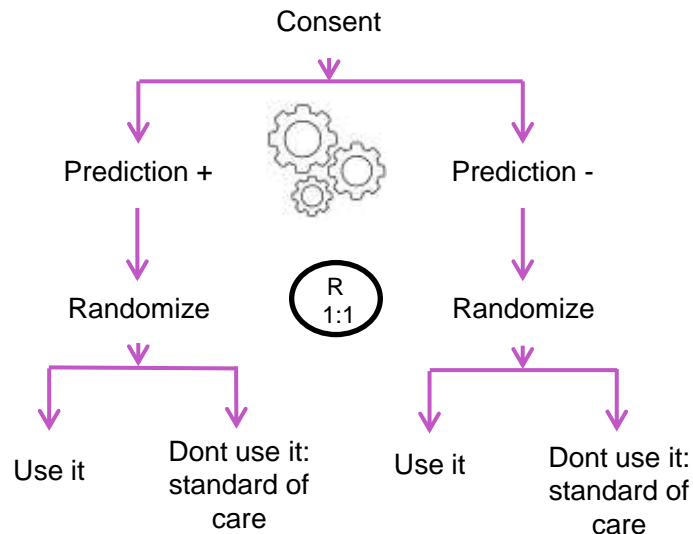
Prospective 3,746 women

Compared to double reading,
implementing the AI-assisted
additional-reader process could
achieve 0.7–1.6 additional cancer
detection per 1,000 cases

How to evaluate?

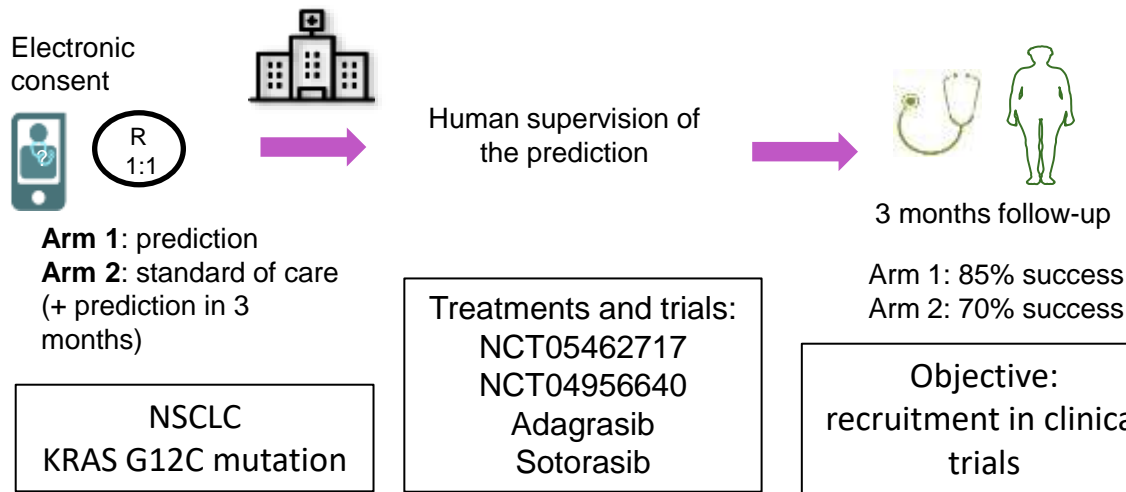
Scenario #1: inter-patients comparison

- Patient monitoring (e.g symptoms)
- Treatment recommendation systems
- Treatment effect prediction
- Prognosis estimation for an intervention



Scenario #2: intra-patient comparison

- Clinical trial matching systems
- Treatment recommendation systems
- Multidisciplinary tumor board recommendations



Evaluate the impact on Patient – physician relationship

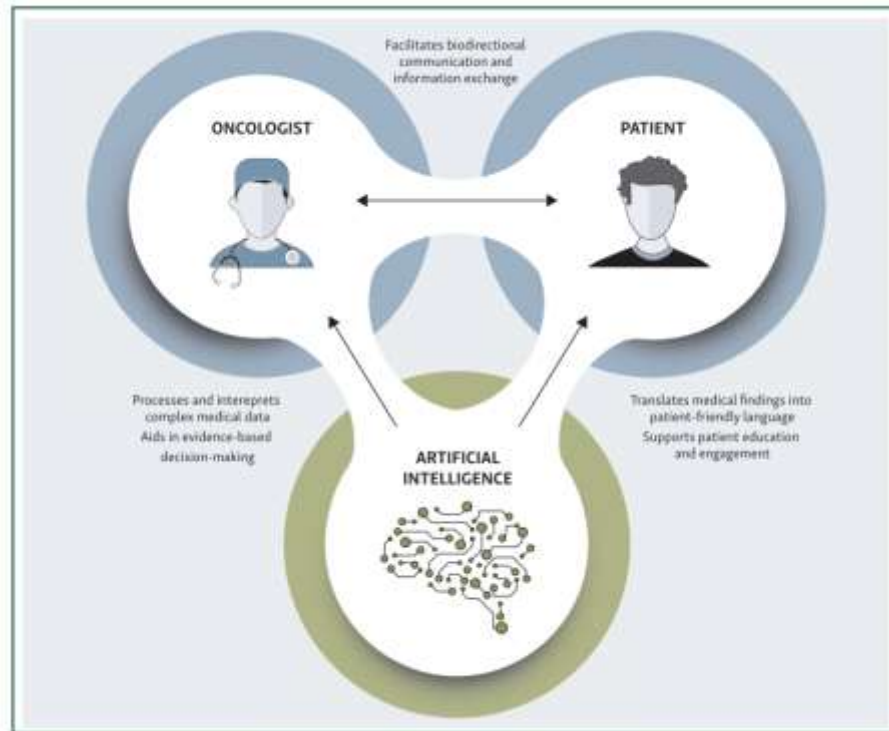


Figure 1. Triadic communication model in oncology with artificial intelligence (AI) mediation.

SaMD & IA act = haut risque

- Principes de Maitrise de l'IA
- Principes concernant la gouvernance des données (**Article 10**)
- Maintenir le **contrôle humain** (Article 14)
- **Transparence** + intégration AI act de la documentation technique

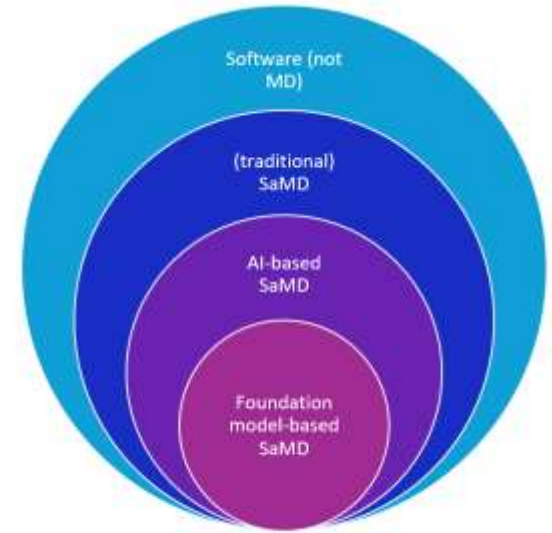


Figure 1. Software and Medical devices

Credit @Francesca Gennari



Communication and training



Acerca de la medicina de Precisión
#episode53

32 vues • il y a 6 jours



Precisionsmedicin inom cancer -
precisionsdiagnostik, målinriktad...

187 vues • il y a 7 jours



Tutoriel d'utilisation des outils de
recherche d'essais cliniques...

13 vues • il y a 1 mois



L'accès transfrontalier France -
Belgique #episode51

36 vues • il y a 1 mois



La médecine de précision en france,
le point de vue sociologique...

32 vues • il y a 6 jours



#episode49 - Las inteligencias
artificiales para las mutaciones en...

187 vues • il y a 7 jours



Chordoma Network & Access to
clinical trials in other countries...

13 vues • il y a 1 mois



Data pooling & Implementation of
DLCT in Norway #episode47

36 vues • il y a 1 mois



Lucas Coelho,
Manon Antouly

<https://www.youtube.com/@PCM4EU>

Data / IA santé





... Access to clinical
trials in
oncology

12th of November 2024

Annecy - France



HUG Hôpitaux
Universitaires
Genève

CENTRE
DE LUTTE
CONTRE LE CANCER
**LEON
BERARD**



Interreg



Cofinancé par
l'Union Européenne

France - Suisse



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



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COEXYA
Connect skills, create more

Qim
info

2025 **ESMO AI & DIGITAL
ONCOLOGY**

Annual Congress

BERLIN GERMANY
12-14 NOVEMBER 2025



10 ET 11 FÉVRIER 2025

SOMMET POUR L'ACTION SUR L'IA.



**SOMMET
POUR L'ACTION
SUR L'IA**



**AI ACTION
SUMMIT**

CLB Phase 1 team



CRCL Saintigny team



Data Science team



Thank you

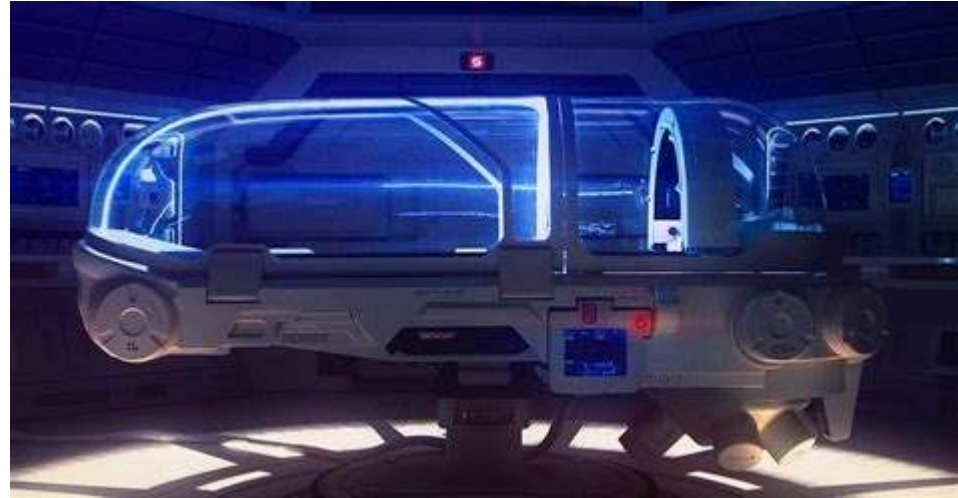
Molecular tumor board



loic.verlingue@lyon.unicancer.fr

Info <https://github.com/DITEP>

Pour / contre ?



Energy

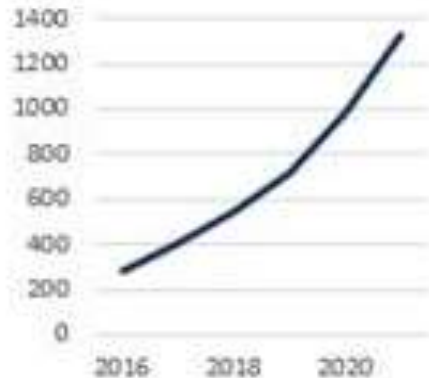
Consumption	CO ₂ e (lbs)
Air travel, 1 passenger, NY↔SF	1984
Human life, avg, 1 year	11,023
American life, avg, 1 year	36,156
Car, avg incl. fuel, 1 lifetime	126,000

Training one model (GPU)	
NLP pipeline (parsing, SRL)	39
w/ tuning & experimentation	78,468
Transformer (big)	192
w/ neural architecture search	626,155



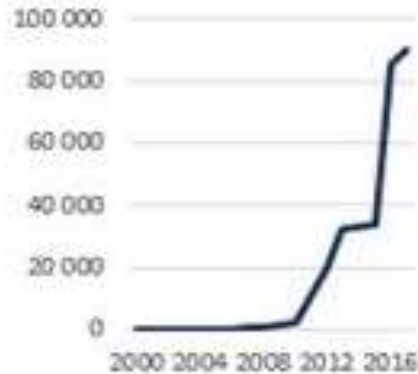
Power & money & Energy

Données stockées (Exaoctets)



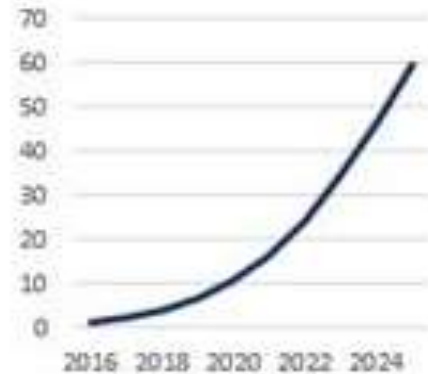
Source : Cisco

Puissance de superordinateur (FLOPS)



Source : Base de données du Top 500 des superordinateurs

Chiffre d'affaires du marché de l'IA (en milliards de dollars)



Source : Statista

Data sharing

- Data should be FAIR
- Data protection & Property
- Data quality
- Data sharing : is it realistic ?
- Power & money & Energy

Data sharing = data should be FAIR

- **F**indability
 - Identifiable, searchable resource
- **A**ccessibility
 - Communication protocol, persistent (meta)data
- **I**nteroperability
 - Application language
- **R**euse
 - accurate and relevant attributes

<https://www.go-fair.org/fair-principles/>

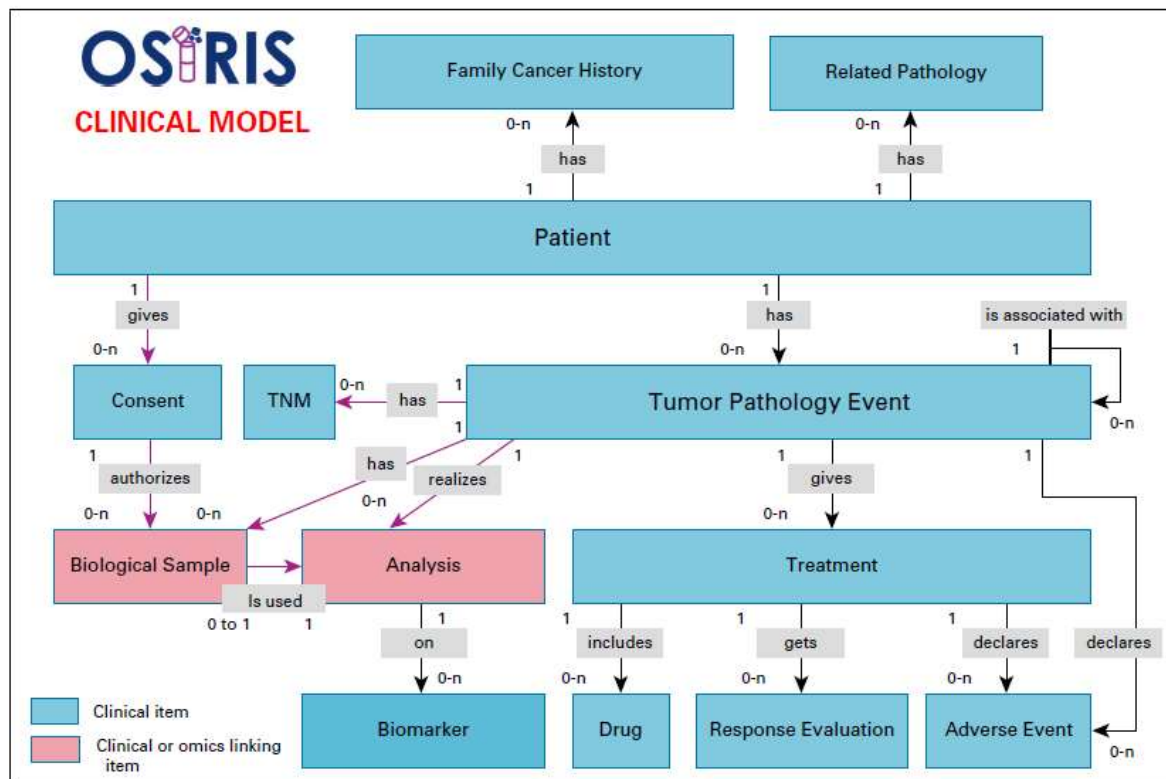


FIG 2. OSIRIS clinical data model. This figure shows the OSIRIS event-based clinical data model to follow the disease course longitudinally. For each event type (primary tumor and local and metastatic relapse), the response and adverse events of a treatment are associated. Moreover, any analysis carried out on a sample (imaging, omics, biology, pathologic examination) is also linked to a specific event.

Data protection & Property

- Identifiable data - GDPR (RGPD)
 - De-id
 - De-id et droit rétraction des patients (eg IQVIA)
- Who the data belong to ?
 - Property depending on the data : public or not, knowledge or patients...
 - Business: cost v benefit

Data sharing



La protection des données de santé



LE ROYAUME-UNI OUVRE L'ACCÈS COMPLET AUX DONNÉES DU NHS À AMAZON

✎ Bastien L. 🕒 9 décembre 2019 📁 RGPD, Sécurité 💬 Ecrire un commentaire

Un contrat dévoilé au grand jour révèle que le gouvernement britannique autorise Amazon à accéder librement et gratuitement à toutes les données de santé du National Health System du Royaume-Uni. Un véritable scandale aux yeux de nombreux citoyens.

En juillet 2019, le secrétaire à la santé britannique Matt Hancock annonçait un partenariat avec Amazon. L'objectif annoncé était de **permettre aux patients de recevoir de meilleurs conseils médicaux** par le biais de **l'assistant vocal Alexa**.

ÉCONOMIE

L'acc
cent

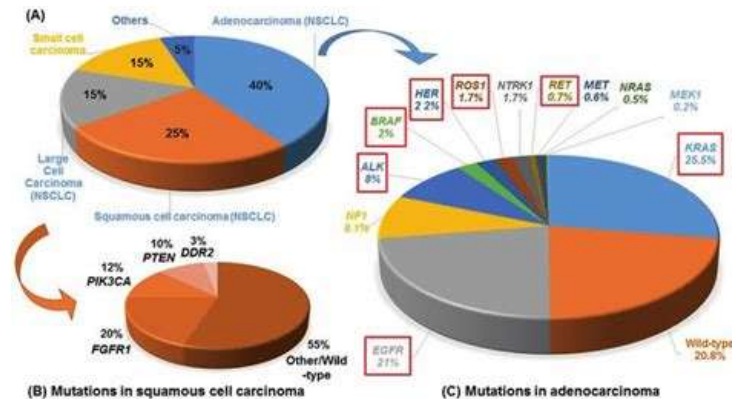
Le géar
Journa
conse

Par Ale

nts
avoir quels
s.

Data sharing: data quality

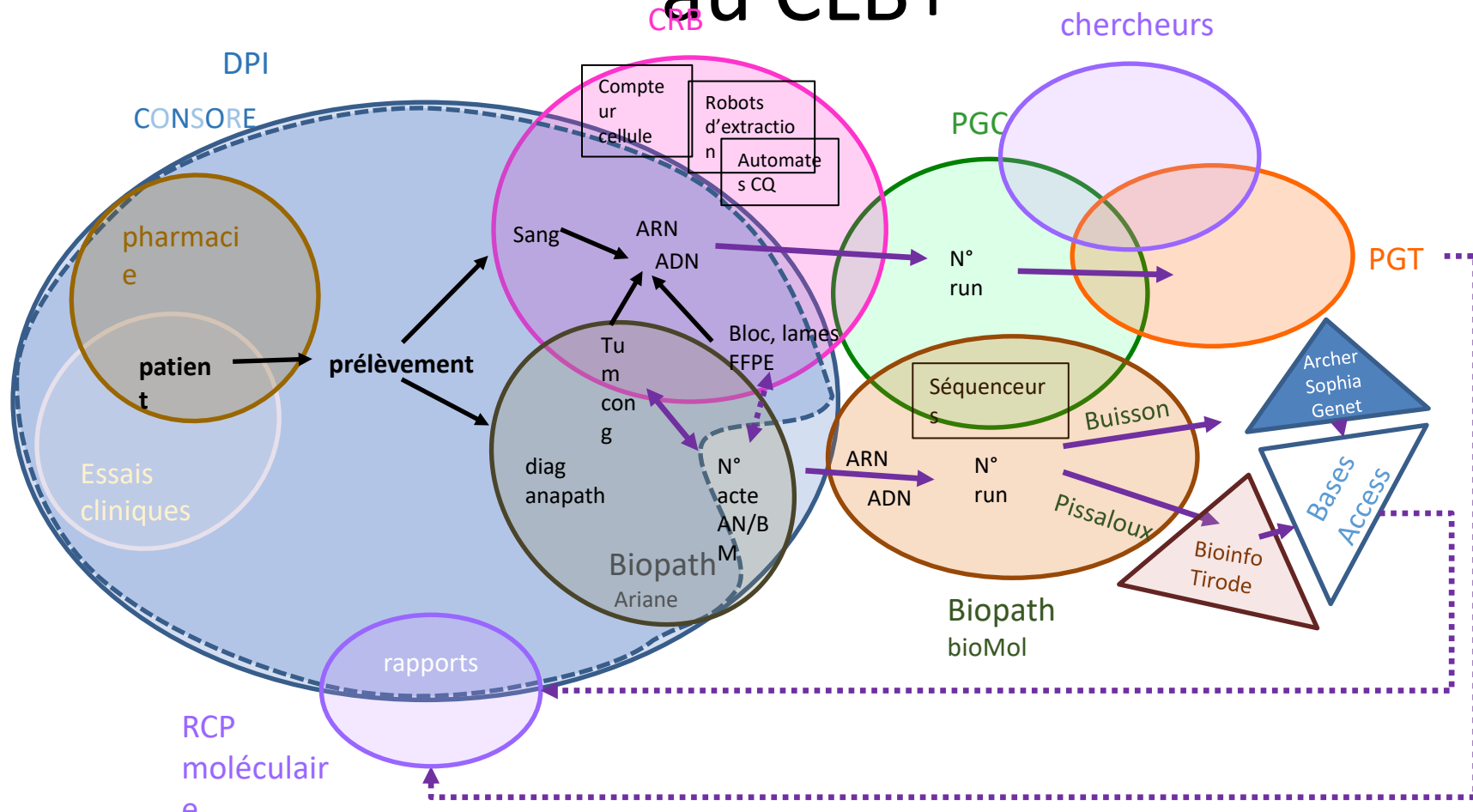
- Multiple data sources
- Interoperability
- Cancer: multiple diseases, few homogeneous cohorts



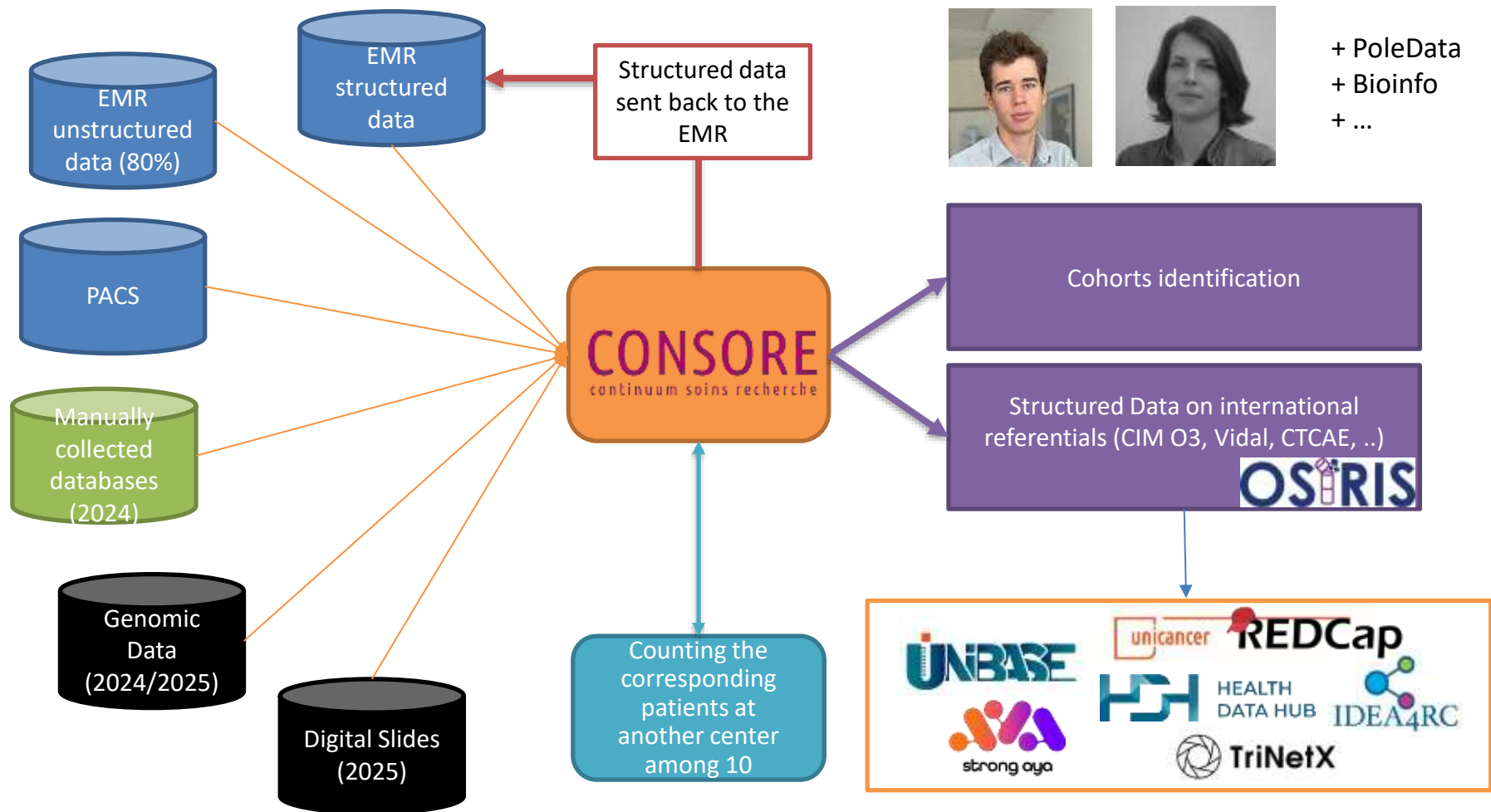
Data sharing : is it realistic ?

- Public data
 - Molecular: [The Cancer Genome Atlas Program](#), [ICGC](#), [UK Biobank - UK Biobank](#), [EGA](#))
 - clinical trial data : ([ClinicalStudyDataRequest.com](#), [European Medicines Agency](#));
 - health databases ([danishhealthdata](#), [mimics 3&4](#))
 - health-data-hub
- Medical information exchange
 - **Dossier médical partagé** <https://www.dmp.fr/>
 - **H2020** interopehrate.eu protocols for secure and cross border exchange of health data
- Consortium data
 - Difficult

Etat actuel du stockage de données au CLB+



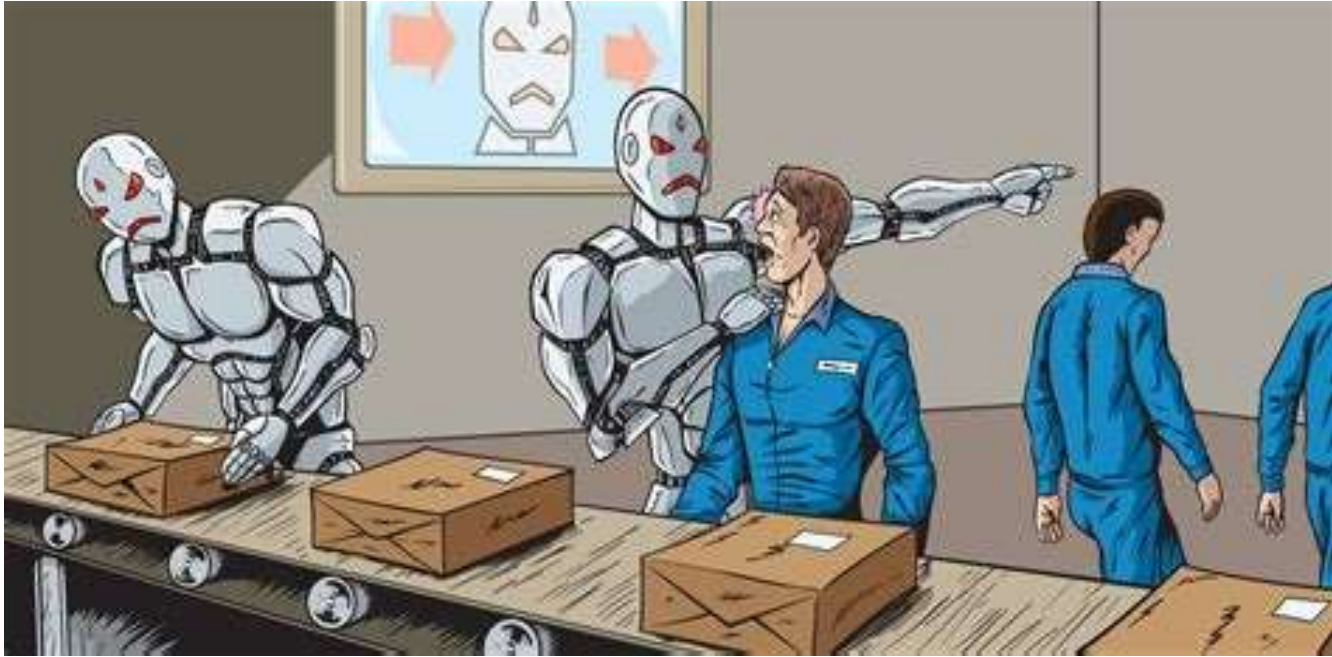
Urbanisation des données au CLB+



The dark side of LLMs and potential harm for healthcare applications

- **Environmental impact**
- **Alienating work**
- **Disproportionate fashion**
- **Gender discrimination**
- **Demographic origin and other stigmatisations**
- **Models' distractions**
- **Bias transmission to offspring models**
- **Humans under influence**
- **Challenge for reproducibility in AI**
- **Impossible evaluation**
- **Hustling the physician-patient relationship**

Will AI take my job ?



Checklist to increase the bright side of language models in healthcare

- **Data collection and cleaning**
- **Model training**
- **Selection of the outcome**
- **External validation**
- **Data sharing**
- **Federated learning**
- **Generalization performance and evaluation**
- **Deployment of the tools**
- **Calibration drifts**
- **Monitoring for dataset shifts**
- **Master regulatory requirements**
- **Ecological impact of your project**
- **Evaluate impact on patient-physician relationship**