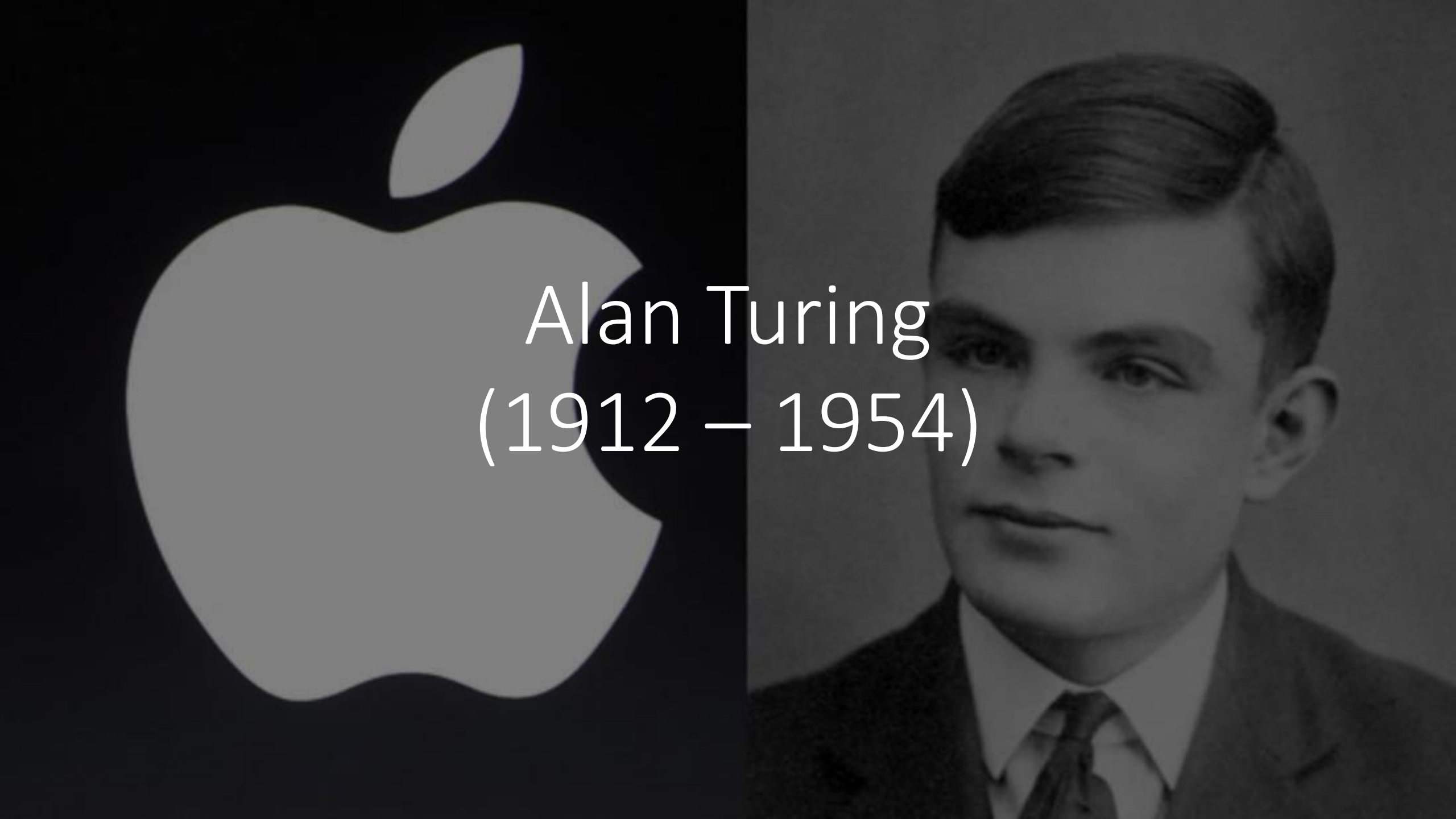
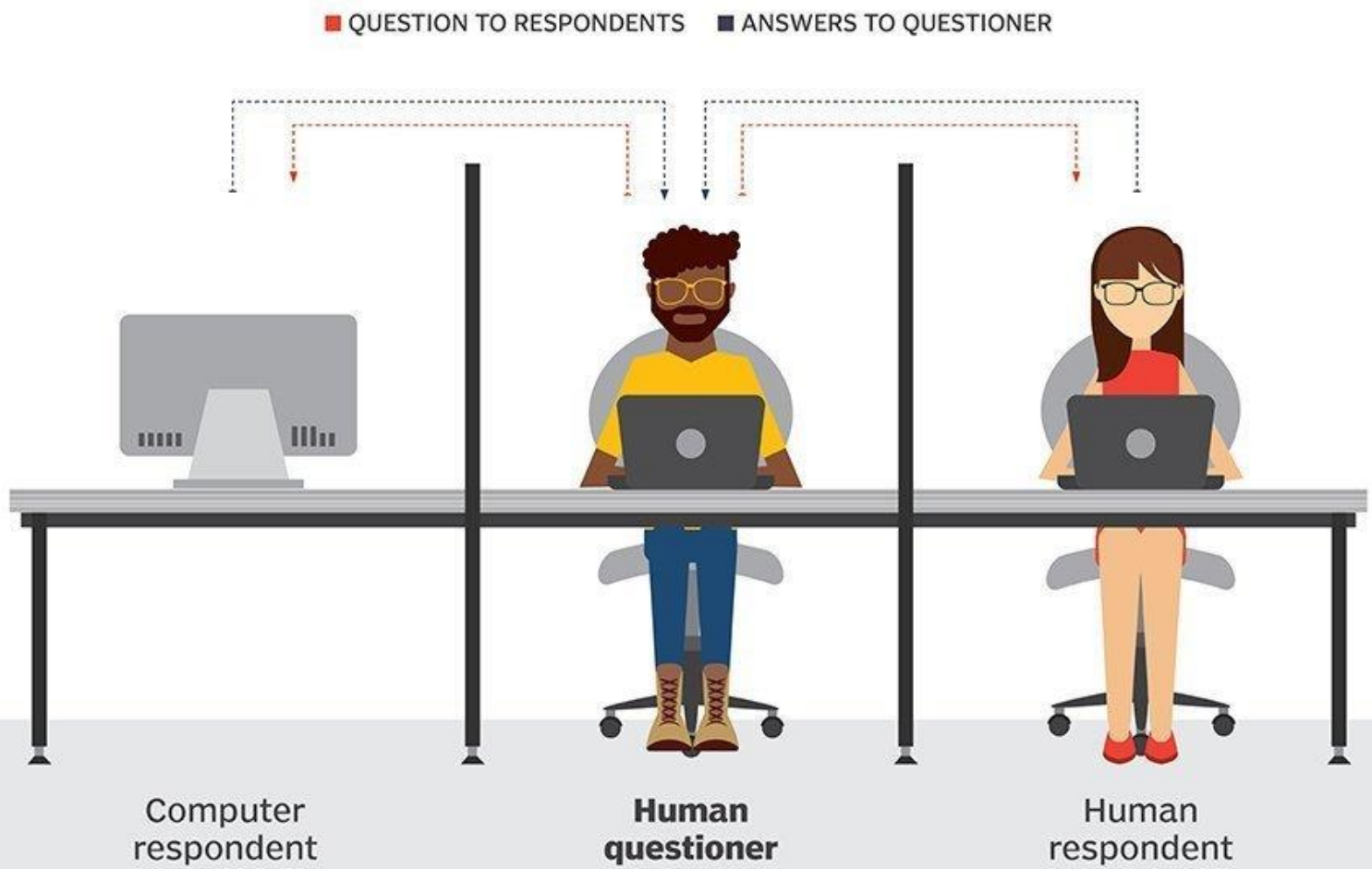
Intelligence Artificielle : Bonne fée ou mauvais génie ?

Anh Tuan DINH-XUAN – Hôpital Cochin, Université de Paris


Alan Turing
(1912 – 1954)

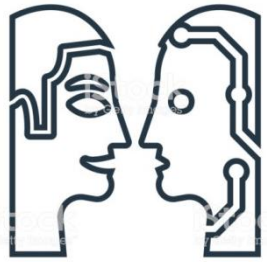
Turing test

During the Turing test, the human questioner asks a series of questions to both respondents. After the specified time, the questioner tries to decide which terminal is operated by the human respondent and which terminal is operated by the computer.



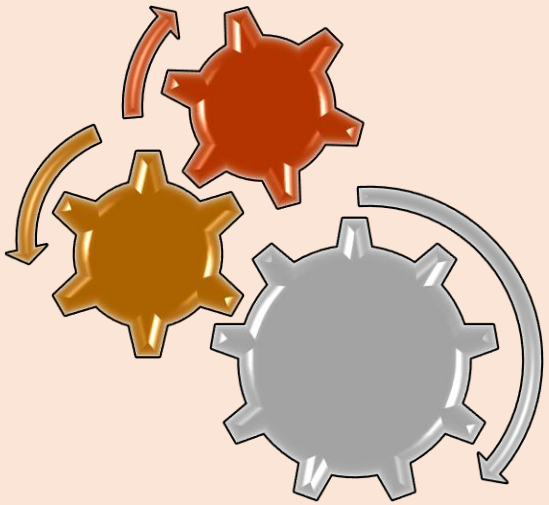
Arthur Lee Samuel
(1901 – 1990)

Intelligence artificielle



Test de Turing

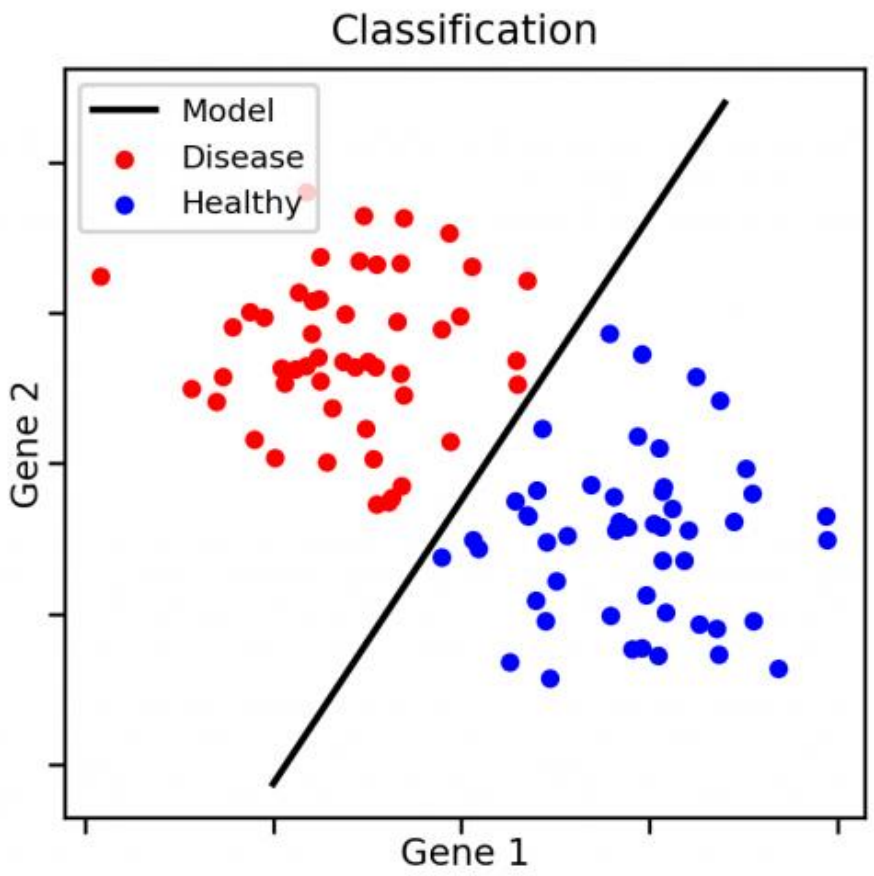
Apprentissage automatique/statistique (Machine Learning)

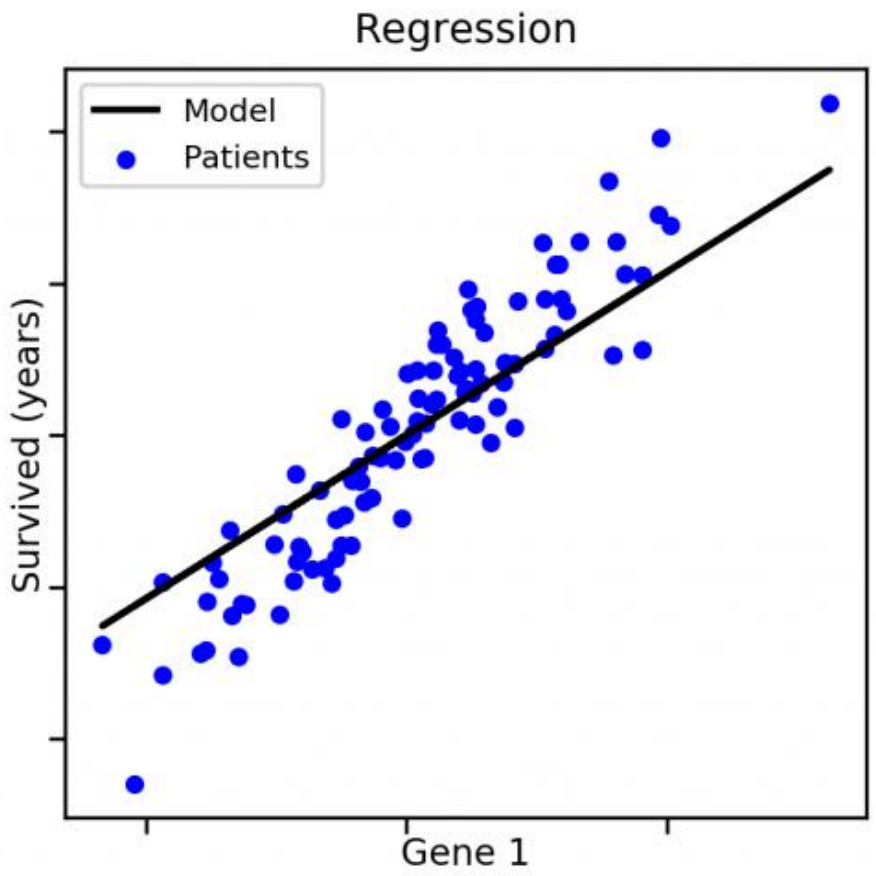


Apprentissage profond (Deep Learning)

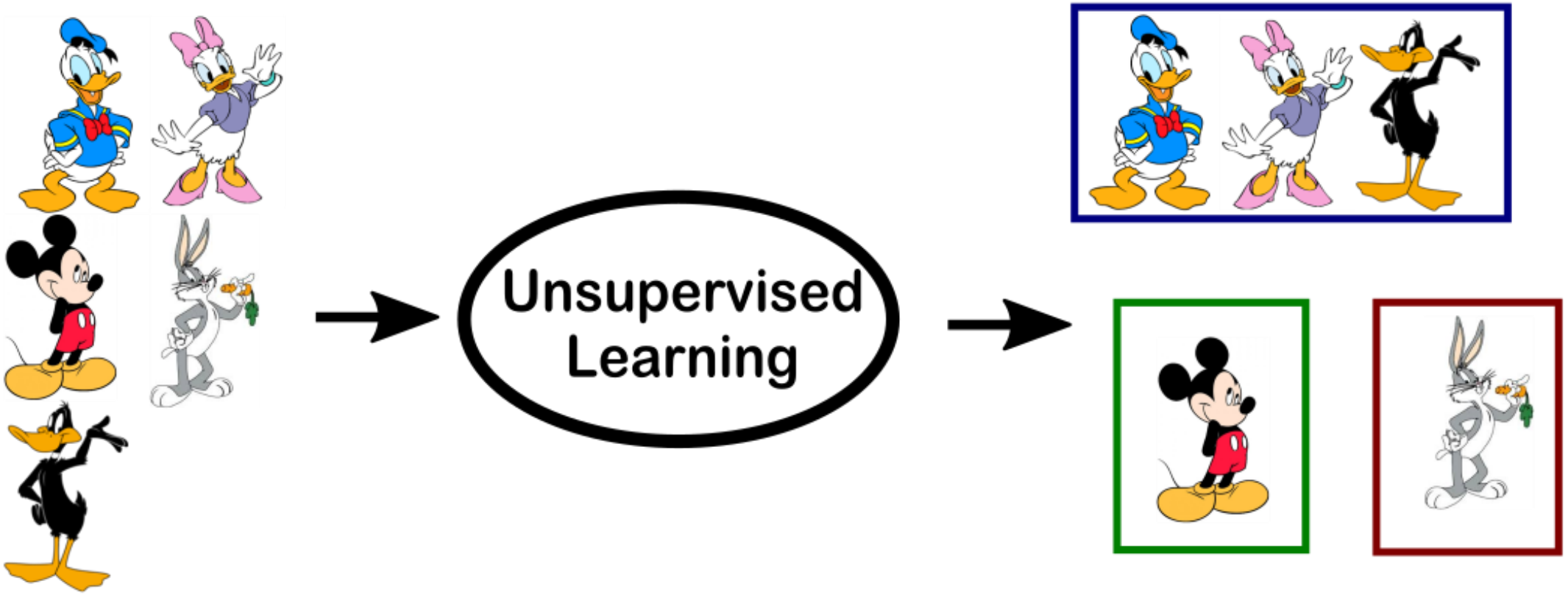
1950 1960 1970 1980 1990 2000 2010 2020

Machine learning (apprentissage supervisé)

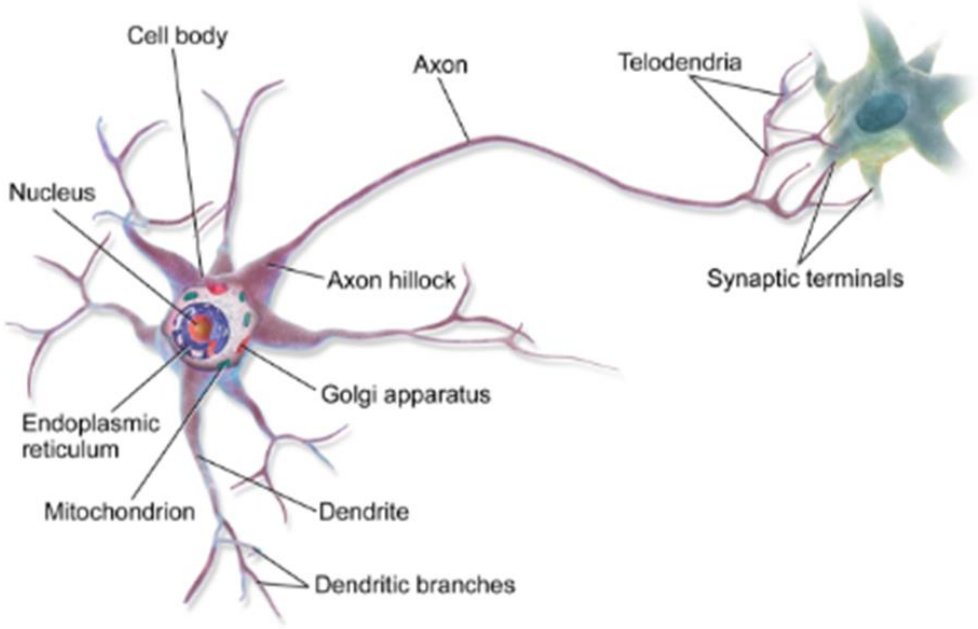




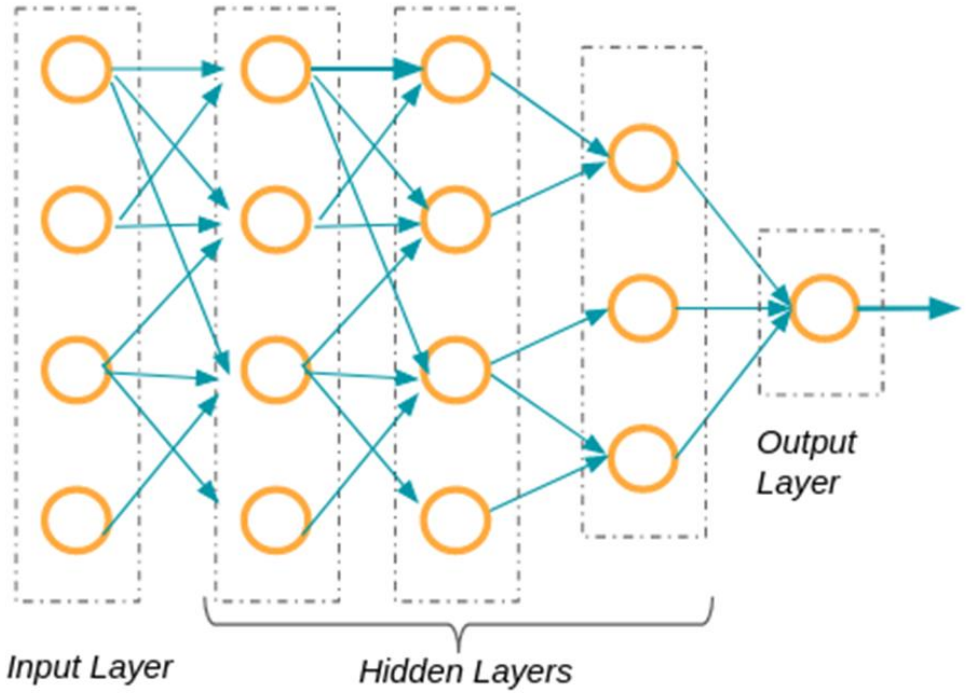
Machine Learning (Apprentissage non supervisé)



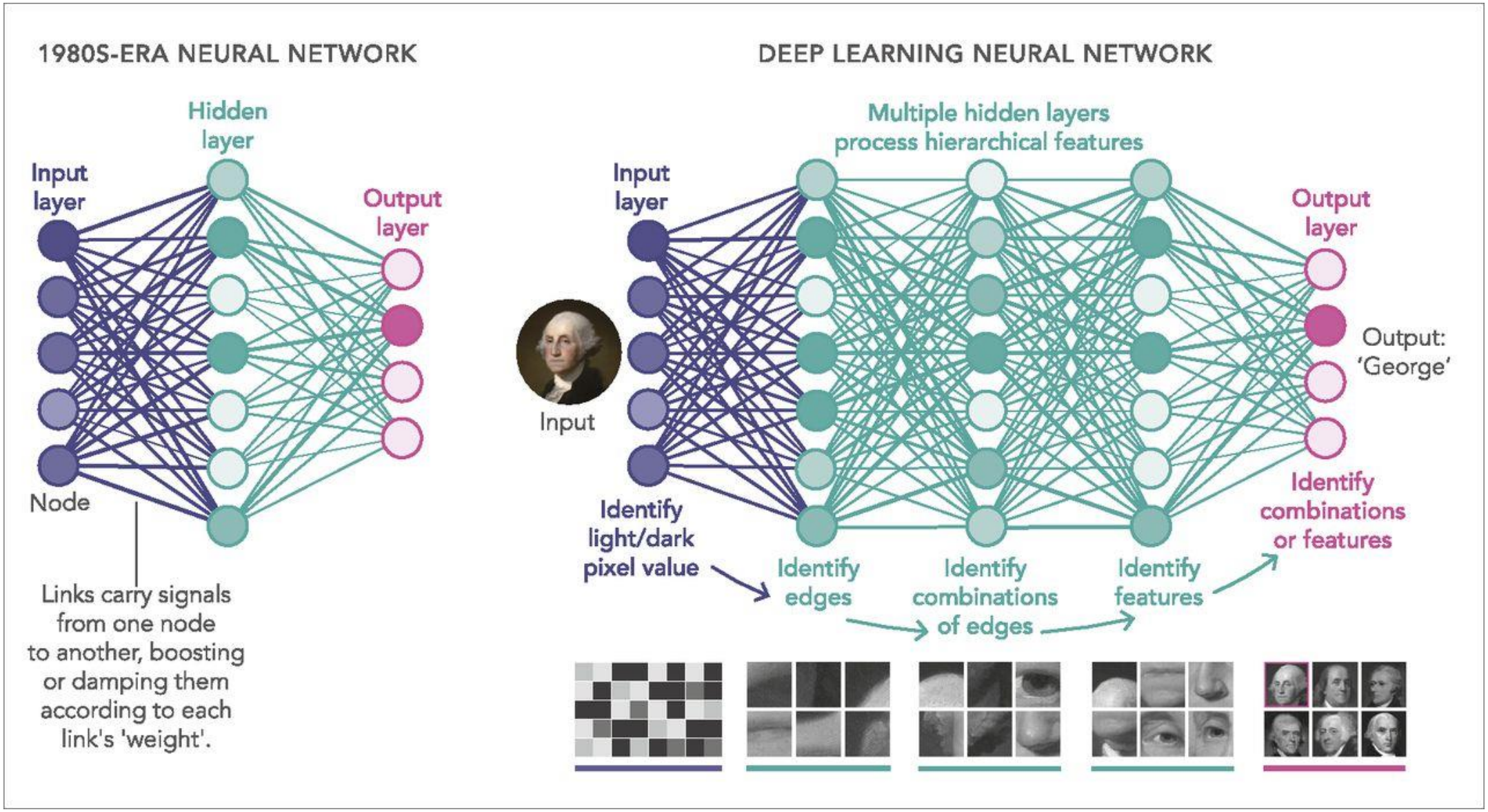
Deep Learning (Apprentissage profond)



A Multipolar Neuron

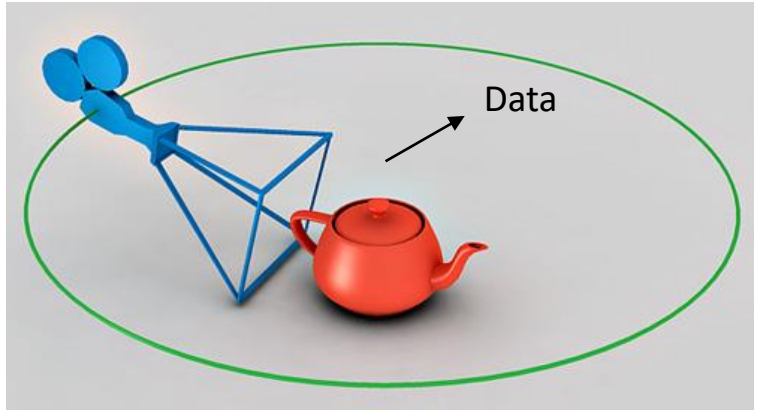


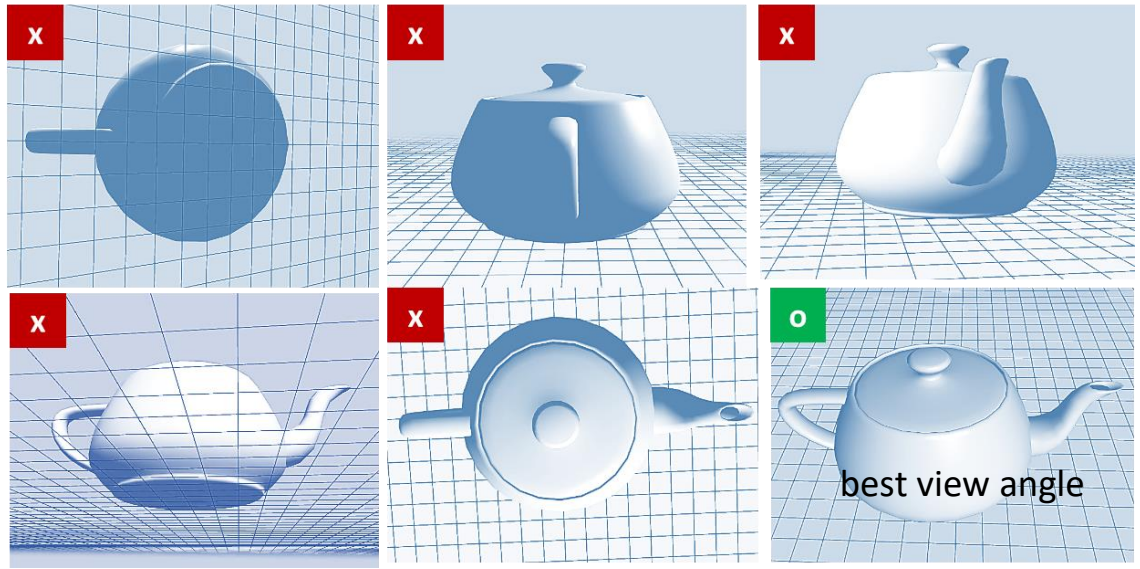
A Neural Network


1980S-ERA NEURAL NETWORK
Hidden layer
Input layer
Output layer
Node
Links carry signals from one node to another, boosting or damping them according to each link's 'weight'.
DEEP LEARNING NEURAL NETWORK
Multiple hidden layers process hierarchical features
Input layer
Output layer
Input
Output: 'George'
Identify light/dark pixel value
Identify edges
Identify combinations of edges
Identify features
Identify combinations or features

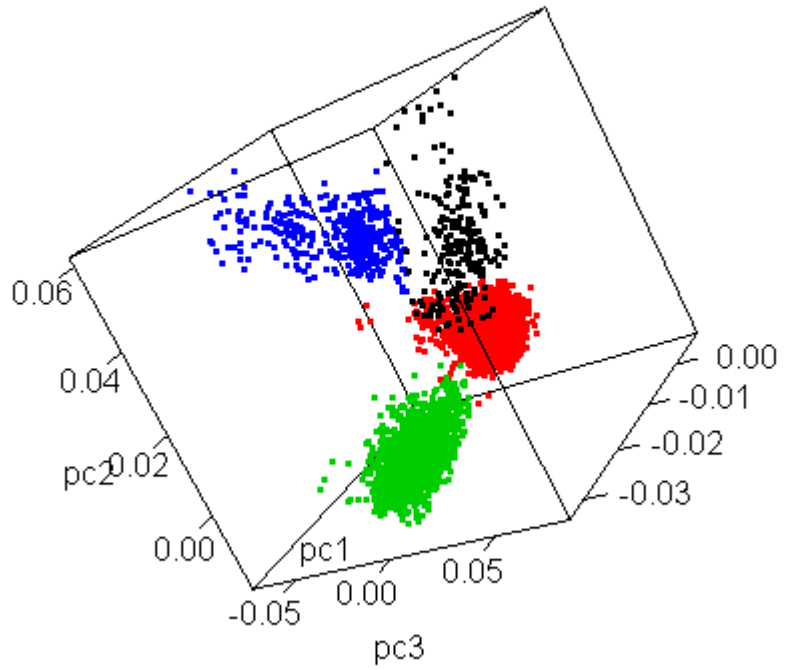
Principal component analysis (PCA) = **Analyse en composantes principales**

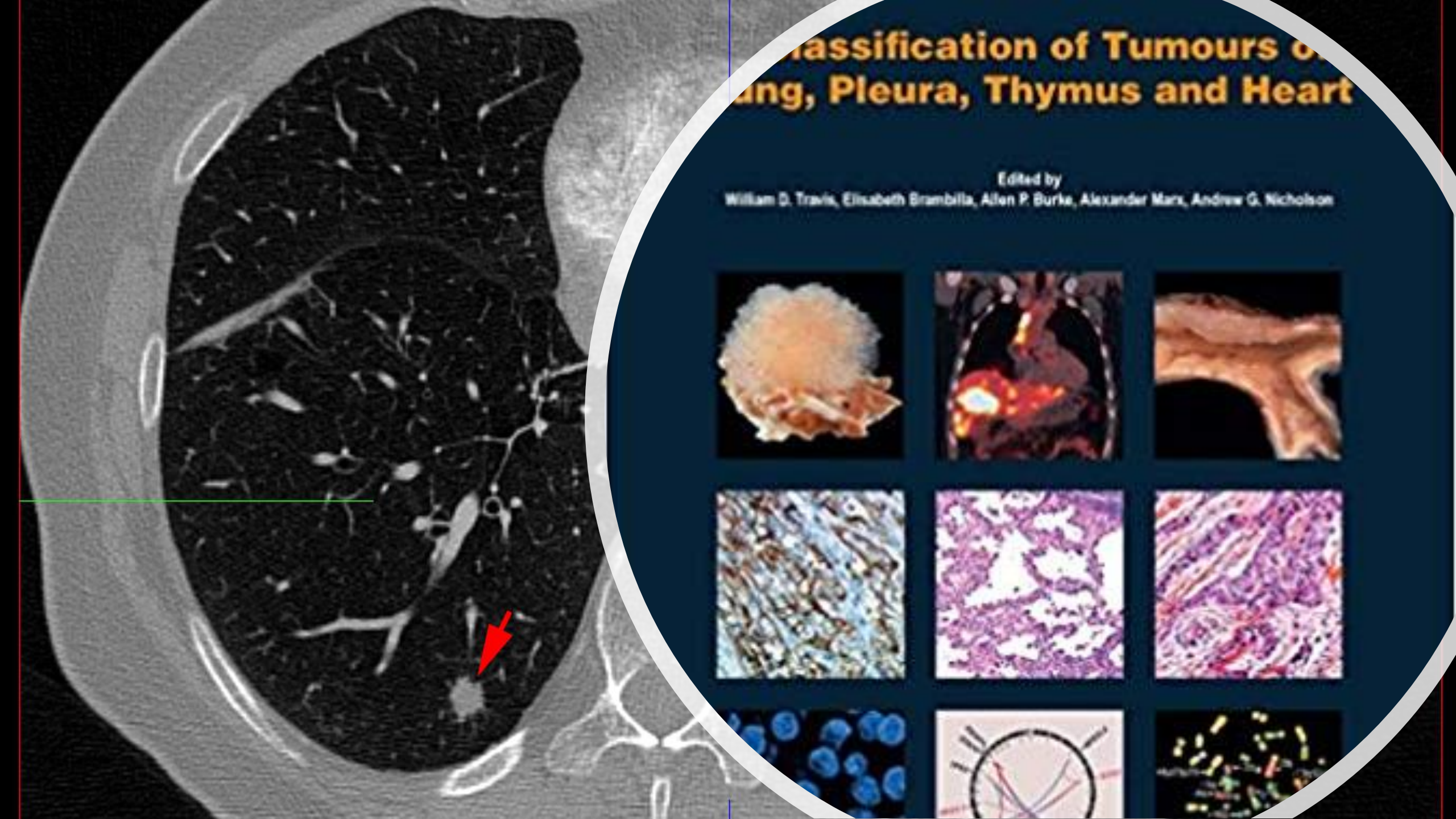
Finding the best view angle to describe the data → Dimensionality reduction for big data





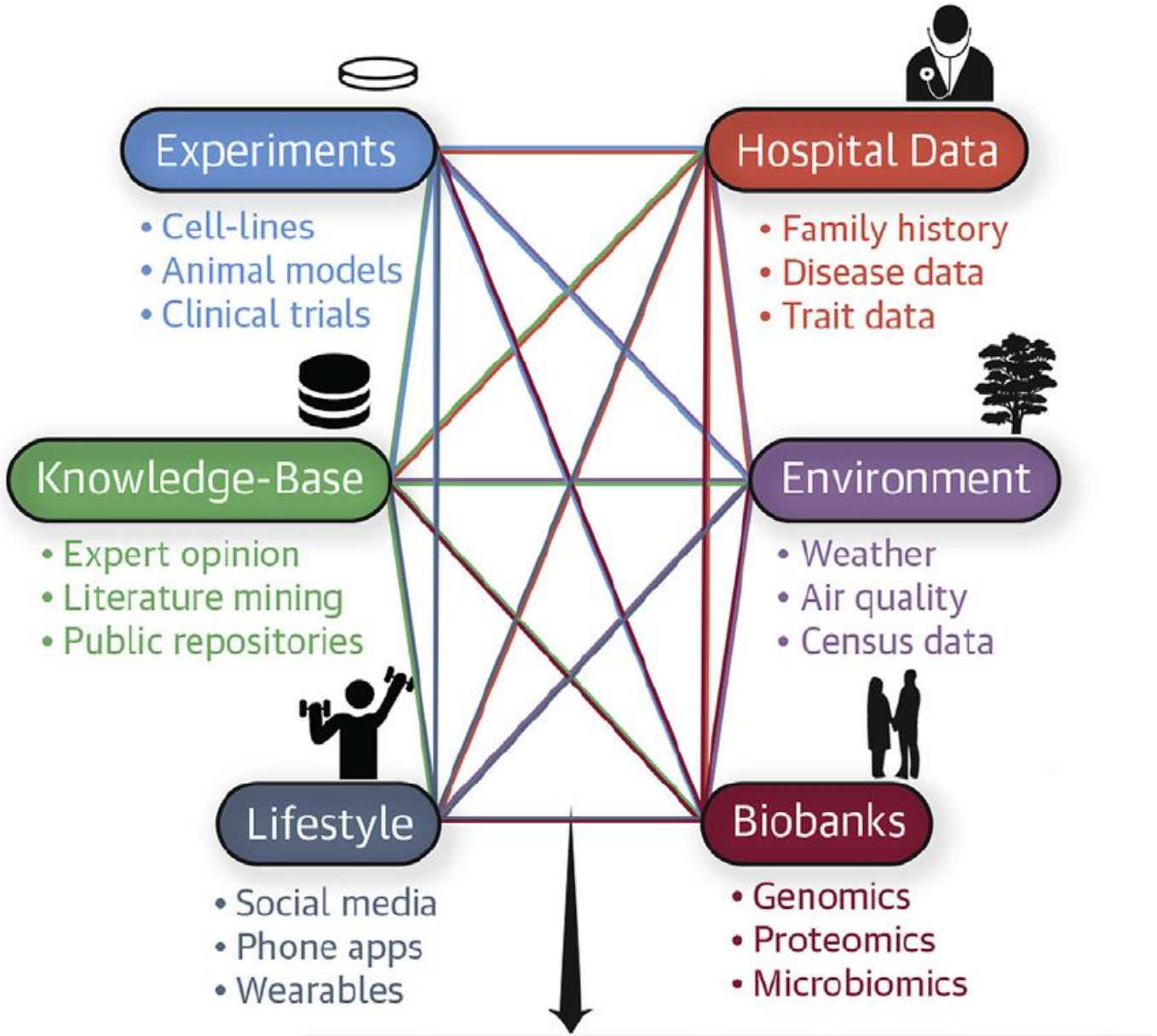
Clustering based on PCA




lassification of Tumours o
ung, Pleura, Thymus and Heart
Edited by
William D. Travis, Elisabeth Brambilla, Allen P. Burke, Alexander Marx, Andrew G. Nicholson

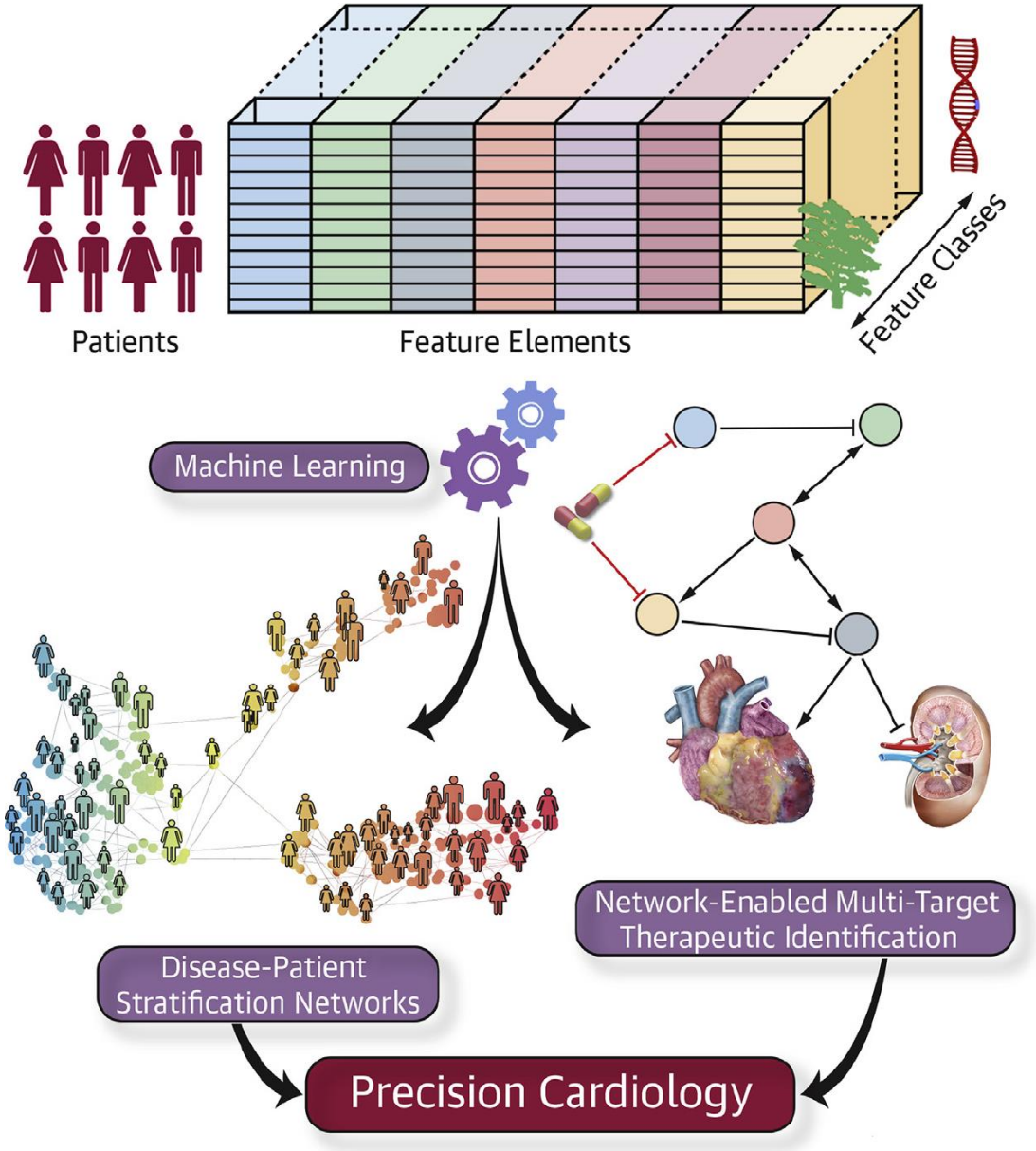
Volume **Vitesse** **Variété** **Véracité**

Données massives (Big Data)

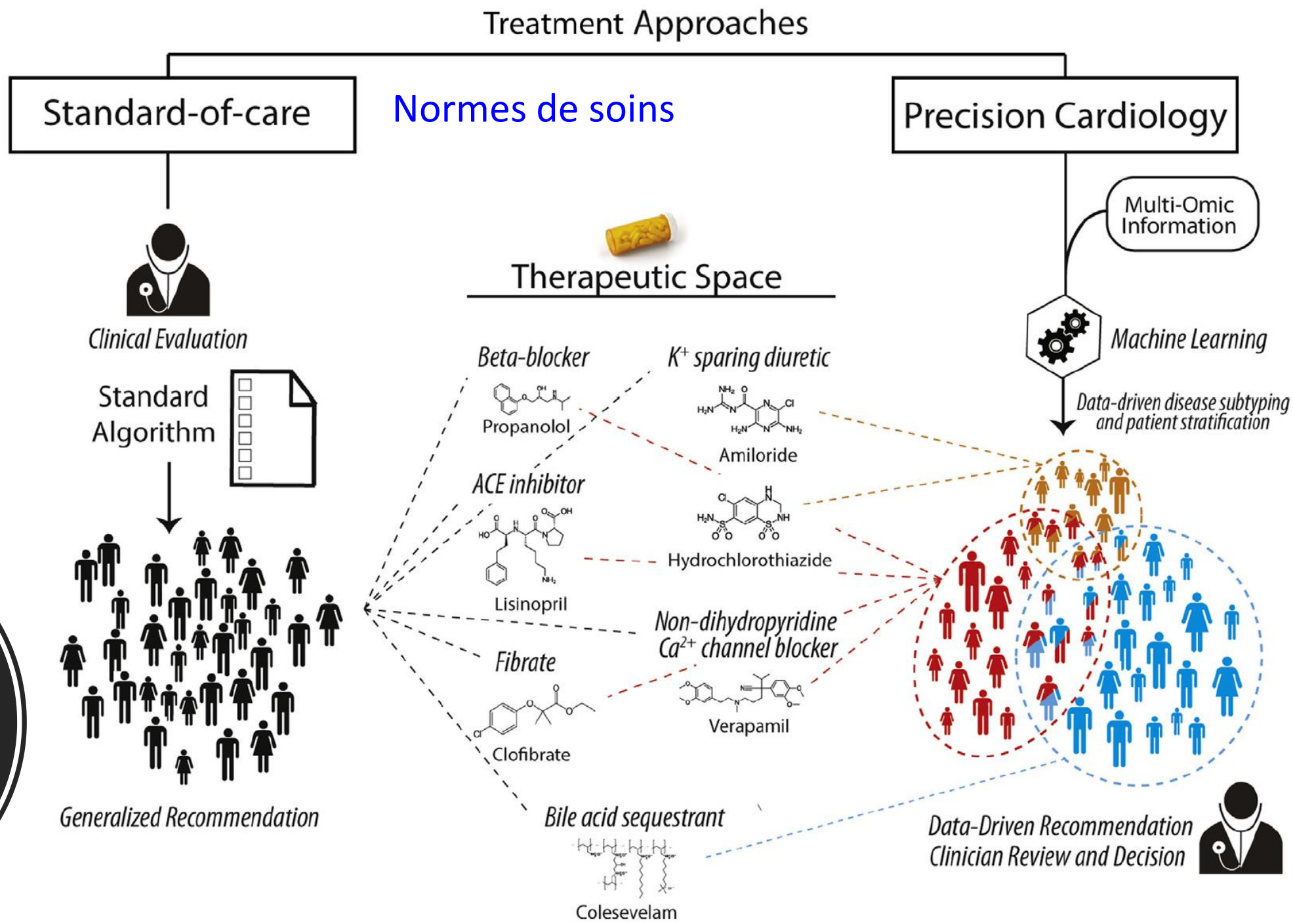


Johnson et al. J Am Coll Cardiol Basic Trans Scie 2017

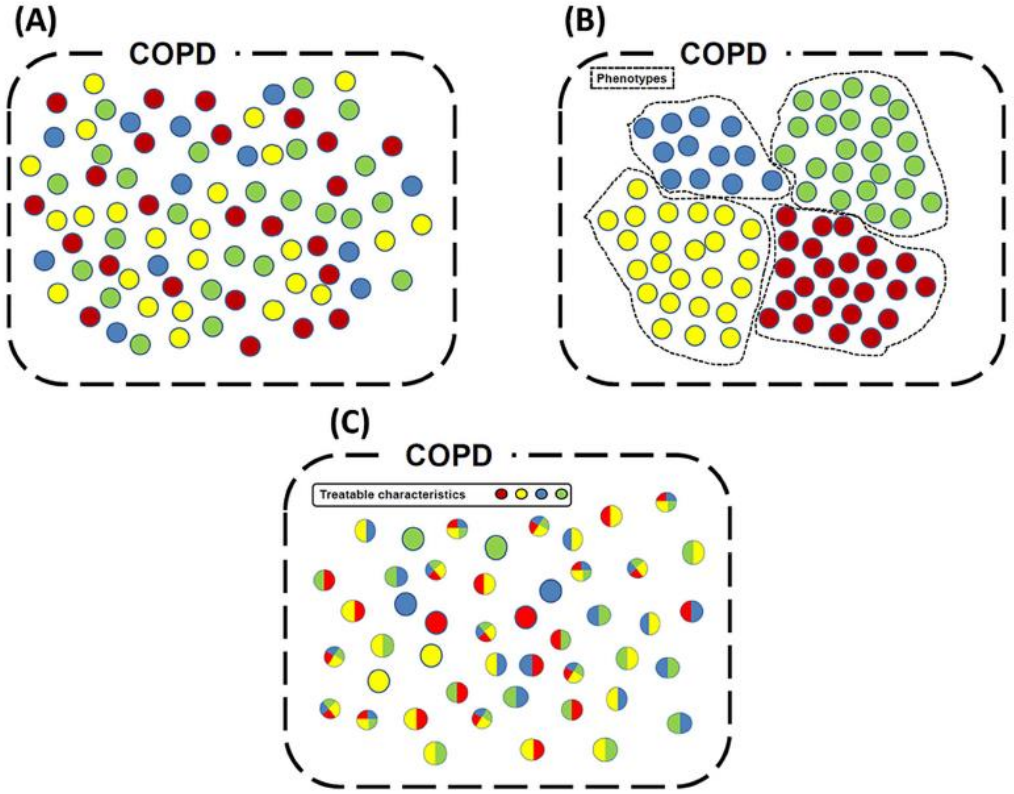
Apprentissage automatique (Machine Learning)



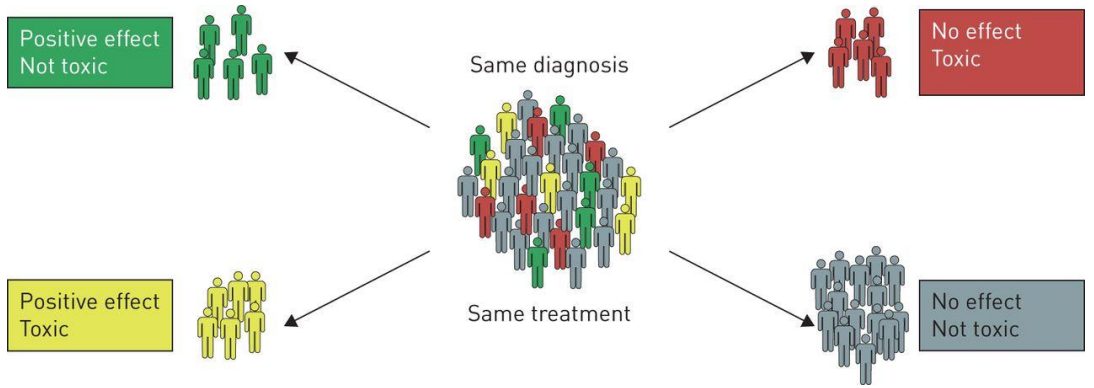
Johnson et al. J Am Coll Cardiol Basic Trans Scie 2017



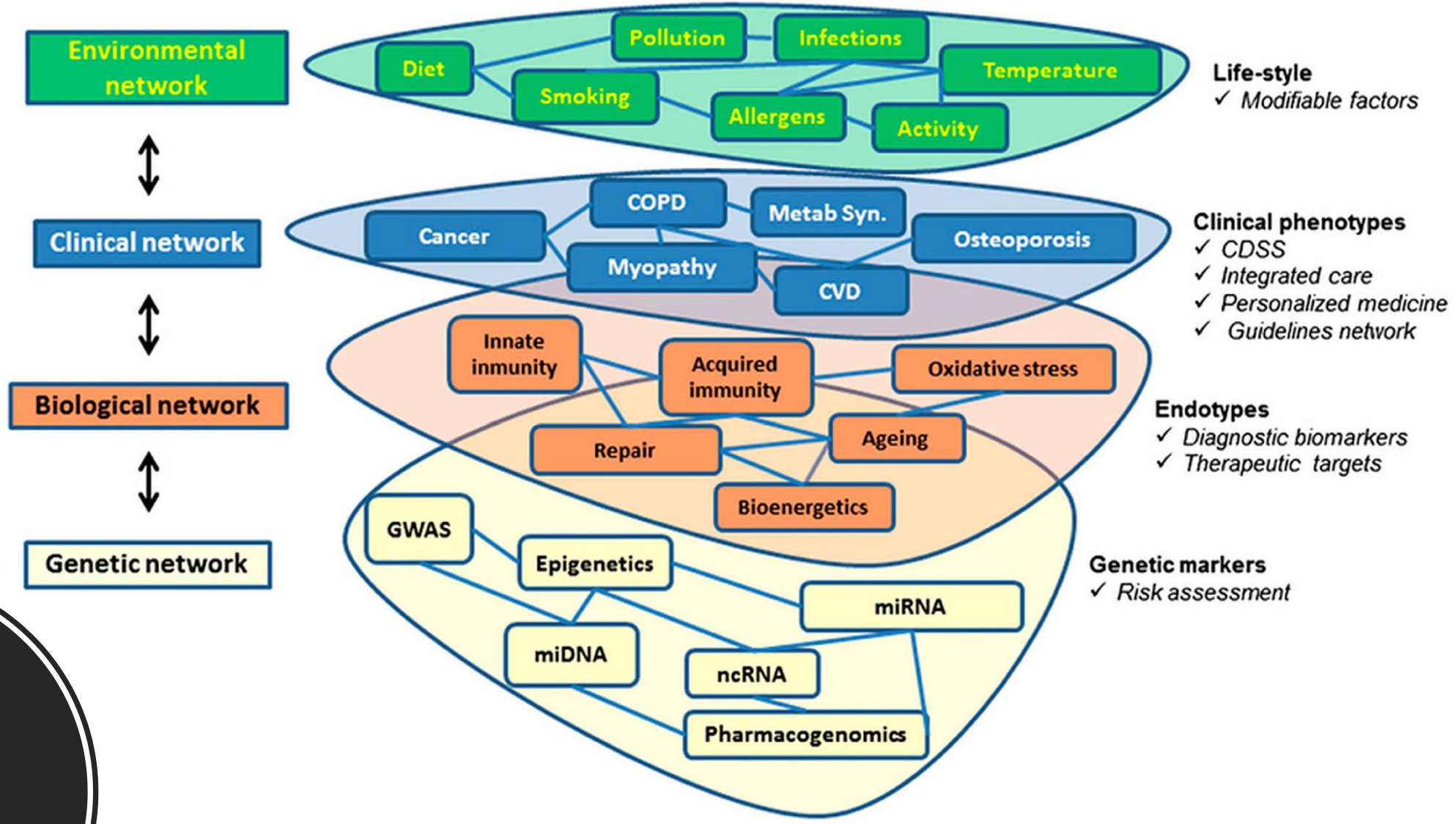
Johnson et al. J Am Coll Cardiol Basic Trans Scie 2017



Agusti. Thorax 2014; 69: 857-64.



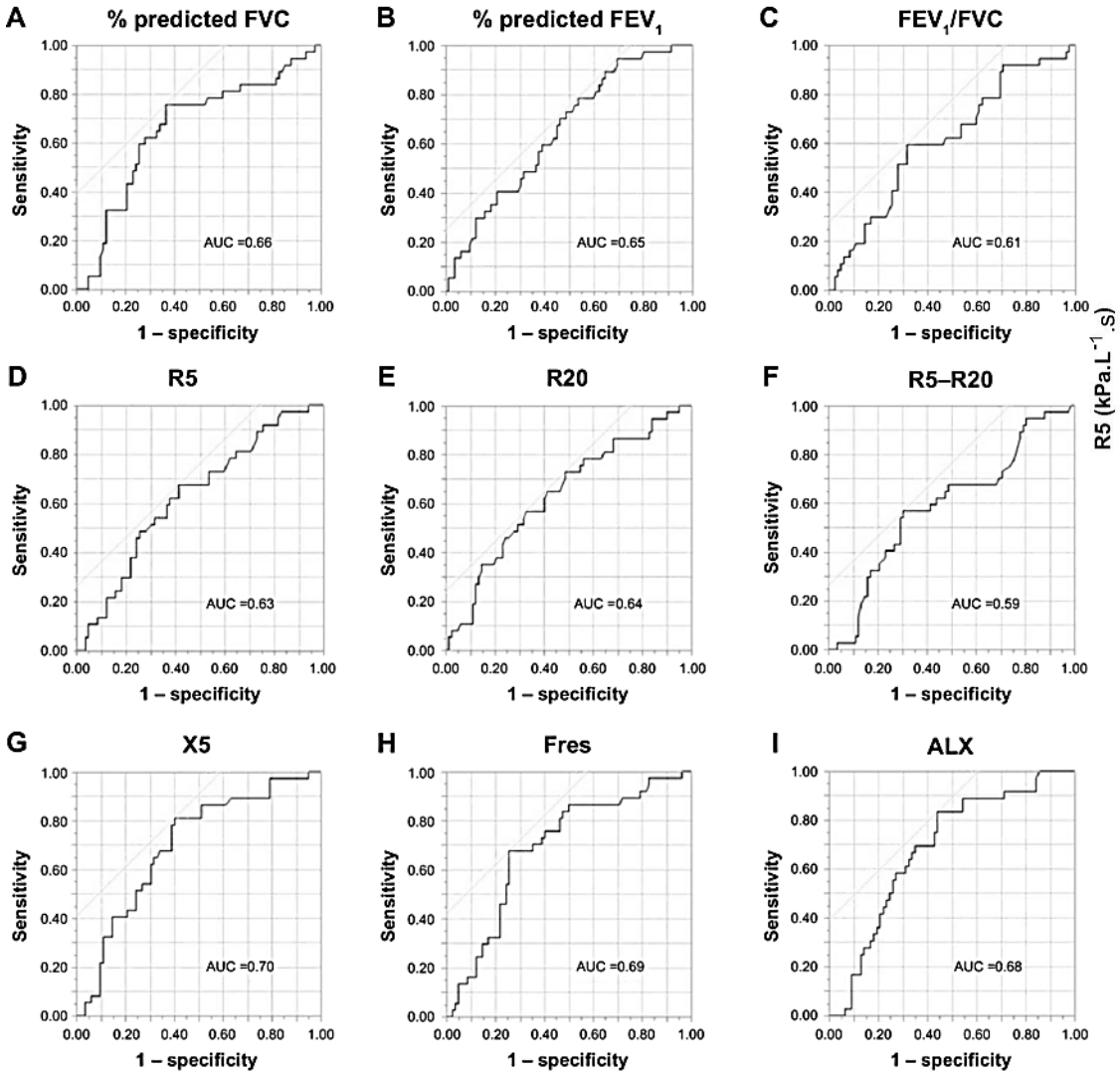
Agusti *et al*. Eur Respir J 2017; 50: 1701655.

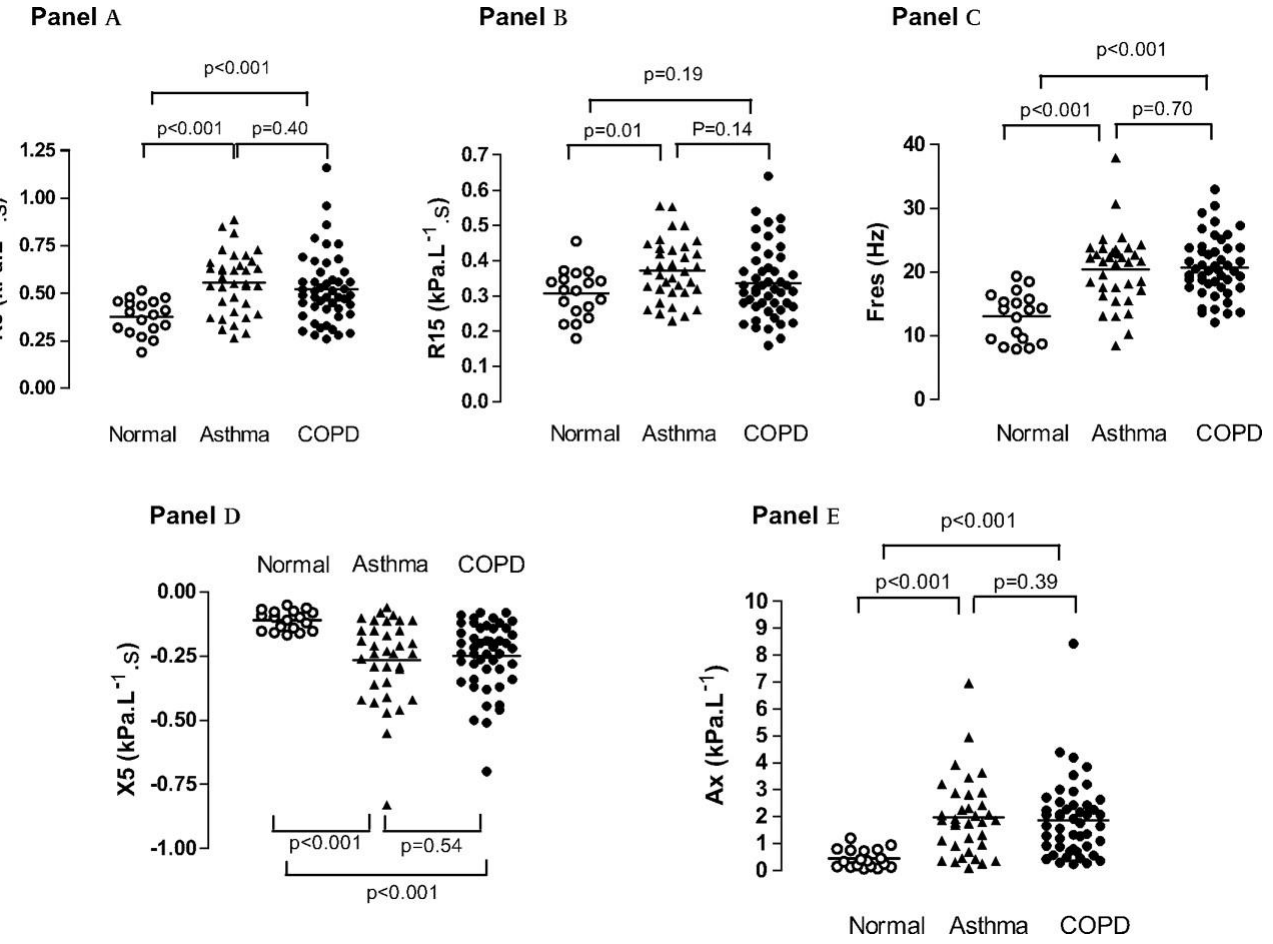


Agusti. Thorax 2014.

Approche classique par analyse univariée

Technique des Oscillation Forcées

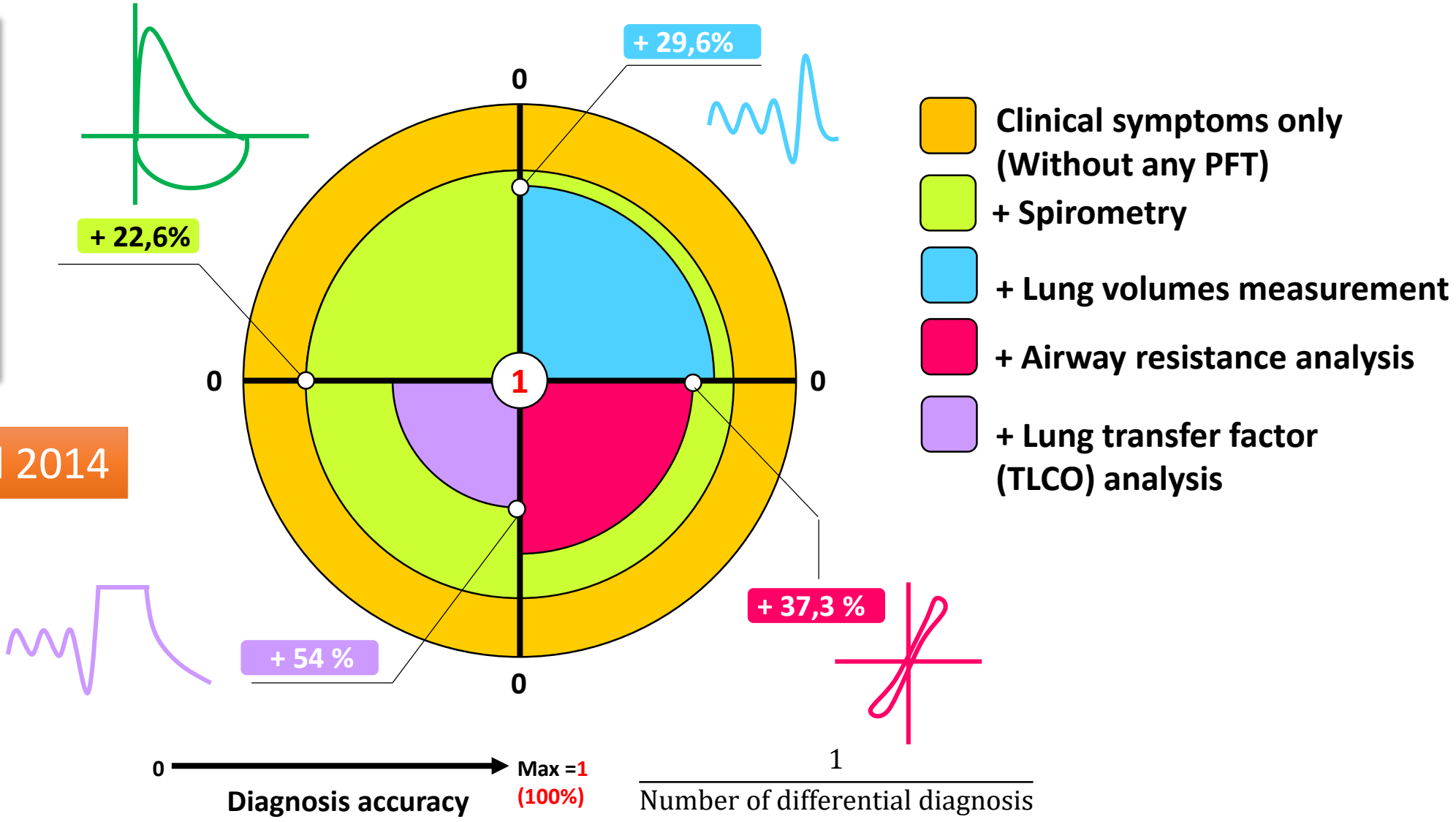




More data means better decision ?

Contribution of 4 Pulmonary function tests to the diagnosis of patients with respiratory symptoms

Topalovic et al 2014



Heat Map – Carte de chaleur – Carte d'activité -

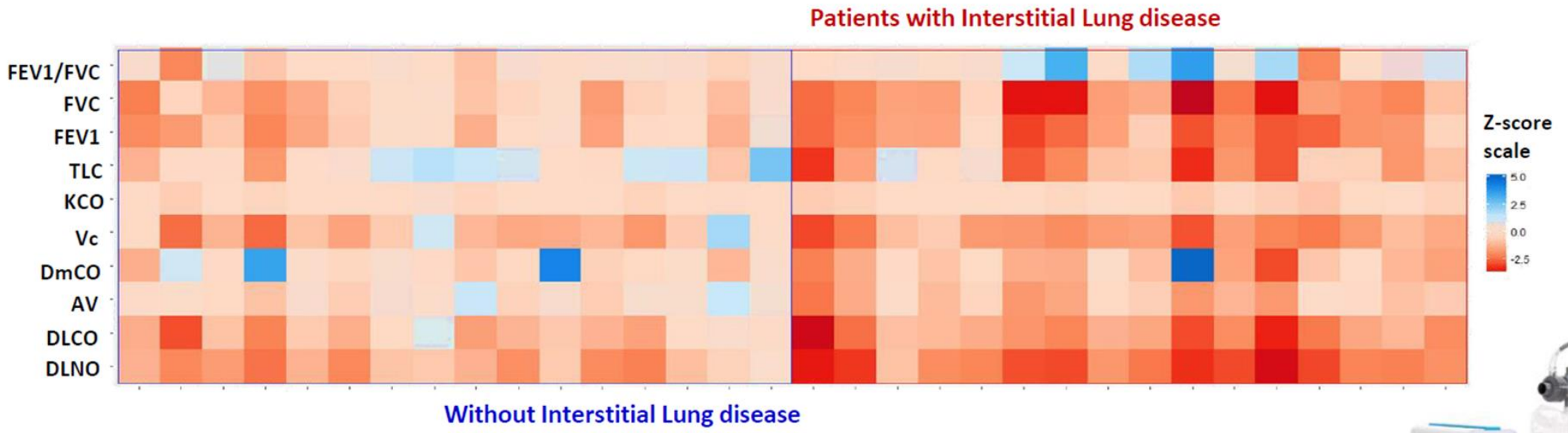


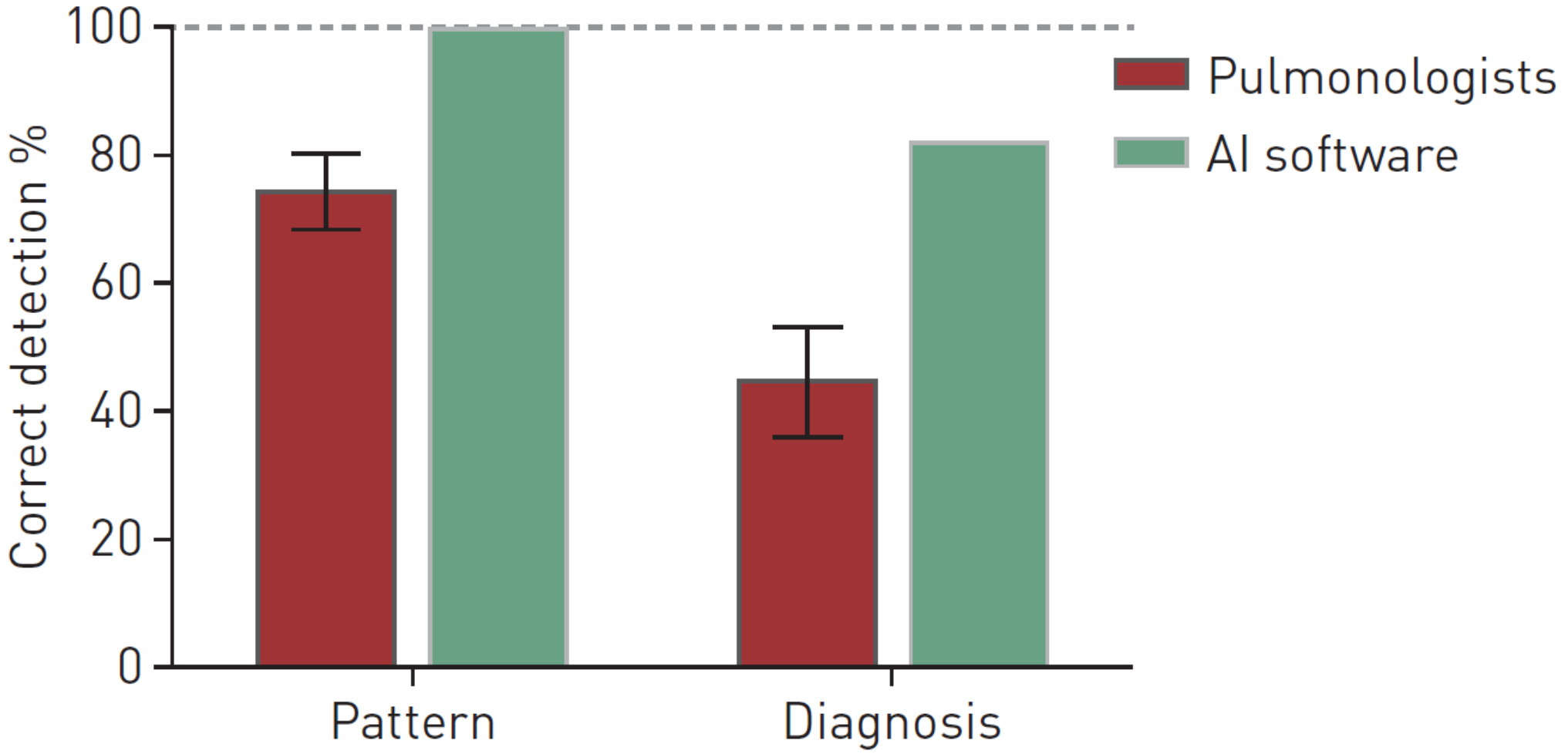
Figure 2: Z-score result of 10 PFT indices in 32 real SSc patients. Combined result of Spirometry, Lung volume and DLNO-CO would give a better chance for distinguishing between the patients with ILD (n=16, Right side) vs those without ILD (n=16, Left-side)

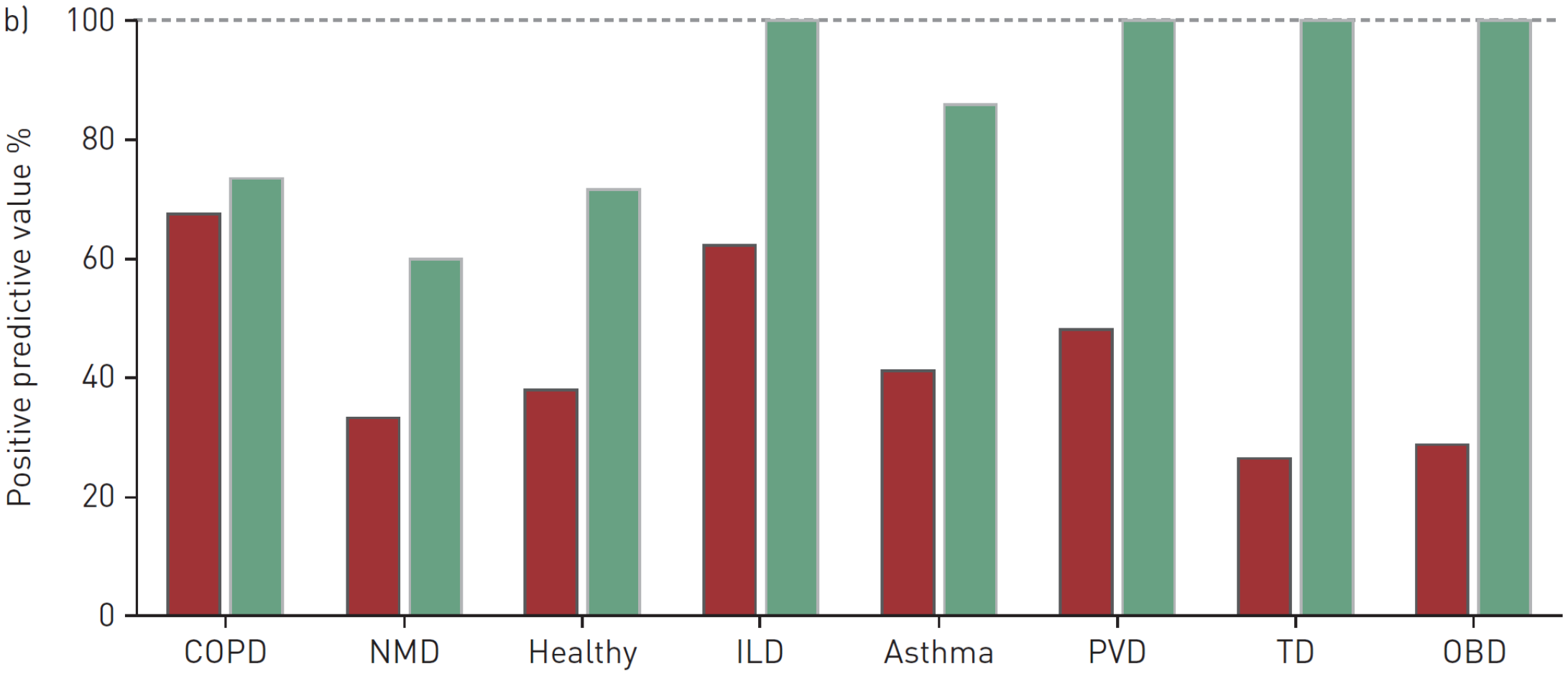
Artificial intelligence outperforms pulmonologists in the interpretation of pulmonary function tests

Marko Topalovic[1], Nilakash Das[1], Pierre-Régis Burgel[2], Marc Daenen[3], Eric Derom[4], Christel Haenebalcke[5], Rob Janssen[6], Huib A.M. Kerstjens[7], Giuseppe Liistro[8], Renaud Louis[9], Vincent Ninane[10], Christophe Pison[11], Marc Schlesser[12], Piet Vercauter[13], Claus F. Vogelmeier[14], Emiel Wouters[15], Jokke Wynants[16,17] and Wim Janssens[1] on behalf of the Pulmonary Function Study Investigators

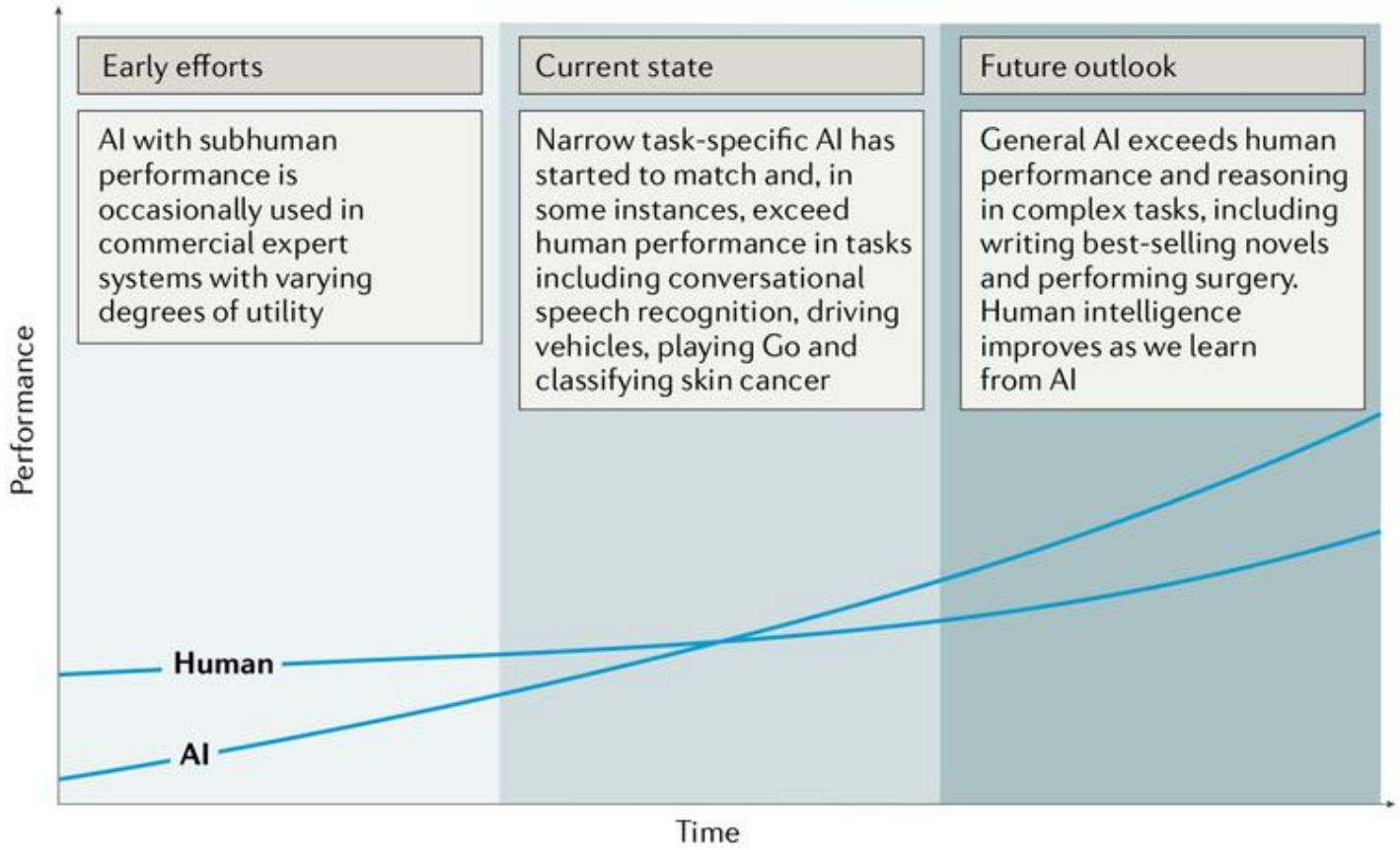
@ERSpublications
There is poor accuracy and substantial disagreement between pulmonologists when interpreting complex pulmonary function data. Automating interpretation with artificial intelligence provides a powerful decision support tool in clinical practice. http://ow.ly/Tj9h30nxw4U

Cite this article as: Topalovic M, Das N, Burgel P-R, *et al.* Artificial intelligence outperforms pulmonologists in the interpretation of pulmonary function tests. *Eur Respir J* 2019; 53: 1801660 [https://doi.org/10.1183/13993003.01660-2018].


Correct detection %
100
80
60
40
20
0
Pattern
Diagnosis
Pulmonologists
AI software


b)
Positive predictive value %
100
80
60
40
20
0
COPD
NMD
Healthy
ILD
Asthma
PVD
TD
OBD


nature
REVIEWS
CANCER
HIGH DOSE VITAMIN C
A perspective on anticancer properties and clinical potential
Chromatin-modifying oncogenic fusion proteins
From mechanisms to therapies


Early efforts
AI with subhuman performance is occasionally used in commercial expert systems with varying degrees of utility
Current state
Narrow task-specific AI has started to match and, in some instances, exceed human performance in tasks including conversational speech recognition, driving vehicles, playing Go and classifying skin cancer
Future outlook
General AI exceeds human performance and reasoning in complex tasks, including writing best-selling novels and performing surgery. Human intelligence improves as we learn from AI
Performance
Human
AI
Time

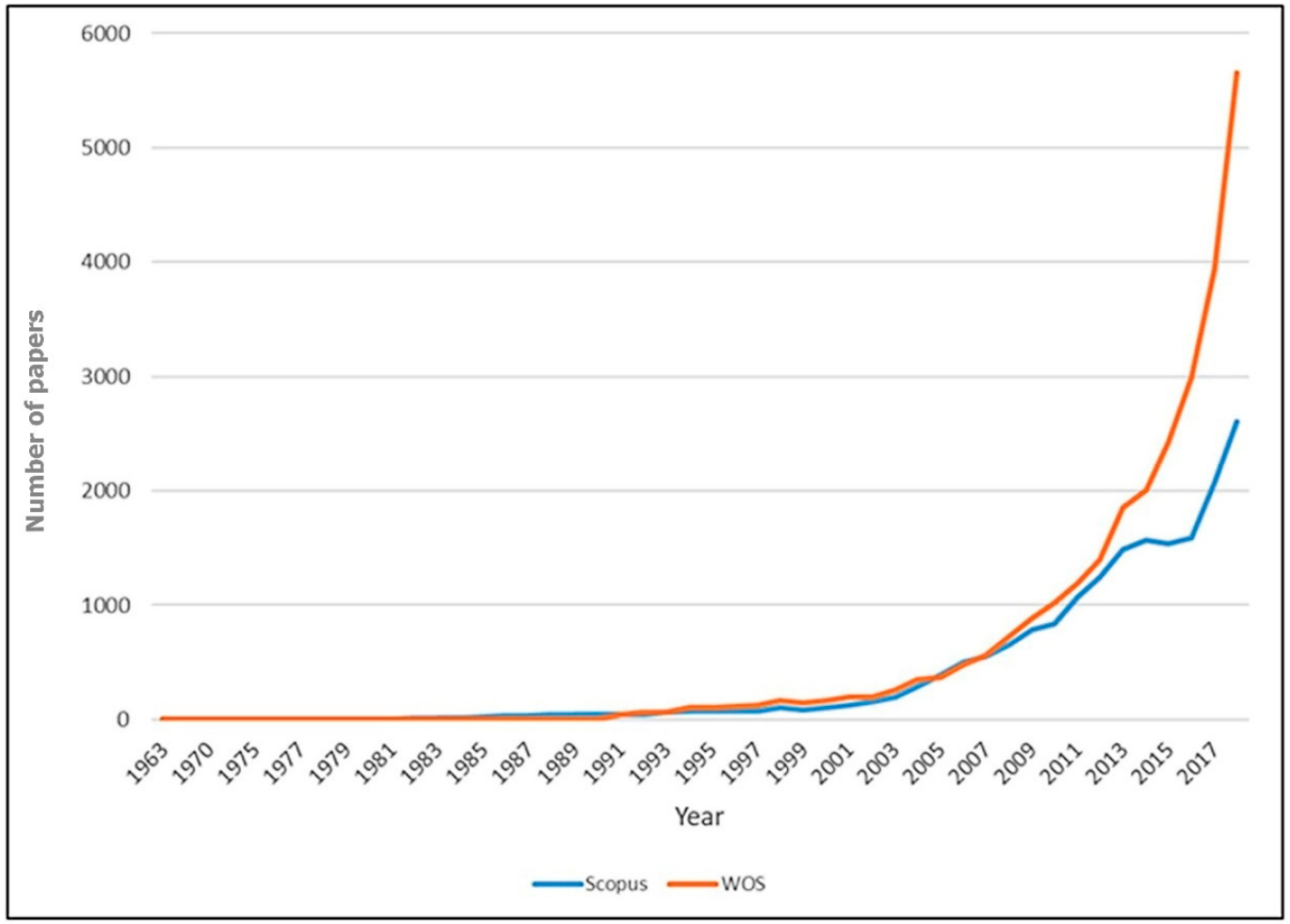


Figure 2. The number of papers by year in the database, 1977–2017.

Journal of *Clinical Medicine*

Global Evolution of Research in Artificial Intelligence in Health and Medicine: A Bibliometric Study

Bach Xuan Tran [1,2,*], Giang Thu Vu [3,4], Giang Hai Ha [5], Quan-Hoang Vuong [6,7], Manh-Tung Ho [6,7], Thu-Trang Vuong [8], Viet-Phuong La [6,7], Manh-Toan Ho [6,7], Kien-Cuong P. Nghiem [9], Huong Lan Thi Nguyen [5], Carl A. Latkin [2], Wilson W. S. Tam [4,10], Ngai-Man Cheung [3,11], Hong-Kong T. Nguyen [12], Cyrus S. H. Ho [13] and Roger C. M. Ho [14,15,16]

J. Clin. Med. **2019**, *8*, 360; doi:10.3390/jcm8030360

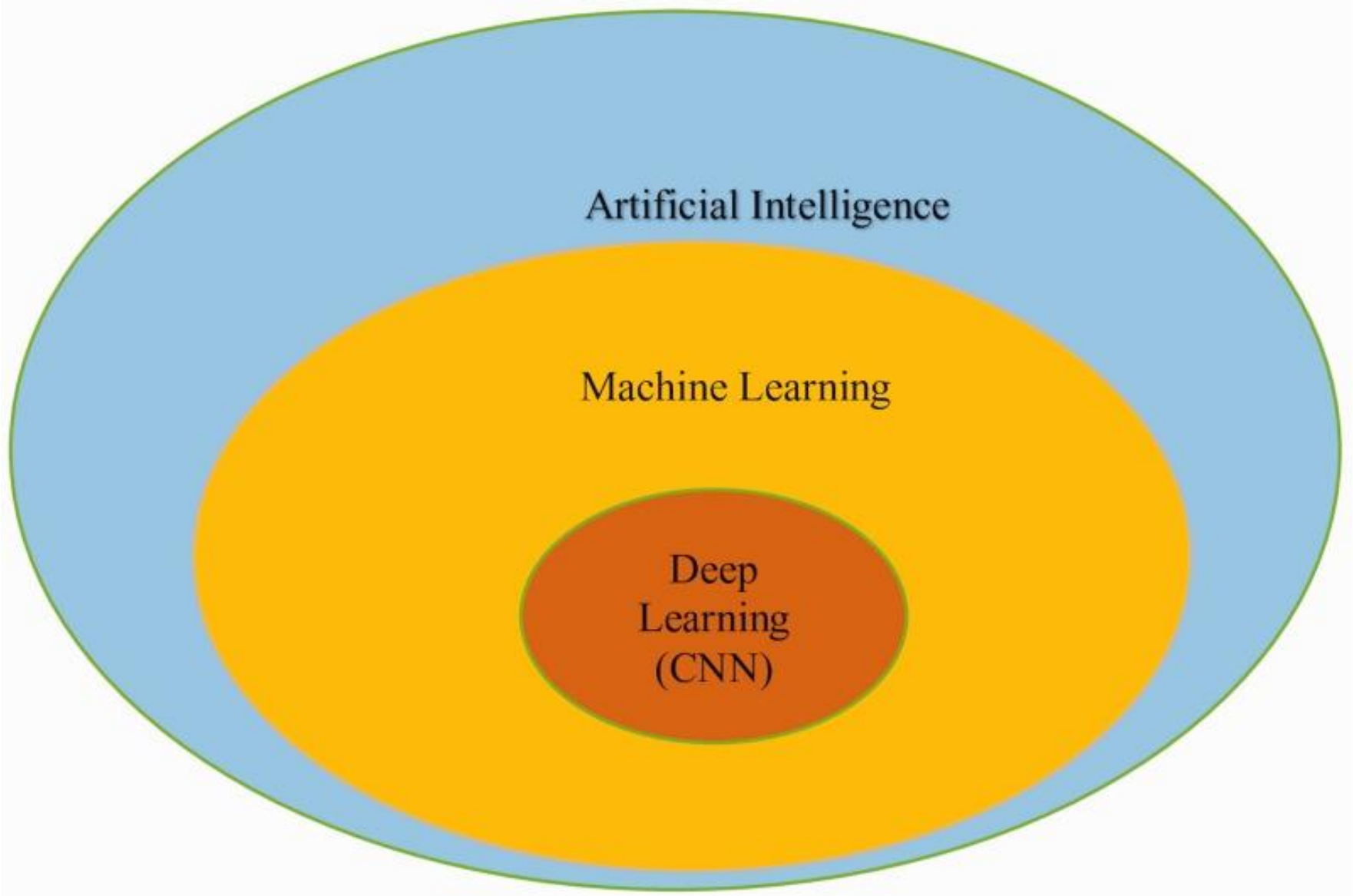
Table 2. The most prolific countries in AI in Health/Medicine research and their collaborations.

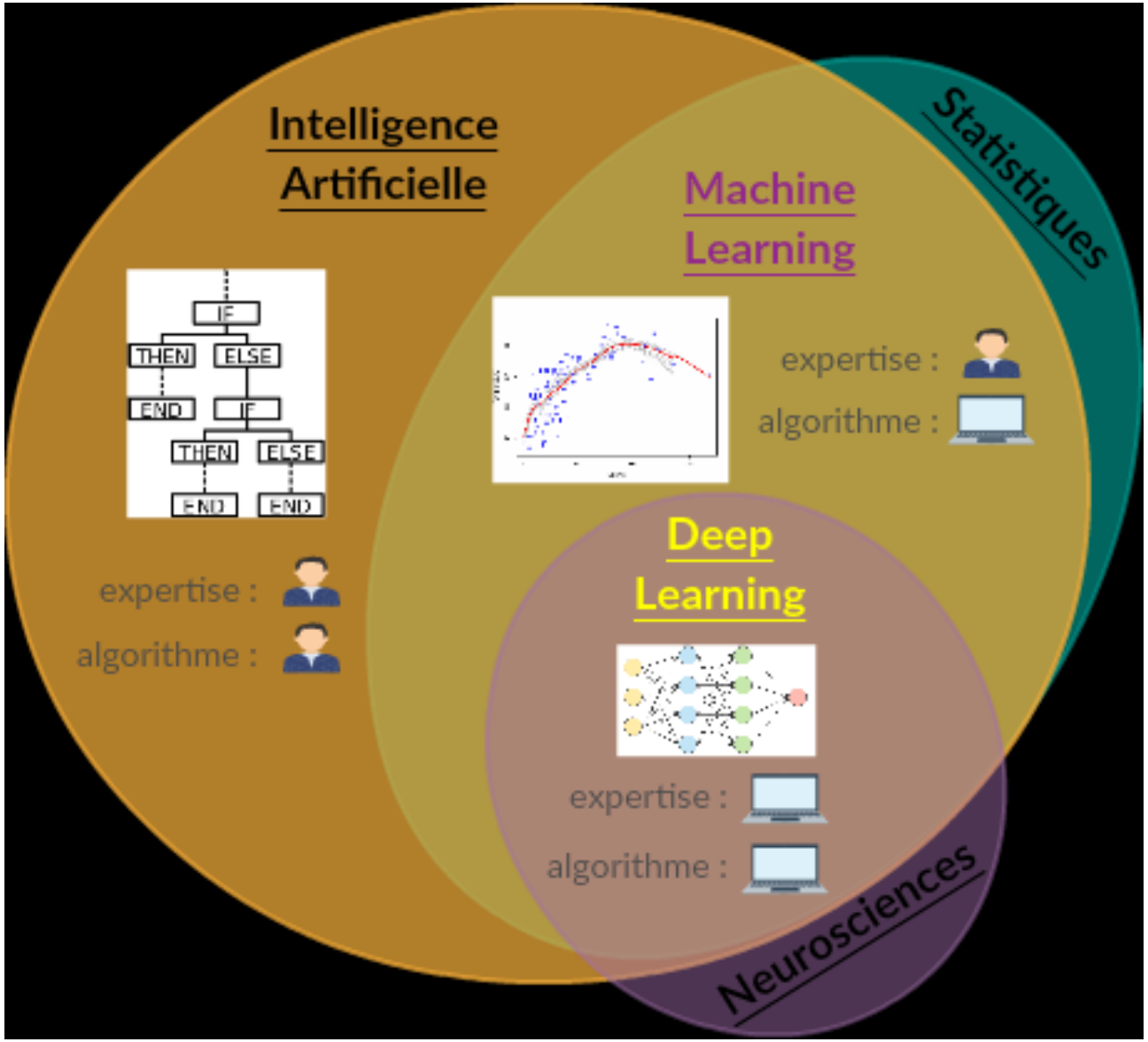
No.	Country	Total Papers	% Papers	Total Citations	Cite Rate	Total Downloads	Total Co-Authors	Total Institutes	Total Country	% Papers with International Collaboration
1	United States	10,623	30.8	232,669	3.4	25,384	5.8	6.8	1.5	33.6%
2	China	2617	7.6	27,997	2.9	15,995	5.9	7.3	1.7	44.8%
3	Italy	1834	5.3	29,485	2.8	3343	7.4	8.4	2.1	55.2%
4	Germany	1553	4.5	31,219	3.3	3415	7.4	8.9	2.1	53.1%
5	Canada	1312	3.8	22,608	2.9	3343	6.2	8.0	1.8	48.5%
6	France	1308	3.8	22,687	3.1	2623	7.4	9.0	2.2	63.7%
7	India	1264	3.7	12,871	2.1	3350	4.5	4.9	1.6	31.6%
8	Spain	1029	3.0	14,653	2.6	2852	6.5	7.7	2.0	49.3%
9	Australia	910	2.6	17,413	3.5	3337	5.8	7.5	2.0	50.5%
10	Japan	841	2.4	11,054	2.2	2107	6.7	7.5	1.7	35.7%
11	Turkey	787	2.3	9058	1.8	1121	4.1	4.4	1.4	20.3%
12	Iran	713	2.1	7438	2.2	1599	4.1	4.6	1.4	30.2%
13	Netherlands	640	1.9	14,811	4.4	1948	8.0	10.1	2.4	59.2%
14	Switzerland	554	1.6	10,197	3.6	1804	7.6	9.7	2.3	63.5%
15	Taiwan	543	1.6	6213	1.8	1084	5.1	6.6	1.5	28.5%
16	Brazil	489	1.4	6097	2.6	1380	6.6	8.1	1.9	44.6%
17	Israel	384	1.1	6393	3.4	950	7.8	9.8	2.4	69.8%
18	Sweden	382	1.1	6220	3.0	700	7.7	9.7	2.4	61.3%
19	Belgium	365	1.1	7269	3.5	696	8.8	10.7	2.8	66.6%
20	Singapore	349	1.0	5378	3.2	1904	6.0	7.1	2.2	66.2%

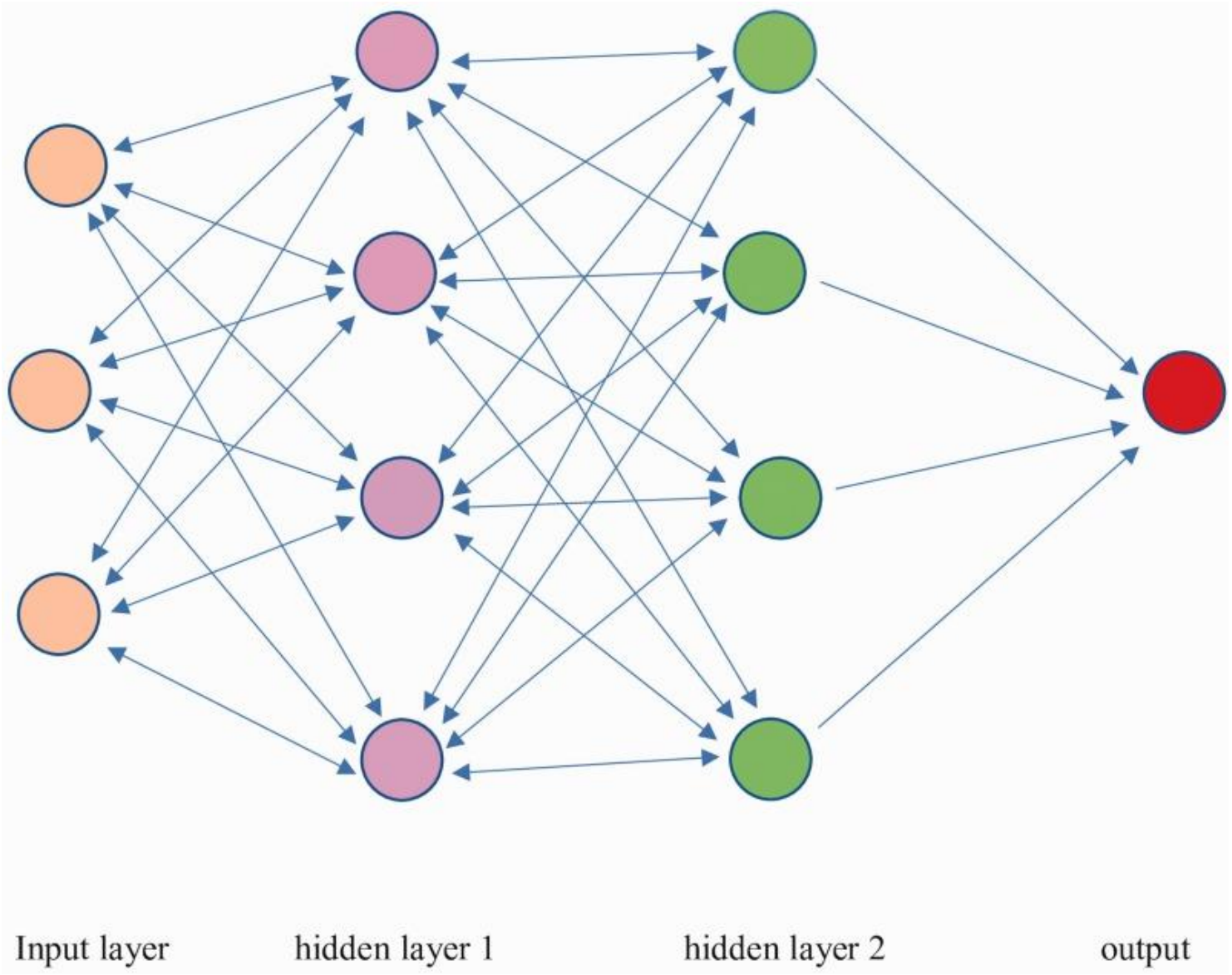
Table 3. Number of papers related to AI techniques, clinical application of AI, and top burden of diseases.

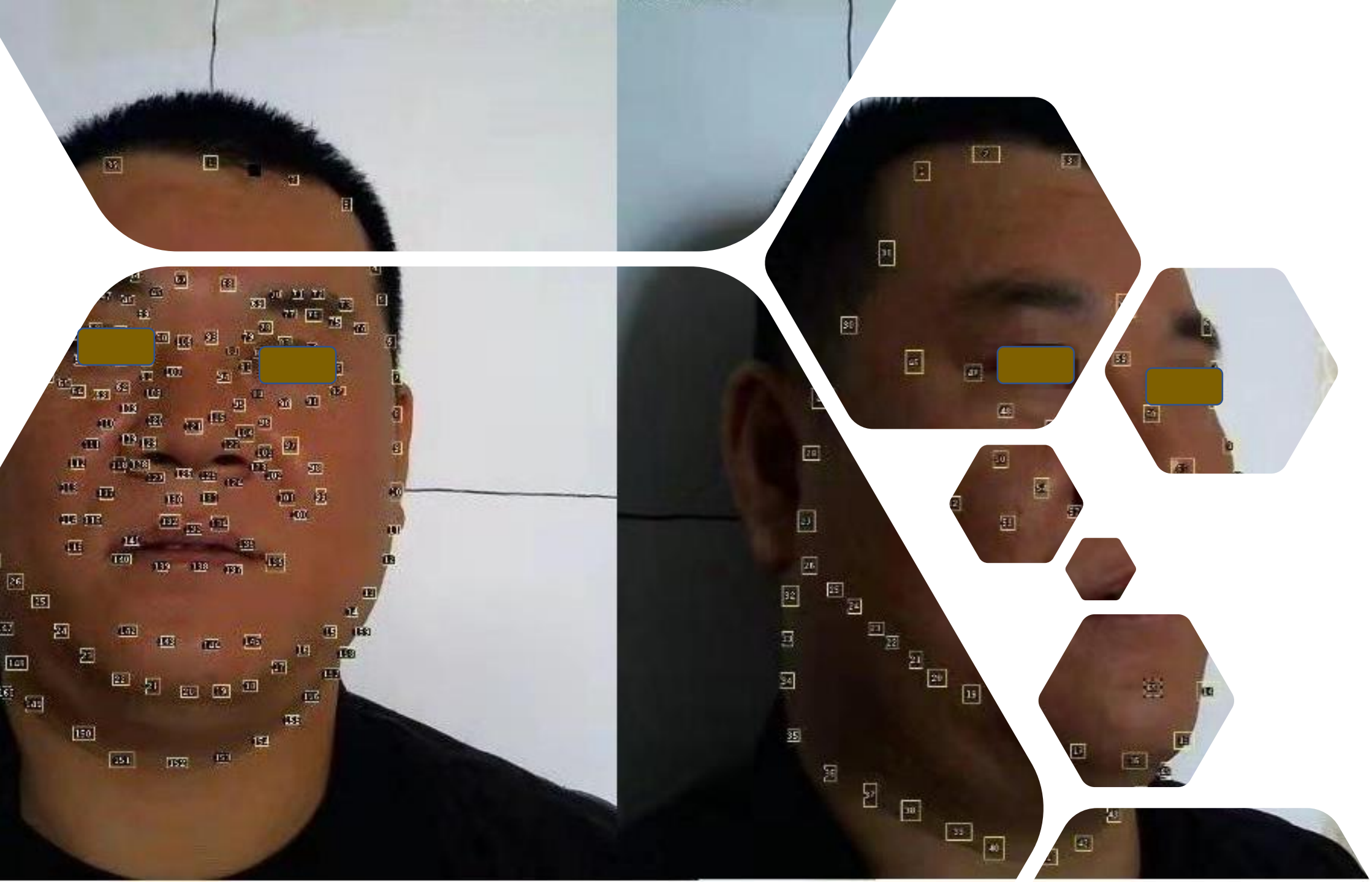
Title	Robotic	Machine Learning	Artificial Neural Network	Artificial Intelligence	Natural Language Process	Deep Learning	Fuzzy Expert System	Evolutionary Computation	Clinical Application	Treatment	Prediction	Diagnosis	Total	Rank Burden of Diseases (DALY)
Cancer	1774	767	366	144	103	0	5	6	28	209	1008	82	4492	12
Heart Diseases	263	357	166	75	33	59	11	3	11	19	331	33	1361	1
Vision	543	264	81	101	57	1	4	5	19	27	189	21	1312	22
Stroke	543	99	45	16	9	0	0	2	13	32	119	5	883	3
Alzheimer	17	314	70	18	8	0	0	1	5	2	210	48	693	24
Depression	71	232	29	33	24	0	1	0	7	39	178	6	620	20
Kidney	293	64	38	14	9	0	2	0	1	17	125	9	572	19
Diabetes	38	159	86	34	20	0	4	3	1	6	176	21	548	8
Respiratory	119	104	64	20	16	2	0	0	1	9	136	6	477	4
Substance use	75	101	57	17	35	7	0	0	2	20	120	4	438	16
HIV	24	114	35	28	21	6	0	2	6	10	113	4	363	13
Injuries	162	32	9	9	5	0	1	0	5	7	30	1	261	5
Asthma	12	60	29	6	12	1	2	0	0	0	62	4	188	25
Tuberculosis	8	42	17	12	2	2	0	0	1	2	42	15	143	14
Congenital	64	24	14	5	1	3	0	0	3	6	19	3	142	9
Cirrhosis	11	23	24	6	2	0	0	0	2	4	38	2	112	11
Malaria	4	38	9	8	1	0	1	0	1	0	42	2	106	15
Suicide	0	43	1	3	10	0	0	0	1	1	34	1	94	16
COPD	5	32	7	3	3	0	1	0	0	0	29	1	81	6
Neonatal	7	22	8	5	4	3	1	0	0	0	22	1	73	2
Hearing	7	11	9	6	0	0	0	1	0	1	14	3	52	21
Back pain	18	5	9	2	1	0	0	0	2	2	11	0	50	10
Headache disorders	0	0	0	0	0	5	0	0	0	0	0	0	5	23
Diarrhea	1	0	0	0	0	0	0	0	0	0	0	0	1	7
Headache disorders	0	0	0	0	0	1	0	0	0	0	0	0	1	18
Total	4059	2907	1173	565	376	90	33	23	109	413	3048	272	13,068	

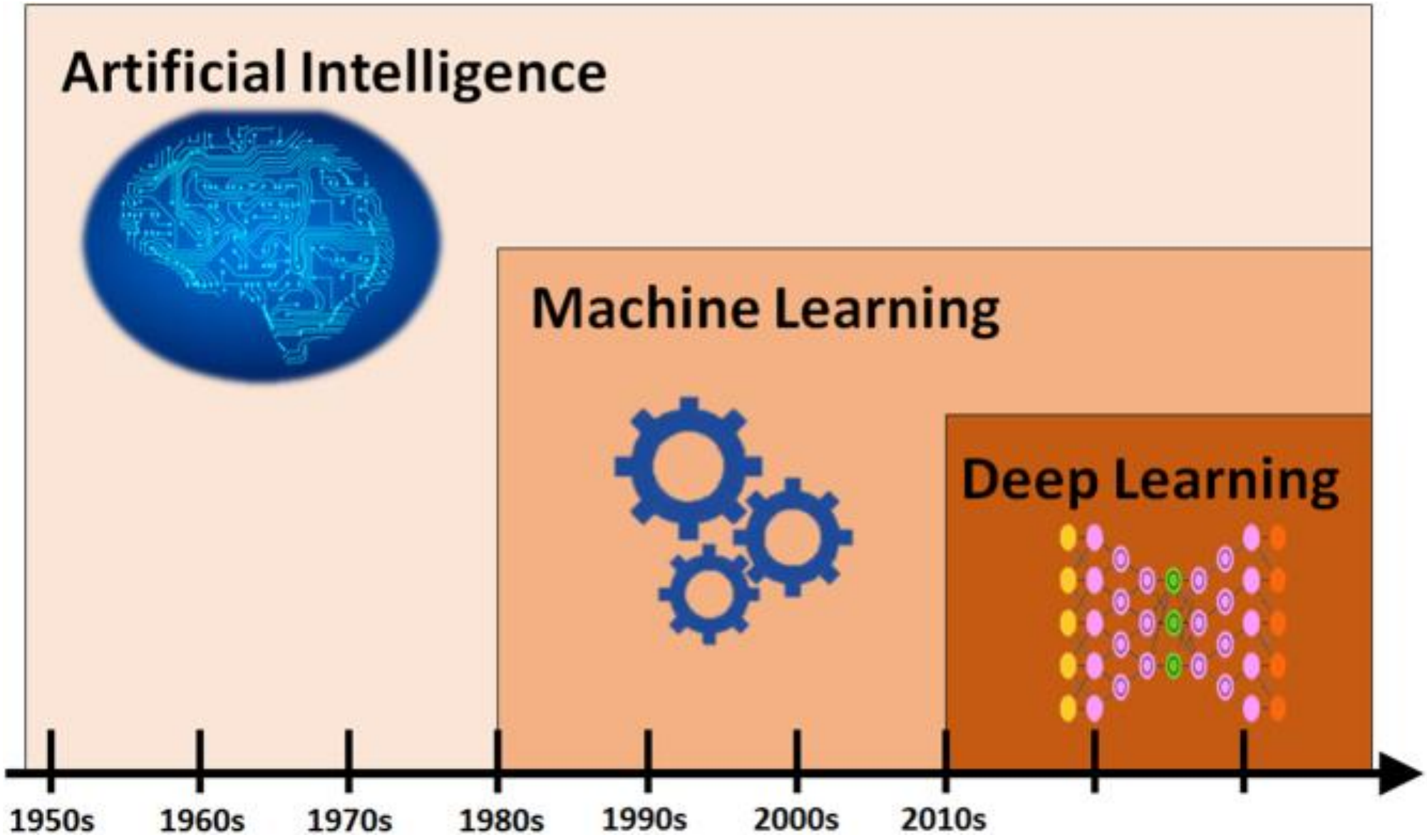
J. Clin. Med. **2019**, *8*, 360; doi:10.3390/jcm8030360


Artificial Intelligence
Machine Learning
Deep
Learning
(CNN)


Intelligence Artificielle
IF
THEN
ELSE
END
IF
THEN
ELSE
END
END
expertise :
algorithme :
Machine Learning
expertise :
algorithme :
Statistiques
Deep Learning
expertise :
algorithme :
Neurosciences


Input layer
hidden layer 1
hidden layer 2
output




Artificial Intelligence
Machine Learning
Deep Learning
1950s
1960s
1970s
1980s
1990s
2000s
2010s