



United Nations  
Educational, Scientific and  
Cultural Organization



- UNESCO Chair on Adolescent Health Care
- National and Kapodistrian University of Athens
- Greece



UNIVERSITY  
RESEARCH INSTITUTE  
**OF MATERNAL  
AND CHILD HEALTH  
& PRECISION MEDICINE**

# ***Open Science, Artificial Intelligence, Machine Learning, Precision Medicine, and Health***

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National and Kapodistrian University of Athens**

**Open Science = Knowledge for Everyone**

**Agora *vs.* Clergy**

**Ancient Greece *vs.* Ancient  
Egypt**

# THE SCHOOL OF ATHENS: AGORA by Raphael



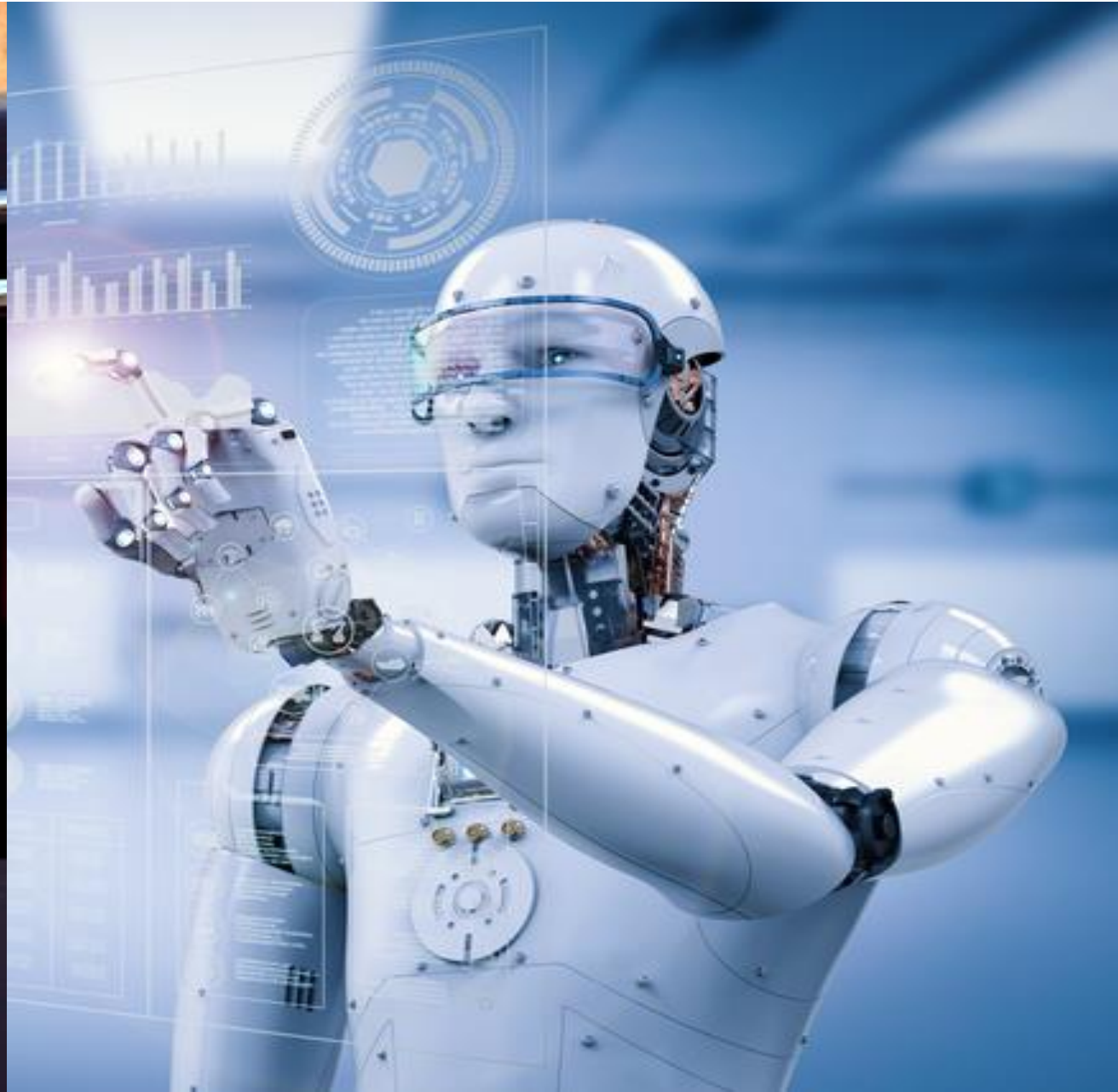




WHY **A.I.**



**What can the computers  
do that we can't?**



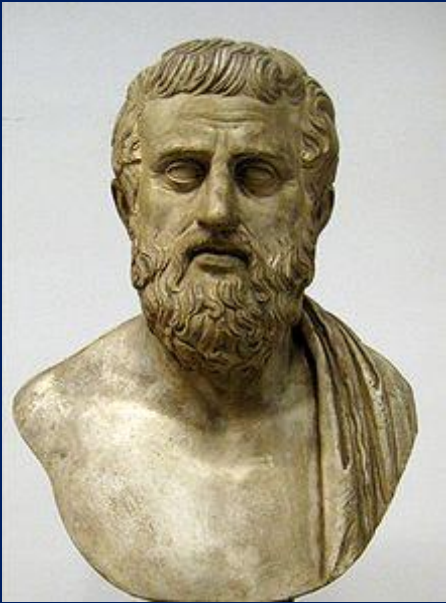
**Intelligence vs. Artificial Intelligence**



WHAT

WENT

WRONG



*“Πολλά τα δεινά κ’ουδέν ανθρώπου δεινότερον  
πέλλει....”*

*'There are many wonderful things and nothing is  
more wonderful than the human ...’*

*Σοφοκλής*

*Sophocles*

*496-406 BCE*



# HUMAN COMPLEXITY: POST(EPI)GENOMIC ERA

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Human genome:

**About 3+3 billion bases, 98% formerly “junk DNA”, 40-60% retroviral!**

**About 20 thousand protein-coding genes**

**About 24 thousand ncRNA-coding genes**

**About 16 thousand pseudogenes**

**About 100-140 thousand transcripts**

**(mRNAs, ncRNAs = miRNAs, lncRNAs, piRNAs, cRNAs, eRNAs)**

**About 200-260 thousand proteins**

Single nucleotide polymorphisms (snp's or snv's),  
microsatellites or copy number variants : **(91.1 vs. 0.9%)**

**>25 million snp's (snv's), 1.5 million indels**

**About 20 million microsatellites**

**>5000 cnv' s (many million bases), > 100 k disease-related mutations**

**>60% of promoters have CpG islands, >1 million reg. regions**

**Superenhancers**



**EPIGENETICS    (Epi)mutations**

# HUMAN COMPLEXITY: **SOME HUMAN BRAIN NUMBERS**

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- ~ 100 billion neurons ( $100 \times 10^{12}$ ) x >10.000 synapses per neuron  
=  $>10^{18}$  synapses)
- ~ 100.000 km of fibers
- ~ 1 trillion or more glial cells
- ~ 1.25 terabytes (recalculated ~1.4 petabytes)
- ~ 15 Watt lamp (2% of BW uses 20% energy)



**Plasticity**

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# *Complex Systems*

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- Multiple interactants
  - Self-organizing
  - Adapting through feedback loops
  - Resilient to perturbations
  - **Emergent properties**
-

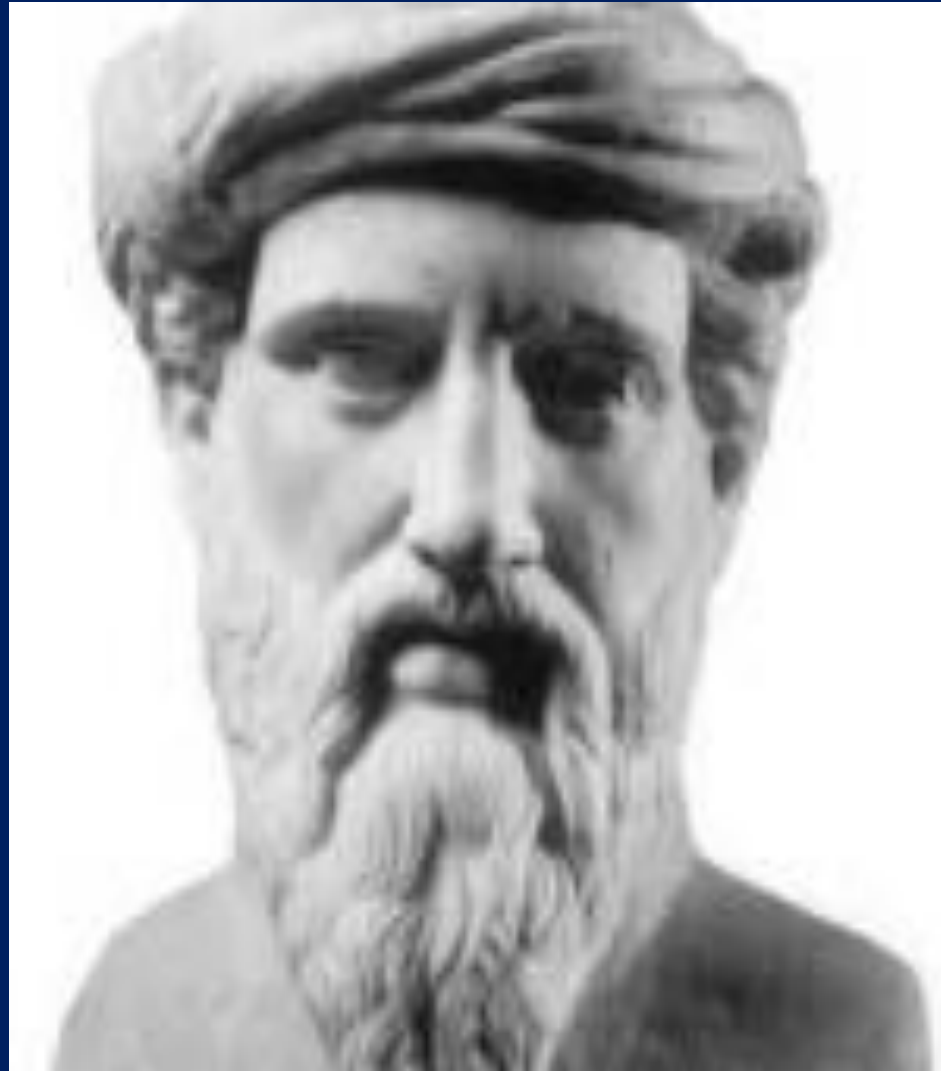


# *Emergent Properties*

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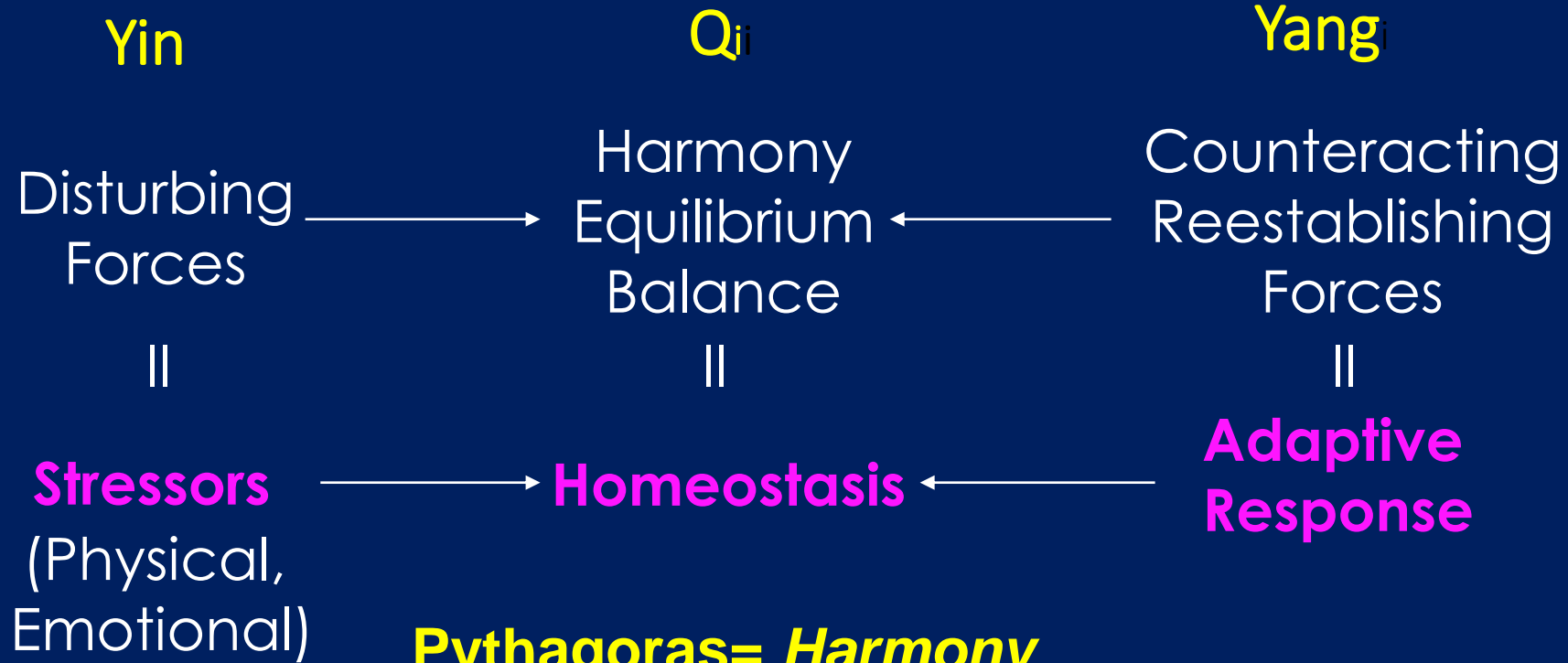
- Earth Ecosystem
  - Earth Life (Biosphere)
  - Human beings
  - Human intellect/soul
  - **Human civilization**
-

# ***COMPLEXITY***



**Pythagoras 6th century BCE**

# Complex Systems Theory



**Pythagoras= *Harmony***

**Alcmaeon= *Iso-nomia***

**Hippocrates= *Eucrasia***

**Epicurus= *Eustatheia***

**Walter Cannon= *Homeostasis***



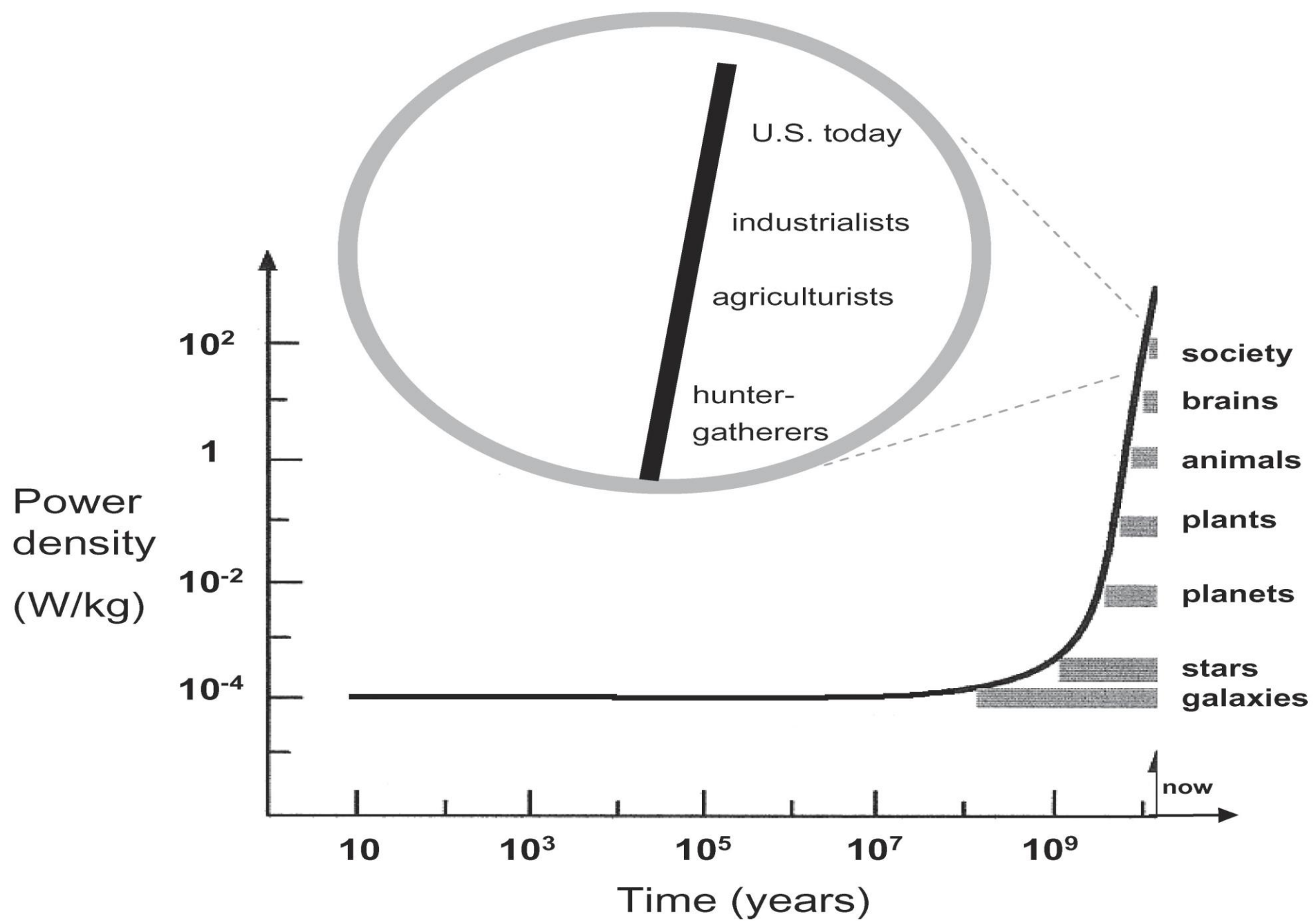
# *Complex Systems*

*“Ἀρμονία δ’ ἐστὶ πολυμιγέων ἔνωσις καὶ δίχα  
φρονεόντων συμφρόνησις”*

*“Harmony is the union of multiple mixed  
components and the agreement of the  
opposites”*

*Ἀλκμαίων Κροτωνιάτης  
Almaeon of Croton □*

*Stress is the State of Threatened  
(or Perceived as Threatened for us  
Humans) Homeostasis for any  
Complex System*





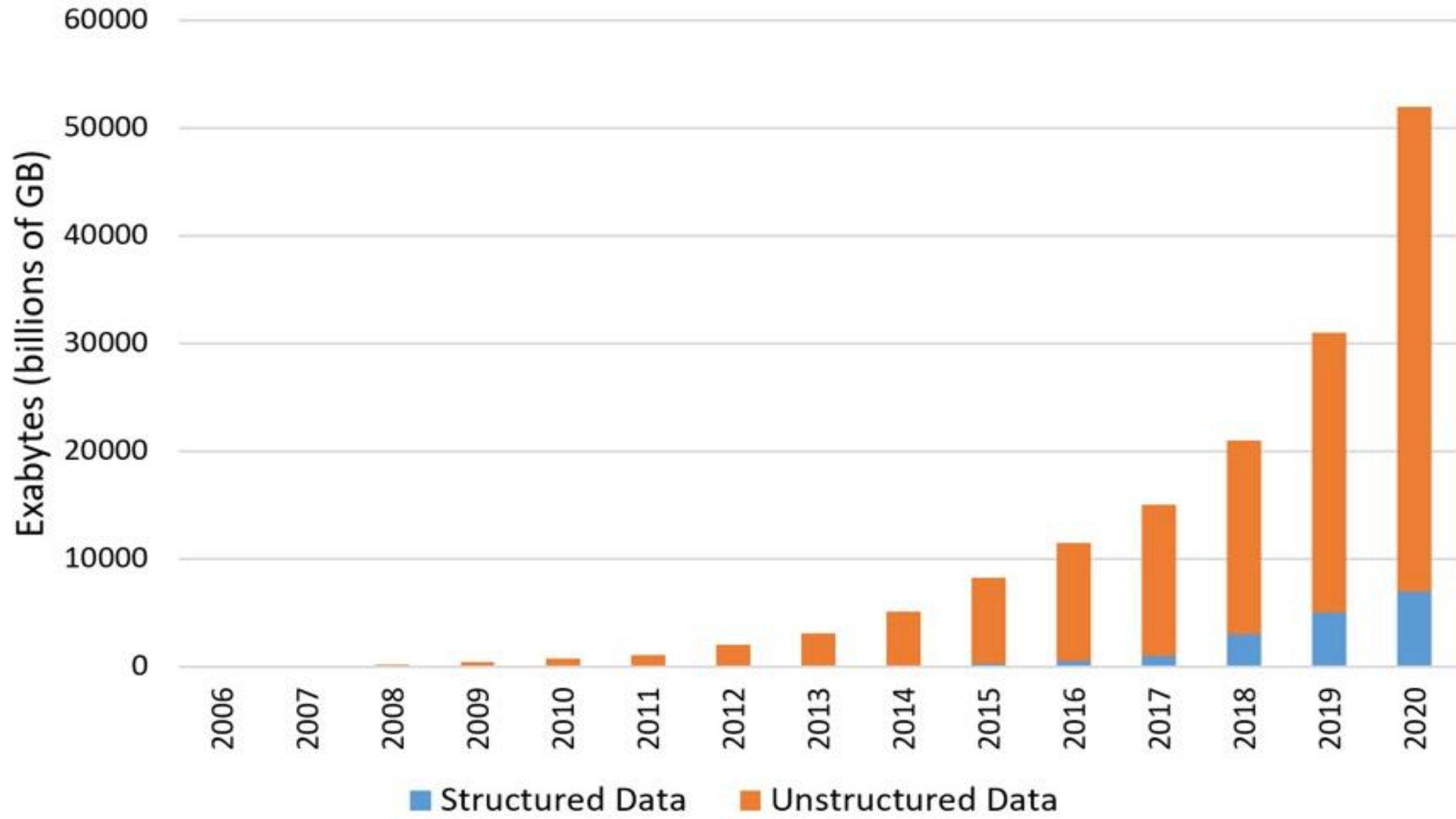
Man and his/her civilization are of **unique complexity** in the known universe.

Complex systems are in **a dynamic disequilibrium** that requires energy to be sustained.

Complex systems have **organizing principles** and follow mathematic rules.



**SYSTEMS BIOLOGY, SYSTEMS MEDICINE**  
**NARRATIVE AND PRECISION MEDICINE**  
**P4 MEDICINE (predictive, personalized, preventive, participatory)**

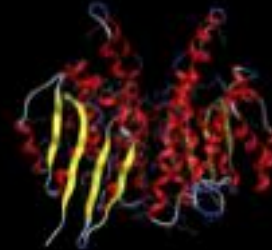
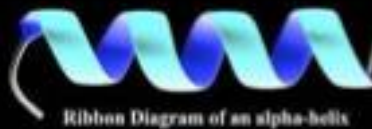


# Why do we need artificial intelligence?

1D

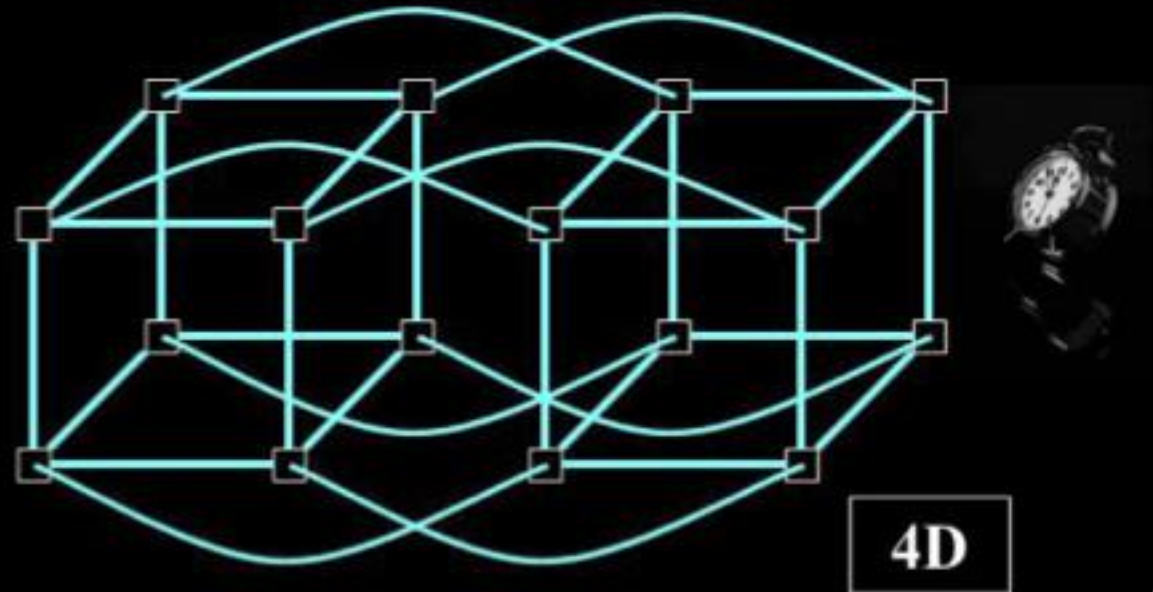
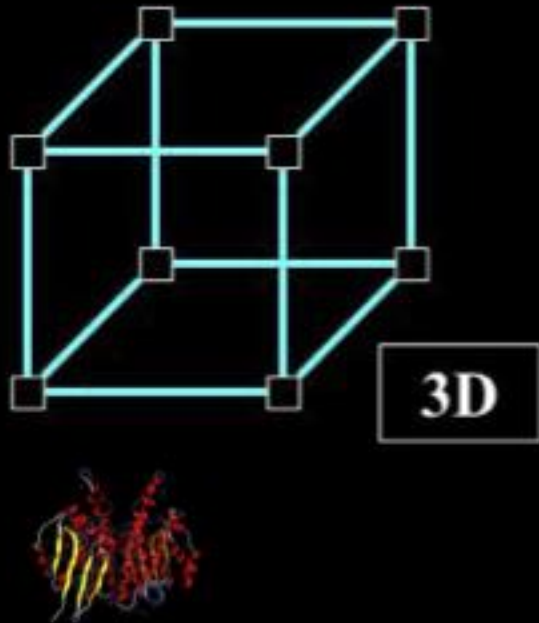
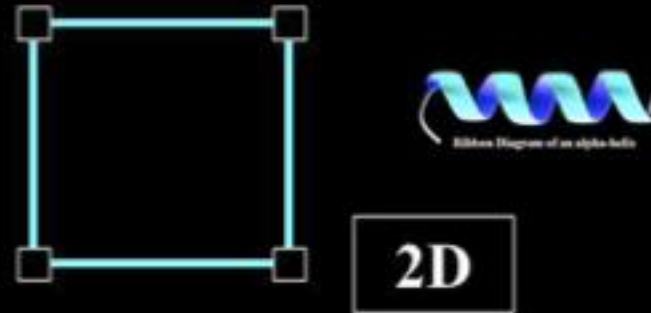
20
























3D

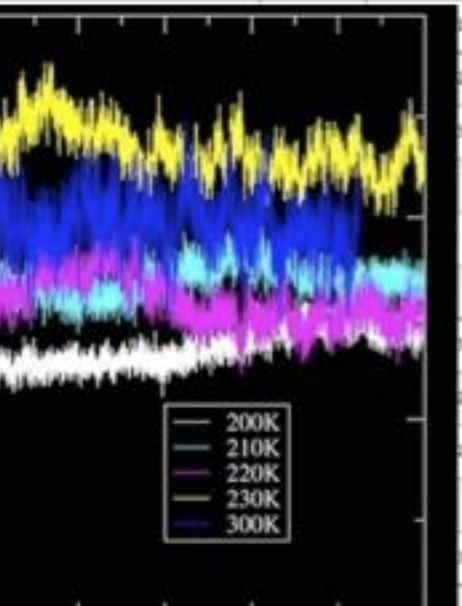




Let us add another dimension....

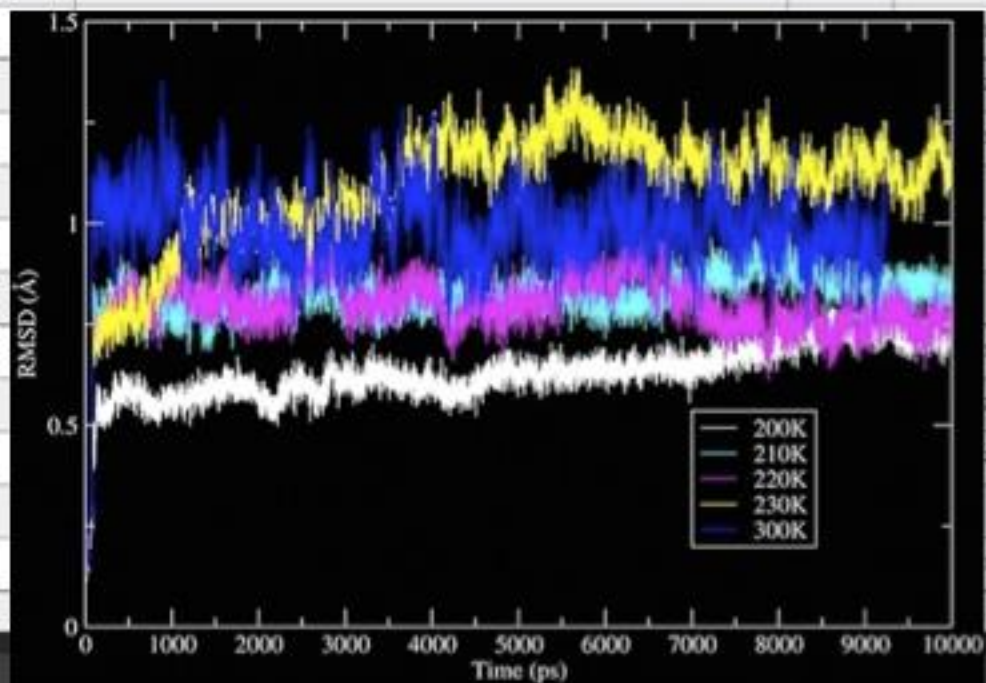


	mol	chain	domains	score	aligned	percent_identity	rmsd	suboptimal	molSSNFO										N	repair	R	T	qm	AM1_dipole
2		2CLS.A	R Ras (0.00035e-0)	10.0000	168/177	44	1.2509	1	77 79 83 83 4 0 0 0 1 0 0 0 13 0 0 0 115 104 115 115 115 104 115 104 115 10	20	10 11 12 1	-0.0911 0.	-56.7336	0 2 3 4 5	0.0000									
3		3RAP.R	P Ras (2.49977e-0)	9.6000	156/177	31	1.4283	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 115 104 115 104 115 10	18	2 3 4 5 6	-0.0015 0.	-56.7127	0 2 3 4 5	0.0000									
4		2CSL.A	G Ras (2.19989e-0)	9.5000	150/177	31	1.3904	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 115 104 115 104 115 10	19	9 10 11 12	-0.0708 0.	-56.3822	0 2 3 4 5	0.0000									
5		3REF.B	R Ras (1e-047)	9.3000	161/177	41	1.2504	0	77 79 83 83 4 0 0 0 1 0 0 0 11 0 0 0 115 104 115 115 104 115 104 115 104 11	15	22 23 24 2	-0.0607 0.	-56.5721	0 2 0 0 4	0.0000									
6		2u2V.A	R Ras (1.20005e-0)	9.0000	162/177	49	0.8813	1	77 79 83 83 4 0 0 0 1 0 0 0 13 0 0 0 115 104 115 115 104 115 104 104 115 10	15	9 10 11 12	-0.0937 0.	-56.5533	0 2 0 3 0	0.0000									
7		5CH2.A	R Ras (1.29987e-0)	8.0000	157/177	29	1.6001	1	77 79 83 83 4 0 0 0 1 0 0 0 13 0 0 0 115 104 115 115 115 104 115 104 104 11	19	5 6 7 8 9	-0.1102 0.	-56.0503	0 2 3 4 5	0.0000									
8		4C22.A	R Ras (7.29962e-0)	8.0000	151/177	20	1.4692	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 115 115 115 104 115 10	16	29 30 31 3	-0.0753 0.	-56.2427	0 2 4 5 6	0.0000									
9		4001.B	R Ras (1.99991e-0)	8.0000	138/177	25	1.6200	0	77 79 83 83 4 0 0 0 1 0 0 0 11 0 0 0 115 104 115 115 115 115 104 115 104 11	13	11 12 13 1	0.8130 0.0	-93.6975	0 2 0 0 5	0.0000									
10		1R2Q.A	R Ras (2.49977e-0)	7.9000	156/177	20	1.5049	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 115 104 115 104 115 10	17	5 6 7 8 9	-0.1254 0.	-56.9493	0 2 3 4 5	0.0000									
11		1Z08.A	R Ras (1.20005e-0)	7.9000	150/177	24	1.6001	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 115 115 115 104 115 10	15	5 6 7 8 9	-0.1288 0.	-56.5491	0 2 4 5 6	0.0000									
12		2TL1.A	R Ras (1.69981e-0)	7.8000	146/177	21	1.3303	1	77 79 83 83 4 0 0 0 1 0 0 0 12 0 0 0 115 104 115 115 104 115 104 104 115 10	18	25 26 27 2	-0.0719 0.	-56.2665	0 2 0 3 4										
13		31CQ.B	G Ras (2.09991e-0)	7.7000	154/177	24	1.5559	1	77 79 83 83 4 0 0 0 1 0 0 0 10 0 0 0 115 104 115 115 115 115 104 115 115 10	15	3 4 5 6 7	-0.0662 0.	-56.1145	0 2 3 4 5										
14		3ESH.A	R Ras (2.99994e-0)	7.5000	155/177	27	1.3961	1	77 79 83 83 4 0 0 0 1 0 0 0 13 0 0 0 115 104 115 115 115 115 104 115 104 11	14	5 6 7 8 9	-0.0834 0.	-56.5194	0 2 4 5 6										
15		3BC1.A	R Ras (1.99986e-0)	7.4000	157/177	26	1.6369							-0.0685 0.	-56.7003	0 2 3 4 26								
16		1BYU.A	P Ras (1.9002e-05)	7.0000	139/177	21	1.6530							0.8366 -0.	-11.2738	3 0 2 0 5 6								
17		231L.A	R Ras (5.40000e-0)	6.6000	150/177	41	1.0635							0.9672 -0.	-98.7091	1 0 2 0 23 4								
18		2RHO.A	S Ras (2.70023e-0)	6.6000	145/177	25	1.3611							-0.0618 0.	-56.6260	0 2 0 0 5								
19		1RYF.A	R Ras (6.09956e-0)	6.5000	156/177	47	0.9504							-0.0935 -0	-27.1135	6 0 0 0 0 0								
20		1XTQ.A	G Ras (4.79954e-0)	6.5000	152/177	27	1.4516							-0.0704 0.	-56.6665	0 2 0 3 4								
21		2P55.A	R Ras (5.00035e-0)	6.4000	142/177	25	1.3078							-0.0637 0.	-56.0073	0 2 0 0 4								
22		2BME.A	R Ras (3.29989e-0)	6.3000	161/177	20	1.3745							-0.0049 0.	-56.4731	0 2 3 4 5								
23		1Z06.A	R Ras (4.70002e-0)	6.3000	149/177	23	1.5031							-0.0052 0.	-56.3211	0 2 0 3 4								
24		2GF0.A	G Ras (4.90004e-0)	6.2000	136/177	22	1.5068							-0.0742 0.	-56.5143	0 2 0 0 5								
25		3ATV.A	R Ras (5.30029e-0)	5.8000	149/177	24	1.6478							-0.0944 0.	-56.4626	0 2 0 4 5								
26		2C2V.B	G Ras (3.69999e-0)	5.6000	141/177	23	1.5145							-0.0753 0.	-56.6064	0 2 0 0 4								



RMSD (Å)

— 200K  
— 210K  
— 220K  
— 230K  
— 300K





# The problem of dimentionalty...

Calculate Descriptors

Database File: c:/dropbox/3\_dv3\_shared/gene1ab/wa\_84/des\_4xol\_cha.mdb

Molecule Field: mol

Auto Select: Database Fields Selected Database Fields Clear Selection

Descriptors Selected: 0

Code	Class	Description
AM1_dipole	1D	Dipole moment
AM1_E	1D	Total energy (kcal/mol)
AM1_Eele	1D	Electronic energy (kcal/mol)
AM1_HF	1D	Heat of formation (kcal)
AM1_HOMO	1D	HOMO energy (eV)
AM1_IP	1D	Ionization potential (eV)
AM1_LUMO	1D	LUMO energy (eV)
apol	2D	Sum of atomic polarizabilities
ASA	1D	Water accessible surface area
ASA+	1D	Positive accessible surface area
ASA-	1D	Negative accessible surface area
ASA_H	1D	Total hydrophobic surface area
ASA_P	1D	Total polar surface area
ast_fraglike	2D	Aster Fragment-like Test
ast_fraglike_ext	2D	Aster Fragment-like Test (Extended)
ast_violation	2D	Aster Fragment-like Violation Count
ast_violation_ext	2D	Aster Fragment-like Violation Count (Extended)
a_acc	2D	Number of H-bond acceptor atoms
a_acid	2D	Number of acidic atoms
a_ar	2D	Number of aromatic atoms
a_base	2D	Number of basic atoms
a_count	2D	Number of atoms
a_donor	2D	Number of H-bond donor atoms
a_donacc	2D	Number of H-bond donor + acceptor atoms
a_heavy	2D	Number of heavy atoms
a_hyd	2D	Number of hydrophobic atoms
a_IC	2D	Atom information content (total)
a_ICM	2D	Atom information content (mean)
a_NB	2D	Number of boron atoms
a_NBr	2D	Number of bromine atoms
a_NC	2D	Number of carbon atoms
a_NCl	2D	Number of chlorine atoms
a_NF	2D	Number of fluorine atoms
a_NH	2D	Number of hydrogen atoms
a_I	2D	Number of iodine atoms
a_N	2D	Number of nitrogen atoms
a_O	2D	Number of oxygen atoms
a_P	2D	Number of phosphorus atoms
a_S	2D	Number of sulfur atoms
atrabian	2D	Balkan averaged distance sum connectivity
BCUT_PEDE_0	2D	PEDE Charge BCUT (0/3)
BCUT_PEDE_1	2D	PEDE Charge BCUT (1/3)
BCUT_PEDE_2	2D	PEDE Charge BCUT (2/3)
BCUT_PEDE_3	2D	PEDE Charge BCUT (3/3)
BCUT_SLOGP_0	2D	LogP BCUT (0/3)
BCUT_SLOGP_1	2D	LogP BCUT (1/3)
BCUT_SLOGP_2	2D	LogP BCUT (2/3)
BCUT_SLOGP_3	2D	LogP BCUT (3/3)
BCUT_SMR_0	2D	Molar Refractivity BCUT (0/3)
BCUT_SMR_1	2D	Molar Refractivity BCUT (1/3)
BCUT_SMR_2	2D	Molar Refractivity BCUT (2/3)
BCUT_SMR_3	2D	Molar Refractivity BCUT (3/3)
apol	2D	Difference of bonded atom polarizabilities
r_1rotN	2D	Number of rotatable single bonds
r_1rotR	2D	Fraction of rotatable single bonds
pre_patch_cdr_ion_4	Protein	Area of 4 largest ionic protein patches near CDRs
pre_patch_cdr_ion_5	Protein	Area of 5 largest ionic protein patches near CDRs
pre_patch_cdr_ion_n	Protein	Count of ionic protein patches near CDRs
pre_patch_cdr_neg_1	Protein	Area of largest negative protein patches near CDRs
pre_patch_cdr_neg_2	Protein	Area of 2 largest negative protein patches near CDRs
pre_patch_cdr_neg_3	Protein	Area of 3 largest negative protein patches near CDRs
pre_patch_cdr_neg_4	Protein	Area of 4 largest negative protein patches near CDRs
pre_patch_cdr_neg_5	Protein	Area of 5 largest negative protein patches near CDRs
pre_patch_cdr_neg_n	Protein	Count of negative protein patches near CDRs
pre_patch_cdr_pos_1	Protein	Area of largest positive protein patches near CDRs
pre_patch_cdr_pos_2	Protein	Area of 2 largest positive protein patches near CDRs
pre_patch_cdr_pos_3	Protein	Area of 3 largest positive protein patches near CDRs
pre_patch_cdr_pos_4	Protein	Area of 4 largest positive protein patches near CDRs
pre_patch_cdr_pos_5	Protein	Area of 5 largest positive protein patches near CDRs
pre_patch_cdr_pos_n	Protein	Count of positive protein patches near CDRs
pre_patch_hyd_1	Protein	Area of largest hydrophobic protein patches near CDRs
pre_patch_hyd_2	Protein	Area of 2 largest hydrophobic protein patches near CDRs
pre_patch_hyd_3	Protein	Area of 3 largest hydrophobic protein patches near CDRs
pre_patch_hyd_4	Protein	Area of 4 largest hydrophobic protein patches near CDRs
pre_patch_hyd_5	Protein	Area of 5 largest hydrophobic protein patches near CDRs
pre_patch_hyd_n	Protein	Count of hydrophobic protein patches near CDRs
pre_patch_ion_1	Protein	Area of largest ionic protein patches near CDRs
pre_patch_ion_2	Protein	Area of 2 largest ionic protein patches near CDRs
pre_patch_ion_3	Protein	Area of 3 largest ionic protein patches near CDRs
pre_patch_ion_4	Protein	Area of 4 largest ionic protein patches near CDRs
pre_patch_ion_5	Protein	Area of 5 largest ionic protein patches near CDRs
pre_patch_ion_n	Protein	Count of ionic protein patches near CDRs
pre_patch_neg_1	Protein	Area of largest negative protein patches near CDRs
pre_patch_neg_2	Protein	Area of 2 largest negative protein patches near CDRs
pre_patch_neg_3	Protein	Area of 3 largest negative protein patches near CDRs
pre_patch_neg_4	Protein	Area of 4 largest negative protein patches near CDRs
pre_patch_neg_5	Protein	Area of 5 largest negative protein patches near CDRs
pre_patch_neg_n	Protein	Count of negative protein patches near CDRs
pre_patch_pos_1	Protein	Area of largest positive protein patches near CDRs
pre_patch_pos_2	Protein	Area of 2 largest positive protein patches near CDRs
pre_patch_pos_3	Protein	Area of 3 largest positive protein patches near CDRs
pre_patch_pos_4	Protein	Area of 4 largest positive protein patches near CDRs
pre_patch_pos_5	Protein	Area of 5 largest positive protein patches near CDRs
pre_patch_pos_n	Protein	Count of positive protein patches near CDRs
pre_pl_3D	Protein	Structure-based pl 3D
pre_pl_ssq	Protein	Sequence-based pl ssq
pre_r_gyr	Protein	Radius of gyration
pre_r_solv	Protein	Hydrophobic radius
pre_ssd_const	Protein	Sedimentation Constant
pre_volume	Protein	Protein Volume
pre_zdipole	Protein	Zeta Dipole Moment
pre_zeta	Protein	Zeta potential at Debye length
pre_zquadrupole	Protein	Zeta Quadrupole Moment
Q_PC+	2D	Total positive partial charge
PEDE_VSA-1	2D	Total negative 1 vdw surface area
PEDE_VSA-2	2D	Total negative 2 vdw surface area
PEDE_VSA-3	2D	Total negative 3 vdw surface area
PEDE_VSA-4	2D	Total negative 4 vdw surface area
PEDE_VSA-5	2D	Total negative 5 vdw surface area
PEDE_VSA-6	2D	Total negative 6 vdw surface area
PEDE_VSA_FHYD	2D	Fractional hydrophobic vdw surface area
PEDE_VSA_FNEG	2D	Fractional negative vdw surface area
PEDE_VSA_FPNEG	2D	Fractional polar negative vdw surface area
PEDE_VSA_FPOL	2D	Fractional polar vdw surface area
PEDE_VSA_FPOS	2D	Fractional positive vdw surface area
PEDE_VSA_FPPPOS	2D	Fractional polar positive vdw surface area
PEDE_VSA_HYD	2D	Total hydrophobic vdw surface area
PEDE_VSA_NEG	2D	Total negative vdw surface area
PEDE_VSA_PNEG	2D	Total polar negative vdw surface area
PEDE_VSA_POL	2D	Total polar vdw surface area
PEDE_VSA_POS	2D	Total positive vdw surface area
PEDE_VSA_PPOS	2D	Total polar positive vdw surface area
peptidean	2D	(diameter - radius) / radius
peptideanSC	2D	(diameter - radius) / radius
PM3_dipole	1D	Dipole moment
PM3_E	1D	Total energy (kcal/mol)
PM3_Eele	1D	Electronic energy (kcal/mol)
PM3_HF	1D	Heat of formation (kcal)
PM3_HOMO	1D	HOMO energy (eV)
PM3_IP	1D	Ionization potential (eV)
PM3_LUMO	1D	LUMO energy (eV)
pm1	1D	Principal moment inertia (1)
pm2	1D	Principal moment inertia (2)
pm3	1D	Principal moment inertia (3)
pm4	1D	Principal moment inertia (4)
pm5	1D	Principal moment inertia (5)
pm6	1D	Principal moment inertia (6)
pm7	1D	Principal moment inertia (7)
pm8	1D	Principal moment inertia (8)
pm9	1D	Principal moment inertia (9)
pm10	1D	Principal moment inertia (10)
pm11	1D	Principal moment inertia (11)
pm12	1D	Principal moment inertia (12)
pm13	1D	Principal moment inertia (13)
pm14	1D	Principal moment inertia (14)
pm15	1D	Principal moment inertia (15)
pm16	1D	Principal moment inertia (16)
pm17	1D	Principal moment inertia (17)
pm18	1D	Principal moment inertia (18)
pm19	1D	Principal moment inertia (19)
pm20	1D	Principal moment inertia (20)
pm21	1D	Principal moment inertia (21)
pm22	1D	Principal moment inertia (22)
pm23	1D	Principal moment inertia (23)
pm24	1D	Principal moment inertia (24)
pm25	1D	Principal moment inertia (25)
pm26	1D	Principal moment inertia (26)
pm27	1D	Principal moment inertia (27)
pm28	1D	Principal moment inertia (28)
pm29	1D	Principal moment inertia (29)
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pm31	1D	Principal moment inertia (31)
pm32	1D	Principal moment inertia (32)
pm33	1D	Principal moment inertia (33)
pm34	1D	Principal moment inertia (34)
pm35	1D	Principal moment inertia (35)
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pm43	1D	Principal moment inertia (43)
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pm50	1D	Principal moment inertia (50)
pm51	1D	Principal moment inertia (51)
pm52	1D	Principal moment inertia (52)
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pm64	1D	Principal moment inertia (64)
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pm68	1D	Principal moment inertia (68)
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pm71	1D	Principal moment inertia (71)
pm72	1D	Principal moment inertia (72)
pm73	1D	Principal moment inertia (73)
pm74	1D	Principal moment inertia (74)
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pm77	1D	Principal moment inertia (77)
pm78	1D	Principal moment inertia (78)
pm79	1D	Principal moment inertia (79)
pm80	1D	Principal moment inertia (80)
pm81	1D	Principal moment inertia (81)
pm82	1D	Principal moment inertia (82)
pm83	1D	Principal moment inertia (83)
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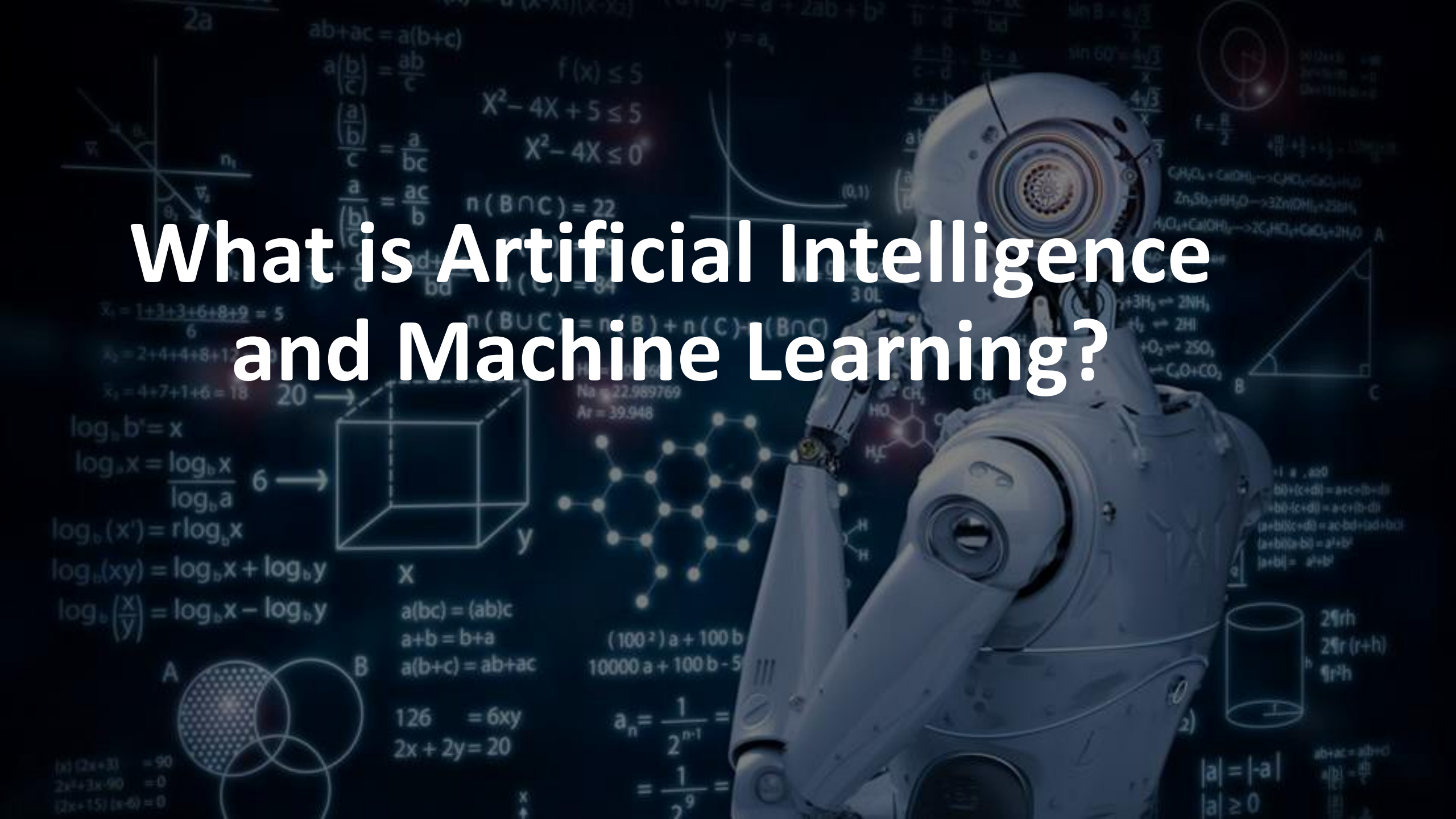




***Now what?***



# What is Artificial Intelligence and Machine Learning?

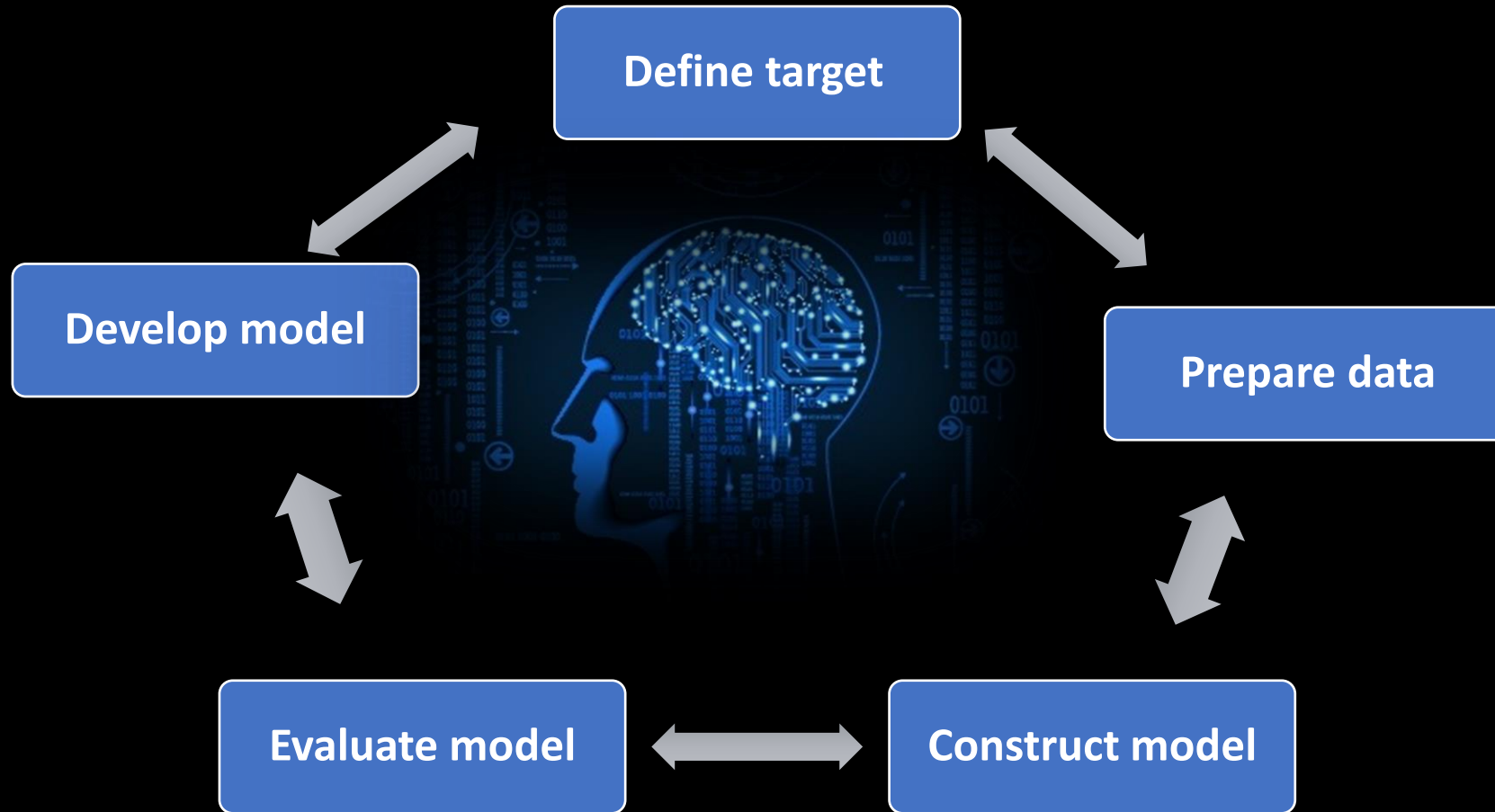


The background is a collage of mathematical concepts:

- Top Left:** A coordinate plane with a line passing through points  $P_1, P_2, P_3, P_4$  and a point  $Q$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .
- Top Center:** A box with  $x \geq 3$ ,  $x^2 - 4x + 5 \leq 5$ , and  $x^2 - 4x \leq 0$ .
- Top Right:** A diagram of a sphere with a point  $P$  and a line  $l$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .
- Middle Left:** A 3D box with dimensions  $20$ ,  $6$ , and  $6$ . Formulas include  $\log_2 16 = 4$ ,  $\log_2 16 = 4$ , and  $\log_2 16 = 4$ .
- Middle Center:** A Venn diagram with two overlapping circles labeled  $X$  and  $Y$ . Formulas include  $\log_2(x^2) = \log_2 x$ ,  $\log_2(xy) = \log_2 x + \log_2 y$ , and  $\log_2\left(\frac{x}{y}\right) = \log_2 x - \log_2 y$ .
- Middle Right:** A diagram of a cylinder with a point  $P$  and a line  $l$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .
- Bottom Left:** A Venn diagram with two overlapping circles labeled  $A$  and  $B$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .
- Bottom Center:** A diagram of a cylinder with a point  $P$  and a line  $l$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .
- Bottom Right:** A diagram of a cylinder with a point  $P$  and a line  $l$ . Formulas include  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ ,  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ , and  $\frac{1}{a} + \frac{1}{b} = \frac{1}{c}$ .



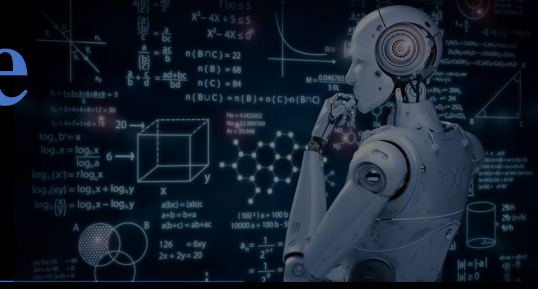
# Machine Learning Process



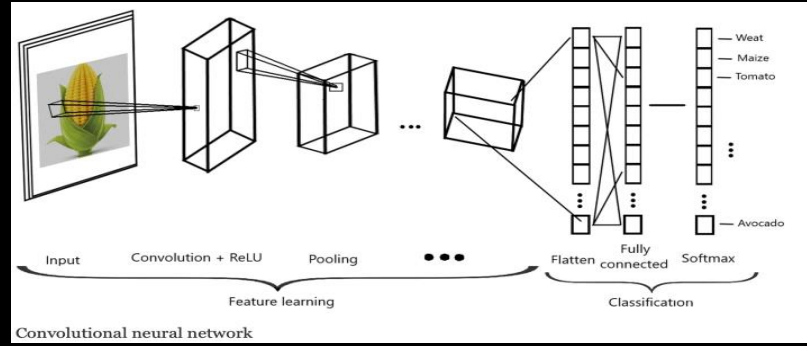




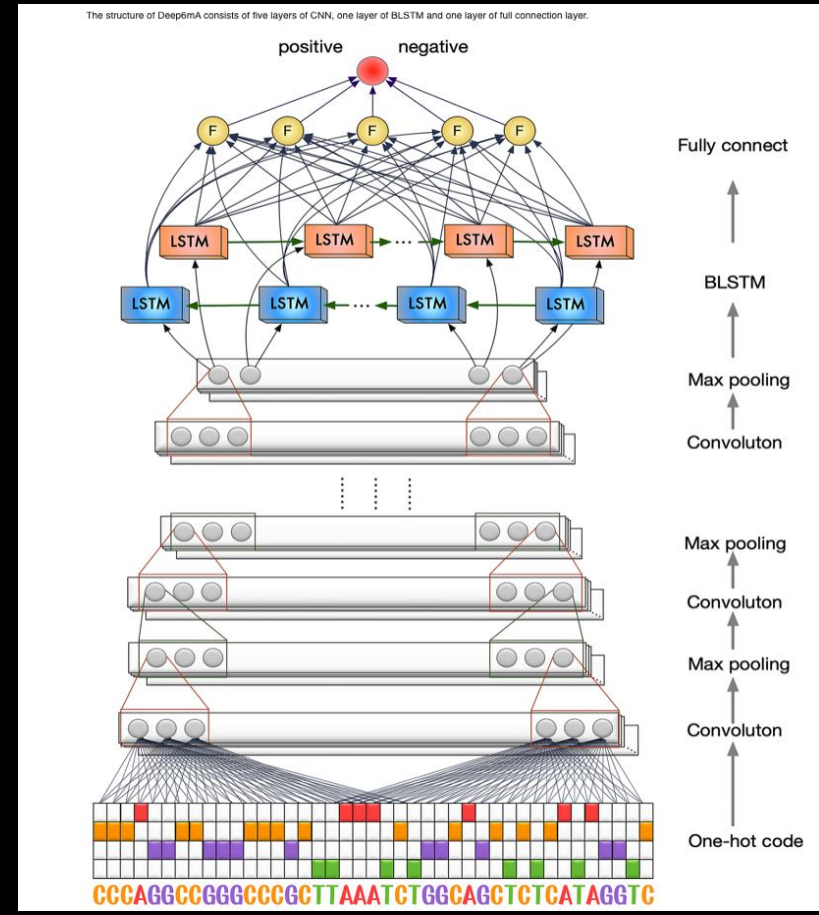
# Applications of AI and ML in the Life Sciences



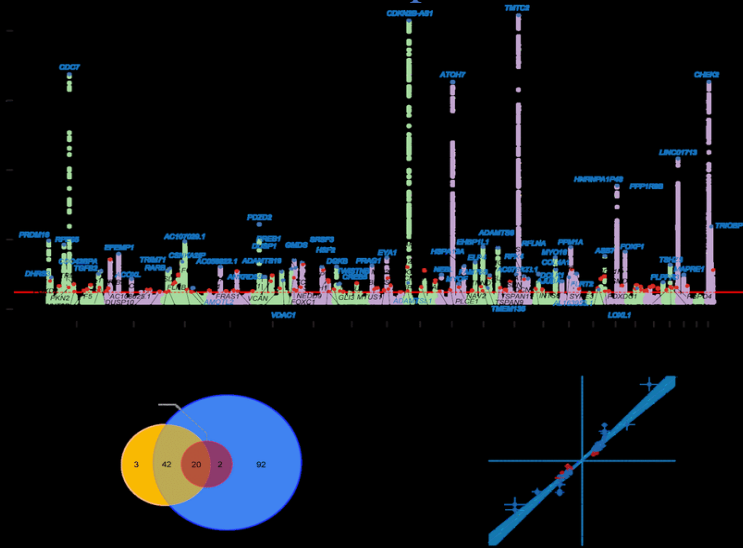
## Genomics through image processing



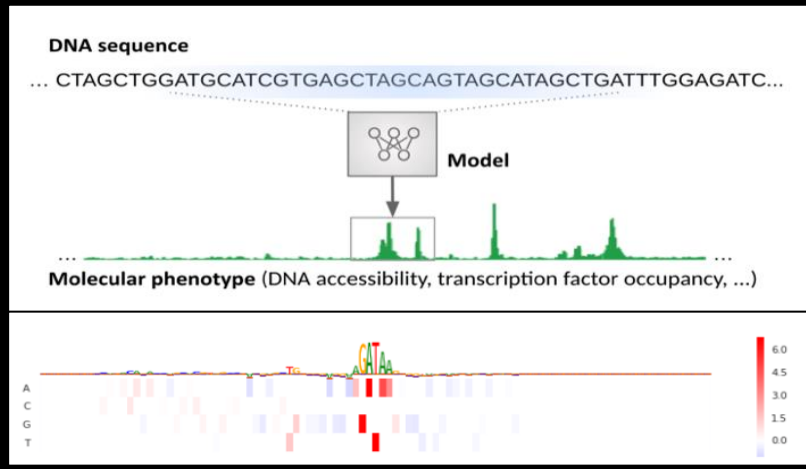
## Model discovery on methylation



## Genomic comparisons

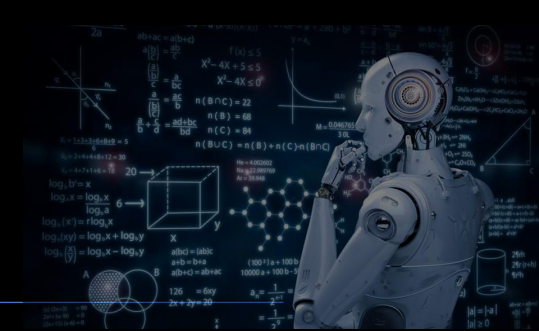


## Transcriptional and posttranscriptional models of gene regulation

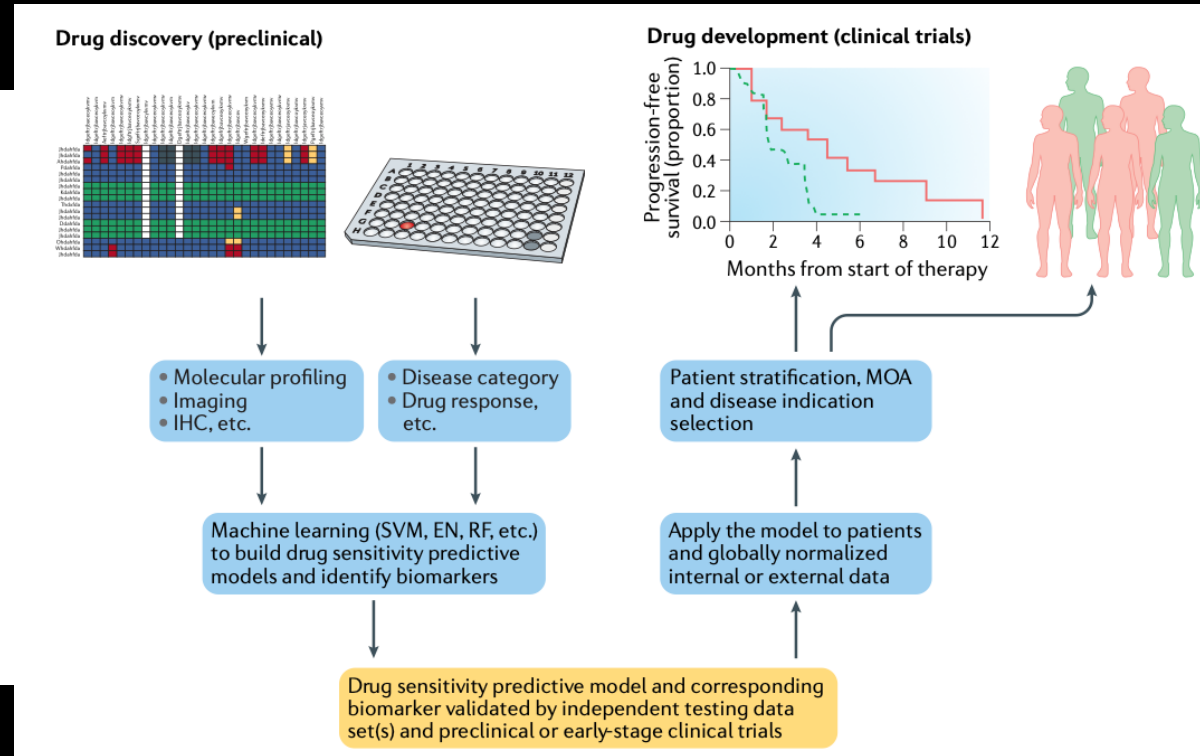
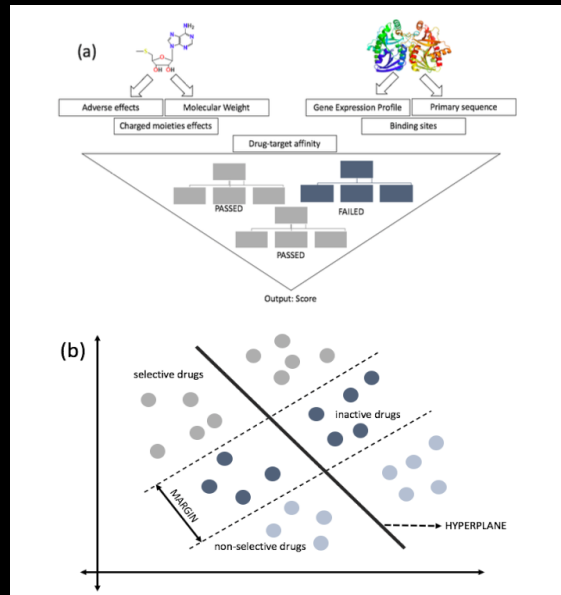




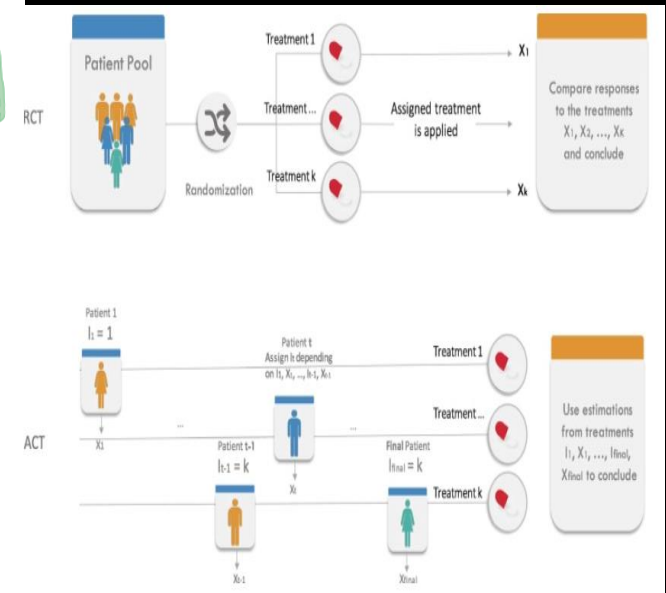
# Applications of AI and ML in the Life Sciences



## Drug Discovery



## Clinical Trials



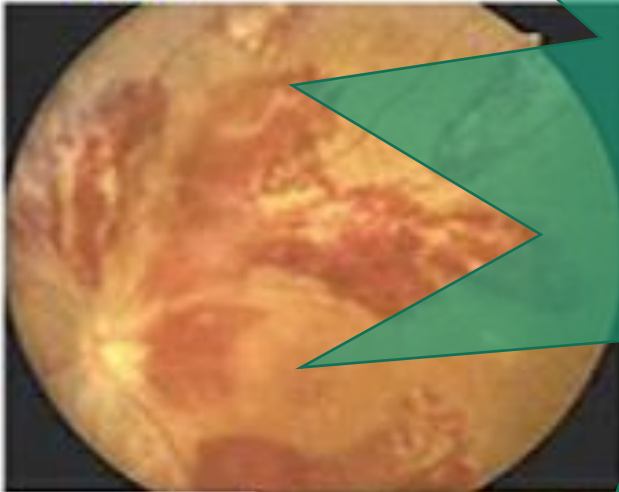
## Development and Evaluation of Medicines



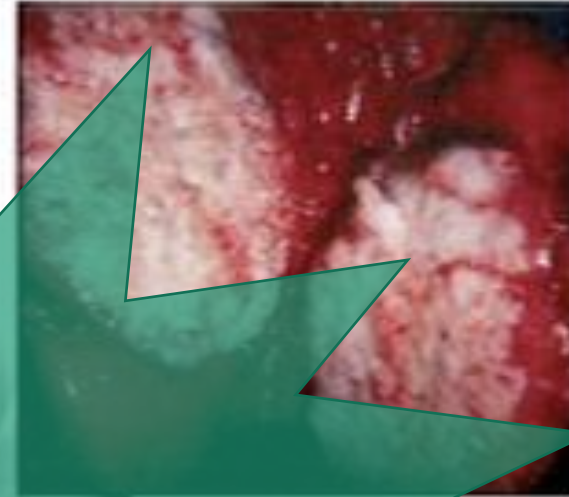
HSV



CMV



Cancer



flu



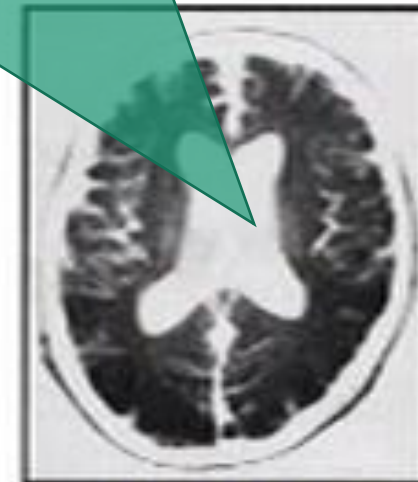
VV/Smallpox



OA



VZV



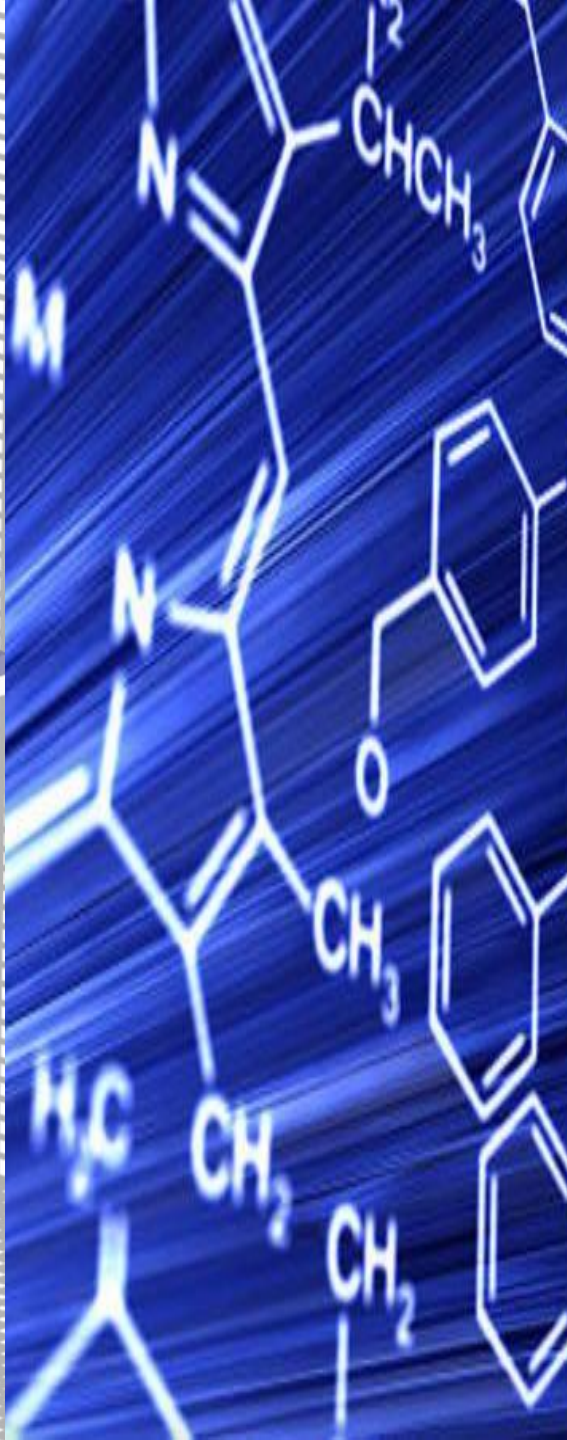
HIV/AIDS



Hepatitis B/C

We NEED drugs!







# The Brave New World is Here !!

