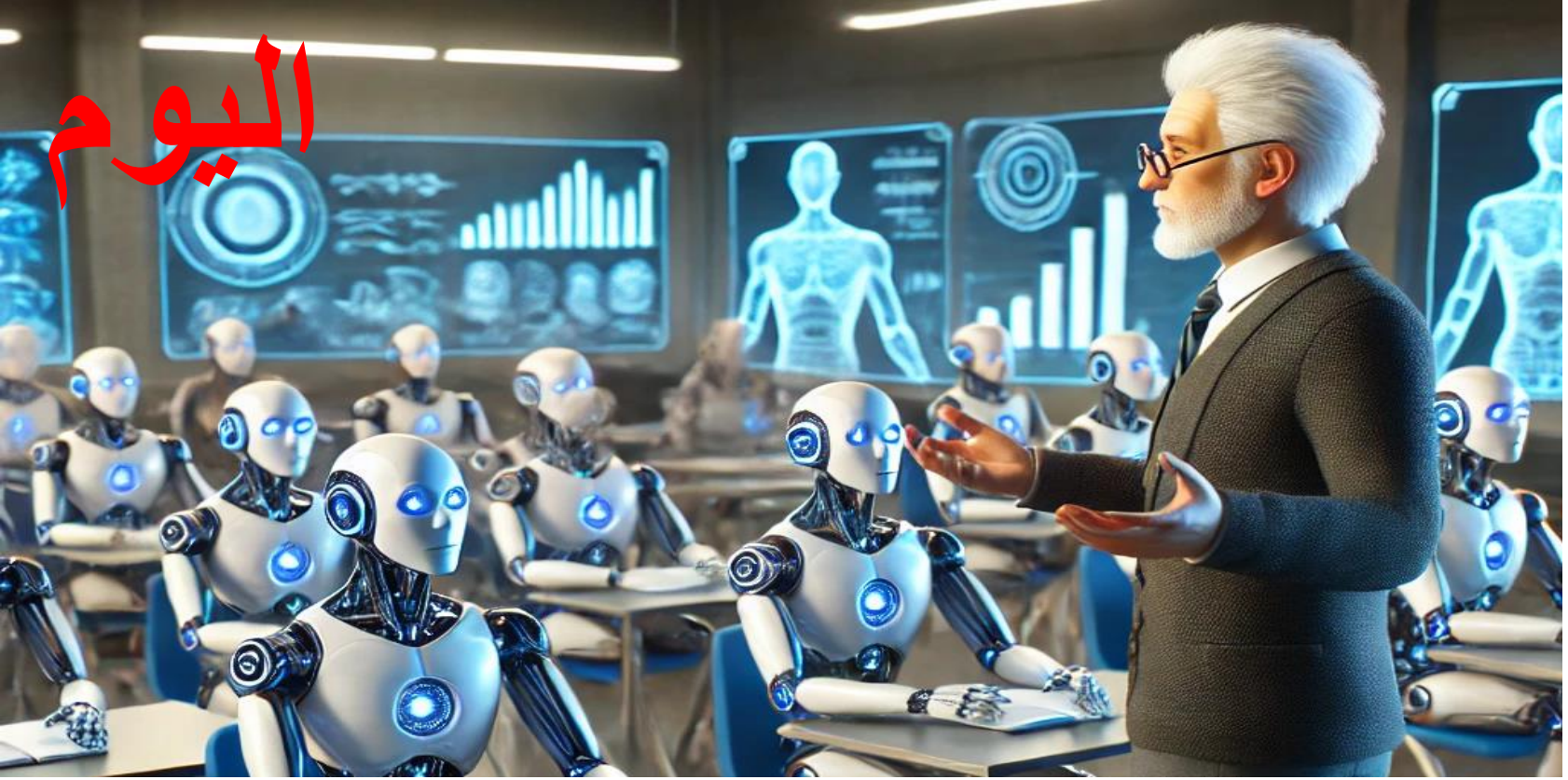
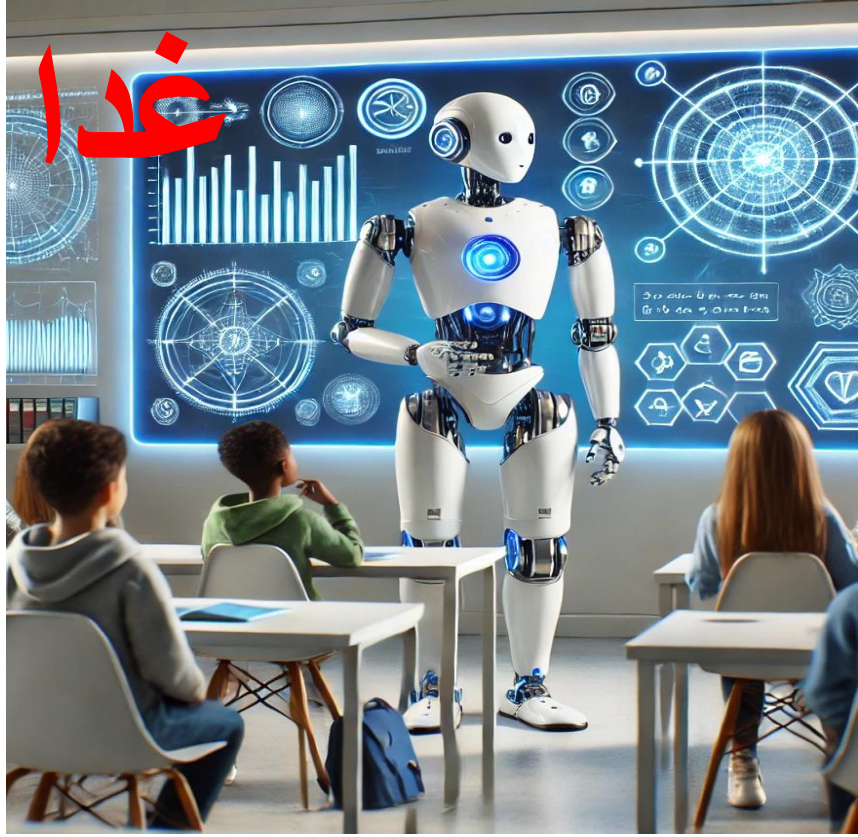




Foundations of Artificial Intelligence

اساسيات الذكاء الاصطناعي

Prof. Mostafa ZAHRI
Department of Mathematics
University of Sharjah
Taourirt Dec. 31st , 2024

جامعة الشارقة
UNIVERSITY OF SHARJAH

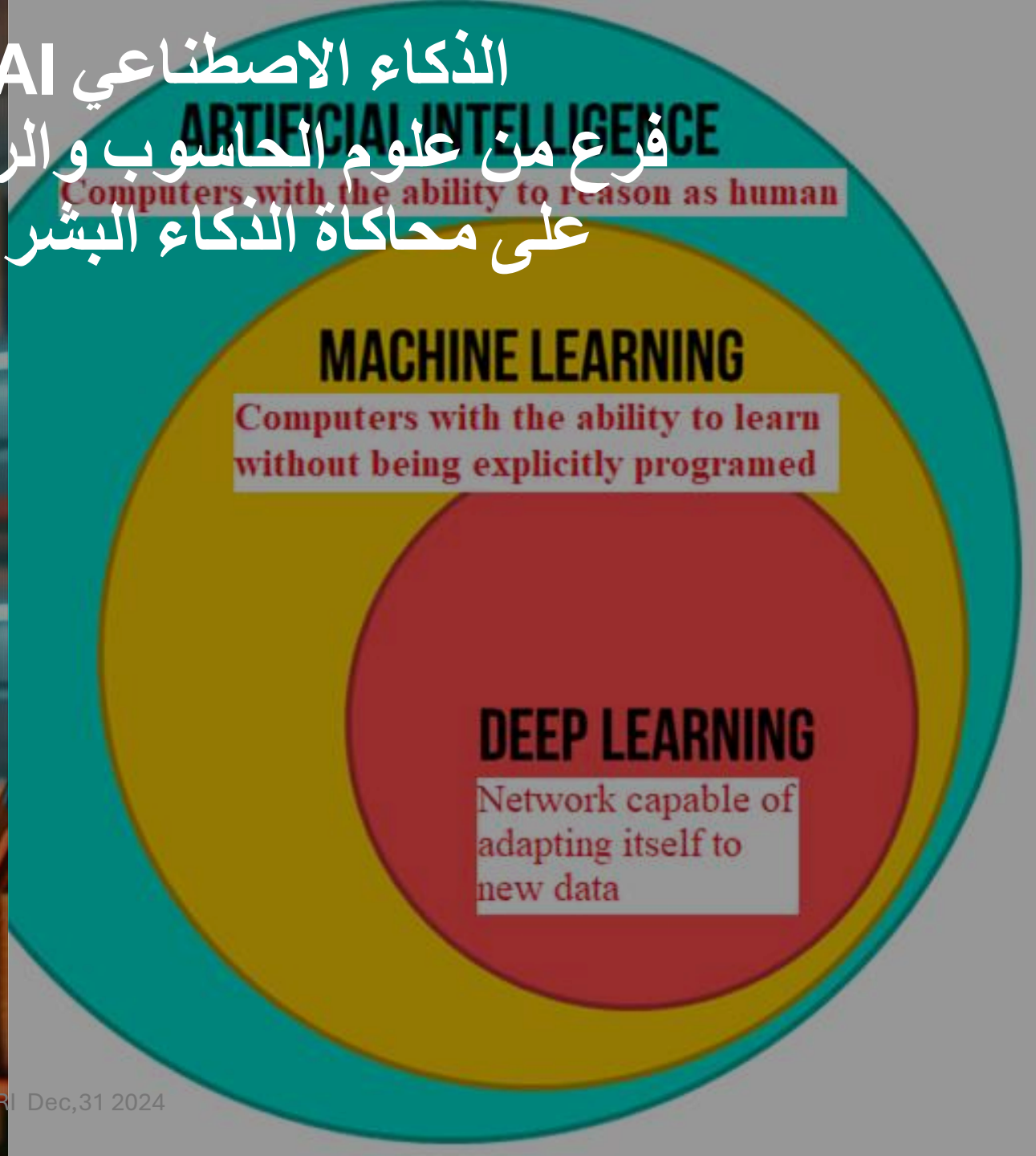
What we will learn

- The mathematical concept of Artificial intelligence
- The machine learning (How it works)
- AI-Reading of Images (Cat)
- AI-Reading of Images (Numbers)
- The Large language model (Example)
- Examples from different fields.

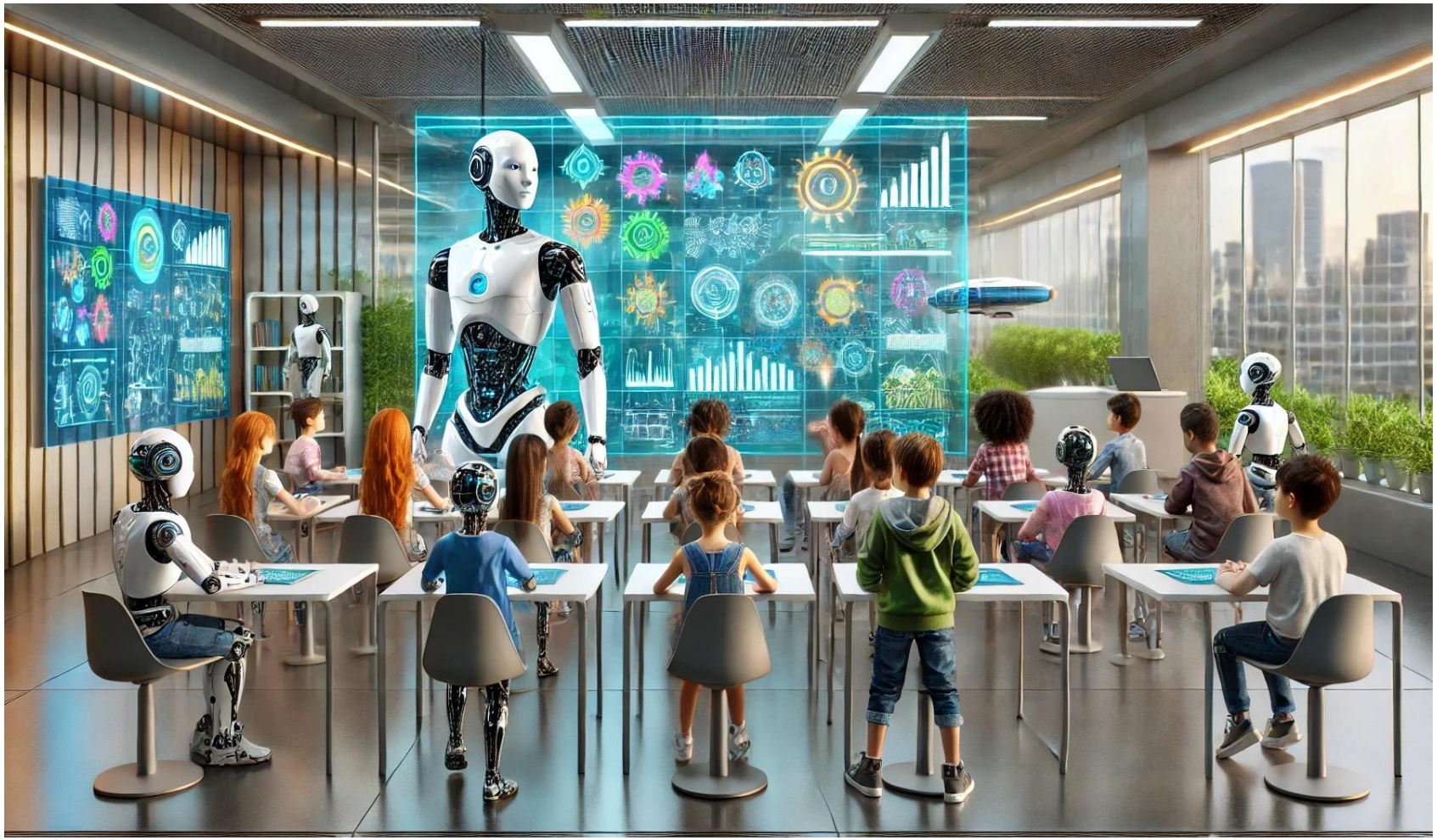
Artificial Intelligence - AI الذكاء الاصطناعي

فرع من علوم الحاسوب و الرياضيات يهدف إلى تطوير أنظمة قادرة على محاكاة الذكاء البشري من خلال التعلم واتخاذ القرارات.





After tomorrow - بعد الغد



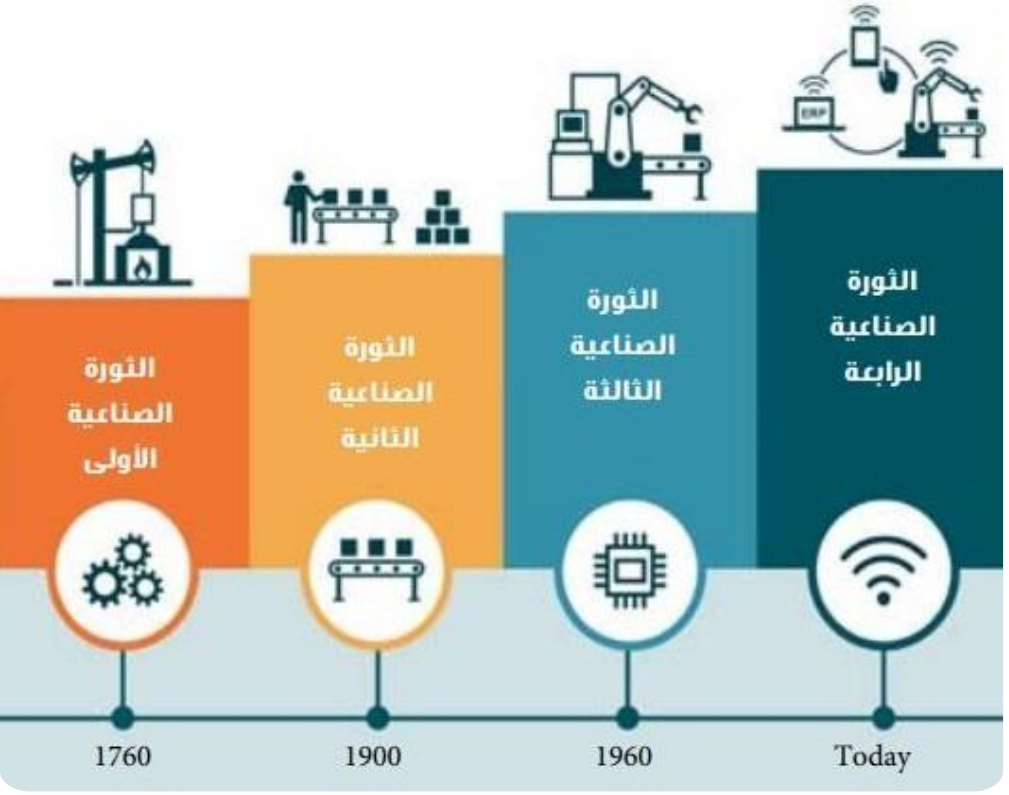
Machines and Humans are learning together: The Rebotomy vs Anatomy.

تعلم الالة والانسان : علم التشريح للإنسان وللألة

Mostafa ZAHRI Dec,31 2024

الثورات الصناعية الاربع

1. الثورة الصناعية الأولى (القرن الثامن عشر) استخدام الطاقة الميكانيكية بفضل الآلة البخارية.
2. الثورة الصناعية الثانية (أواخر القرن التاسع عشر وأوائل القرن العشرين) استخدام الكهرباء كمصدر طاقة.
3. الثورة الصناعية الثالثة (منتصف القرن العشرين) ظهور الإلكترونيات والحواسيب.



4. الثورة الصناعية الرابعة (القرن الحادي والعشرون)

- ✓ ظهور التقنيات الذكية مثل الذكاء الاصطناعي (AI) ،
- ✓ وإنترنت الأشياء (IoT) ، والروبوتات المتقدمة.
- ✓ استخدام البيانات الضخمة
- ✓ والحوسبة السحابية
- ✓ وتقنيات الطباعة ثلاثية الأبعاد.
- ✓ دمج العوالم الرقمية والبيولوجية والمادية.

How do we recognize objects?



قطيطة



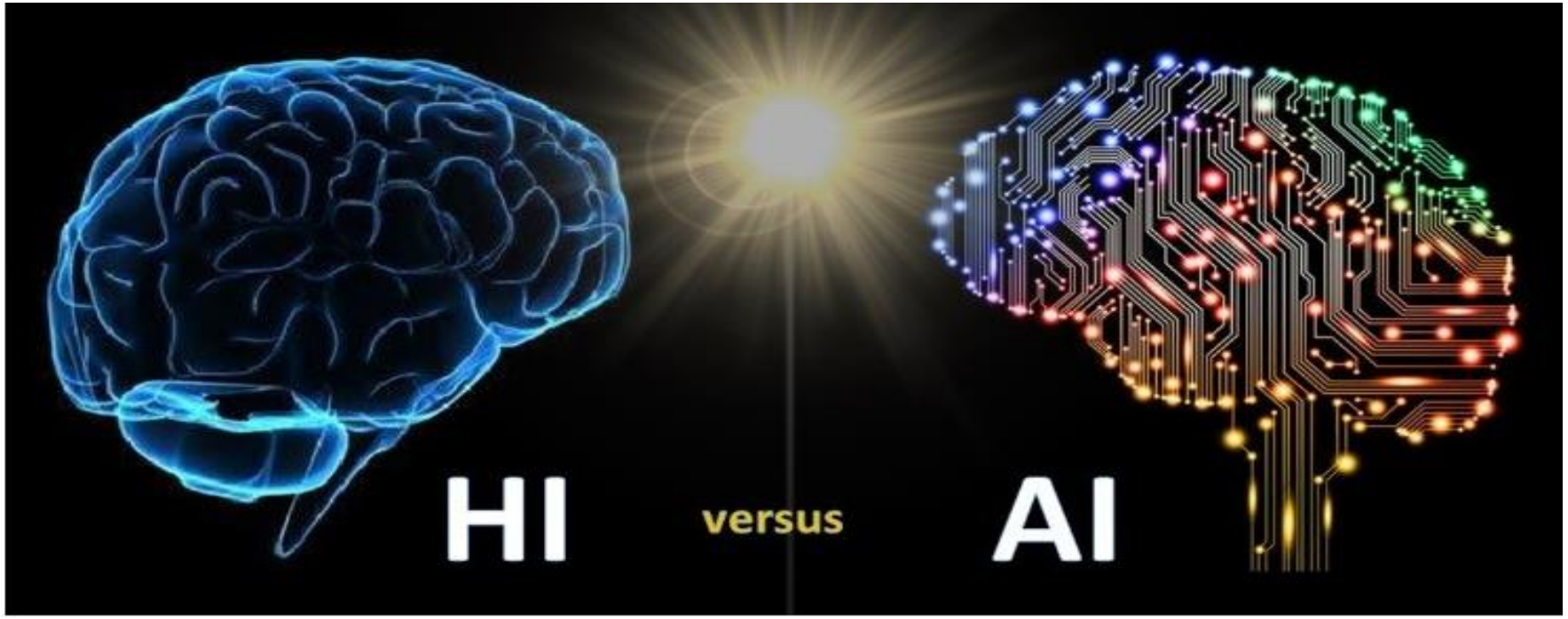
حيوان؟

خلايانا العصبية تخزن معلومات مشابهة

Human Neural Networks vs Artificial Neural Networks

الشبكات العصبية البشرية مقابل الشبكات العصبية الاصطناعية

الشبكات العصبية الاصطناعية
مستوحات من الشبكة العصبية للدماغ







This is a Cat

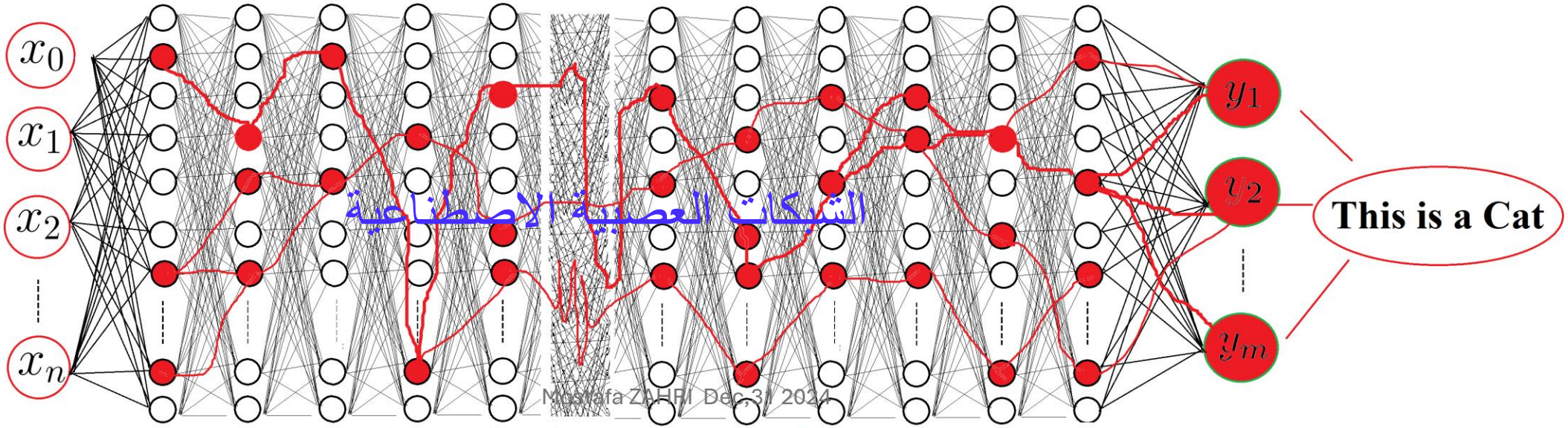
HNN

Hidden Layers

Input data

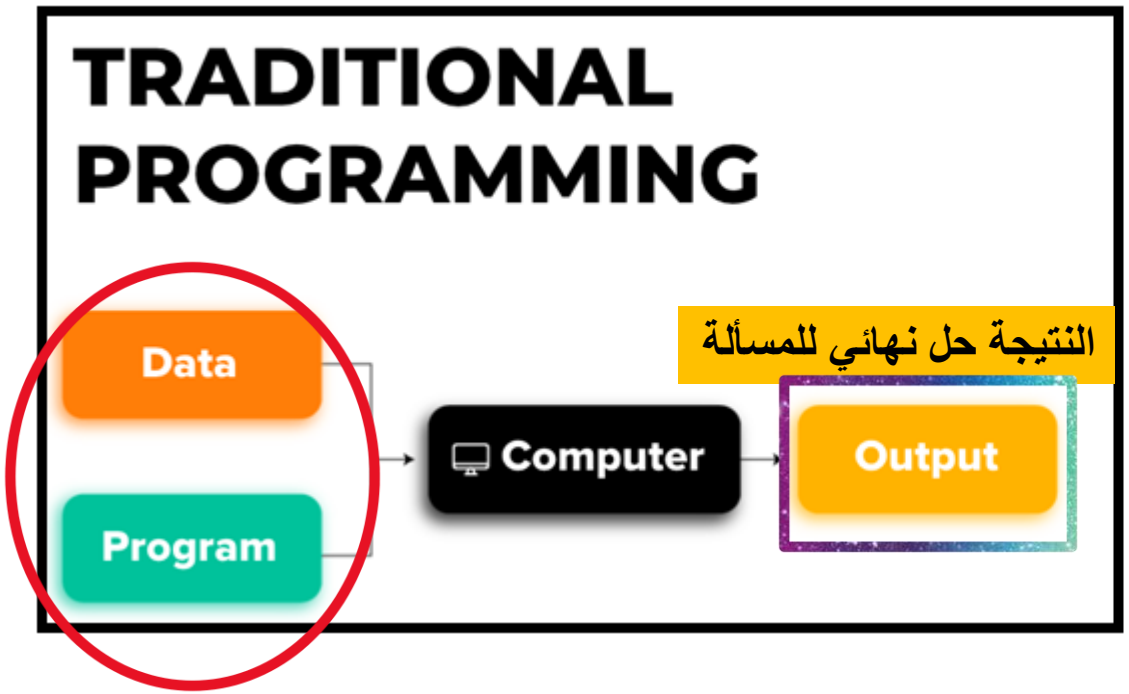
Output data

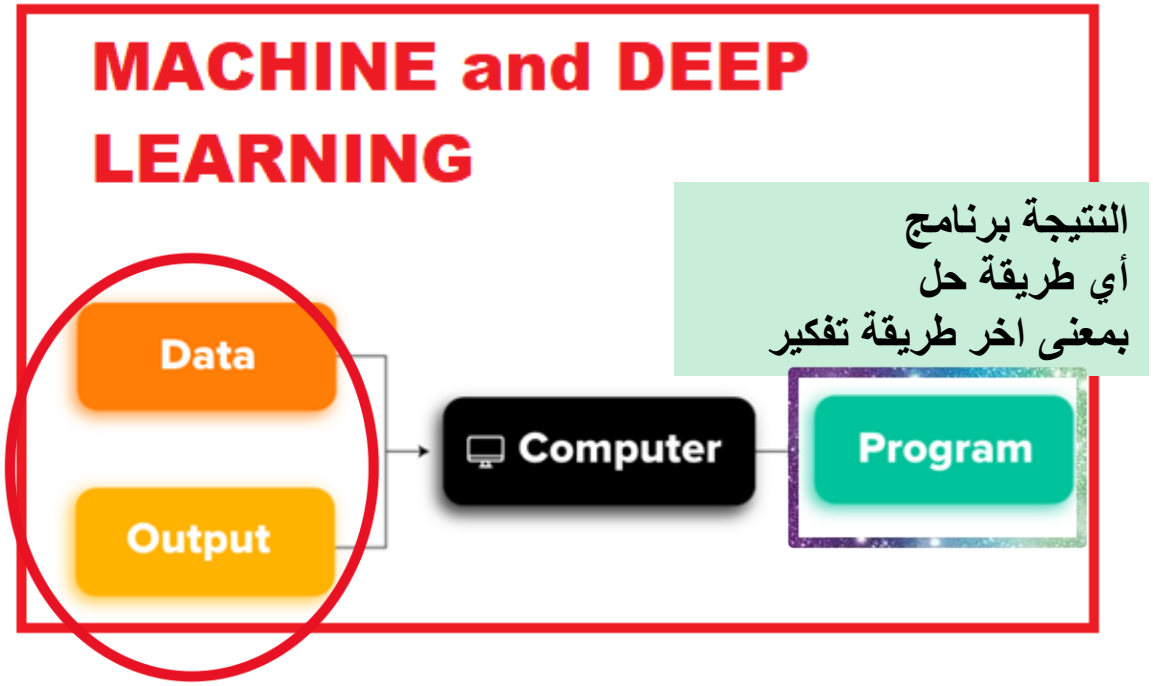




Artificial Neural Network

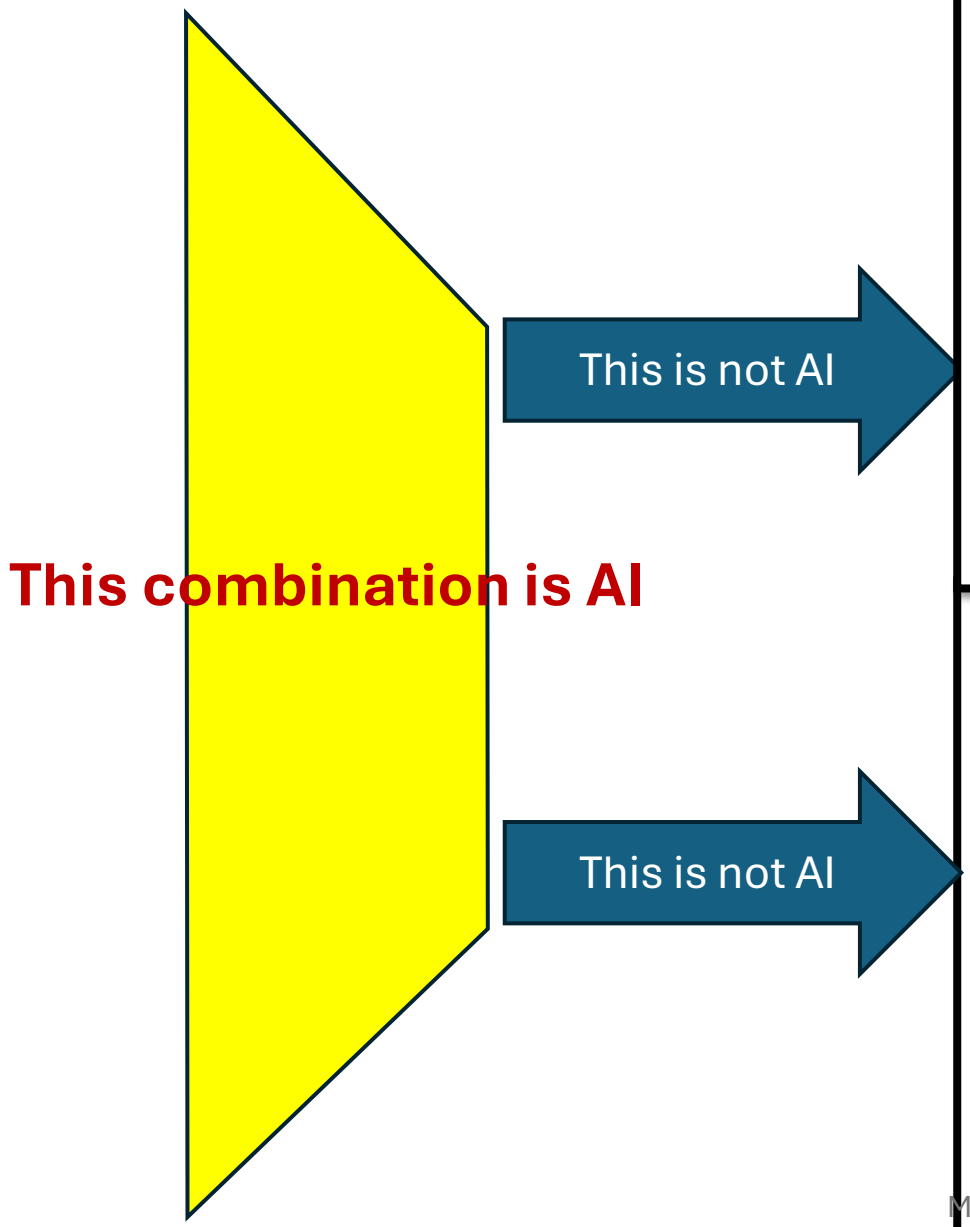
مقارنة بين برمجيات الذكاء الاصطناعي والبرمجة التقليدية





Common between AI, ML, and DL

Chat with ChatGPT



give me an example of a quadratic equation and the solution

Here's an example of a quadratic equation and its solution:

Example:

Solve the quadratic equation:

$$x^2 - 5x + 6 = 0$$

Steps to Solve:

1. **Identify the coefficients**: The quadratic equation is in the form $ax^2 + bx + c = 0$, where:
   - $a = 1$ (the coefficient of x^2),
   - $b = -5$ (the coefficient of x),
   - $c = 6$ (the constant term).

Give me an easy example

Sure! Here's a simpler example of a quadratic equation and its solution:

Example:

Solve the quadratic equation:

$$x^2 - 4 = 0$$

Steps to Solve:

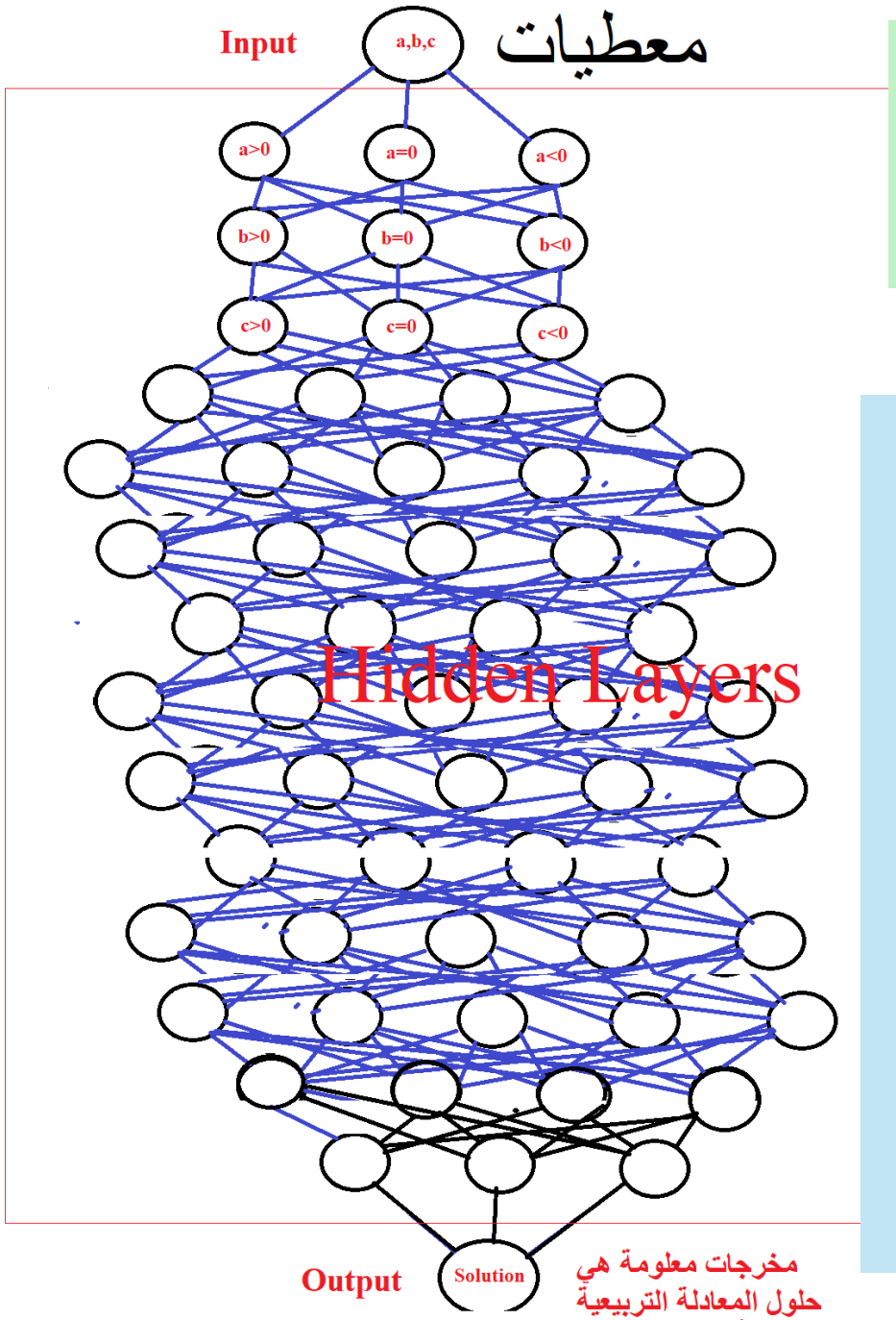
1. **Move the constant to the other side**: Add 4 to both sides to isolate x^2:

$$x^2 = 4$$

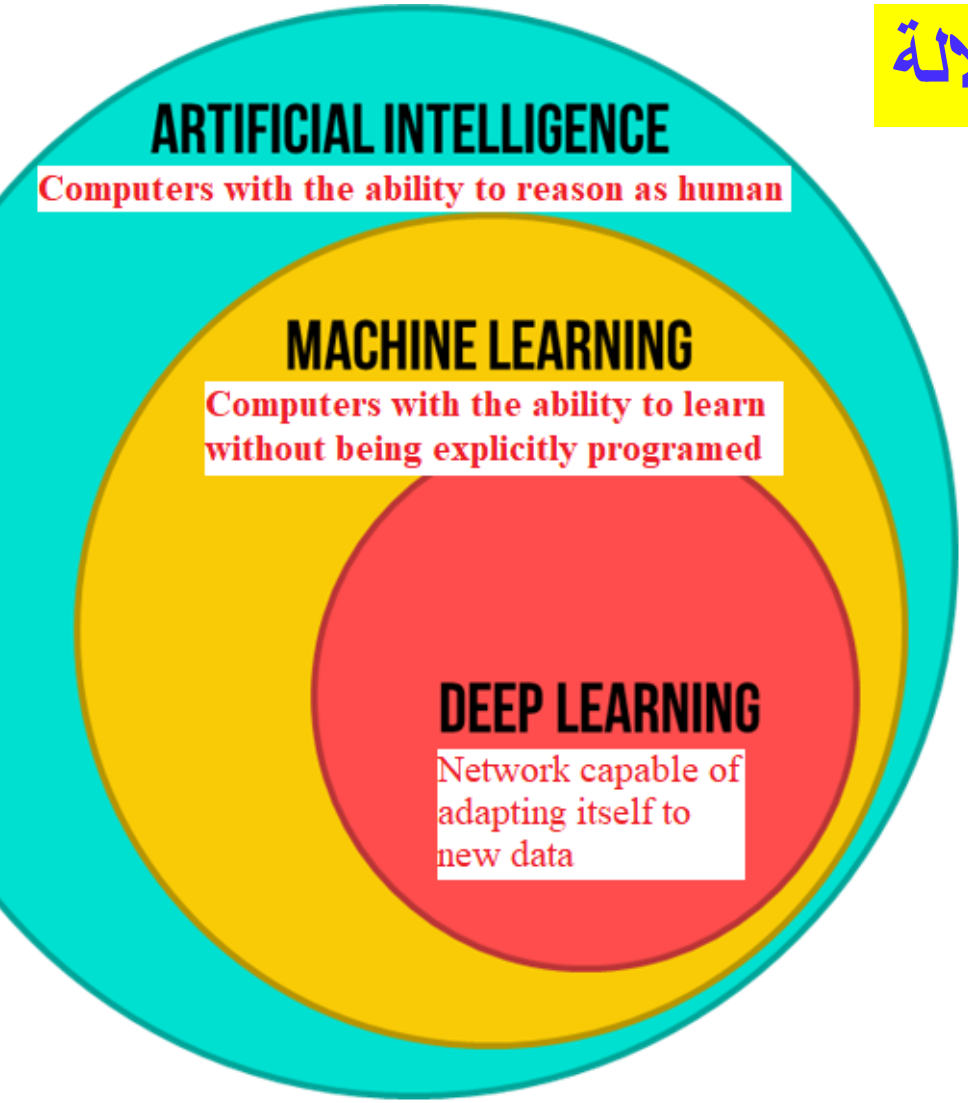
2. **Take the square root of both sides**: To solve for x, take the square root of both sides:

$$x = \pm\sqrt{4}$$

مثال : كيفية تدريب الشبكة العصبية للذكاء الاصطناعي

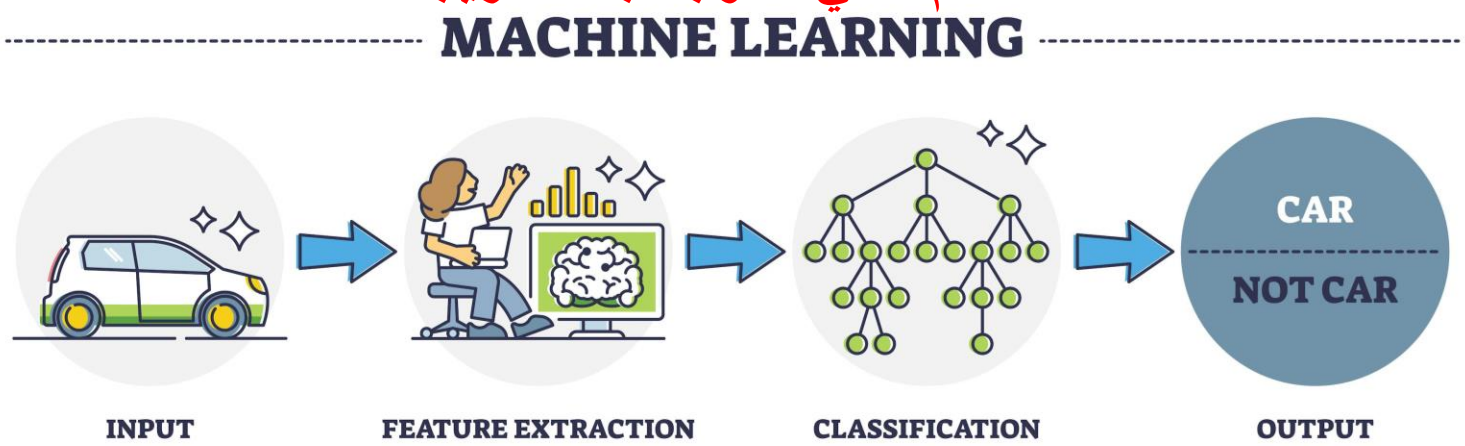


- نفترض ان ندرب الحاسوب على حل المعادلات التربيعية دون سابق معرفة بطرق الحل:
- نغدي الشبكة بمجموعة ضخمة من المعطيات على شكل
- (a,b,c) → (x0) حل وحيد
- (a,b,c) → (x1,x2) حل ثنائي
- (a,b,c) → (0) لا حل
- ...
- **بعد ذلك نعطي للشبكة (a,b,c) ونطلب الحل بناءا على التجربة المكتسبة من التدريب --> يتم توقع الحل وليس حسابه**

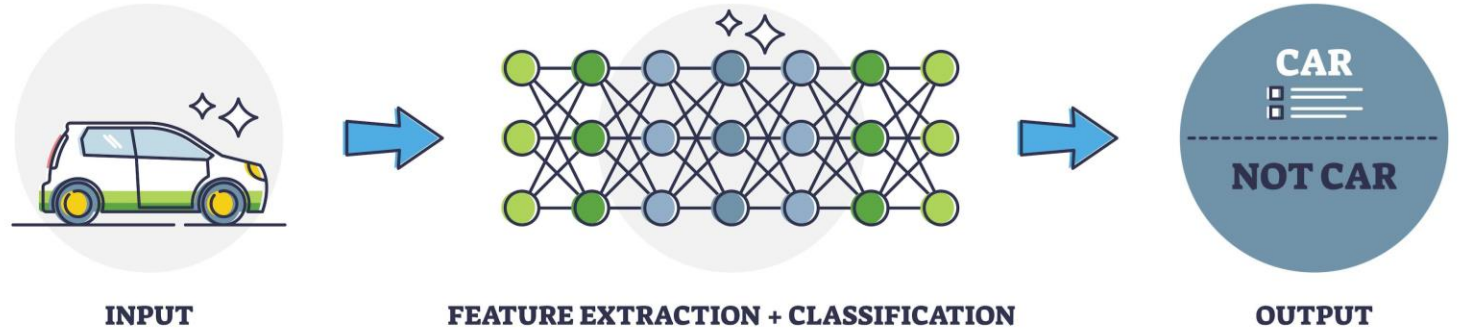


الذكاء الاصطناعي هو التعلم الالي: كيف تتعلم الالة

التعلم الالي الموجه بعد الدريب

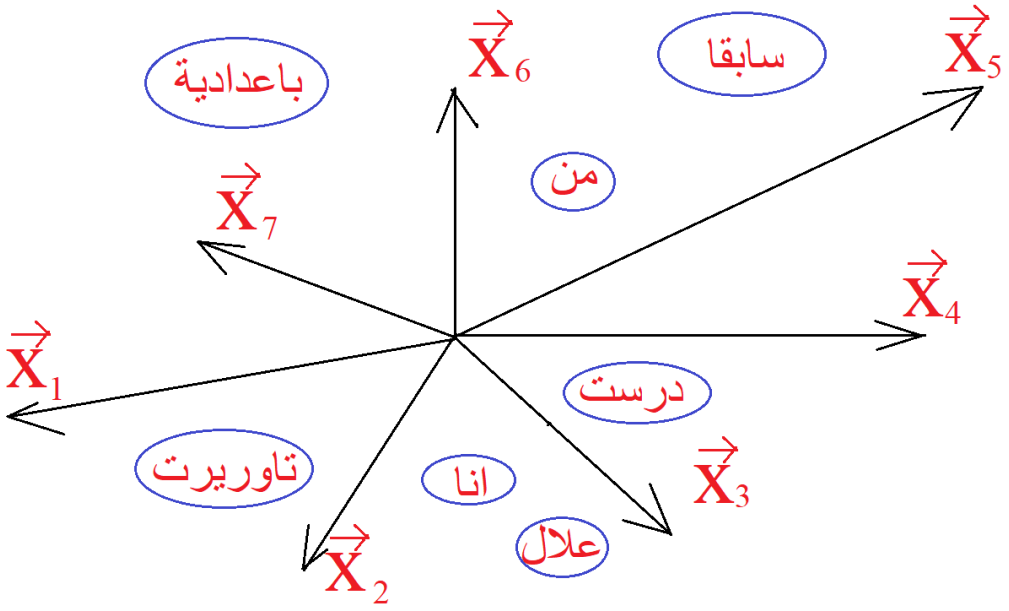


التعلم الالي الذاتي



النموذج اللغوي الاكبر LLM – Large Language Model

انا من تاوريرت درست سابقا باعدادية علال



سابقا = [6.253, −3.405, −0.104, −6.092, 5.368, −1.638, −1.345, −0.138, 6.382, 1.405]

من = [4.606, −4.788, −0.478, 2.092, 3.547, 5.277, 2.925, 6.372, −3.545, 5.998]

درست = [0.955, 2.156, 6.222, −6.767, 0.425, 1.602, 0.209, −0.910, 2.632, 6.286]

علال = [−0.059, −4.281, −1.423, −0.476, 4.229, 2.104, 5.118, 2.101, 4.118, −3.484]

تاوريرت = [−2.712, −2.415, −2.673, 0.847, −2.876, 6.968, −0.719, 0.398, −0.537, −6.280]

انا = [4.233, −5.409, −5.318, −6.870, −6.603, 0.552, 3.943, 3.643, 4.748, −4.073]

باعدادية = [−2.862, 5.677, −1.768, 2.380, −6.400, −5.119, −3.773, 4.567, 6.448, −0.994]

إضافة بن عبد الله للجملة أعلاه

- **يتطلب إضافة اتجاه ثامن ل بن**
- **واتجاه تاسع ل عبد**
- **واتجاه عاشر ل الله**

ChatGpt needs 96 layers to recognize the word, Kitten

Real Case ChatGPT مثال من

The word vector for **kitten** from Fares et al. (2017)

[-0.026059472933411598, 0.0819200724363327, -0.03782853111624718,
-0.002372768707573414, 0.017853455618023872, -0.010323595255613327
0.039157990366220474, -0.058086372911930084, 0.015318121761083603,
-0.10645580291748047, -0.004456744529306889, 0.023313766345381737,
0.025088327005505562, 0.007215415127575397 5, -0.013688554055988785
-0.03298889845609665, -0.004386535380035639, -0.04709241911768913,
0.04769571125507355, -0.006803441792726517, 0.005545333959162235,
0.025991084054112434, -0.03940916806459427, -0.002753516659140587,
-0.031202999874949455, 0.04800510033965111, 0.004792094696313143,
-0.012802486307919025, 0.0065046814270317554, 0.004128053784370422
-0.07111172378063202, -0.03835855424404144, -0.1093975305557251,
-0.03261841461062431, -0.08141417056322098, -0.1750892847776413,
-0.02986721694469452, -0.019759630784392357, -0.05967727303504944,
0.03591247275471687, 0.019785955548286438, -0.0537031814455986,
0.03070545755326748, 0.009812678210437298, -0.06506845355033875,
-0.07733407616615295, -0.023483071476221085, -0.05530179291963577,
0.10370959341526031, -0.033689409494400024, -0.023546922951936722,



- GPT-3 may use between 1,024 and 3,072 dimensions to describe one word.

دقة اكبر تعني خلايا عصبية اكثر

More accuracy needs a large number of Layers

Language Modeling → Large Language Model LLM

الذكاء الاصطناعي لديه القدرة على تخزين البيانات واسترجاعها واستخدامها بطرق مختلفة تُعرف غالبًا باسم الذاكرة أو آليات تخزين البيانات.

- **الذاكرة قصيرة المدى (تخزين مؤقت)**
- **الذاكرة طويلة المدى (التخزين الدائم)**

ذاكرة الذكاء الاصطناعي خزنت كلمت رمضان

المسافة بين رمضان والكلمات المقترحة هي الاقرب



Language Modeling → Large Language Model

1. **Probabilistic methods.**
2. **Neural network-based modern language models**

Suppose we're calculating the probability of the word "w1" occurring after the word "w2," then the formula for this is as follows:

```
count(really like) / count(really)
= 1 / 3
= 0.33
```

```
count(really appreciate) / count(really)
= 1 / 3
= 0.33

count(really sorry) / count(really)
= 1 / 3
= 0.33
```

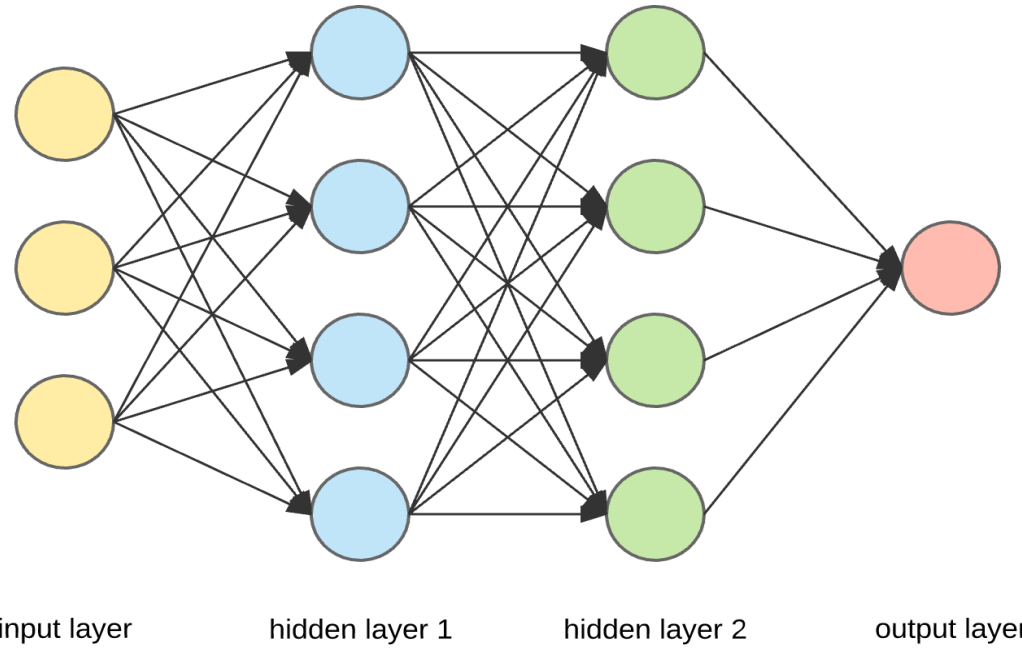
- **Counting Process,**
- **Conditional Probability,**
- **Probability depending on the language.**

The process will continue calculating the probability of the word "w3" occurring after the words "w2," and "w1" …..

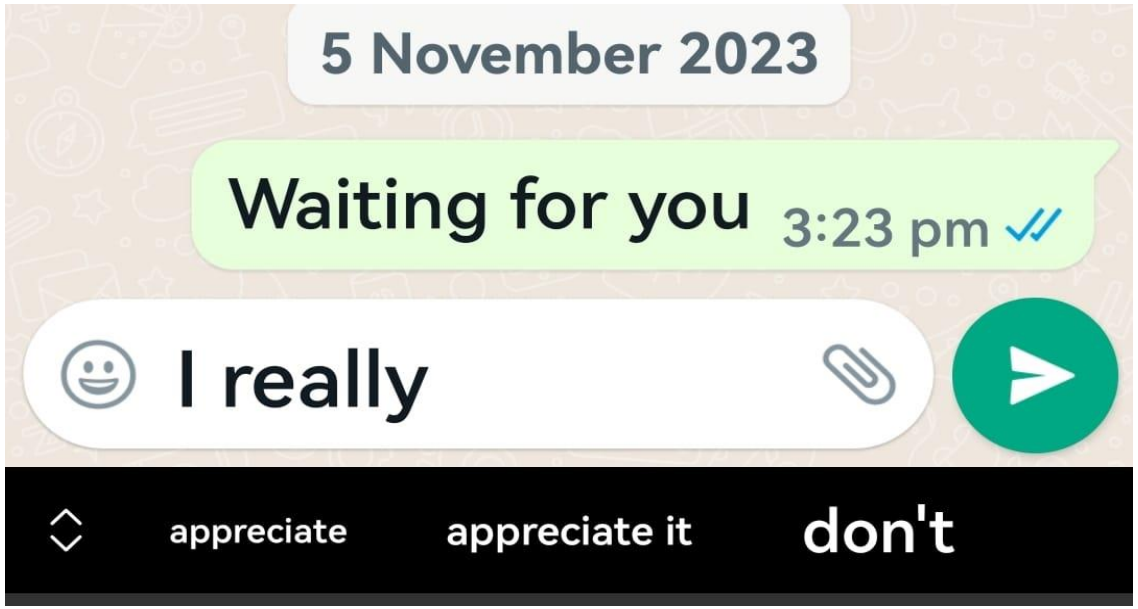
Language Modeling

1. **Probabilistic methods.**
2. **Neural network-based modern language models**

- **Counting Process,**
- **Conditional Probability,**
- **Probability depending on the language.**

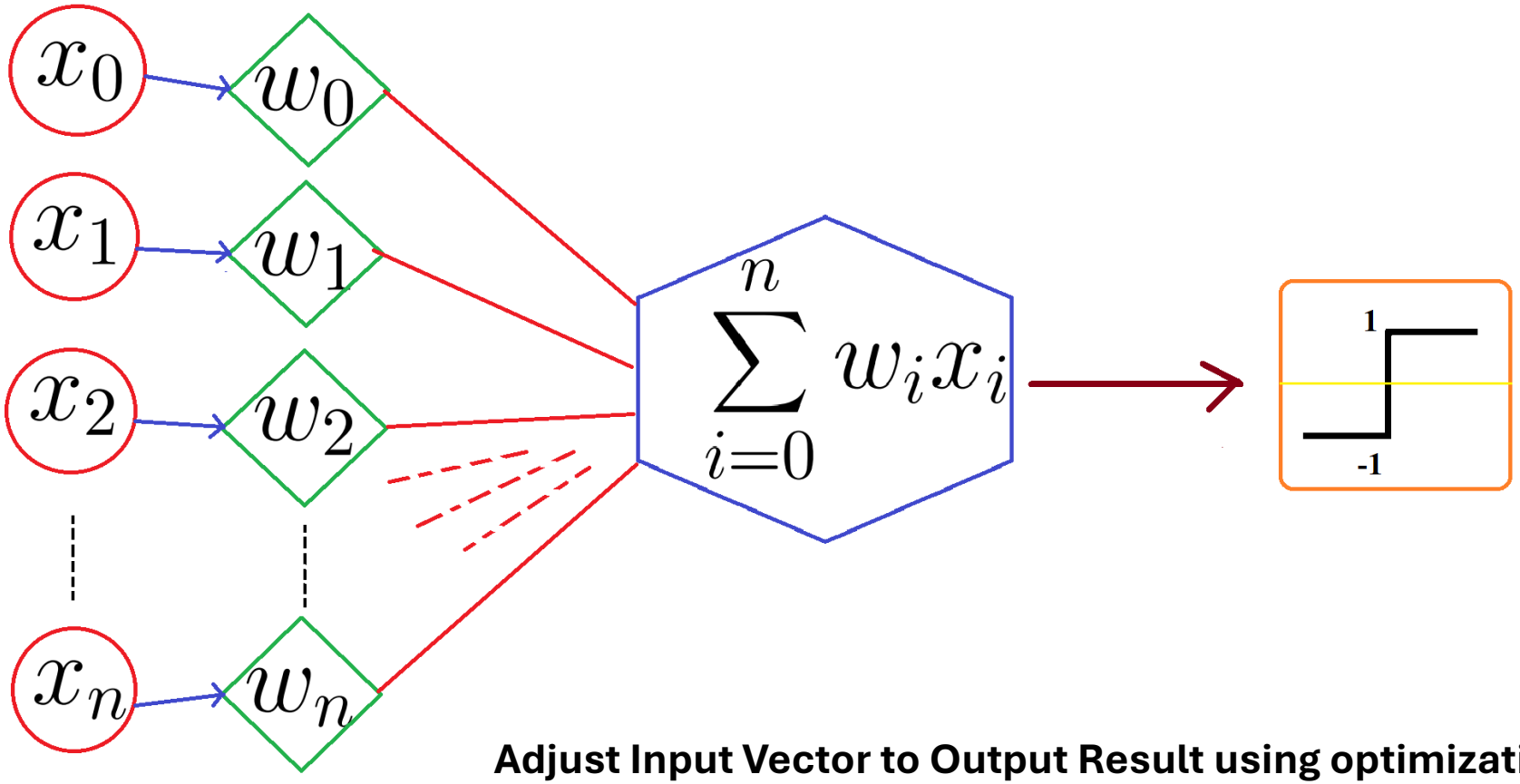


Example WhatsApp



“appreciate” is one of the suggestions

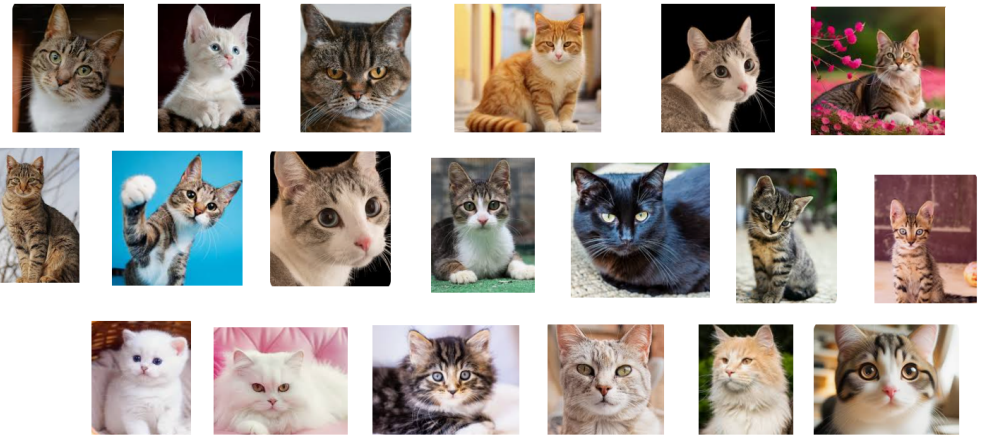
تدريب" الشبكات العصبية الاصطناعية

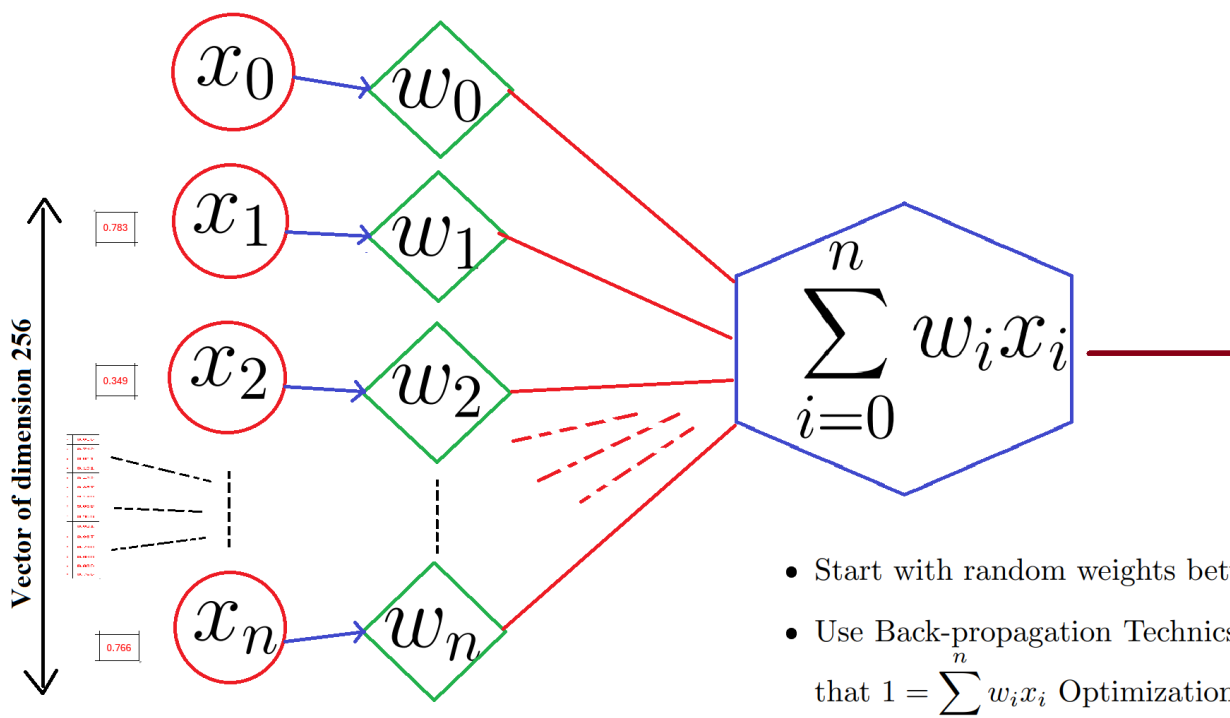


Adjust Input Vector to Output Result using optimization techniques



0.783	0.573	0.648	0.534	0.361	0.855	0.889	0.724	0.773	0.732	0.540	0.511	0.630	0.416	0.016
0.349	0.952	0.949	0.622	0.862	0.563	0.890	0.485	0.209	0.979	0.285	0.923	0.606	0.478	0.742
0.334	0.884	0.396	0.686	0.080	0.025	0.729	0.793	0.622	0.598	0.357	0.946	0.492	0.766	0.011
0.237	0.480	0.216	0.188	0.389	0.466	0.584	0.246	0.200	0.843	0.301	0.307	0.529	0.513	0.191
0.640	0.952	0.089	0.589	0.920	0.637	0.863	0.497	0.924	0.380	0.554	0.581	0.015	0.899	0.432
0.456	0.369	0.080	0.276	0.100	0.229	0.114	0.331	0.388	0.251	0.838	0.538	0.110	0.346	0.357
0.907	0.842	0.579	0.082	0.554	0.382	0.050	0.779	0.182	0.432	0.804	0.587	0.269	0.405	0.180
0.246	0.777	0.121	0.827	0.492	0.798	0.423	0.008	0.952	0.887	0.112	0.196	0.852	0.788	0.058
0.119	0.314	0.852	0.766	0.579	0.742	0.236	0.766	0.920	0.809	0.920	0.375	0.508	0.987	0.968
0.590	0.049	0.006	0.776	0.488	0.466	0.237	0.845	0.848	0.653	0.240	0.862	0.185	0.097	0.021
0.217	0.278	0.806	0.368	0.822	0.814	0.396	0.881	0.123	0.044	0.819	0.365	0.835	0.448	0.097
0.000	0.481	0.263	0.982	0.385	0.423	0.226	0.300	0.400	0.725	0.568	0.563	0.318	0.542	0.748
0.046	0.414	0.662	0.882	0.134	0.689	0.044	0.268	0.756	0.506	0.651	0.911	0.127	0.003	0.646
0.610	0.814	0.010	0.402	0.139	0.840	0.242	0.961	0.283	0.797	0.805	0.782	0.730	0.145	0.899
0.012	0.189	0.502	0.165	0.329	0.076	0.316	0.501	0.624	0.534	0.988	0.119	0.229	0.600	0.766



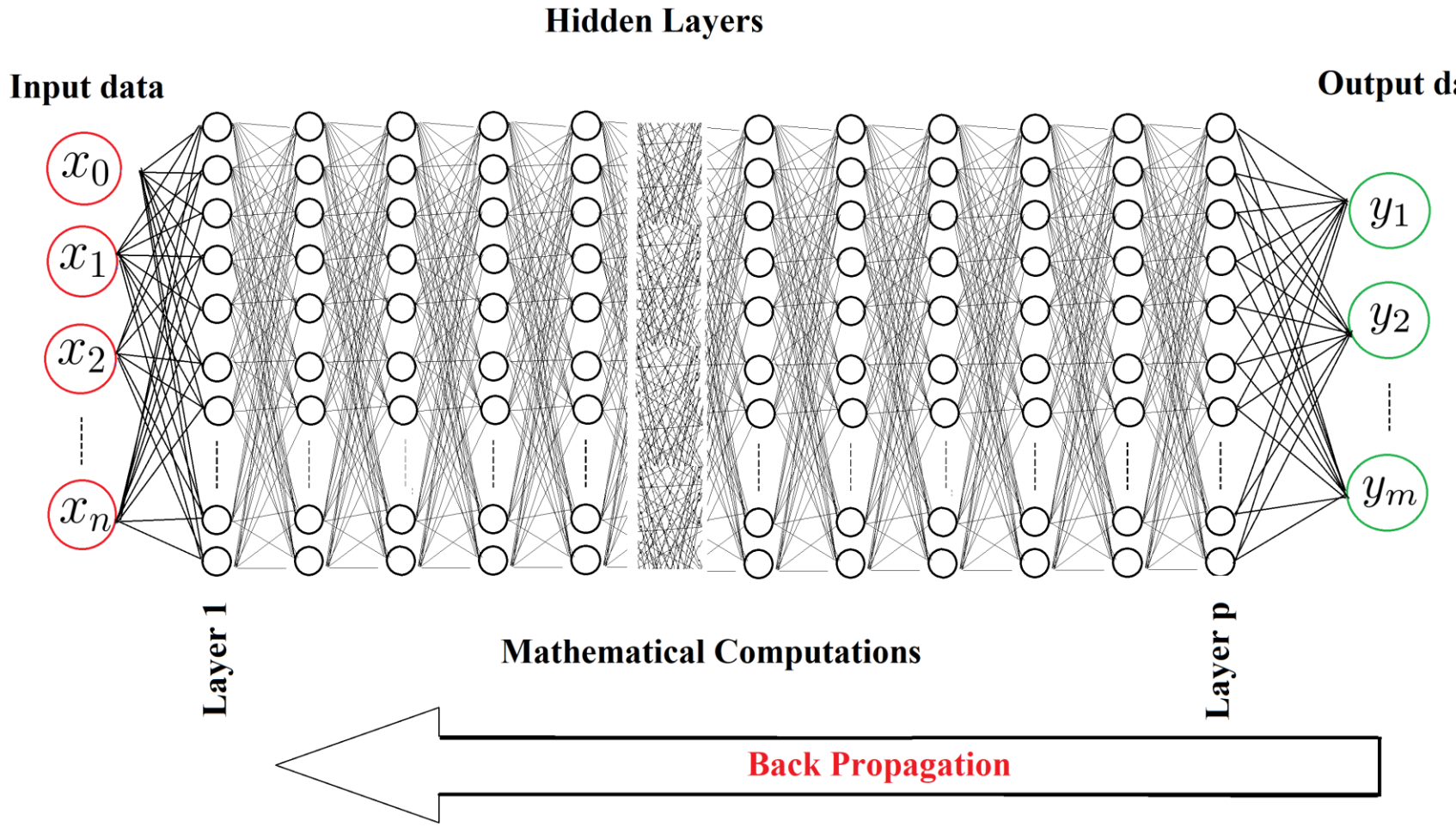


16x16 pixels = 256

- Start with random weights between -1 and 1
- Use Back-propagation Technics for estimating the best choice of w_i such that $1 = \sum_{i=0}^{n} w_i x_i$ Optimization problem
- Repeat this process million times
- Result: The computer will learn how to detect the image of a Cat.

Back Propagation in Neural Network: Machine Learning Algorithm

1. Error Calculation (Forward Pass)
2. Gradient Computation (Backward Pass)
3. Weight Update (Optimization Step)



Machine Training using (Input, Output)=(X,Y)

Mathematical Modeling of Input-output Training

Consider the mapping $F : \mathbb{R}^{n+1} \to \mathbb{R}^m, \quad f(x_0, x_1, x_2, \ldots, x_n) = (y_1, y_2, \ldots, y_m).$

F is said to be stable if small changes in the input $\mathbf{x} = (x_0, x_1, \ldots, x_n)$ result in small changes in the output $\mathbf{y} = (y_1, y_2, \ldots, y_m)$.
One formal definition of stability is the *Lipschitz condition*:

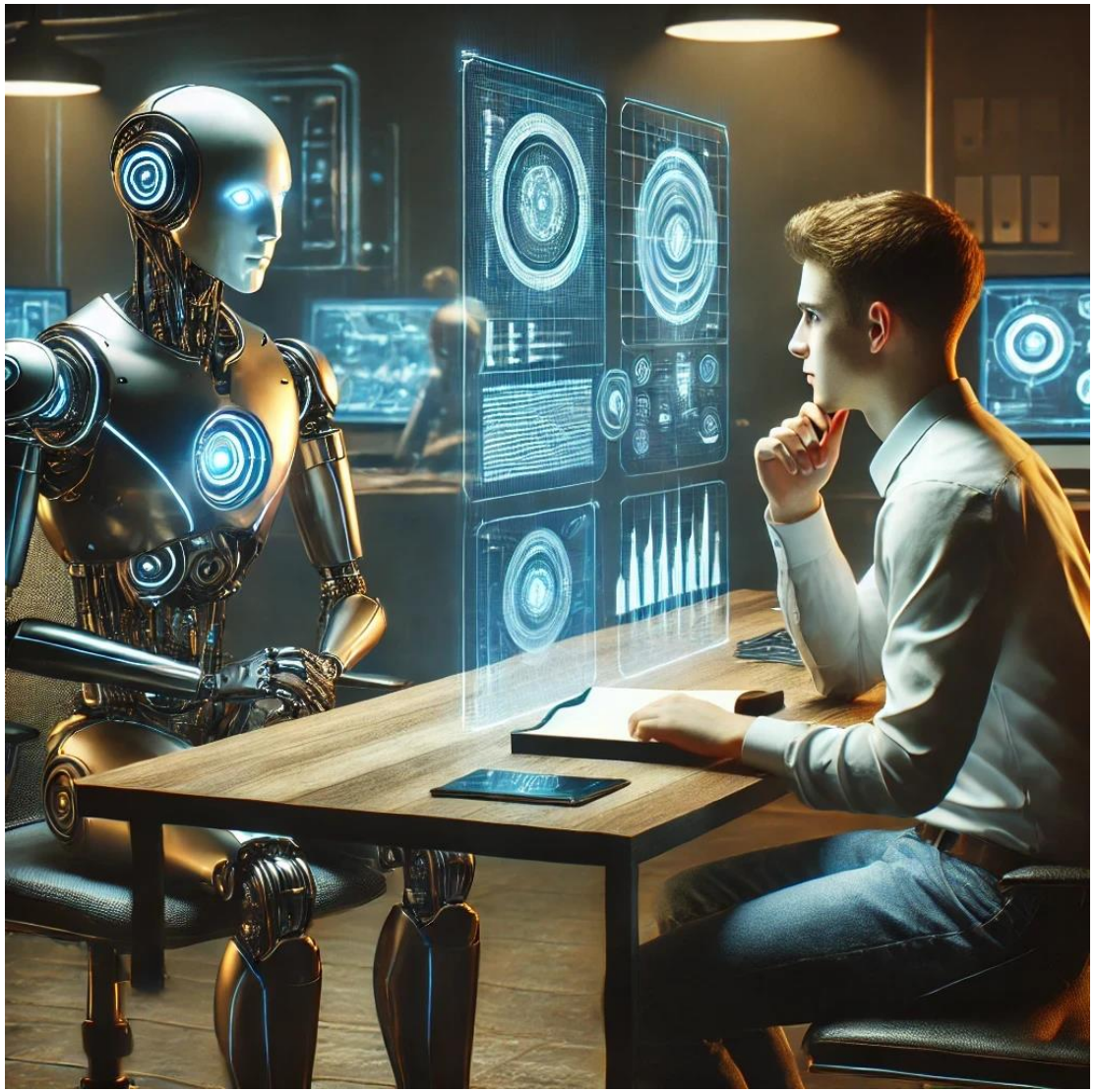
$$\|F(\mathbf{x}) - F(\mathbf{x}')\| \leq L\|\mathbf{x} - \mathbf{x}'\|,$$

where $\mathbf{x}, \mathbf{x}' \in \mathbb{R}^{n+1}$, $\|\cdot\|$ is a norm (e.g., the Euclidean norm), and $L \geq 0$ is a constant known as the *Lipschitz constant*.
If such an L exists, the function F is said to be *Lipschitz stable*.

Another notion of stability is *structural stability*, where the function remains qualitatively unchanged under small perturbations of its parameters.

If $\mathbf{x}, \mathbf{x}' \in \mathbb{R}^{n+1}$ represent a convolution representation of a pixel matrix, such that $\|\mathbf{x} - \mathbf{x}'\|$ is enough small (up to a tolerance), then $F(\mathbf{x})$ and $F(\mathbf{x}')$ belongs to the same class.

Machine and Human Collaboration



AI-specialist and AI-Robot are working together

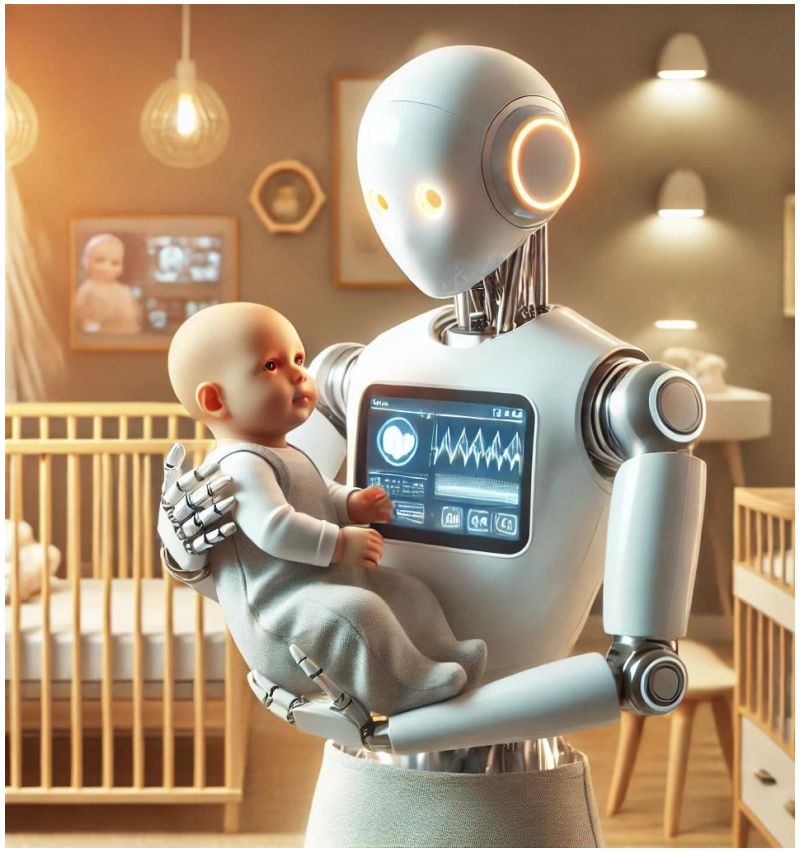
Artificial Intelligence (AI) attempts to imitate human intelligence by constructing machines that realize tasks like a human.

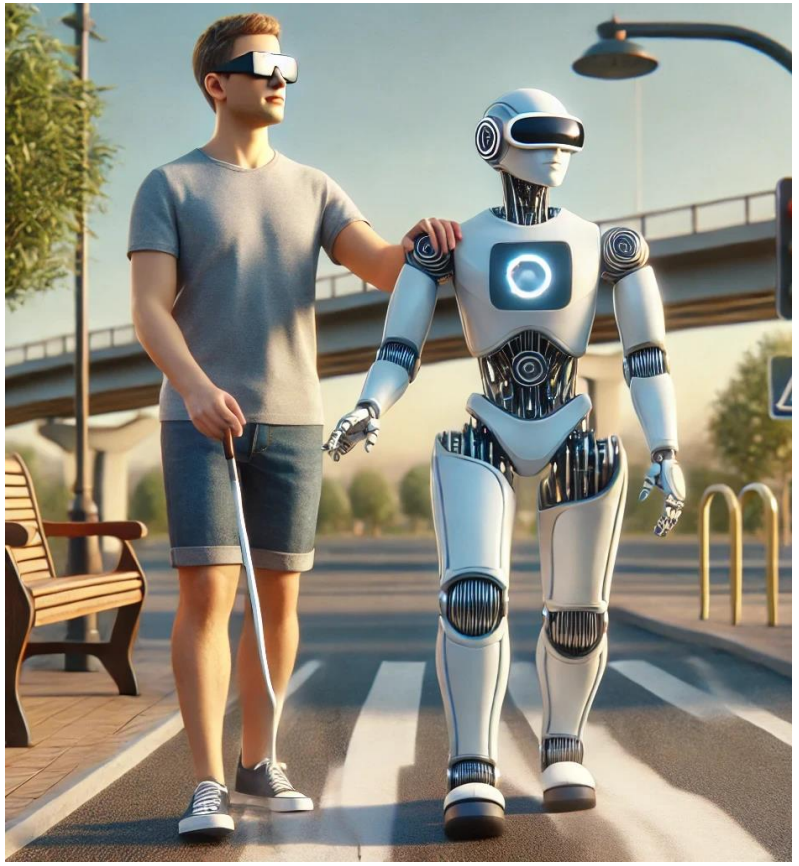


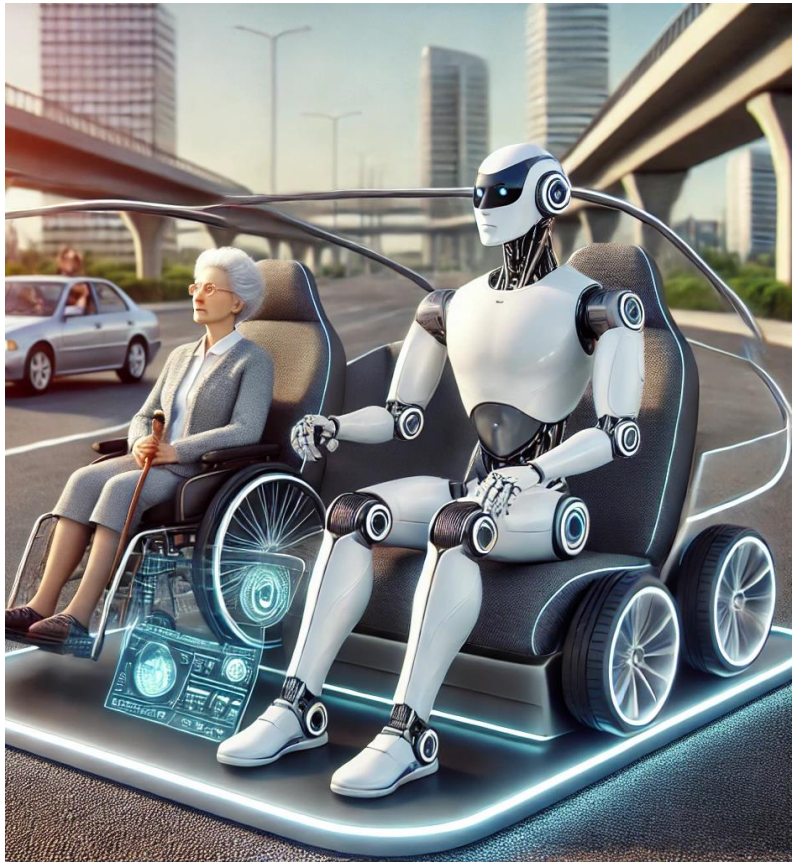


AI-Robots can accomplish dangerous work

Mostafa ZAHRI Dec,31 2024



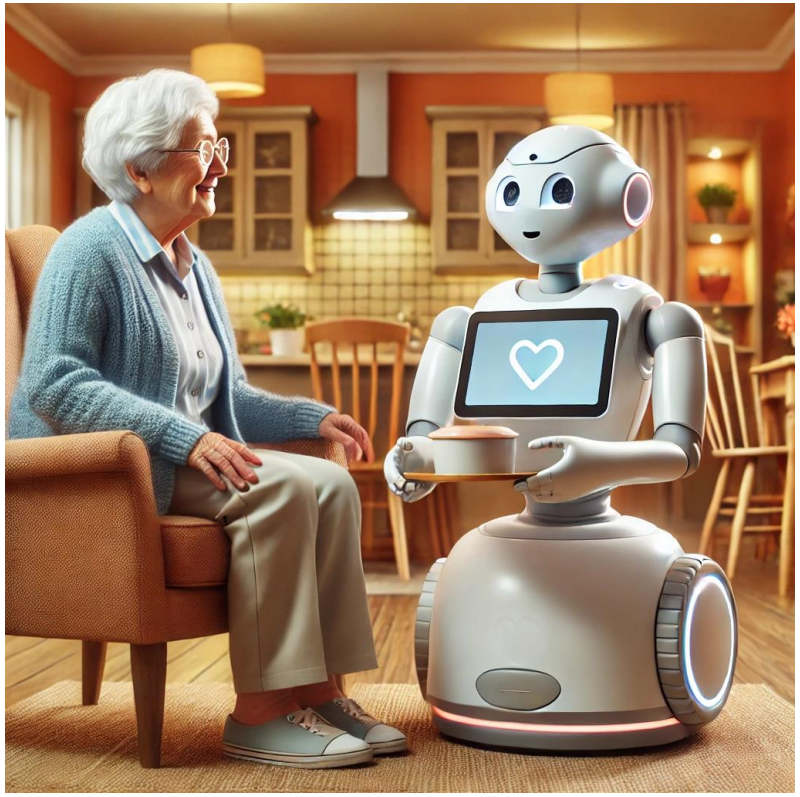


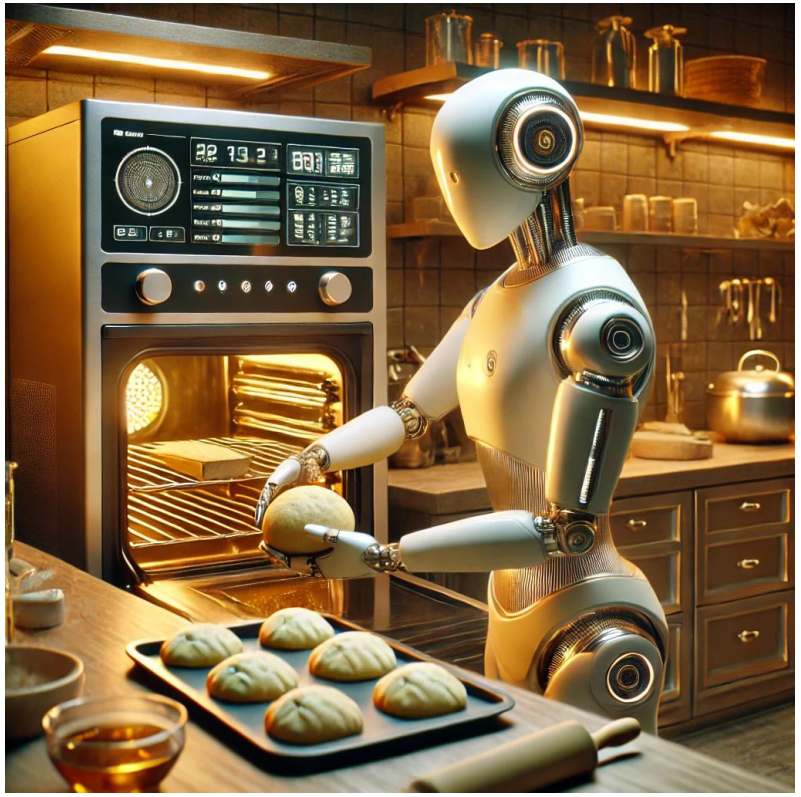


AI-Robot can take care of us

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AI-Robot can serve us

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Robot as Doctor for Human

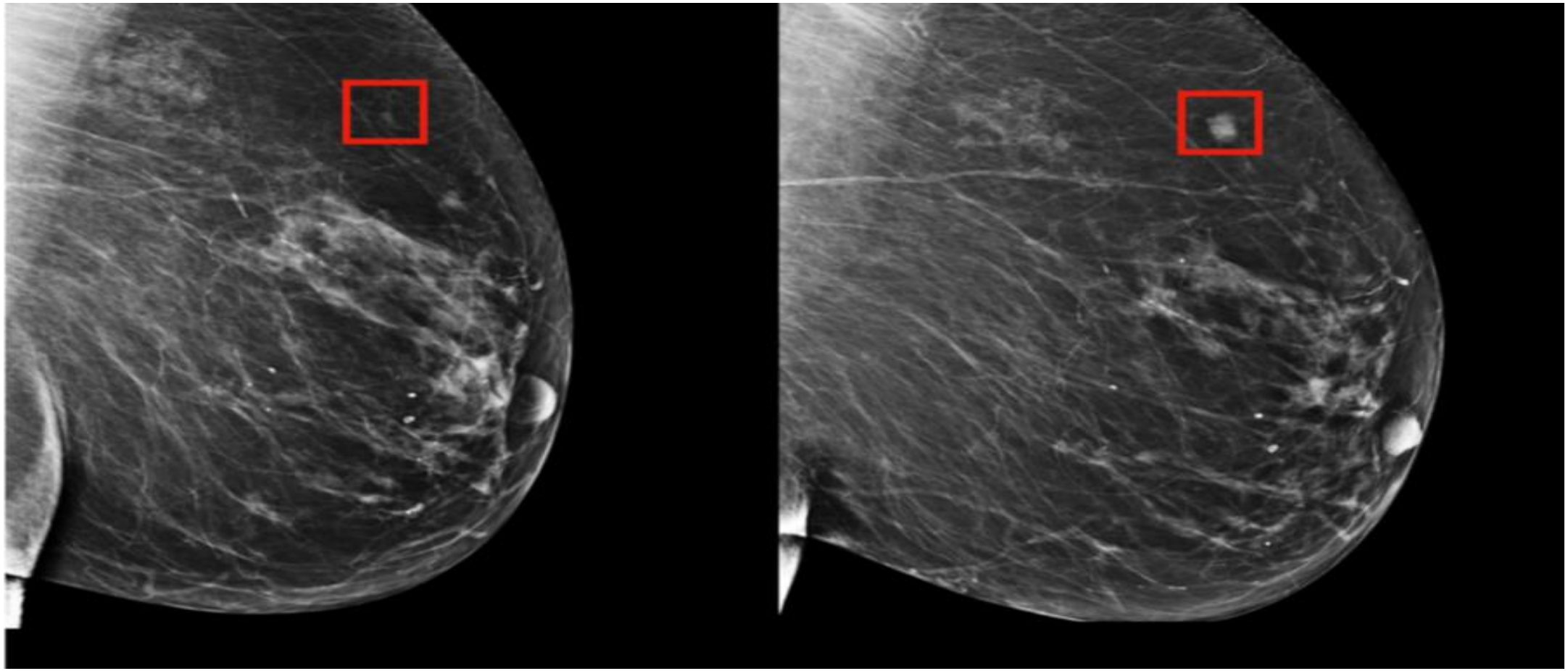
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Moroccan Future Army



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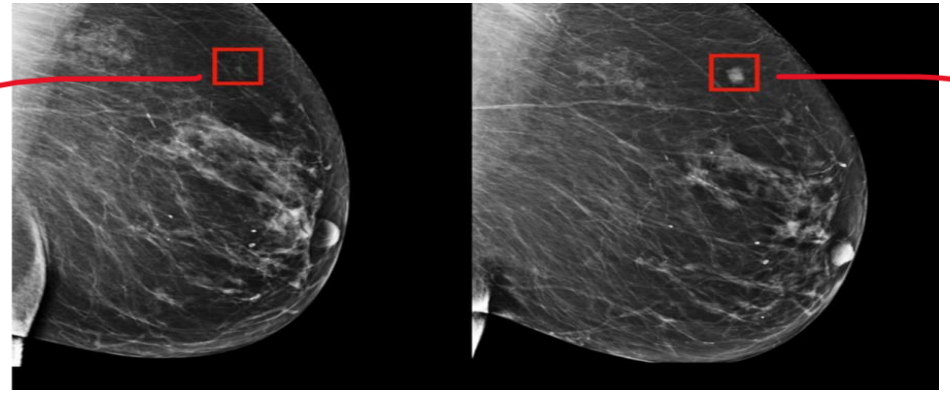
Using AI to predict breast cancer



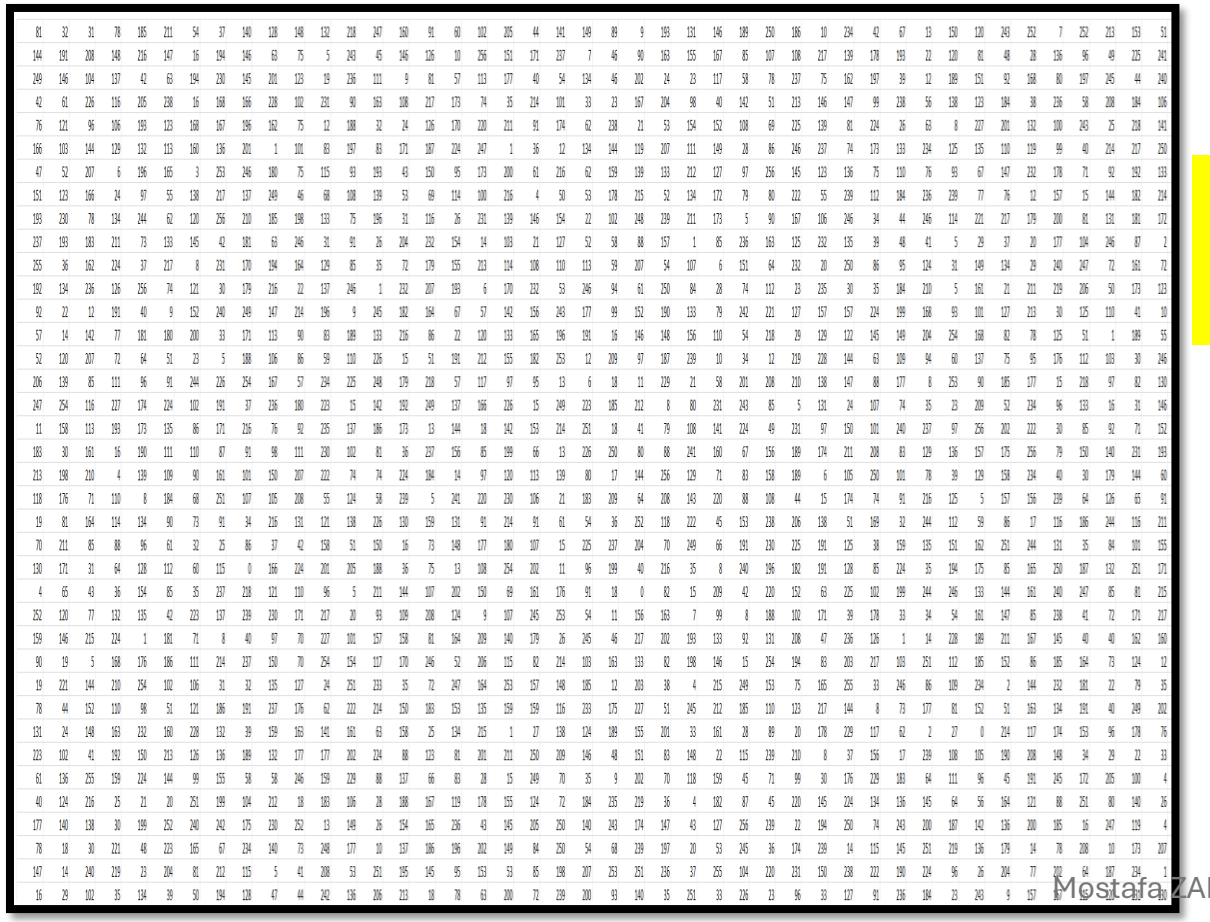
Without using AI(left) - Using AI(right)

Question: How AI solves this problem, and how Matrix Algebra is involved in this problem?

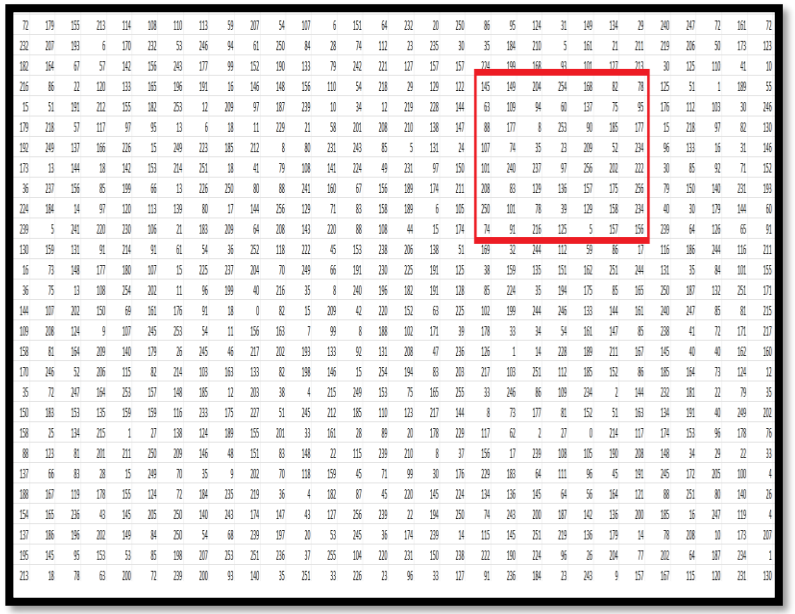
X-Ray capture is transformed to Pixel matrix.



Full Pixel- Matrix with less indication and similarities



- Matrix transformation
- Pixel transformation
- Matrix reduction
- Pixel Size Reduction
- High Resolution



Sub Pixel- Matrix with indicated Matrix similarities

Understanding matrix algebra and properties are compulsory

Parkinson’s Awareness Has Grown Since Muhammad Ali’s Death

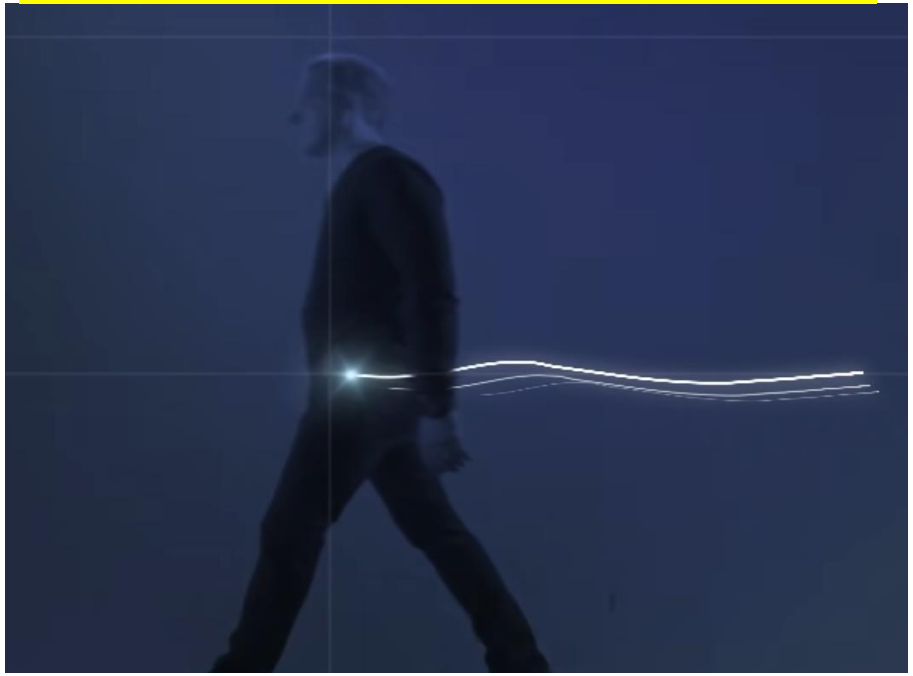




How AI, resp. mathematics predicts Parkinson disease

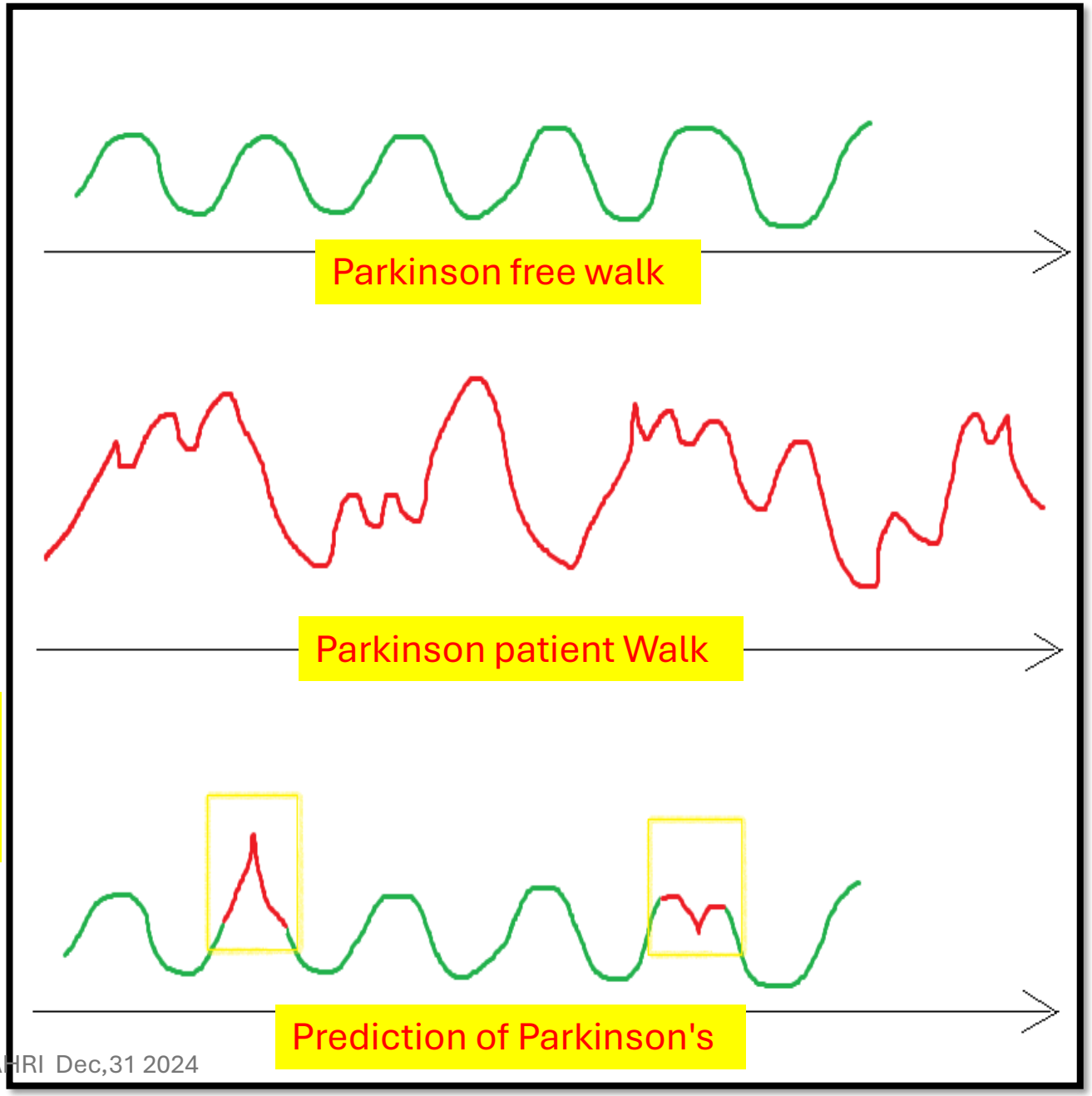
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Apps in your mobile can analyze the walking wave and send feedbacks



Mathematical comparison of the waves could lead automatically to predict Parkinson's disease early.

This involves more mathematical techniques than programming tasks.



الذكاء الاصطناعي لازال شابا في سن المراهقة يصيب ويخطئ،
من ساهم في تكوينه وتغذيته سيجني خيراته ويتجنب شره...
مصطفى زهري

Artificial intelligence is still a young teenager capable of outstanding achievements and mistakes. Those who invest in shaping and feeding him will benefit from its Good things and avoid its risks…
Mostafa Zahri





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