Application of ML industries 3

Computer Science (Anna University)

Welcome to:

Machine Learning in Healthcare and Life Science

Unit objectives

After completing this unit, you should be able to:

- Learn about applications of machine learning in health care
- Gain knowledge on the role of machine learning in drug discovery
- Learn about machine learning approaches in drug discovery
- Understand the applications of machine learning in medical image analysis
- Learn about compare the architectures of different types of deep learning models
- Gain knowledge on the applications of machine learning in genetics and genomics
- Understand the ML applications in breast cancer diagnosis and prognosis

Applications of machine learning in health and life sciences

- Artificial Intelligence (AI), machine learning, and deep learning are storming the healthcare industry.
- The most promising fields of application are automated diagnosis.
- Almost all major healthcare firms have already begun to use the technology.

The most important applications of machine learning in healthcare

- Identifying diseases and diagnosis.
- Drug discovery and manufacturing.
- Medical imaging diagnosis.
- Personalized medicine.
- Machine learning based behavioural modification.
- Smart health records.
- Clinical trial and research.
- Crowd-sourced data collection.
- Better radiotherapy.
- Outbreak prediction.

Role of machine learning in drug discovery

- The drug development and production pipelines are large, complicated and rely on many considerations.
- Machine Learning (ML) methods have plentiful, high-quality data resources that can improve discovery and judgment-making.
- Examples include:
  - Target verification.
  - Prognostic biomarker recognition.
  - Clinical trial analysis of electronic pathology data.
- Applications varied from context to technique, with some methods making detailed forecasts and observations.

Machine learning approaches in drug discovery (1 of 6)

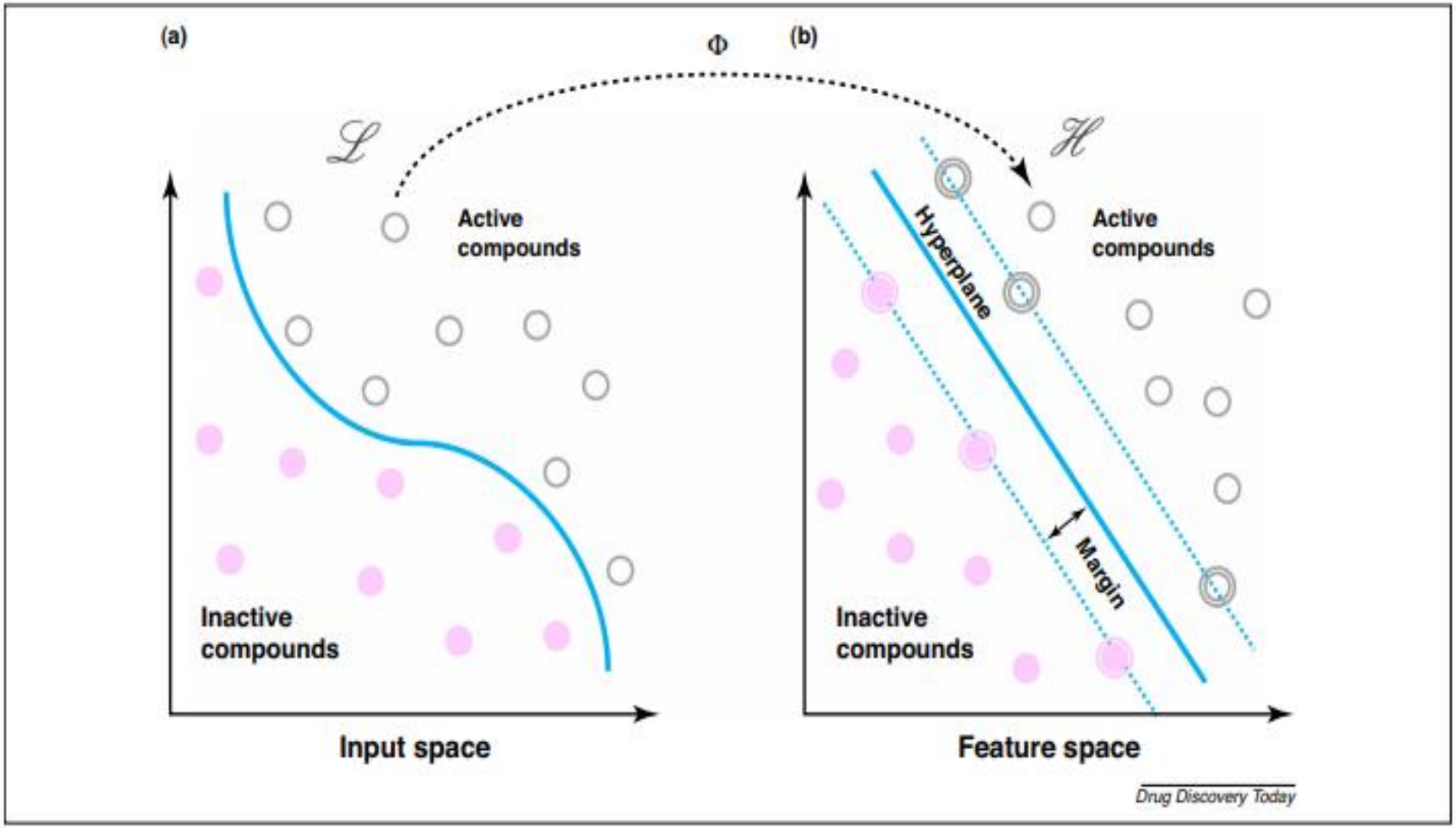

Figure: Support vector machines

Source: https://www.iris.unina.it/retrieve/handle/11588/593395/28708/Lavecchia.pdf

Machine learning approaches in drug discovery (2 of 6)

- Decision Tree (DT): DT includes a collection of regulations that include the process by which chemical characteristics and/or identifier attributes are correlated with interest behaviour or properties.

- Often known as nodes are the root and leaves.

- That leaf module is allocated a location estate, while a non-leaf module (core or inner node) is allocated to a genomic descriptive term the is an exam situation with departments divided into different classes of character.

Machine learning approaches in drug discovery (3 of 6)

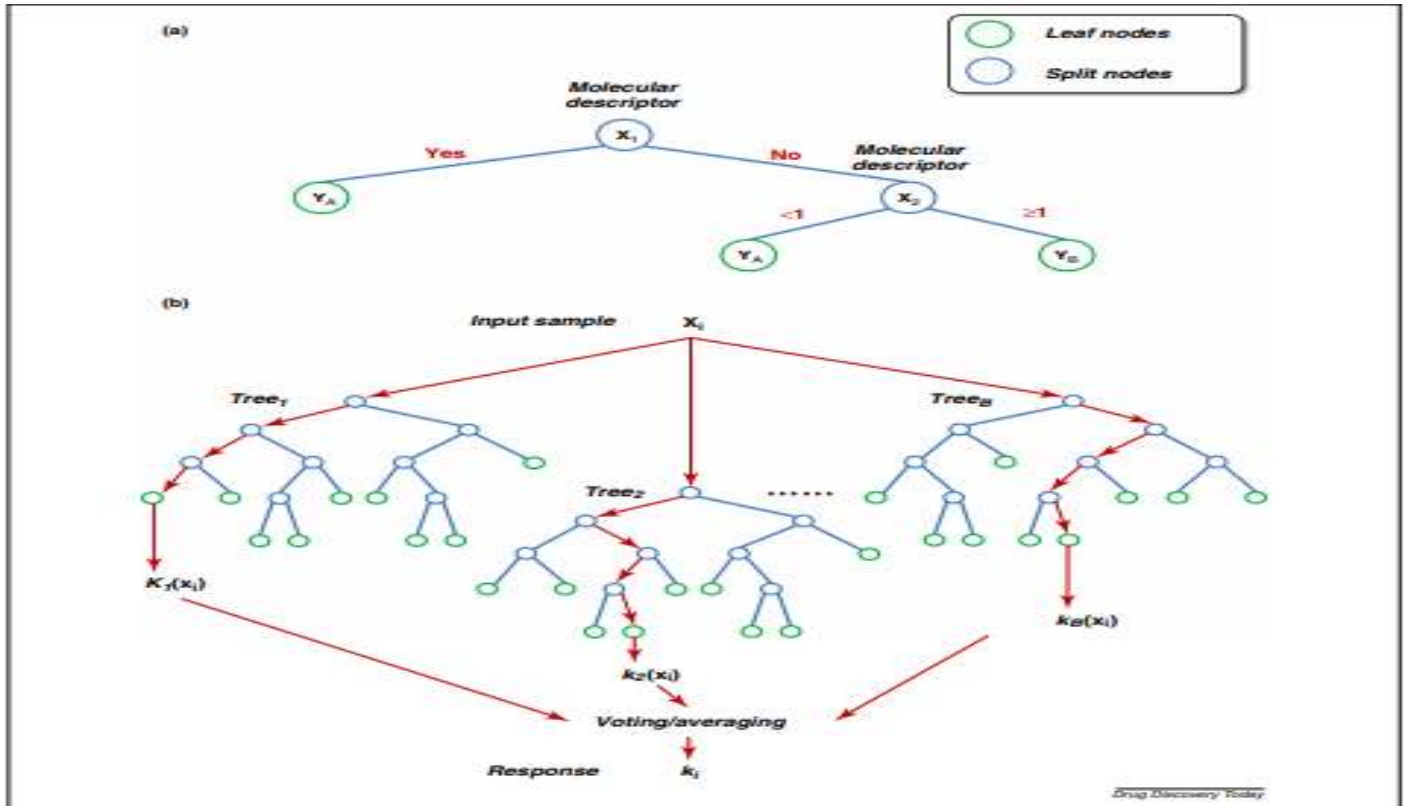

Figure: Ensemble methods

Source: https://www.iris.unina.it/retrieve/handle/11588/593395/28708/Lavecchia.pdf

Machine learning approaches in drug discovery (4 of 6)

- Naïve Bayesian classifier: In chemo informatics, Naive Bayesian classifiers are commonly utilized to estimate biochemical rather than physicochemical characteristics alongside or compared to other classifiers.

- P(A/B) – $P\left(\frac{B}{A}\right)P(A)/P(B)$

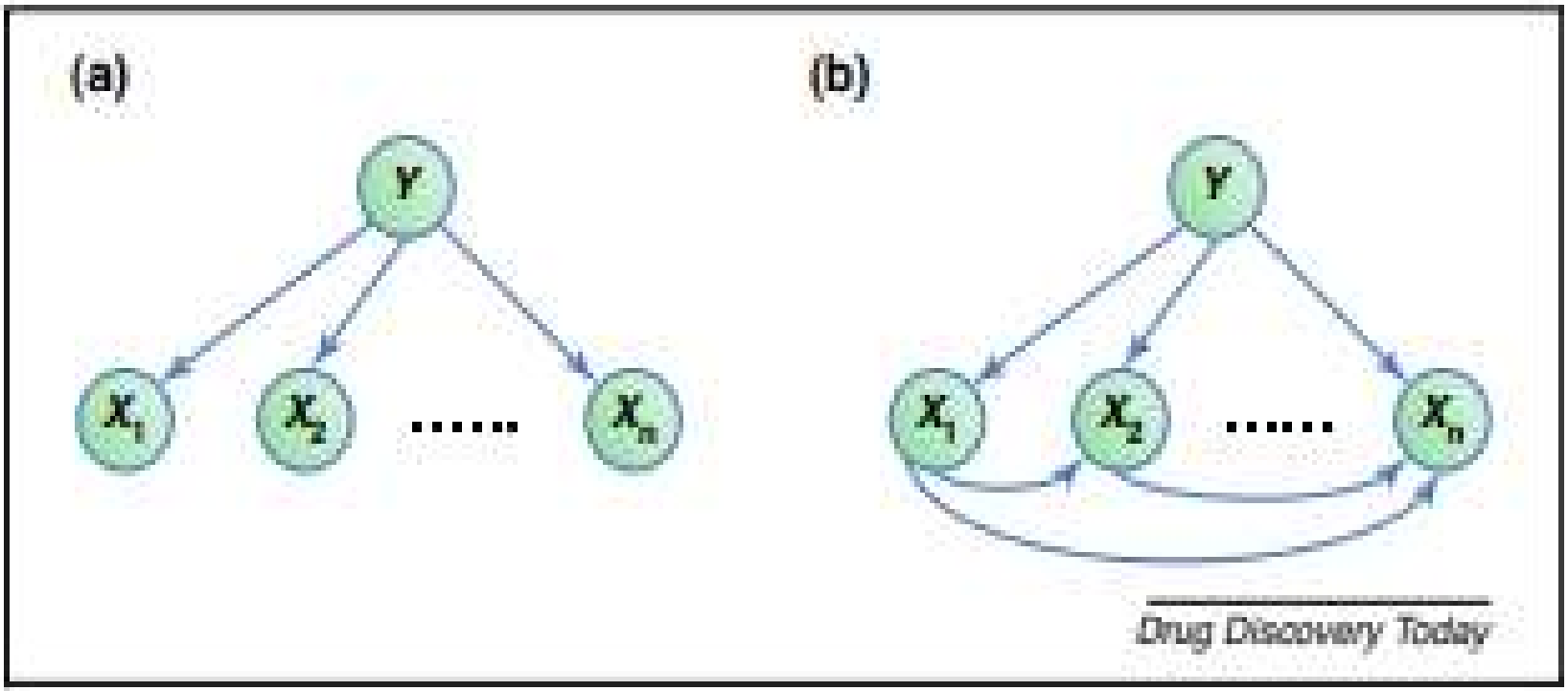

Figure: Drug discovery

Source: https://www.iris.unina.it/retrieve/handle/11588/593395/28708/Lavecchia.pdf

Machine learning approaches in drug discovery (5 of 6)

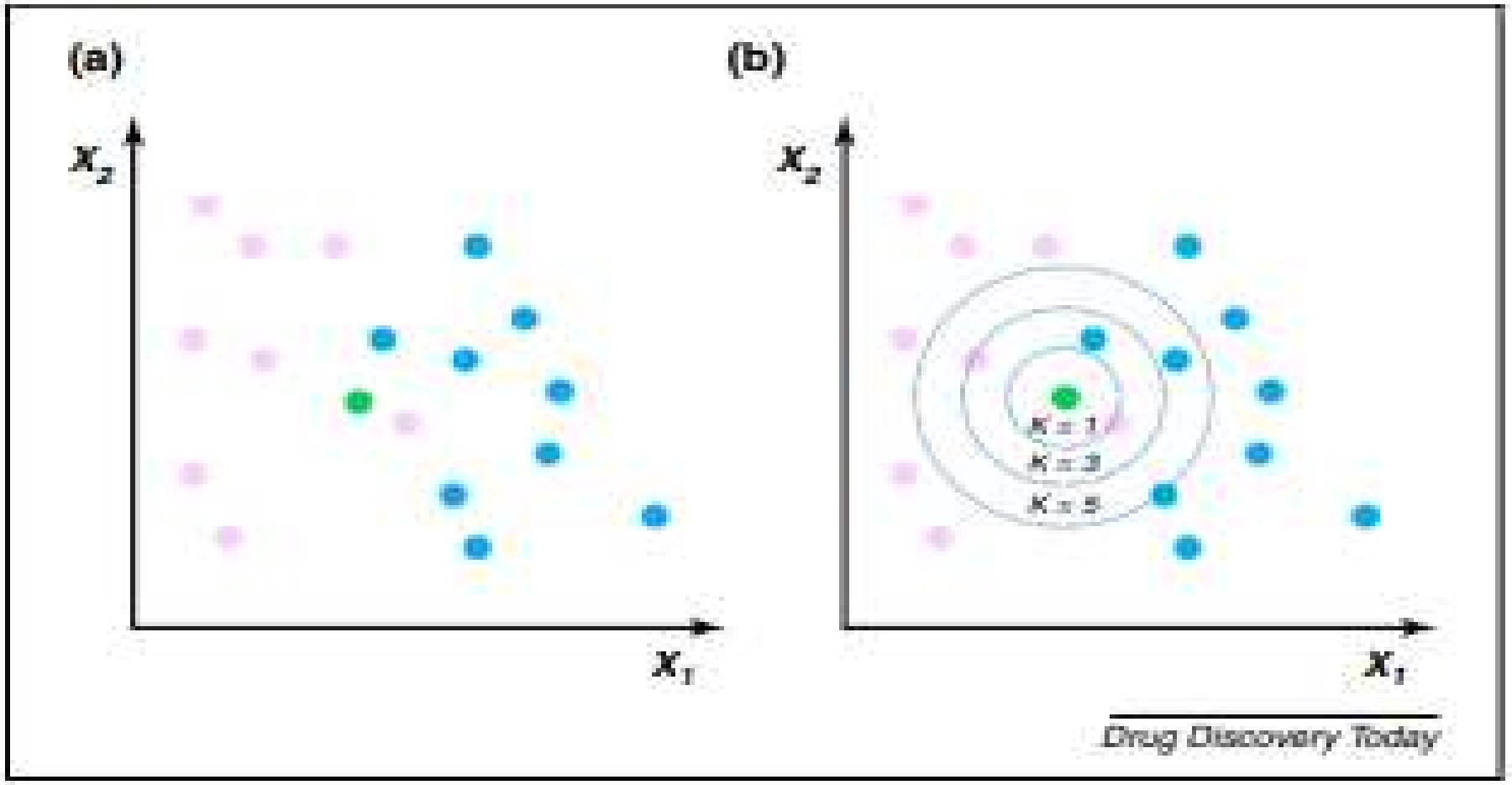

Figure: k-Nearest neighbours

Source: https://www.iris.unina.it/retrieve/handle/11588/593395/28708/Lavecchia.pdf

Machine learning approaches in drug discovery (6 of 6)

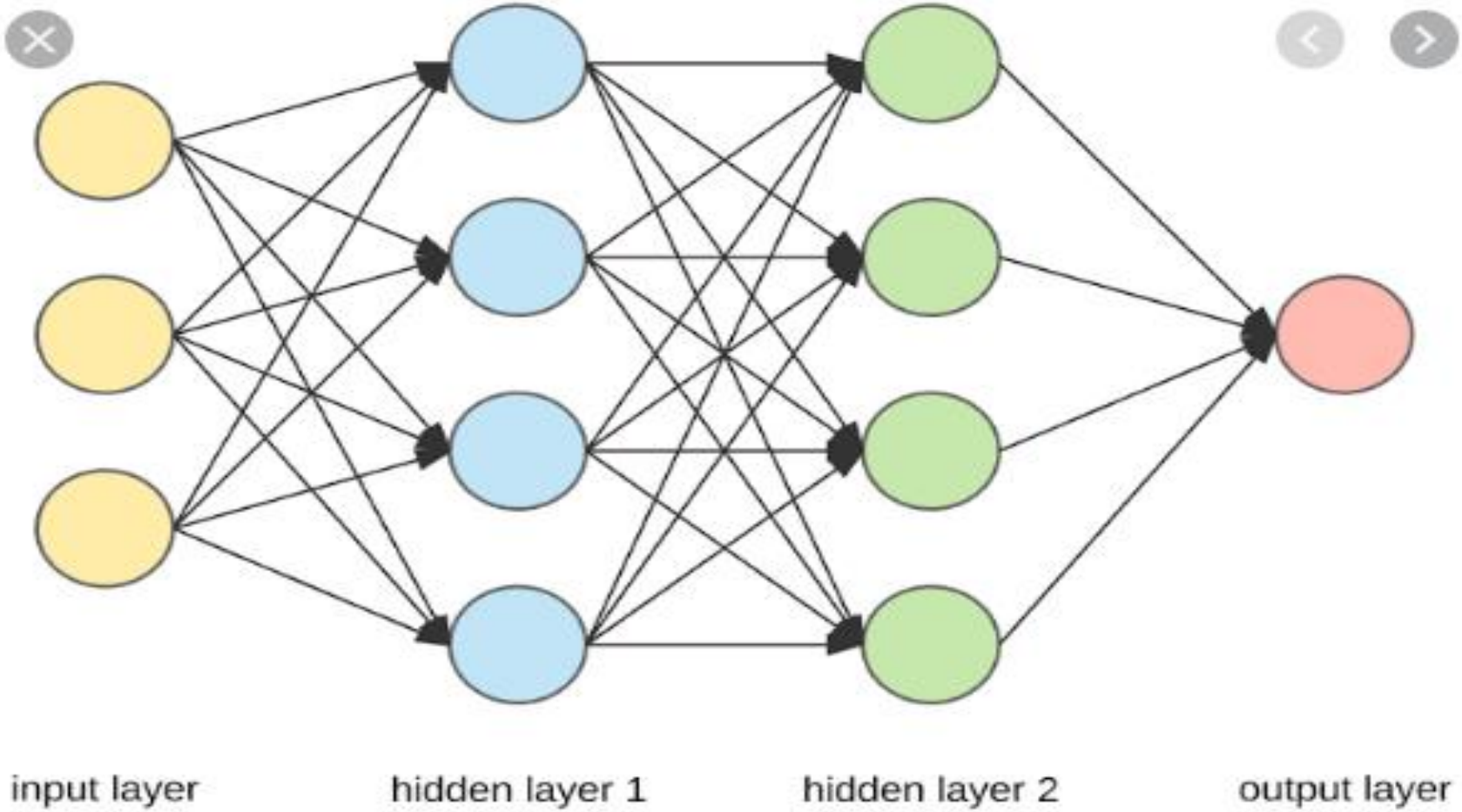

Figure: Artificial neural networks

Source: https://towardsdatascience.com/applied-deep-learning-part-1-artificial-neural-networks-d7834f67a4f6

Medical image analysis

- The medical care industry is completely distinct from other sectors.
- It is a high preferential business and individuals allow the largest degree of care and facilities, regardless of cost.
- Limitations of human interpretation.

Why deep learning for medical image analysis

- Accurate diagnosis of disease.
- Improvements in image processing algorithms.
- Current training approaches are not reliable because of the wide variation between patient and medical outcomes.
- Deep learning now has a considerable potential.

Neural network and deep learning architecture

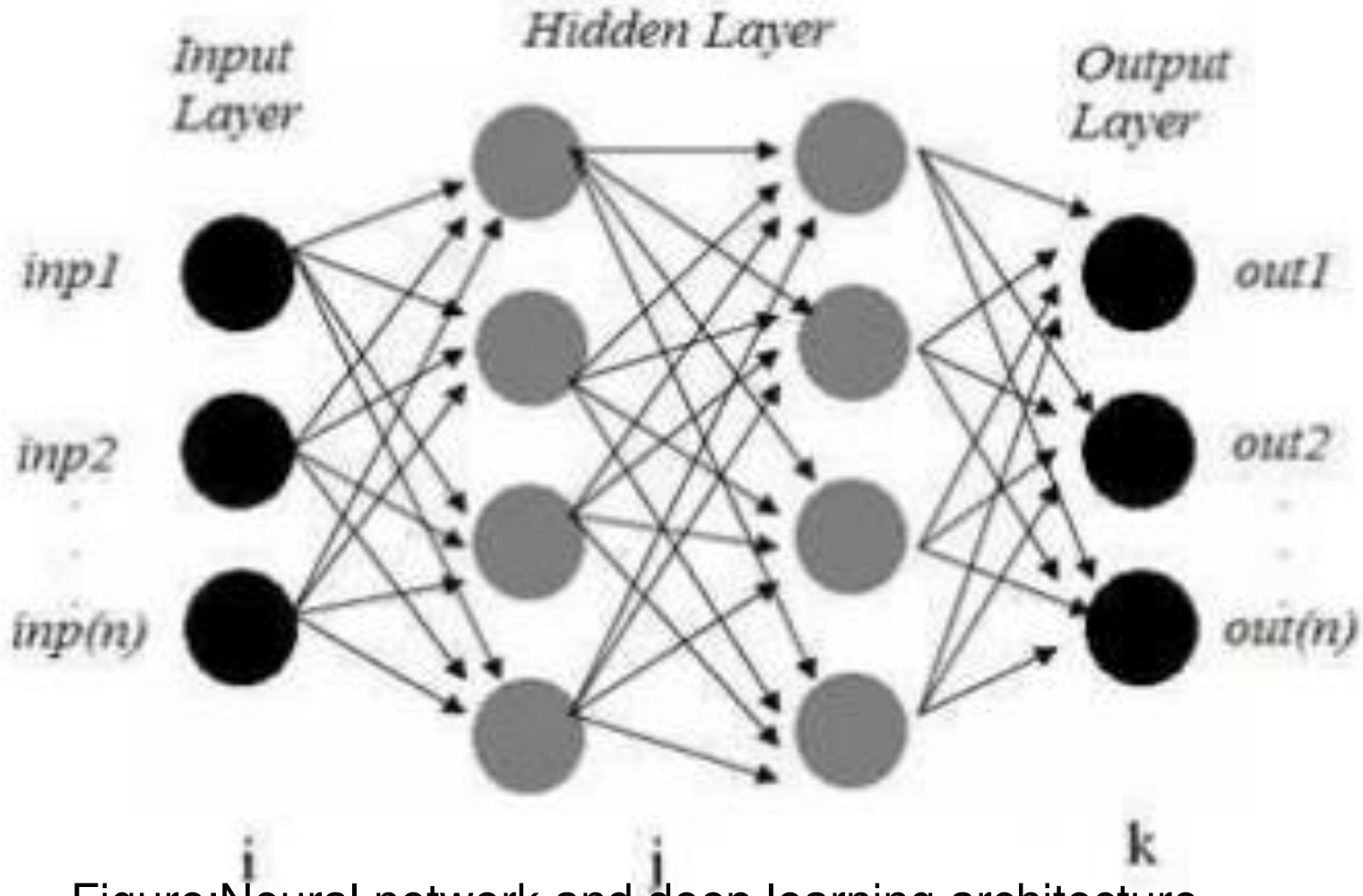

Figure:Neural network and deep learning architecture

Source: https://www.iris.unina.it/retrieve/handle/11588/593395/28708/Lavecchia.pdf

Comparisons between architecture of different types of deep learning models

- Deep Neural Network (DNN).
- Convolution Neural Network (CNN)
- Recurrent Neural Network (RNN).
- Deep Boltzmann Machine (DBM).
- Deep Belief Network (DBN).
- Deep Auto-encoder (DA).

Machine learning in genetics and genomics

- Genetics is a scientific study of the effects genes have on an organism, which are units of inheritance.
- Genes contain information in the DNA molecule, a sequence of chemicals called bases.
- Genomics All the genes taken together by an organism, and all the sequences and details found in it, are called the genome.

Genomics and AI background

- The ability to decode DNA allows scientists to "read" the biological code that directs a human organism's behaviours.
- The genome is also an organism's inherited number of genes.
- Genomics is closely associated with the medicine of accuracy.

Two category of genomics

- Genome sequencing (particularly as it applies to precision medicine).
- Direct-to-consumer genomics.

How to use deep learning effectively

- Data from genomics is often highly unbalanced.

- Effective implementation of profound learning, like all other aspects of machine learning, also involves domain knowledge.

Interpreting deep learning models

- There should be no ambiguity between the experimental methods addressed here and explanatory frameworks seeking to establish connections between cause and effect.

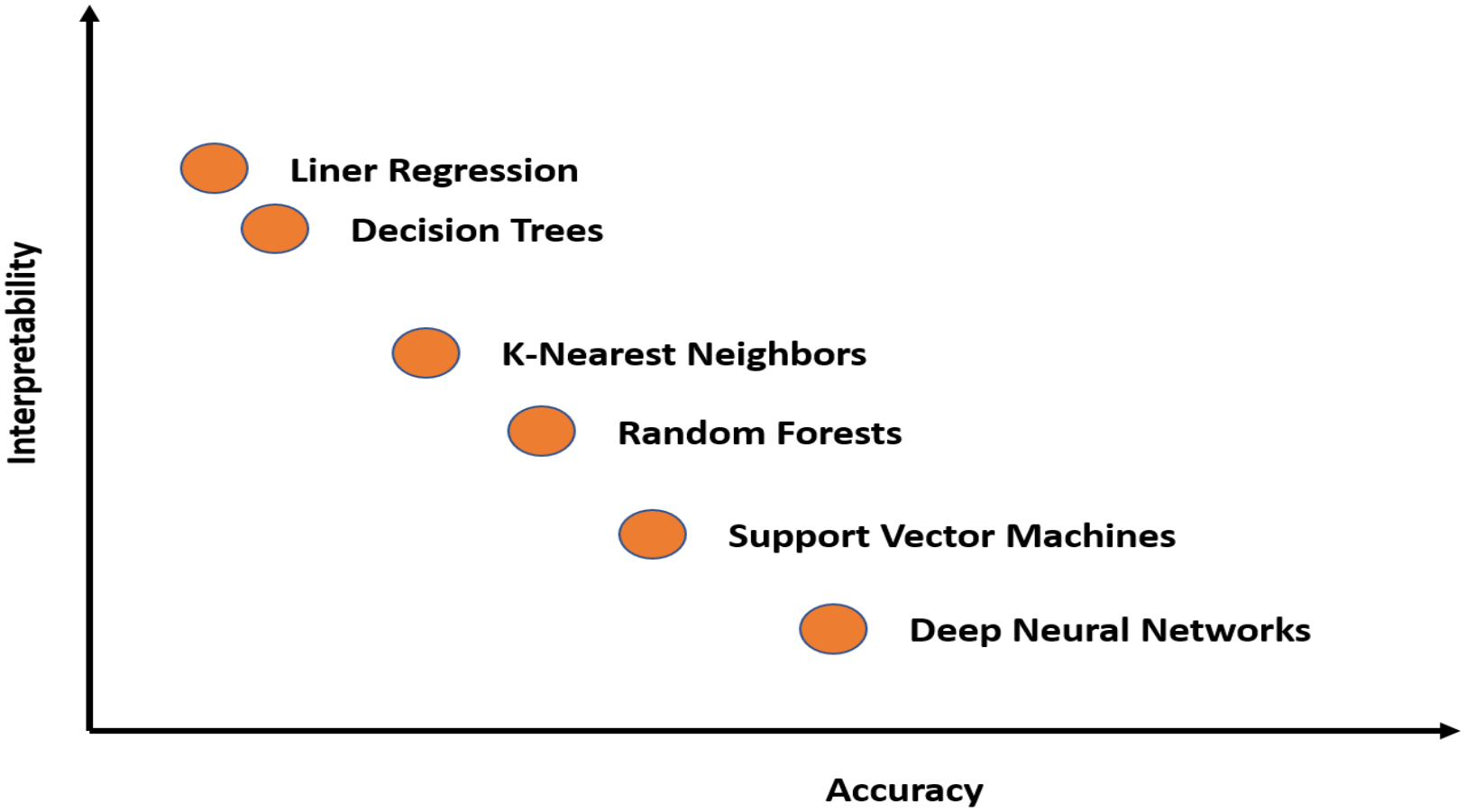

Figure: Interpreting deep learning models

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Predictive medicine: Prognosis and diagnostics accuracy

- Predictive medicine is a medicine area where the threat of infection is forecast and protective steps are applied to either fully avoid the infection or substantially reduce its effects on the person.

- The aim of preventive medication is to foresee the probability of potential illness.

Predictive medicine: Examples

- Carrier testing: Carrier testing is done to classify individuals with one version of a gene defect that, if contained in both versions, induces a genetic illness.
- Diagnostic testing: Diagnostic research is done to help diagnose and classify a particular illness.
- New-born screening: Shortly after birth, infants testing is carried out to recognize genetic illness that can be handled late in life.
- Prenatal testing: Prenatal screening is used to track fetal or embryo illnesses before conception.

ML applications in breast cancer diagnosis and prognosis

- Artificial Neural Networks (ANNs).
- Support Vector Machine (SVM).
- Decision Tree (DT).
- K Nearest Neighbours (KNN;x).

Checkpoint (1 of 2)

Multiple choice questions:

1. Which of the following is a supervised learning models with associated learning algorithms that analyse data used for classification and regression analysis.
   a) Support vector machines
   b) Decision tree
   c) Assembler model
   d) Gradient decent
2. The medical model that separates people into different groups with medical decisions, practices, interventions and/or products being tailored to the individual patient based on their predicted response or risk of disease.
   a) Personalized medicine
   b) Social medicine
   c) General medicine
   d) Analytic medicine
3. In which of the following algorithms a non-parametric method is used for classification and regression. Where in both the cases the input consists of the k closest training examples in the feature space.
   a) K –nearest neighbours
   b) Decision tree
   c) ANN
   d) Naïve Bayesian classifier

Checkpoint solutions (1 of 2)

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Checkpoint (2 of 2)

Fill in the blanks:

1. Sequence learning is the study of machine learning algorithms designed for _____ data.
2. Ways to deal with sequence labeling in memory less models are _____ and _____.
3. Neural networks are complex _____ with many parameters.
4. The network that involves backward links from output to the input and hidden layers is called _____.

True or False

1. Hidden Markov models is a memory full model. True/False
2. Neural networks mimic the way the human brain works. True/False
3. In neural networks the nodes could be in excited state or non-excited state. True/False

Checkpoint solutions (2 of 2)

Fill in the blanks:

1. Sequence learning is the study of machine learning algorithms designed for **sequential** data.
2. Ways to deal with sequence labeling in memory less models are **autoregressive models** and **feed-forward neural nets**
3. Neural networks are complex **linear functions** with many parameters.
4. The network that involves backward links from output to the input and hidden layers is called **recurrent neural network.**

True or False

1. Hidden Markov models is a memory full model.**True**
2. Neural networks mimic the way the human brain works. **False**
3. In neural networks the nodes could be in excited state or non-excited state. **True**

Question bank

Two mark questions:

1. List the applications of machine learning in health and life science.
2. What is medical image diagnosis?
3. What is genetics and genomics?
4. What is drug discovery?

Four mark questions:

1. Explain the difference between business intelligence and business.
2. Machine learning approaches for medical image diagnosis.
3. Why deep learning for medical image analysis?
4. What are the pros and corns of deferent types of deep learning models?

Eight mark questions:

1. Describe the machine learning approaches in drug discovery.
2. Explain the role of machine learning in genetics and genomics.

Unit summary

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