Welcome to:

Basic of Cognitive computing and Design Principles for Cognitive Systems

Unit objectives

After completing this unit, you should be able to:

- Understand the concept of cognitive computing and analytics
- Learn about NLP process
- Understand the concepts of cognitive analytics architecture and working model
- Gain knowledge on cognitive analytics components
- Gain an insight into process of Hypothesis generation and testing process

What is cognitive computing? (1 of 2)

- “Cognitive computing refers to systems that learn at scale, reason with purpose, and interact with humans naturally. Rather than being explicitly programmed, they learn and reason from their interactions with us and their experiences with their environment. They are made possible by advances in some scientific fields over the past half-century and are different in important ways from the information systems that preceded them". - IBM Watson

What is cognitive computing? (2 of 2)

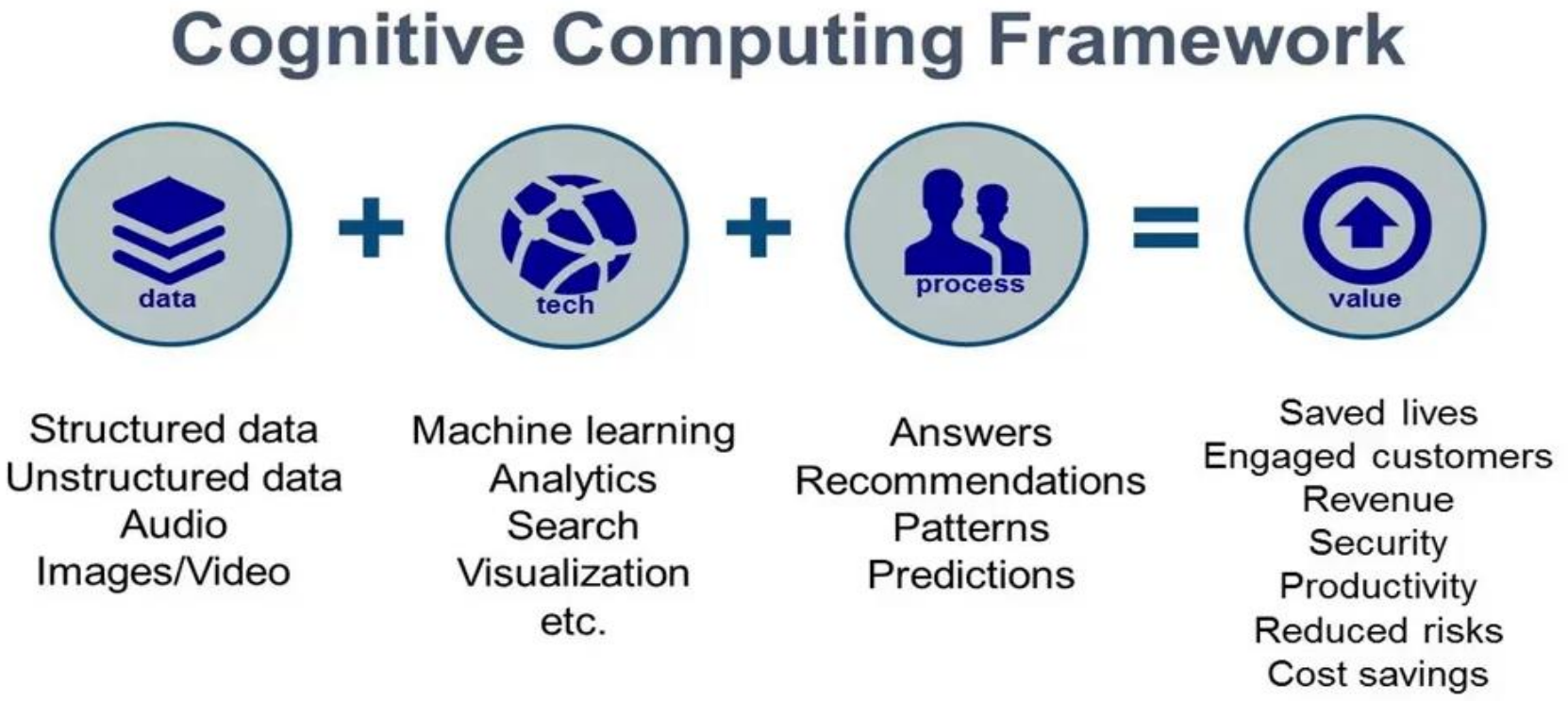

Figure: Cognitive computing framework

Source: https://images.app.goo.gl/9BeqpayPgyry8m1G8

Features of cognitive computing

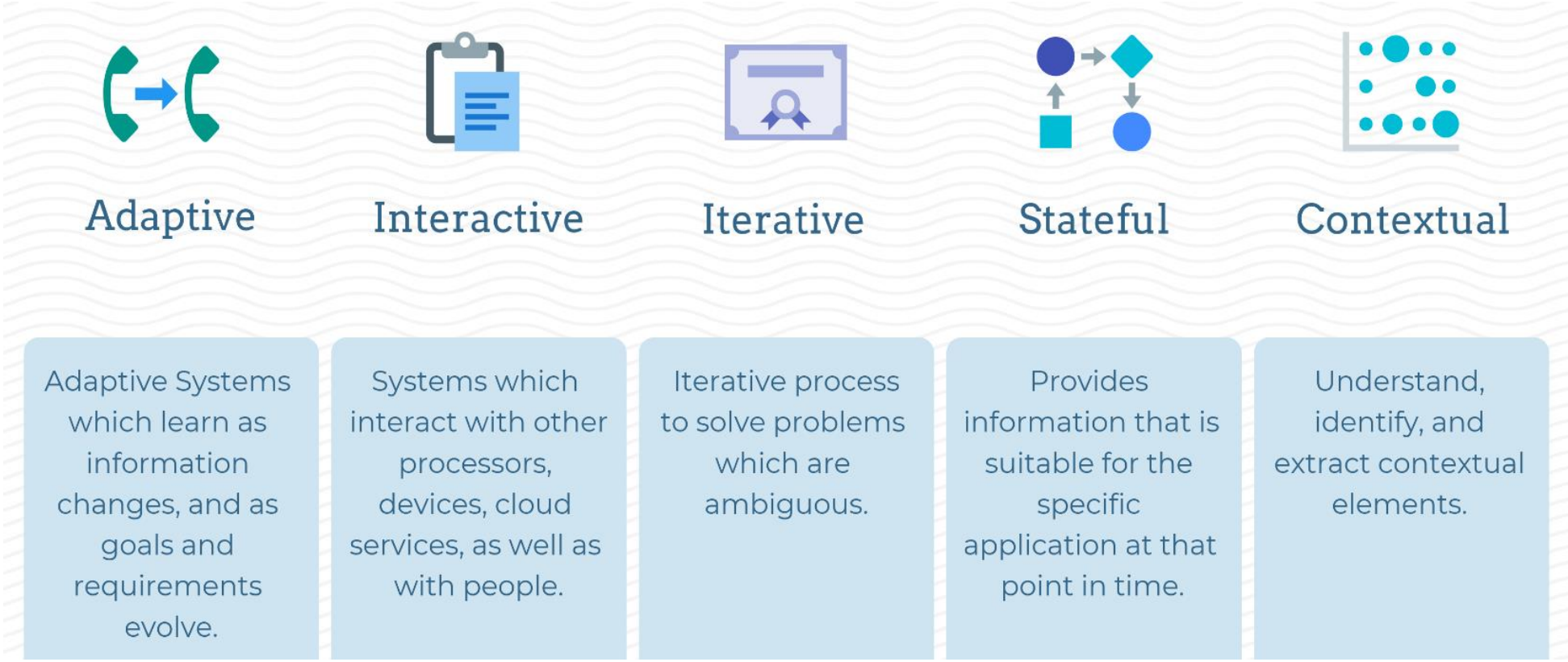

Figure: Features of cognitive computing

Source: https://images.app.goo.gl/RAk6kpe3VERD9Ksq7

Cognitive computing as a new generation

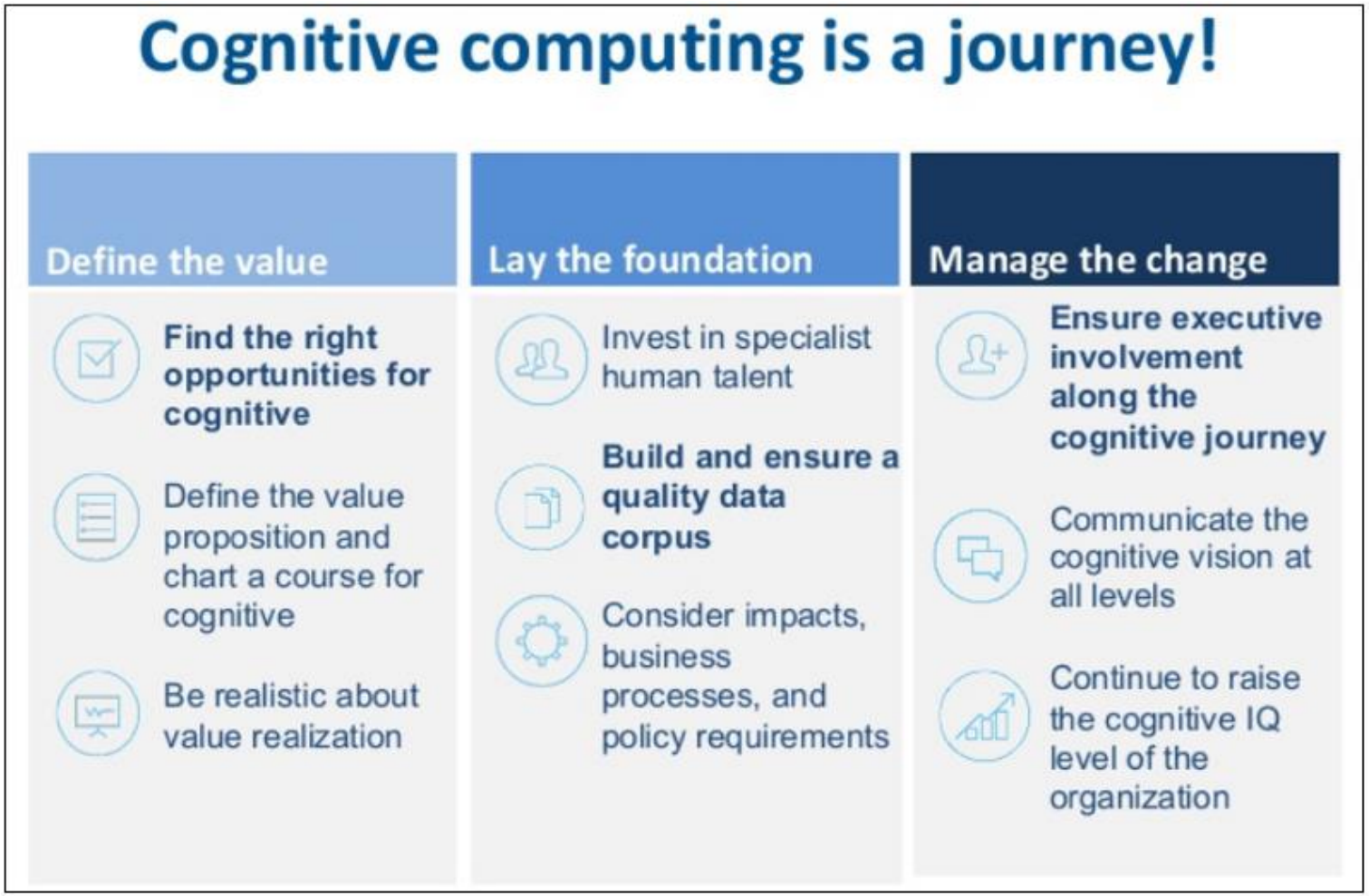

Figure: Cognitive Computing process

Source: https://images.app.goo.gl/rRHMWkMzZoQ9ZRLW6

How does a system become cognitive?

- Three essential principles assist to render a machine cognitive:
  - Contextual insight from the model.
  - Hypothesis generation.
  - Continuous learning from data across time.

Cognitive analytics

- The cognitive system is computer-branded development systems that are skilled in storing and interpreting massive, unstructured datasets.

- Word processing records, texts, photographs, photos, audio files, slides, web sites, social networking, and many other data types frequently must be tagged with metadata before they can be fed to a machine for review and creation of insights.

- The key advantage of using cognitive analytics over conventional big data analytics is that no pre-tagging of these datasets is needed.

- Many capabilities of a cognitive analytics program include:
  - Adaptability: Cognitive analytics programs may use machine-learning to respond with limited human intervention to various contexts.
  - Natural language interaction: Cognitive analytics systems may be furnished with a Chabot or search aide that recognizes questions, describes data perspectives, and communicates in natural language with humans.

Three principles of cognitive computing

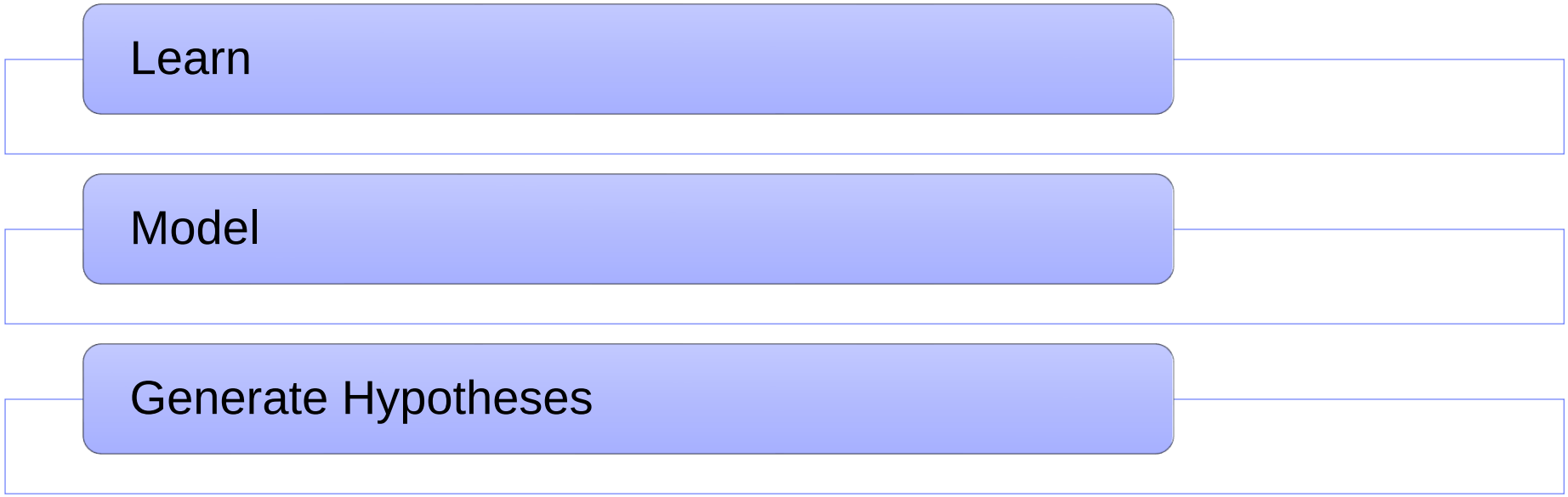

Figure: Three principles of cognitive computing

Cognitive computing domain (1 of 2)

- Cognitive computing is sometimes utilized in contexts where one question or data collection may give rise to theories that offer two or many potential responses.

- Often the responses are not inconsistent (for example, several, similar health conditions where one or more of the identified disorders can occur simultaneously).

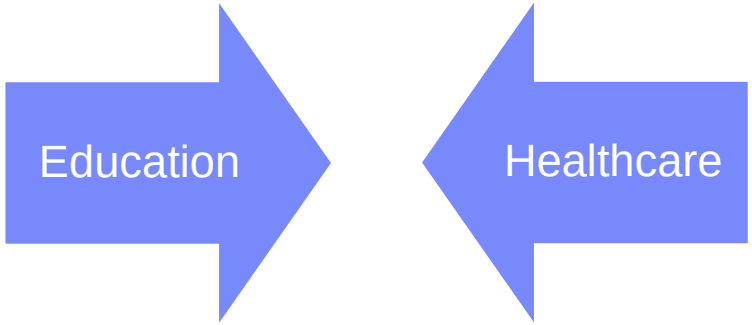

Figure: Application

Cognitive computing domain (2 of 2)

- Natural Language Processing (NLP), is commonly described by software as the automated modification of natural languages, such as speech and writing.

- The research of natural language processing has been there for over several years and with the emergence of computers developed out of the world of linguistics.

- Natural Language Processing (NLP) is a field in artificial intelligence devoted to creating computers that use natural language as input and/or output.

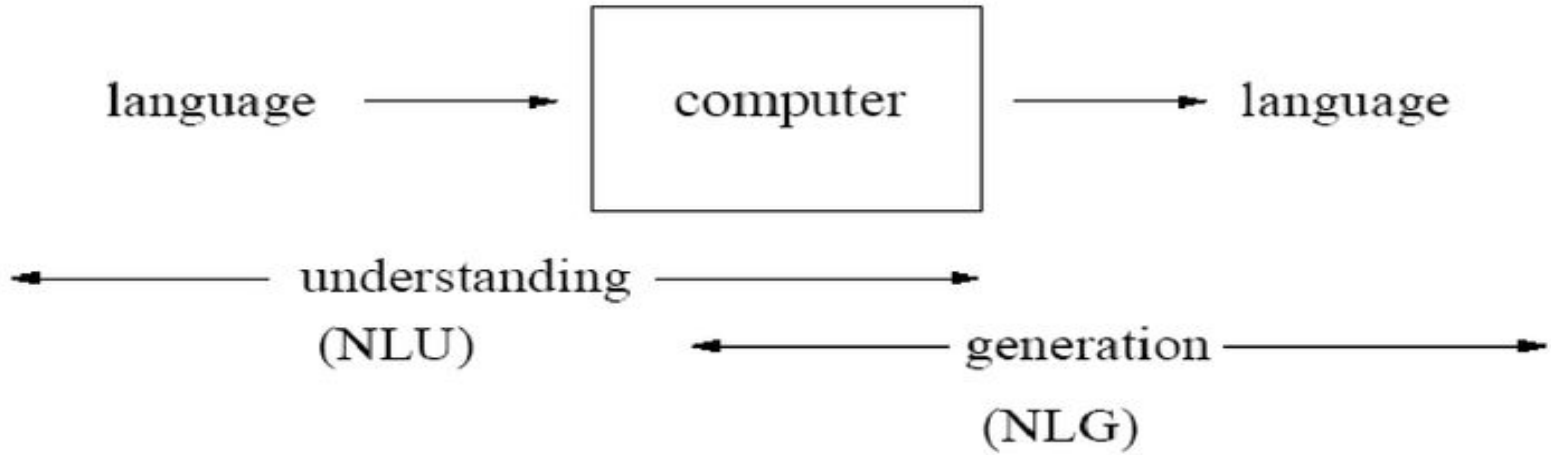

Figure: NLP

Source: https://images.app.goo.gl/CuVUA58PqK7GpYQVA

Cognitive computing domain (3 of 3)

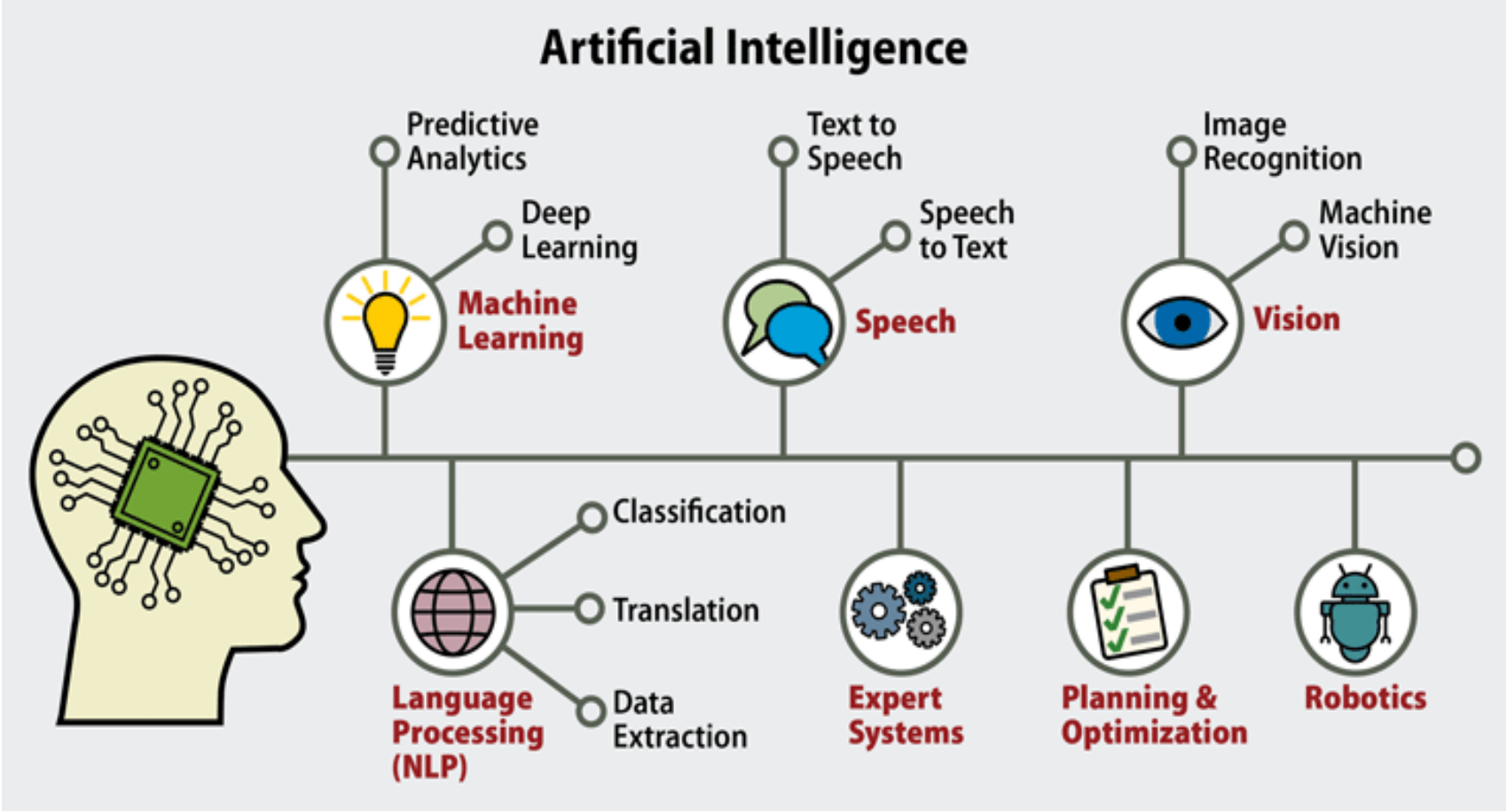

Figure: AI

Source: https://images.app.goo.gl/FhDj9pTC87Mi4iZ36

AI history

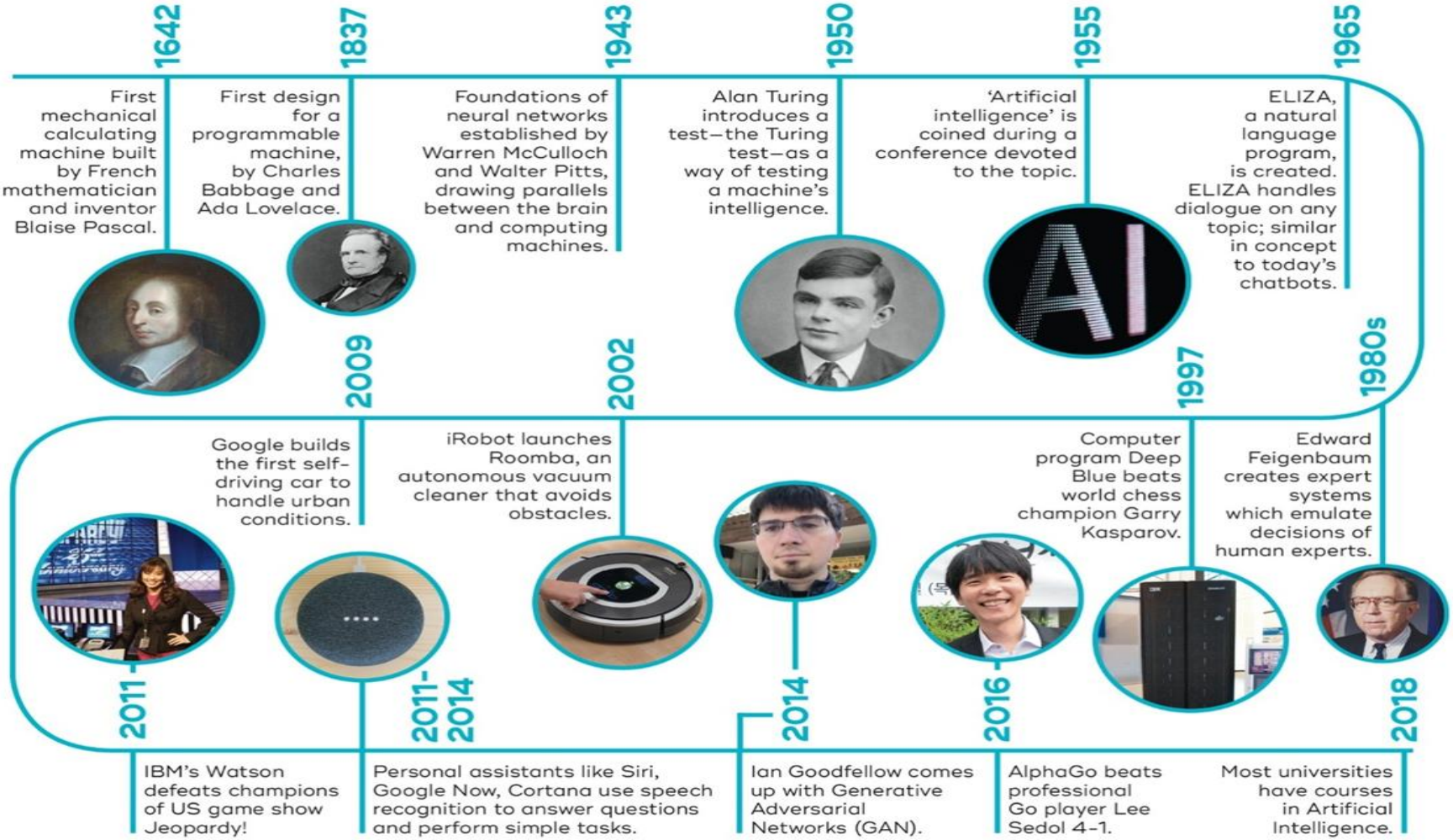

Figure: AI history

Source: https://images.app.goo.gl/Sj2c5SFZjdbFjuDJ8

AI subunits

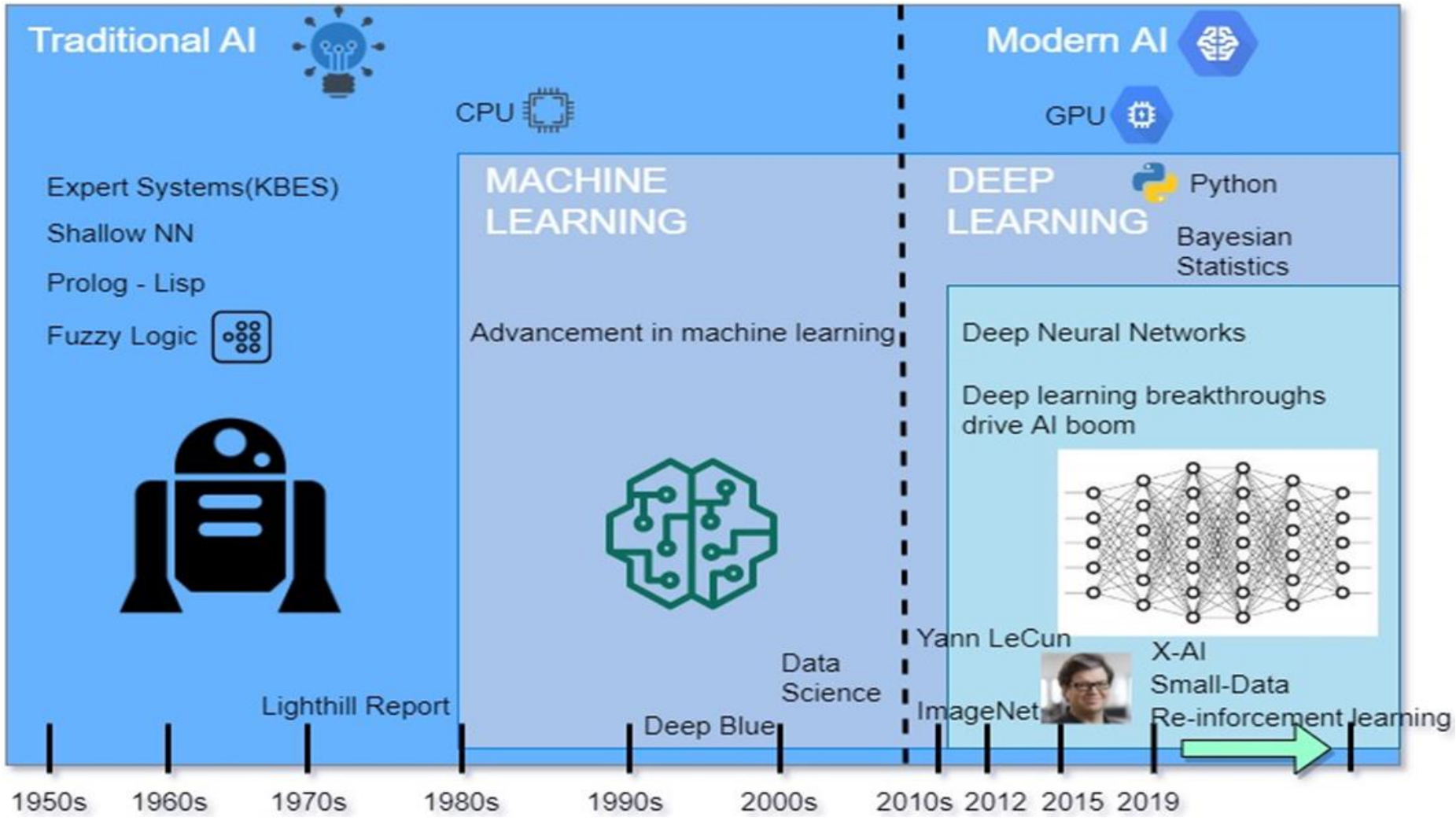

Figure: Modern AI

Source: https://images.app.goo.gl/mafb3k62w39wXyG96

Expert system? (1 of 2)

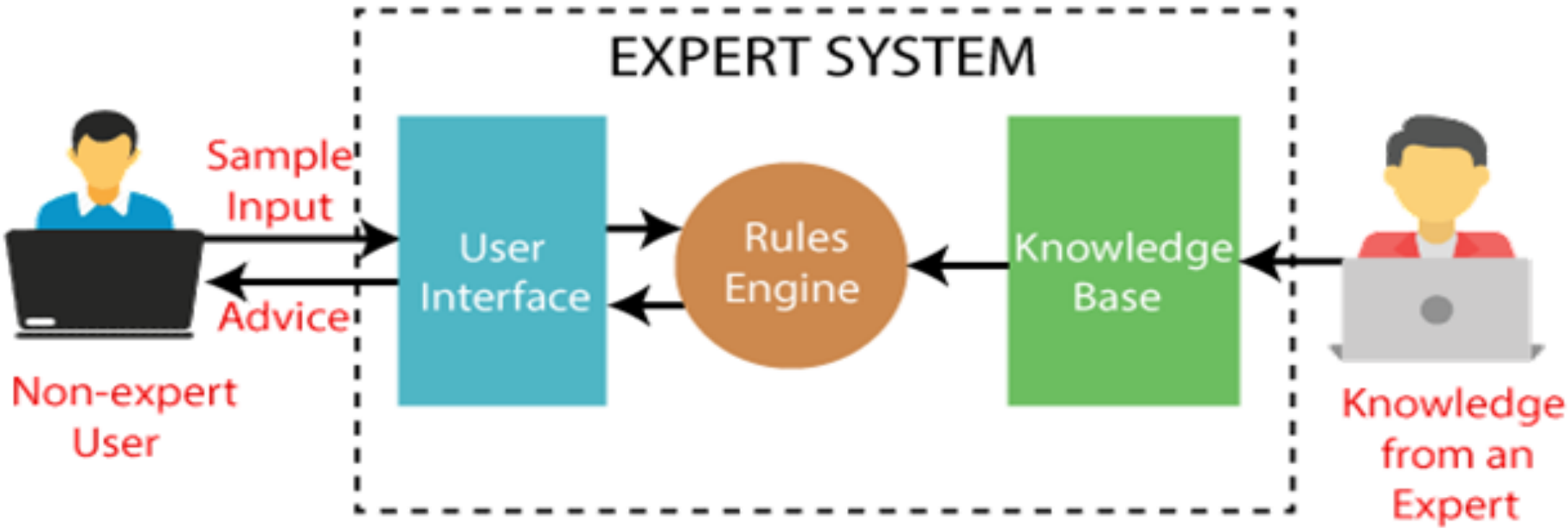

Figure: Expert System

Source: https://images.app.goo.gl/DAr2pT6GmNSv4EDG7

Expert system? (2 of 4)

- Understanding cognition.
- Cognitive science: The science of the mind.
- Computer technology: The theoretical and functional programming method and its implementations. It is the systemic methodology used to turn this principle into practice.

Expert system? (2 of 4)

- Two systems of judgment and choice.
- Translating the meaning of human thinking and behavior into processes is very difficult.
- In humans, feeling, perception, patterns, and implicit beliefs about the environment always affect us. Cognition is a foundational methodology that not only leverages how we perceive but also how we behave and how we make choices.

System 1 (Intuitive)	System 2 (Analytical)
Unconscious	Conscious
Rapid	Slow
Automatic	Controlled
Low effort	High effort
Low cognitive awareness	High cognitive awareness

Expert system? (2 of 2)

- Understanding complex relationships between systems.

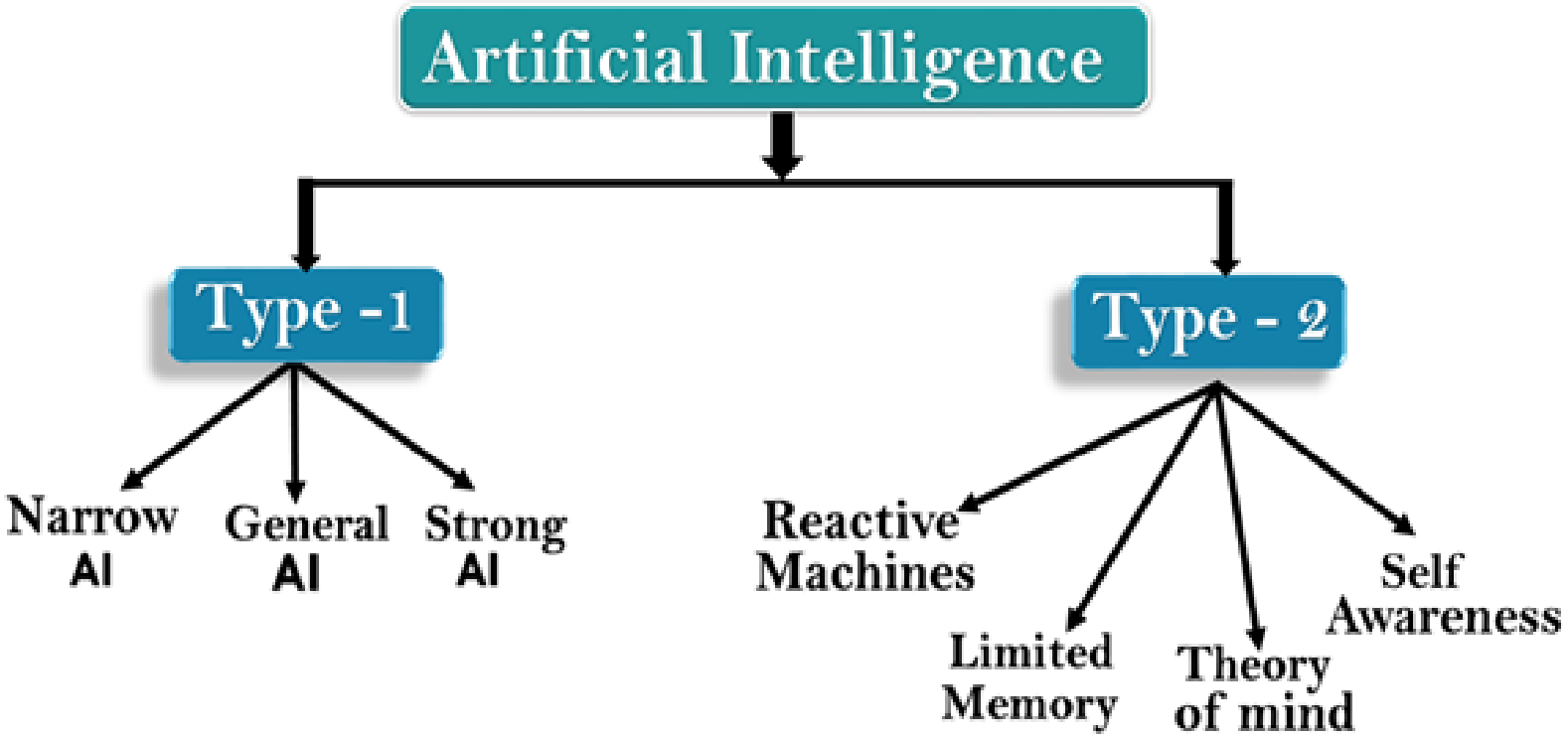

Figure: AI relation with other elements

Source: https://images.app.goo.gl/npmbKzsMSbqJaBAYA

Adaptive systems types

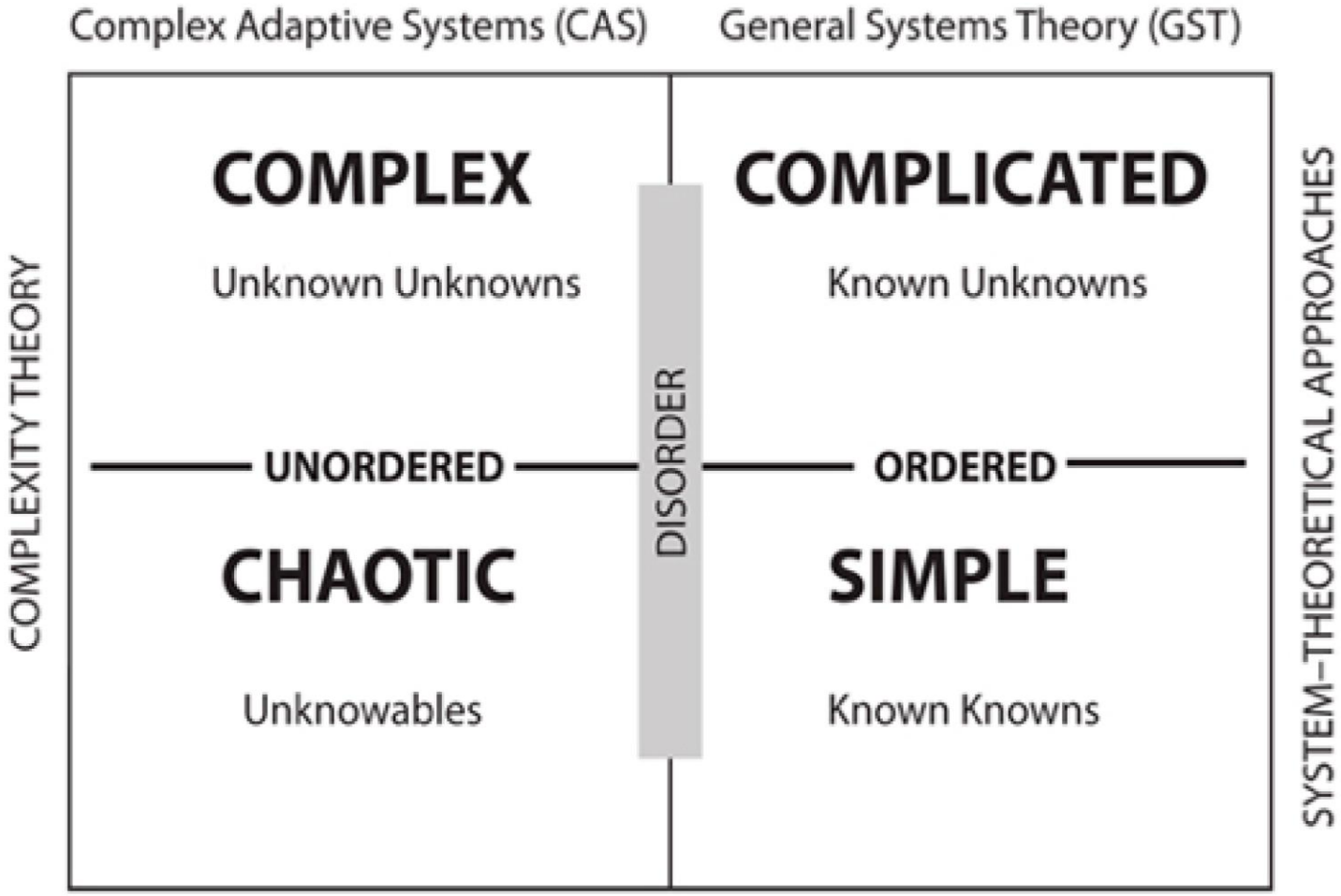

Figure: CAS and GST Systems

Source: https://images.app.goo.gl/4hu8rvu3qyH8pBLdA

The elements of a cognitive system

- Infrastructure and deployment modalities.
- Data access, metadata, and management services.
- The corpus, taxonomies, and data catalogs.
- Data analytics services.
- Hypothesis generation and evaluation.
- The learning process.
- Presentation and visualization services.
- Cognitive applications.

Hypothesis definition

- A statistical hypothesis is an explanation about the relationship between data populations that is interpreted probabilistically.

- A machine learning hypothesis is a candidate model that approximates a target function for mapping inputs to outputs.

Components of a cognitive system

- To collect extra information and eventually upgrade external applications, a cognitive processing device requires an inner store of information (corpus) and communicates with the outer world.

- Cognitive systems use natural language processing to interpret text, but they do require other processing resources, deep learning technologies, and tools for interpreting pictures, speech, videos, and place.

- These analysis features include the cognitive framework with a means of interpreting data in detail and making meaning of a specific information domain.

- The cognitive system produces theories and proposes alternate responses or observations with relevant degrees of trust. This is meant as a general reference for the architectures of cognitive computing.

Building the corpus

- For computational linguistics people, corpus = representative sample of the problem. If you're lucky, corpus = structured and annotated dataset you can just import into your python program, to do cool stuff right now. Because linguists have been working at corpus annotation for decades (e.g., first release of the Brown Corpus dates to the 70's).

- Now, for linguists, the notion of "representative" sample is a little tricky. As far as I know, nobody really knows how to assess linguistic representatively, from a statistical viewpoint (if anybody knows, please comment). That's why corpora tend to get bigger and bigger (Common Crawl Corpora are in the 100 billion words range).

Corpus management regulatory and security considerations

- Data privacy, security, and enforcement concerns are relevant to all apps.
- Planning for successful corpus management will provide a plan for tracking the related policies influencing the corpus results.
- This involves contemplation of various modalities of delivery or as cloud storage, which can spread data over geographical frontiers.
- Such applications can provide risk control, protection, and regulatory features that help protect the consumer against data abuse or offer guidelines where sources include confidential data.
- The data access layer mechanisms listed in the next segment must be followed by or embedded enforcement guidelines.

Including data into the cognitive system

Information Processing

- **System Image**
  - Communication Channel
  - Dyadic Semiotic System (symbol processing)
- **Emphasis on Human Limitations**
  - 7+ or – 2 Chunks
  - Heuristics = Biases
- **Workload** - Too much data
- **Task Analysis** – Procedures & Activities
- **Design Focus**
  - Respect Limitations
  - Match expectations (mental models)

Important, but not sufficient!

Meaning Processing

- **System Image**
  - Control System
  - Triadic Semiotic System (pragmatic assessment)
- **Emphasis on Human Capabilities**
  - Recoding/Chunking
  - Heuristics = Tricks of the trade
- **Situation Awareness** – Too little meaning
- **Work Analysis** – Constraints & Possibilities
- **Design focus**
  - Leverage Capabilities
  - Shape expectations (mental models)

Potential enhancements in perspective!

Figure: Data into cognitive system

Source: https://images.app.goo.gl/1CDDbM2MFActbWQ57

Leveraging internal and external data sources

	Current paradigm	New paradigm
Data source	Internal	External
Focus	Company	Industry
Analytics	Lagging indicators	Leading indicators
Cadence	Monthly/quarterly	Real-time
Mode of operation	Reactive	Proactive

Figure: Internal and external data source

Source: https://images.app.goo.gl/XLVv95XihByEjUr6A

Data access and feature extraction services

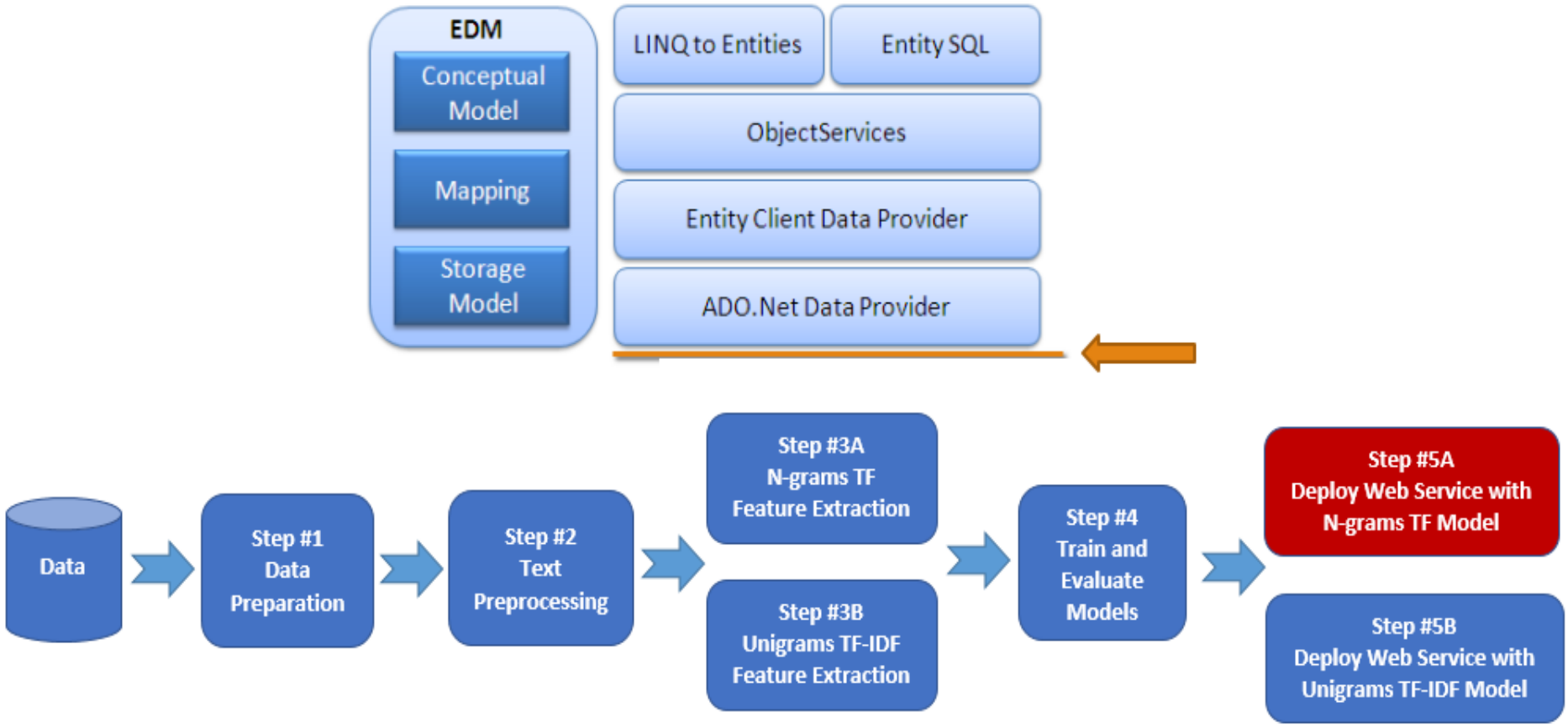

Figure: Data Access and features extraction

Source: https://images.app.goo.gl/2GCgFC1BwaaWncrQ8

Analytics services

Figure: Analytics Services

Source: https://images.app.goo.gl/DUxLFEDKxuTsrCM58

Machine learning (1 of 2)

- Machine learning is an application of Artificial Intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

- Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

Machine learning (2 of 2)

- Identifying patterns in data.

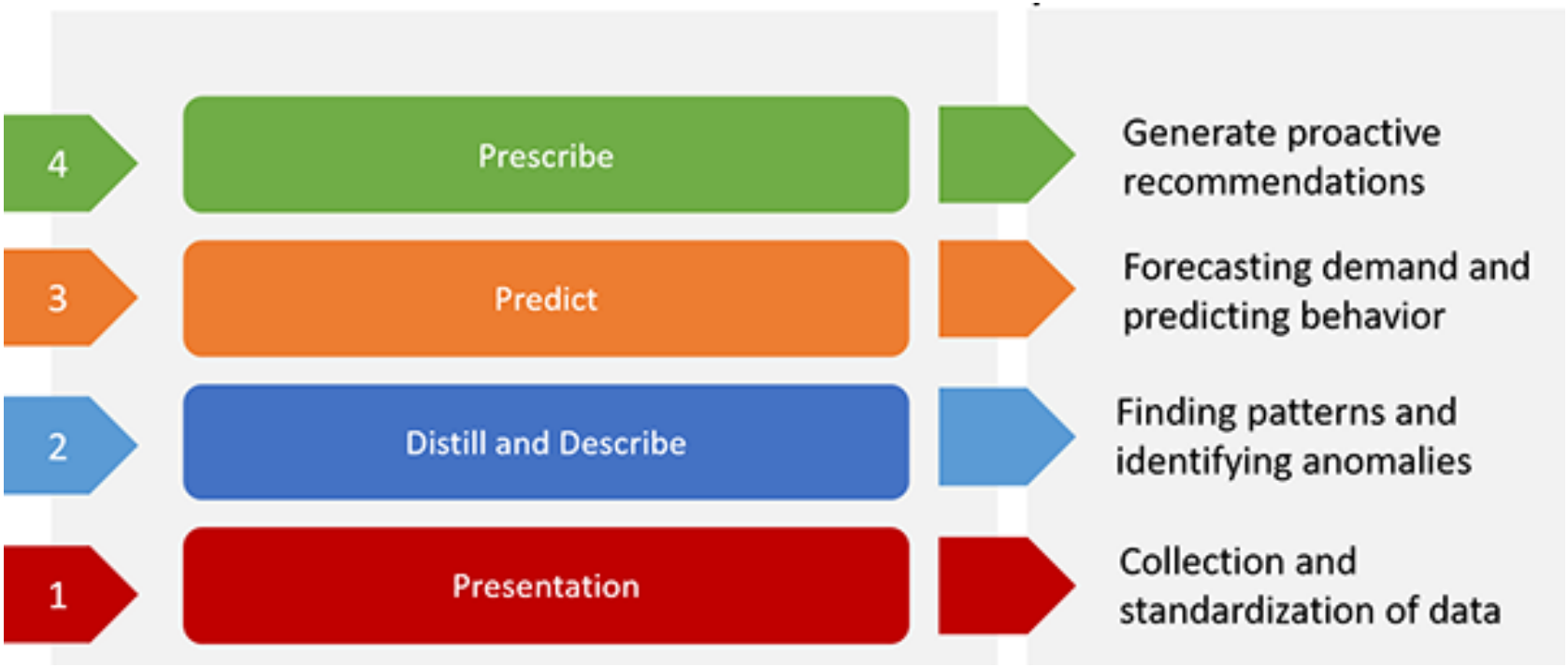

Figure: Identifying patterns in data

Source: https://images.app.goo.gl/smZg56hPYRU8gcpz8

Machine learning types

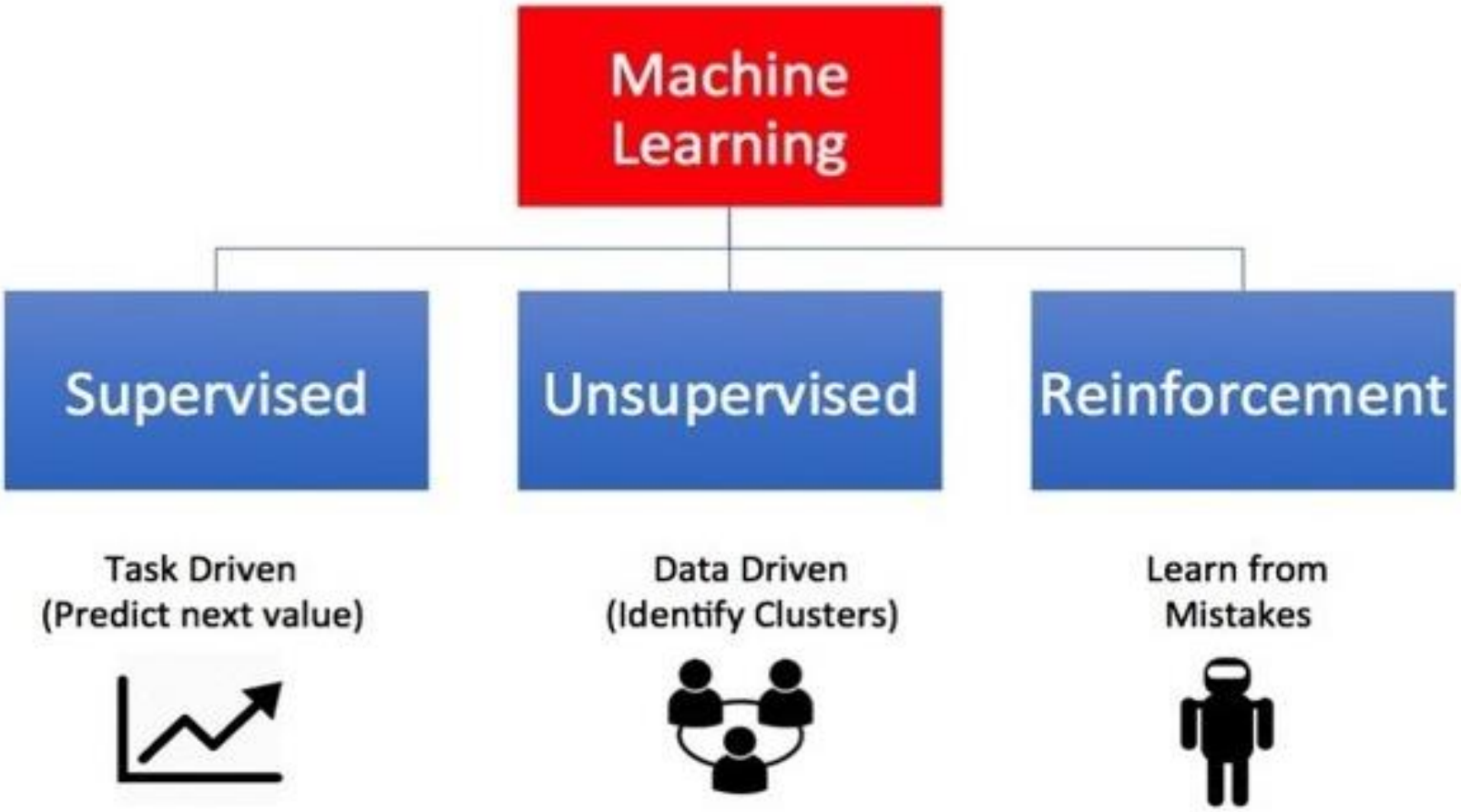

Figure: Machine learning types

Source: https://images.app.goo.gl/9xbeQVDpXo7FPcxdA

Supervised learning

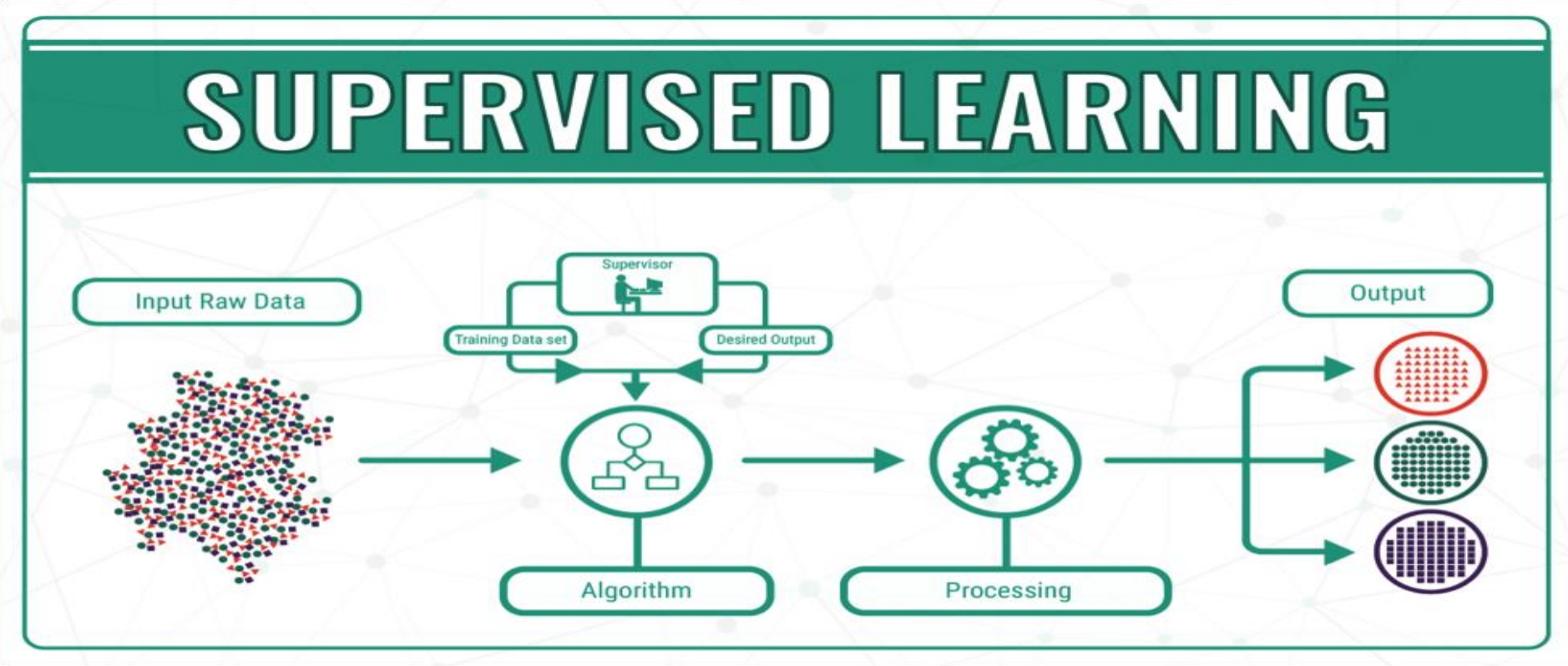

Figure: Supervised learning

Source: https://images.app.goo.gl/5aSEX2mVLqdxHPsf9

Unsupervised learning

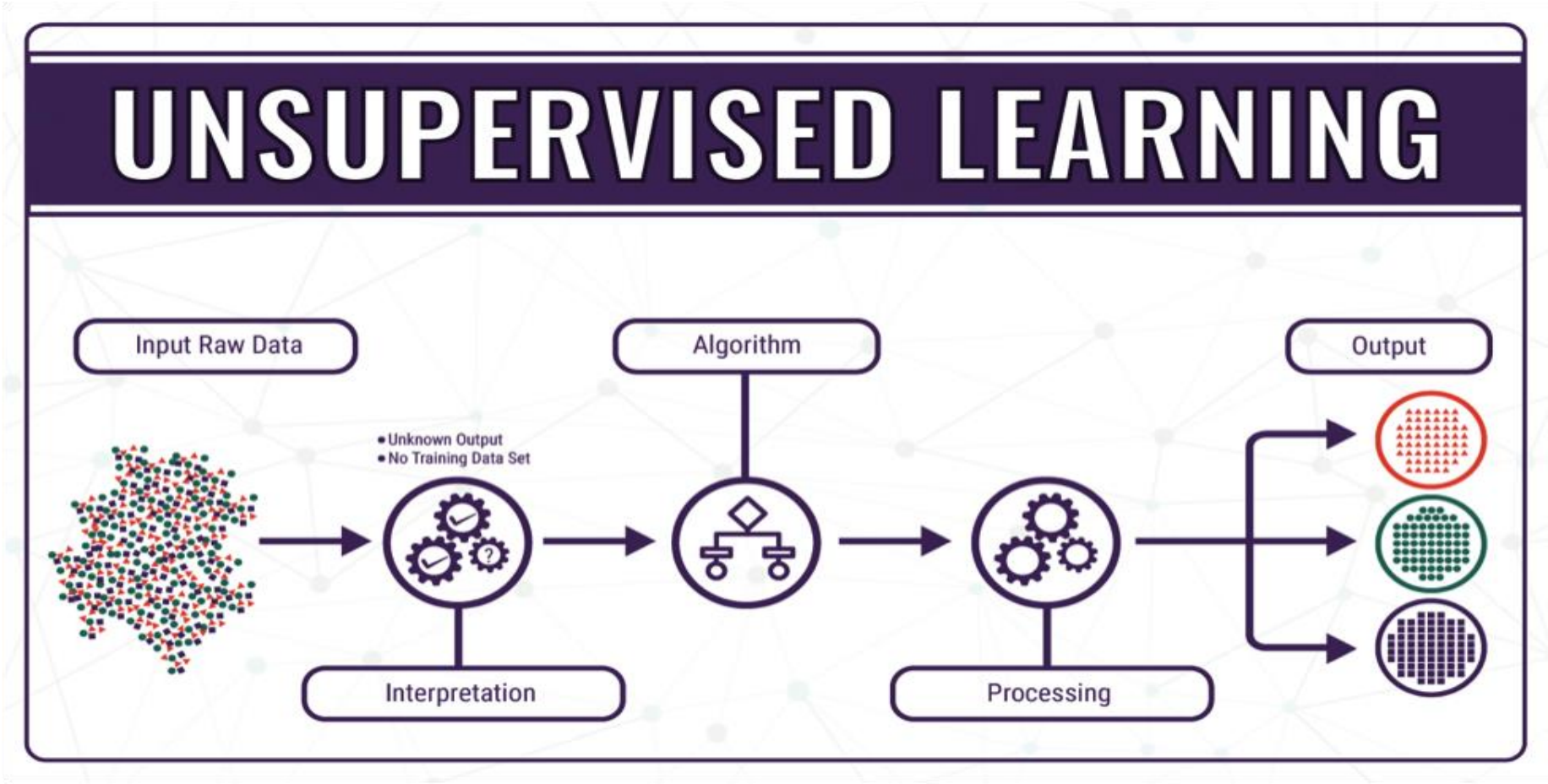

Figure: Unsupervised learning

Source: https://images.app.goo.gl/C359L3VbhxqrLqpy7

Reinforcement learning

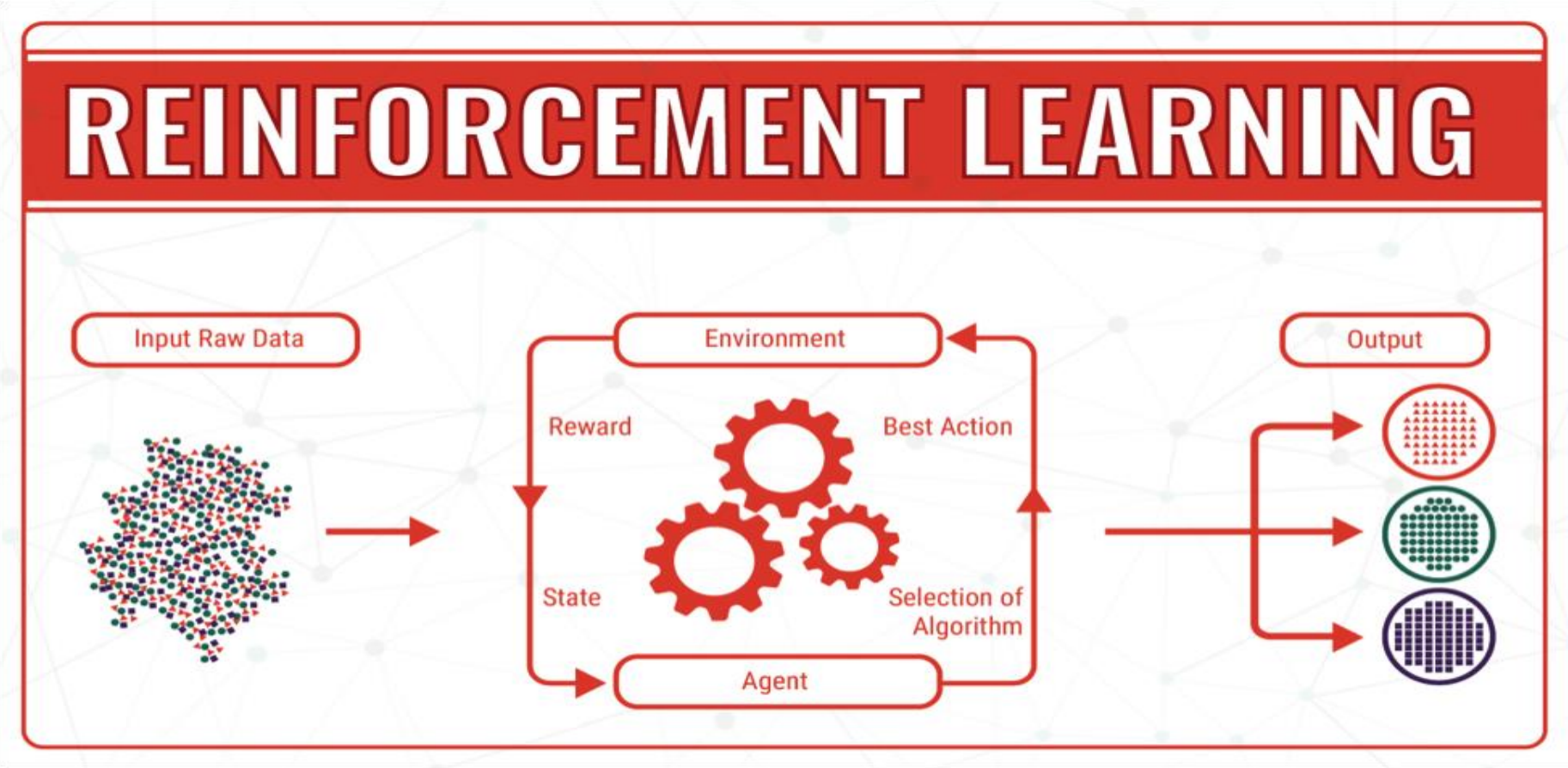

Figure: Reinforcement learning

Source: https://images.app.goo.gl/j6dF44v2QUF37tTo7

Self evaluation: Exercise 1

- To continue with the training, after learning the various steps involved in cognitive analytics and machine learning, it is instructed to utilize the concepts of machine learning algorithms to perform the following activity.

- You are instructed to write the following activities using Python code.

- Exercise 1: Cognitive learning − classification Algorithm.

- Dataset: Breast Cancer W.isconsin Diagnostic Database

Hypothesis generation and scoring (1 of 4)

- Hypothesis generation focuses on how knowledge is activated about plausible hypotheses which should be considered during hypothesis evaluation the calling to mind of possible hypotheses.

- For example, a highly plausible hypothesis can block retrieval from other parts of the hypothesis space.

Hypothesis generation and scoring (1 of 2)

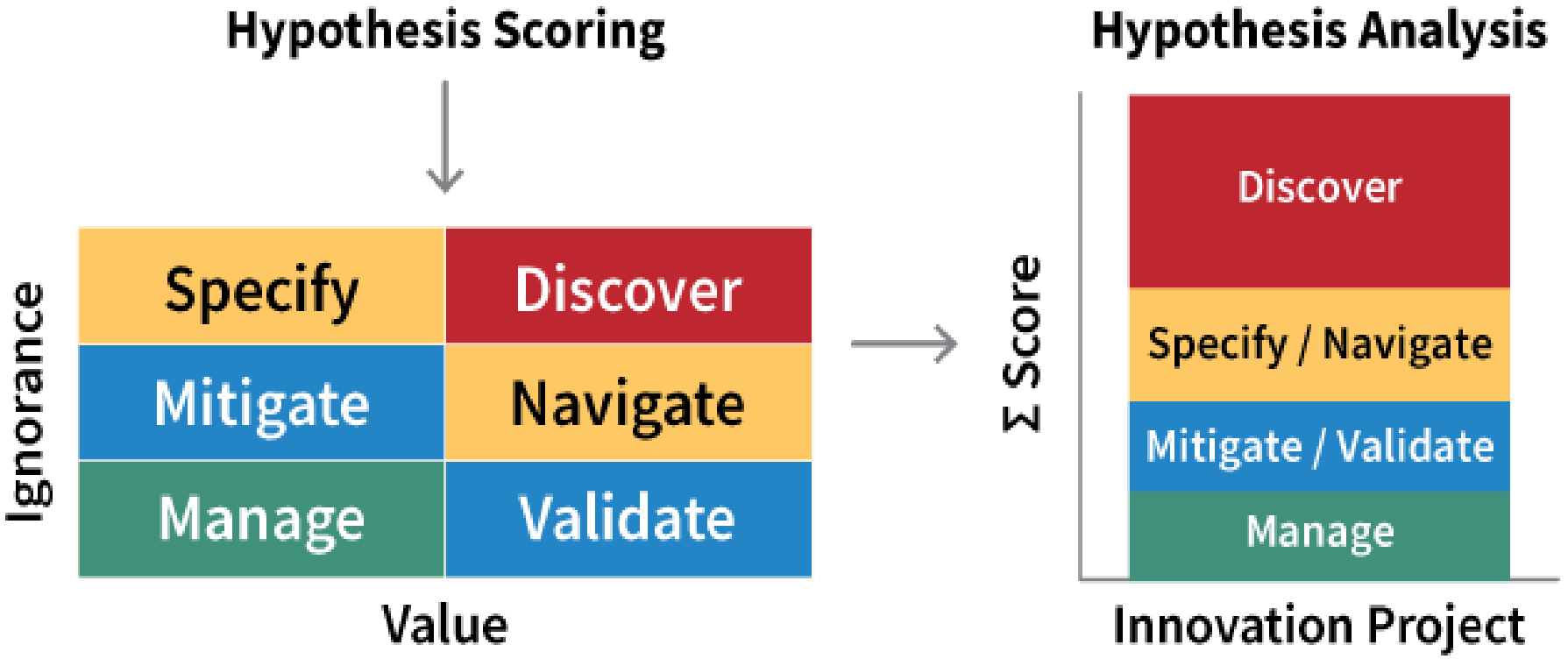

Figure: Hypothesis Scoring with Generated Values

Source: https://images.app.goo.gl/fUKrLTmGubzD4rxa6

Hypothesis generation and scoring (2 of 2)

- Hypothesis scoring.

		Conclusion about null hypothesis from statistical test	
		Accept Null	Reject Null
Truth about null hypothesis in population	True	Correct	Type I error Observe difference when none exists
	False	Type II error Fail to observe difference when one exists	Correct

Figure: Hypothesis testing and scoring

Source: https://images.app.goo.gl/FLjn7AymGw6Ce7NJ8

Hypothesis generation and scoring (4 of 4)

- Hypothesis testing.

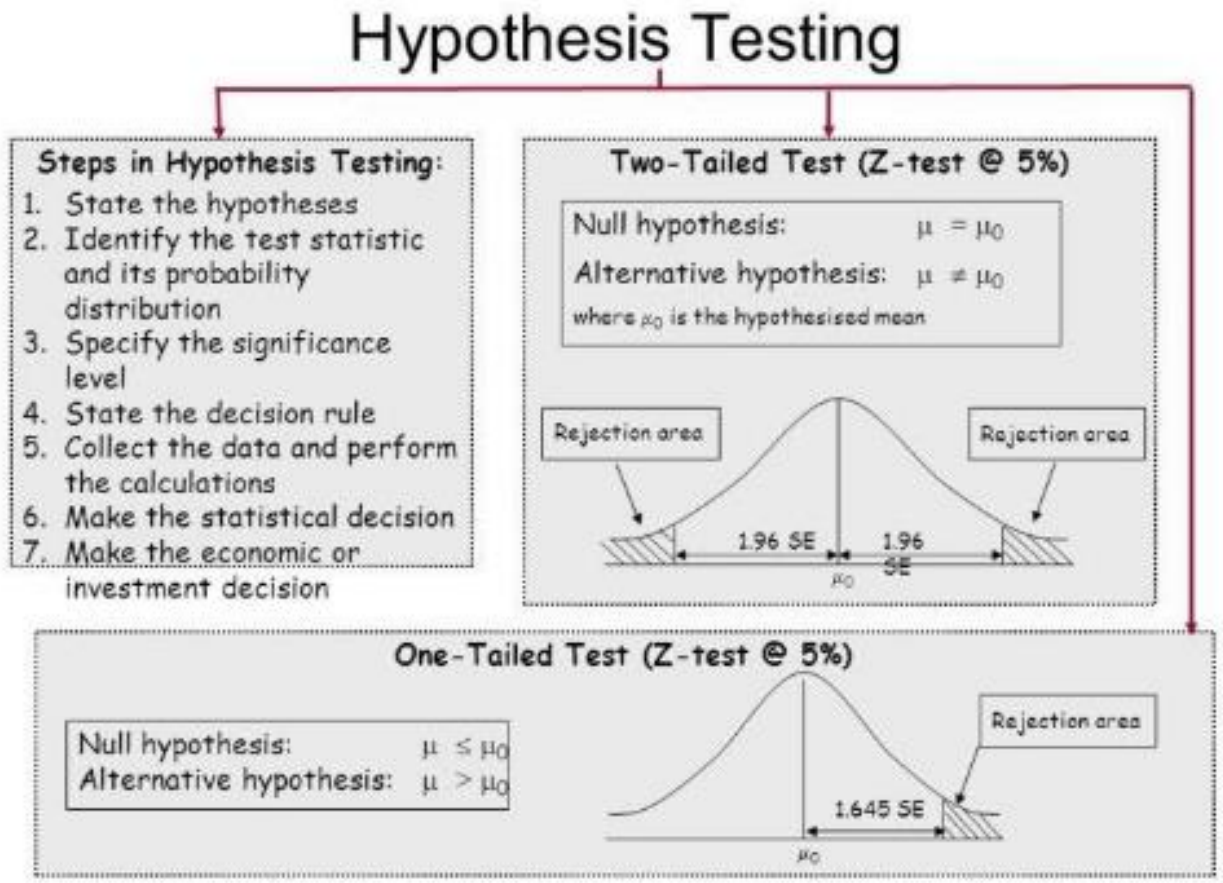

Figure: Hypothesis testing

Source: https://images.app.goo.gl/tNfzqzLQjQNw8hfv8

Self evaluation: Exercise 2

- To continue with the training, after learning the various steps involved in cognitive analytics and machine learning, it is instructed to utilize the concepts of machine learning algorithms to perform the following activity.

- You are instructed to write the following activities using Python code.

- Exercise 2: Building Cognitive Classifier – 1 (Naïve Byes and SVM)

Presentation and visualization services

- Three key categories of resources are then required to achieve these objectives:
  - Narrative approaches that utilize the methods of natural language processing to data features or explain results in the natural language.
  - This is suitable for documenting conclusions or statements about the facts used to draw a hypothesis or query.
  - Data visualizations : provide non-text types of info, including:
    - Graphics, varying from basic maps and graphs to intricate depictions of data connections.
    - Images selected from the data to be presented or generated from an underlying representation. (For example, if feature extraction detects a “face” object, a visualization service could generate a “face” or pictograph from a standard features library)
    - Data manipulation or animation intended to express significance or emotion.
    - Reporting systems apply to activities generating an organized result, such as database reports, which can be appropriate for men or computers.

Infrastructure

- In the cognitive computing framework, the infrastructure/sustainment modalities layer is applied to the equipment, networking, and storage foundations.

- The two key architecture criteria for judgments on cognitive computing technology are:
  - Distributed data management.
  - Parallelism.

Self evaluation: Exercise 3

- To continue with the training, after learning the various steps involved in cognitive analytics and machine learning, it is instructed to utilize the concepts of machine learning algorithms to perform the following activity.

- You are instructed to write the following activities using Python code.

- Exercise 3: Building Cognitive Classifier – 2 (Regression, Decision tree and Random Forest)

Case study: IBM Watson (1 of 2)

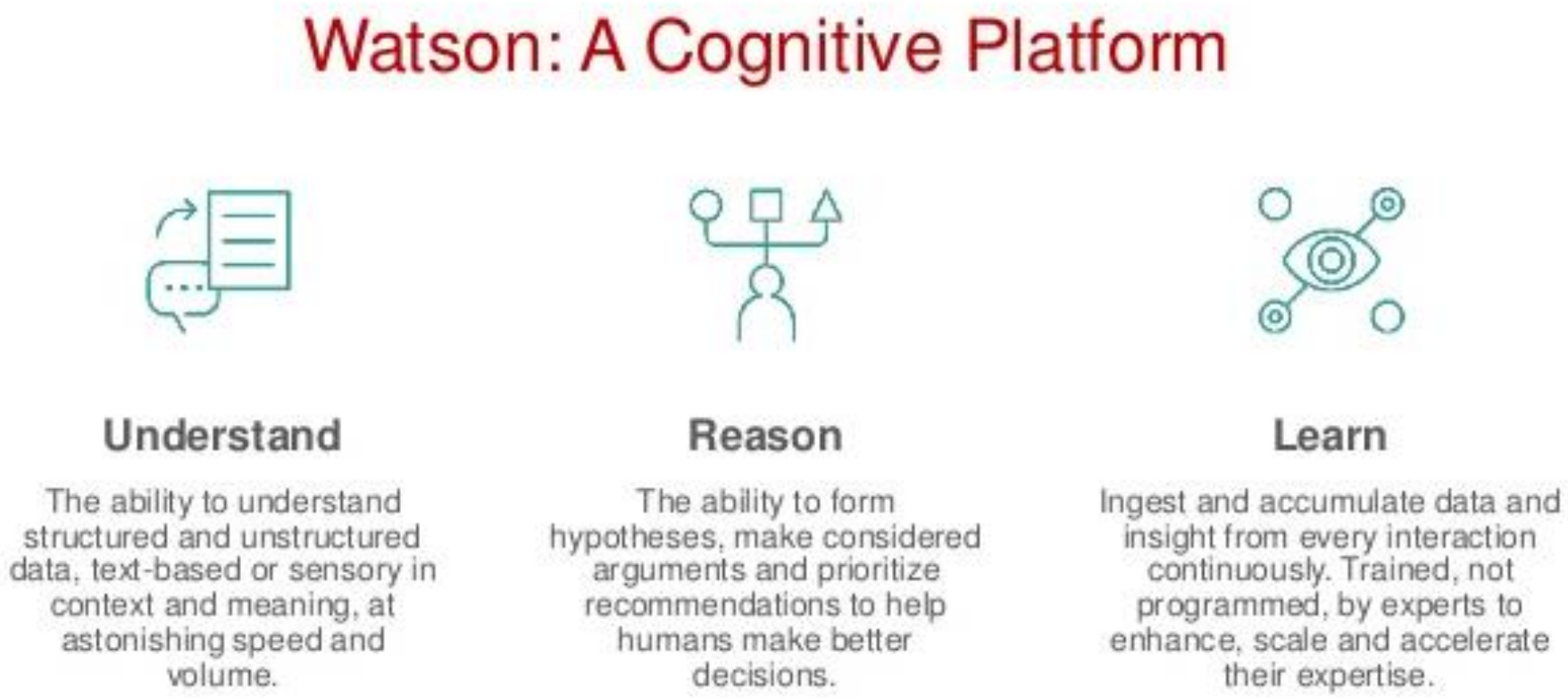

Figure: IBM Watson – Cognitive analytics

Source: https://images.app.goo.gl/9VuW6xywd1P8juHe8

Case study: IBM Watson (2 of 5)

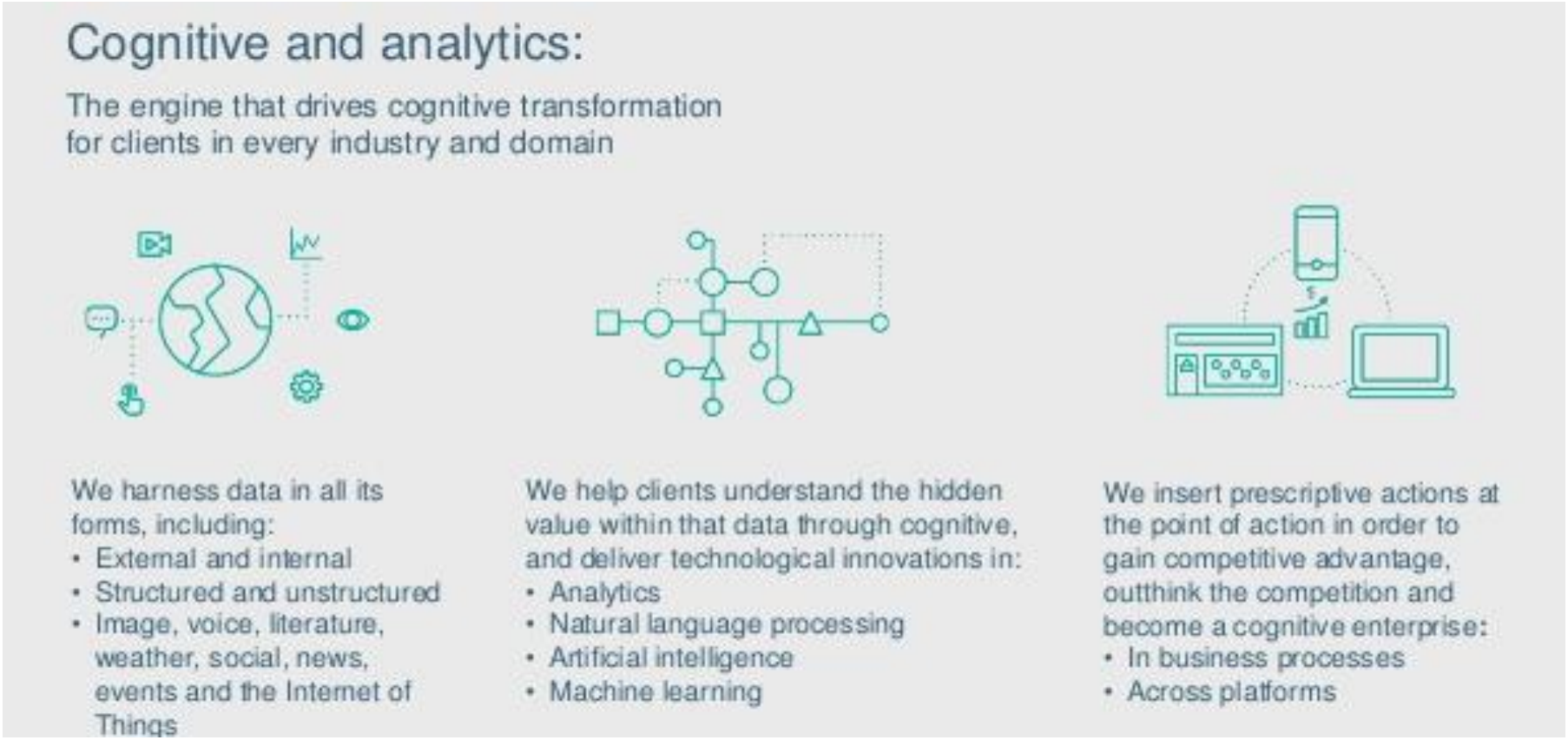

Figure: Cognitive and analytics

Source: https://images.app.goo.gl/LtHYv7FuMxjnkb318

Case study: IBM Watson (2 of 2)

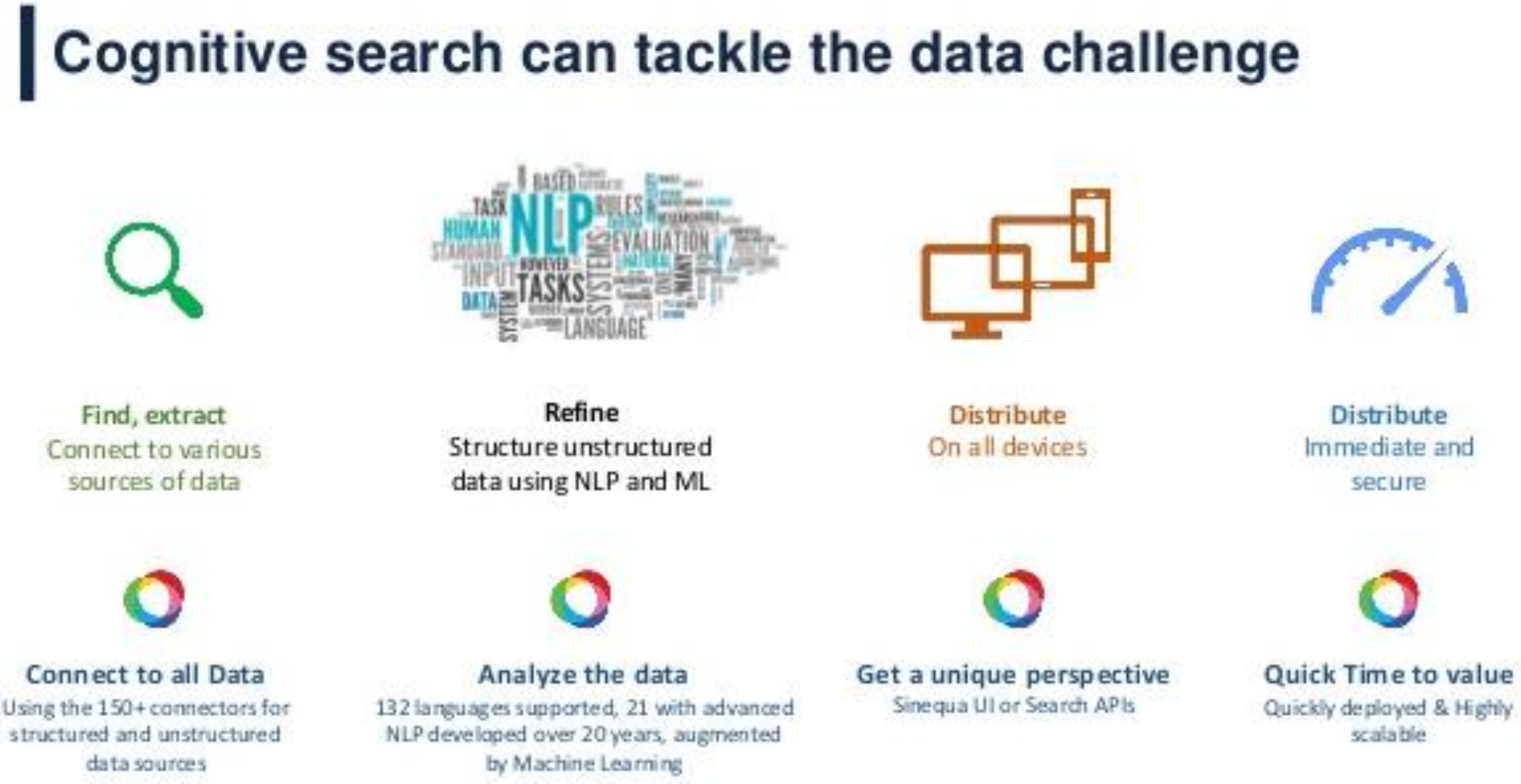

Figure: Cognitive Data Challenges

Source: https://images.app.goo.gl/eLD6fcv3CrnD5xor8

Case study: IBM Watson (4 of 5)

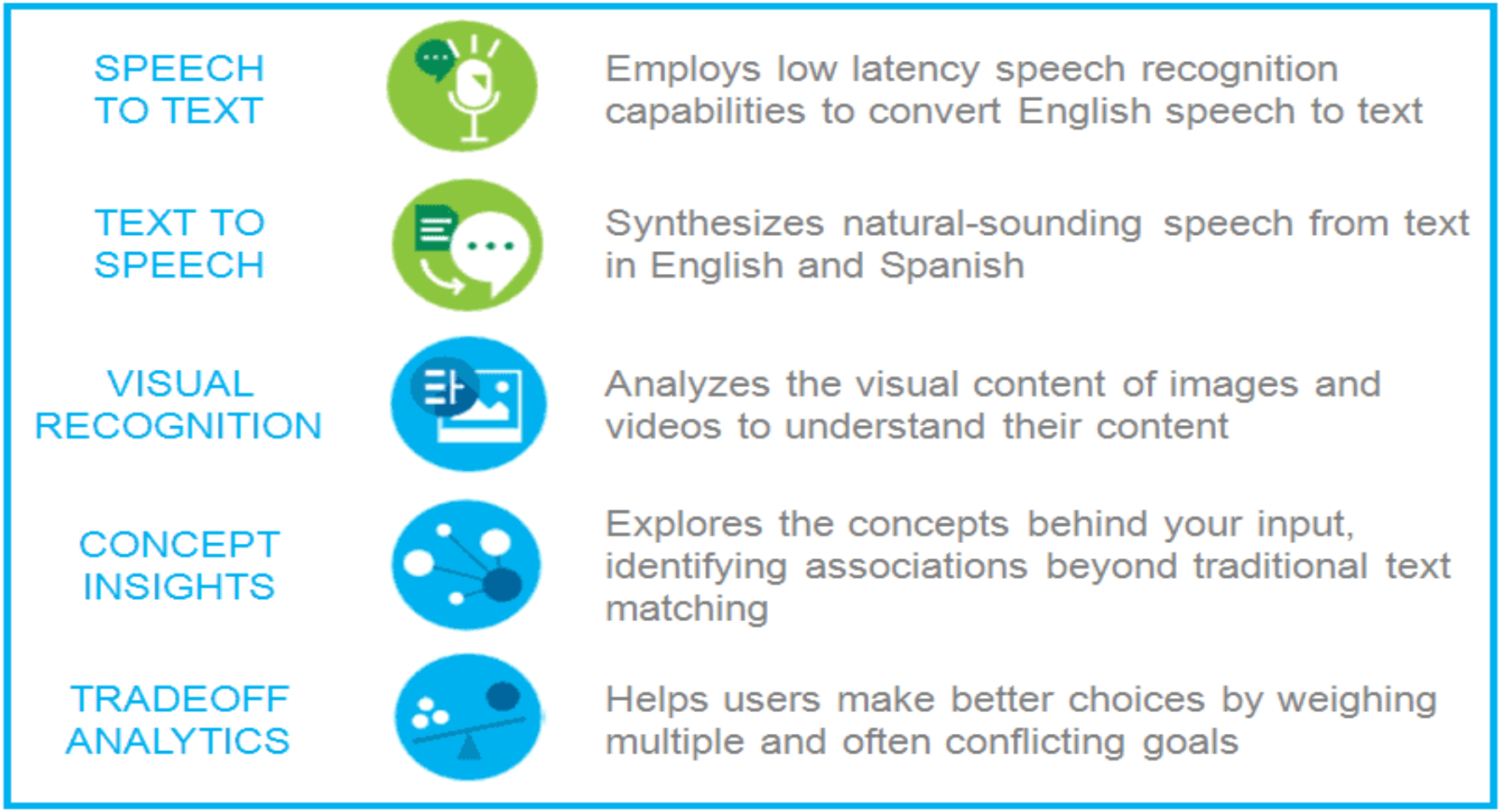

Figure: Watson Applications

Source: https://images.app.goo.gl/fbcZRGv9CtJy7rZ16

Case study: IBM Watson (5 of 5)

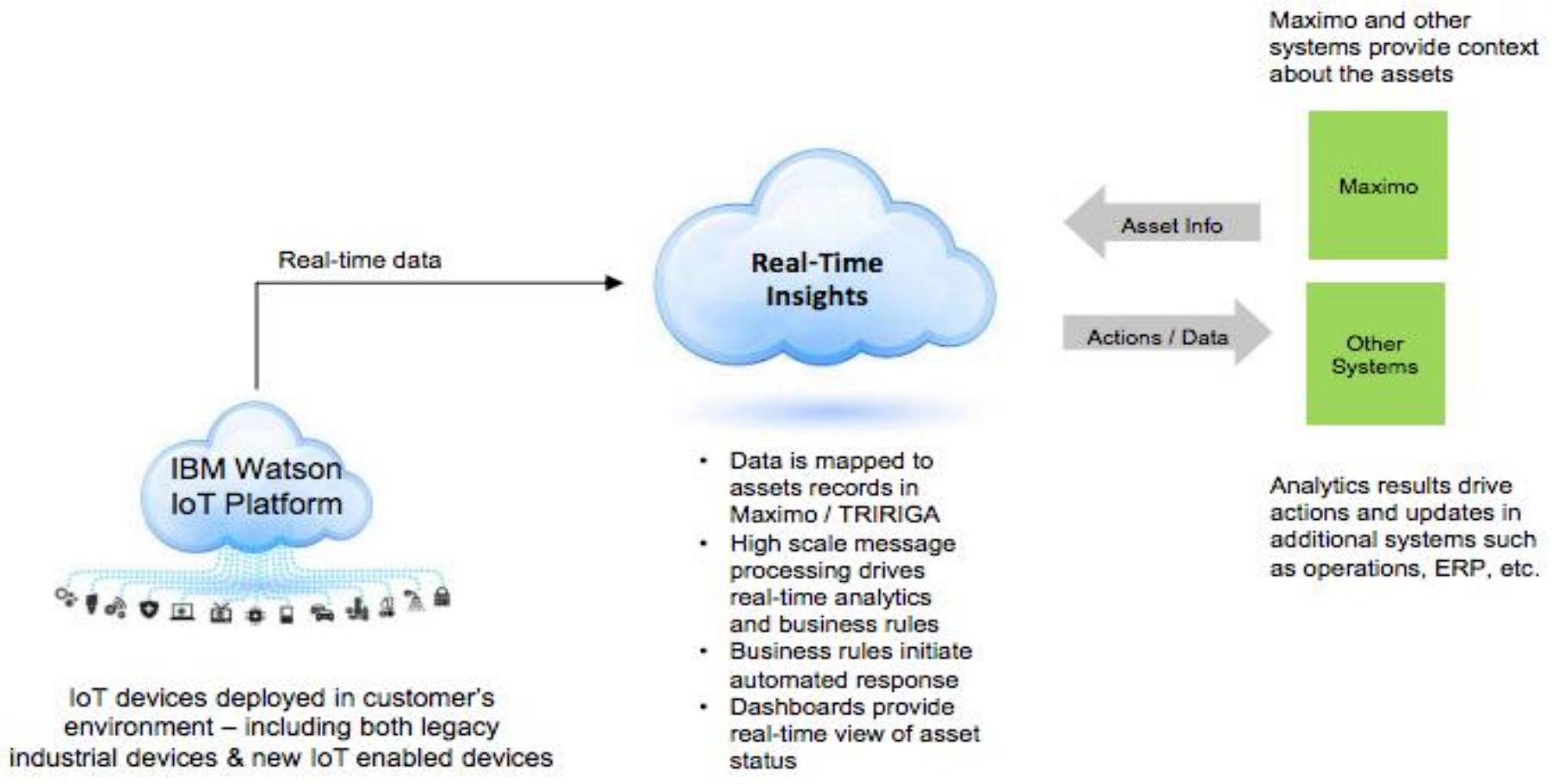

Figure: Architecture of watson cognitive services

Source: https://images.app.goo.gl/cvxcGJ7N3MWk8H1D6

Self evaluation: Exercise 4

- To continue with the training, after learning the various steps involved in cognitive analytics and machine learning, it is instructed to utilize the concepts of machine learning algorithms to perform the following activity.

- You are instructed to write the following activities using Python code.

- Exercise 4: Building Cognitive Performance of a classifier.

- * Confusion Matrix

Checkpoint (1 of 2)

Multiple choice questions:

1. What does cognitive computing involve?
   a) Natural language processing
   b) Machine learning
   c) Deep learning
   d) All the above

2. What is the field of Natural Language Processing (NLP)?
   a) Computer science
   b) Artificial intelligence
   c) Linguistics
   d) All the above

3. If the null hypothesis is false, then which of the following is accepted?
   a) Null Hypothesis
   b) Positive Hypothesis
   c) Negative Hypothesis
   d) Alternative Hypothesis

Checkpoint solutions (1 of 2)

Multiple choice questions:

1. What does cognitive computing involve?
   a) Natural language processing
   b) Machine learning
   c) Deep learning
   d) All the above

2. What is the field of Natural Language Processing (NLP)?
   a) Computer science
   b) Artificial intelligence
   c) Linguistics
   d) All the above

3. If the null hypothesis is false, then which of the following is accepted?
   a) Null Hypothesis
   b) Positive Hypothesis
   c) Negative Hypothesis
   d) Alternative Hypothesis

Checkpoint (2 of 2)

Fill in the blanks:

1. The rejection probability of Null Hypothesis when it is true is called as_____.
2. Given a sound clip of a person or people speaking, determine the textual representation of the speech is called _____.
3. Different learning methods does not include _____.
4. A model of language consists of the categories which does not include_____.

True or False:

1. The more general task of coreference resolution also includes identifying so-called “bridging relationships” involving referring expressions. True/False
2. NLP is concerned with the interactions between computers and human (natural) languages. True/False
3. Speech segmentation is a subtask of speech recognition. True/False

Checkpoint solutions (2 of 2)

Fill in the blanks:

1. The rejection probability of null Hypothesis when it is true is called as **level of significance.**
2. Given a sound clip of a person or people speaking, determine the textual representation of the speech is called **speech to text.**
3. Different learning methods does not include **introduction.**
4. A model of language consists of the categories which does not include **structural units.**

True or False:

1. The more general task of coreference resolution also includes identifying so-called “bridging relationships” involving referring expressions. **True**
2. NLP is concerned with the interactions between computers and human (natural) languages. **True**
3. Speech segmentation is a subtask of speech recognition. **True**

Question bank

Two mark question:

1. What is cognitive analytics?
2. What is machine learning?
3. What is NLP?
4. What is Hypothesis?

Four mark question:

1. Difference between NLP and text mining?
2. Difference between supervised and unsupervised learning.
3. What is the difference between cognitive analytics and BigData?
4. What is the Hypothesis generation and score value?

Eight mark question:

1. Explain Hypothesis testing and null Hypothesis?
2. Explain components of cognitive analytics?

Unit summary

Having completed this unit, you should be able to:

- Understand the concept of cognitive computing and analytics
- Learn about NLP process
- Understand the concepts of cognitive analytics architecture and working model
- Gain knowledge on cognitive analytics components
- Gain an insight into process of Hypothesis generation and testing process