



# 07 – Application Layer

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# Contents

1. Information systems
2. Artificial intelligence
3. Simulation, graphics, gaming and other applications

Information systems

# Managing Information

- ❖ **Information system:** Software that helps the user organize and analyze data.
- ❖ Three most popular applications of information systems:
  - ❑ *Electronic spreadsheets*
  - ❑ *Database management systems*
  - ❑ *E-commerce*

# Spreadsheets

- ❖ **Spreadsheet:** A program that allows the user to organize and analyze data using a grid of cells, e.g.: Microsoft® Excel.
- ❖ **Cell:** An element of a spreadsheet that can contain data or a formula

	A	B	C	D	E	F	G	H
1								
2				Tutor				
3			Hal	Amy	Frank	Total	Avg	
4		1	12	10	13	35	11.67	
5		2	14	16	16	46	15.33	
6	Week	3	10	18	13	41	13.67	
7		4	8	21	18	47	15.67	
8		5	15	18	12	45	15.00	
9		Total	59	83	72	214	71.33	
10		Avg	11.80	16.60	14.40	42.80	14.27	
11								
12								

# Spreadsheet Formulas

- ❖ A computation provided by the spreadsheet software that can be incorporated into formulas

	A	B	C	D	E	F	G	H
1								
2				Tutor				
3			Hal	Amy	Frank	Total	Avg	
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11								
12								

=SUM(C4..E4) points to cell F4 (35)  
 =F7/COUNT(C7..E7) points to cell G7 (15.67)  
 =SUM(C4..C8) points to cell C9 (59)  
 =E9/COUNT(E4..E8) points to cell E9 (72)  
 =F9/COUNT(C4..E8) points to cell G9 (71.33)

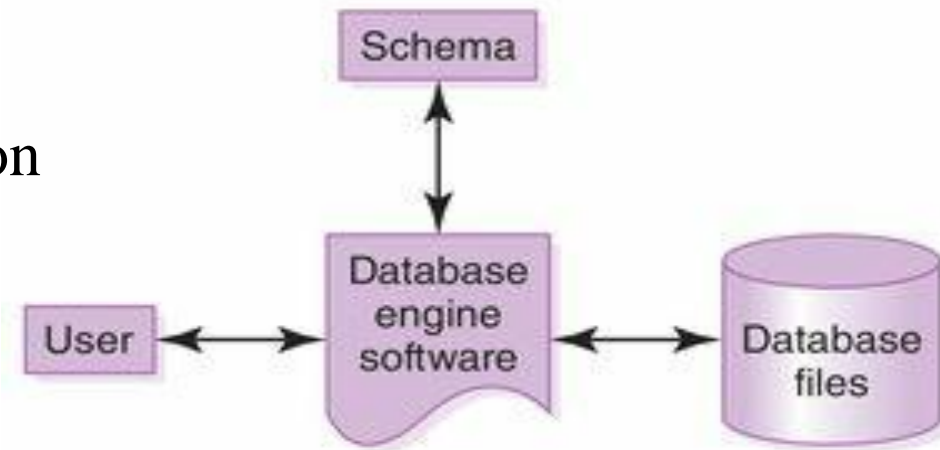


# Spreadsheet Analysis

- ❖ Track sales
- ❖ Analyze sport statistics
- ❖ Maintain student grades
- ❖ Keep a car maintenance log
- ❖ Record and summarize travel expenses
- ❖ Track project activities and schedules
- ❖ Plan stock purchases

# Database Management Systems

- ❖ **Database:** A structured set of data
- ❖ **Database management system (DBMS):** A combination of software and data made up of
  - ❑ **physical database:** collection of files that contain the data
  - ❑ **database engine:** a software that supports access to and modification of the database contents
  - ❑ **database schema:** a specification of the logical structure of the data stored in the database







# Relational-Model DBMS

- ❖ **Relational model:** A database model in which data and the relationships among them are organized into tables
- ❖ **Table:** A collection of database records
- ❖ **Record (or object, or entity):** A collection of related fields that make up a single database entry (rows)
- ❖ **Field (or attribute):** A single value in a database record (columns)

MovieId	Title	Genre	Rating
101	Sixth Sense, The	thriller horror	PG-13
102	Back to the Future	comedy adventure	PG
103	Monsters, Inc.	animation comedy	G
104	Field of Dreams	fantasy drama	PG
105	Alien	sci-fi horror	R
106	Unbreakable	thriller	PG-13
107	X-Men	action sci-fi	PG-13
5022	Elizabeth	drama period	R
5793	Independence Day	action sci-fi	PG-13
7442	Platoon	action drama war	R

Movie table

- ❖ each movie record has: a MovieId, a Title, a Genre, and a Rating
- ❖ **Key field:** One or more fields of a database record that uniquely identifies it among all other records in the table, e.g., MovieId.
- ❖ **Schema:** Movie (MovieId:key, Title, Genre, Rating)



CustomerId	Name	Address	CreditCardNumber
101	Dennis Cook	123 Main Street	2736 2371 2344 0382
102	Doug Nickle	456 Second Ave	7362 7486 5957 3638
103	Randy Wolf	789 Elm Street	4253 4773 6252 4436
104	Amy Stevens	321 Yellow Brick Road	9876 5432 1234 5678
105	Robert Person	654 Lois Lane	1122 3344 5566 7788
106	David Coggin	987 Broadway	8473 9687 4847 3784
107	Susan Klaton	345 Easy Street	2435 4332 1567 3232

Customers table

CustomerId	MovielId	DateRented	DateDue
103	104	3-12-2015	3-13-2015
103	5022	3-12-2015	3-13-2015
105	107	3-12-2015	3-15-2015

Rents table

# Structured Query Language (SQL)

- ❖ A comprehensive relational database language for data management and queries
- ❖ Queries: **select *attribute-list* from *table-list* where *condition***
- ❖ E.g.:
  - ❑ select Title from Movie where Rating = 'PG'
  - ❑ select Name, Address from Customer
  - ❑ select \* from Movie where Genre like '%action%'

# Modifying Database Content

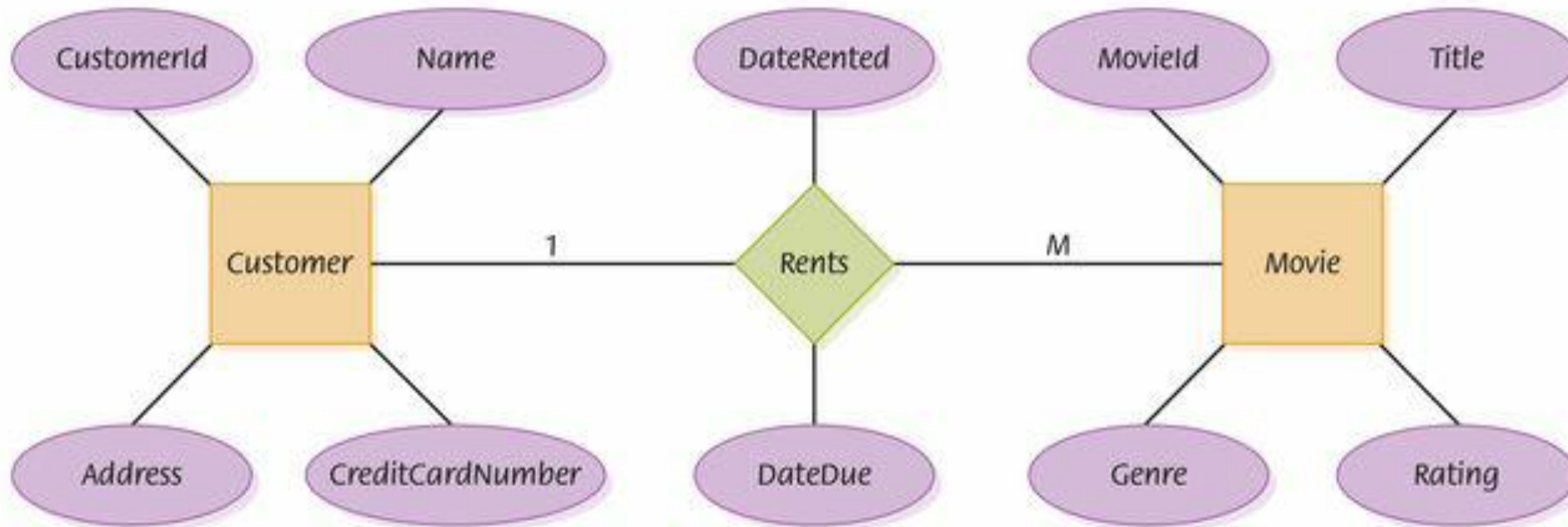
```
insert into Customer values (9876, 'John Smith',  
'602 Greenbriar Court', '2938 3212 3402 0299')
```

```
update Movie set Genre = 'thriller drama' where title =  
'Unbreakable'
```

```
delete from Movie where Rating = 'R'
```

# Database Design

- ❖ Entity-relationship (ER) modeling: A popular technique for designing relational databases
- ❖ ER diagram: A graphical representation of an ER model



An ER diagram  
for the movie  
rental database



# Quiz

- ❖ Define an SQL query that returns all attributes of all records in the Customer table.
- ❖ Define an SQL query that returns the MovieId number and title of all movies that have an R rating.
- ❖ Define an SQL query that returns the address of every customer in the Customer table who lives on Lois Lane.
- ❖ Define an SQL statement that inserts the movie Armageddon into the Movie table.
- ❖ Define an SQL statement that changes the address of Amy Stevens in the Customer table.

# E-Commerce

- ❖ **Electronic commerce:** The process of buying and selling products and services using the World Wide Web. E.g., Amazon.com, eBay, Shopee, Lazada, Tiki,...
- ❖ **Key aspects:** web-based technologies, Electronic shopping carts, recommendation system, security for financial transactions,...





# Other information systems

- ❖ Blackboard, edusoft
- ❖ ERP (Enterprise resource planning), SAP (Systems Applications and Products)

Artificial Intelligence

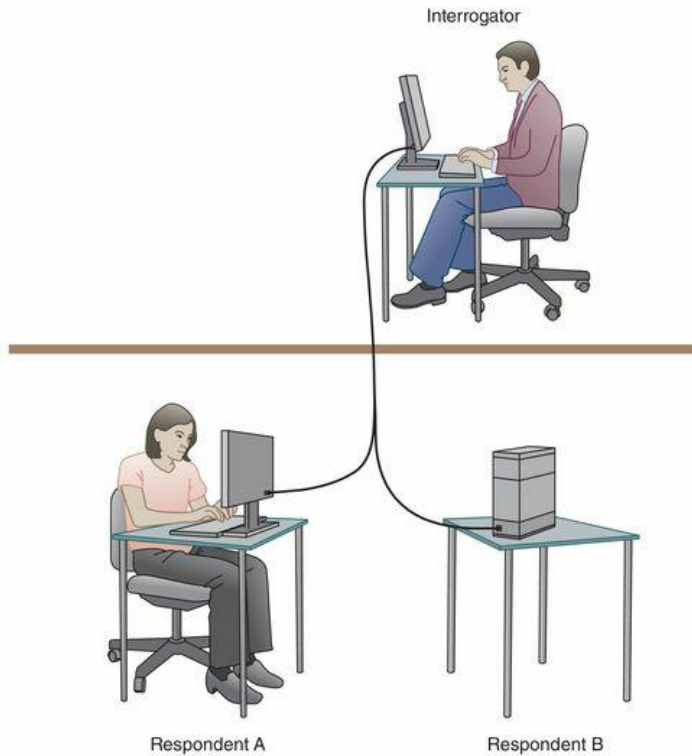


## ❖ Thinking Machines

- ❖ **Artificial intelligence (AI):** The study of computer systems that model and apply the intelligence of the human mind
- ❖ **Chatbot:** A program designed to carry on a conversation with a human user

# The Turing Test

- ❖ A behavioral approach to determining whether a computer system is intelligent
- ❖ A human interrogator sits in a room and uses a computer terminal to communicate with two respondents, A and B. One is human and the other is a computer. The interrogator doesn't know which is which.
- ❖ If the computer pass the Turing test, then it could be considered intelligent.



# Aspects of AI

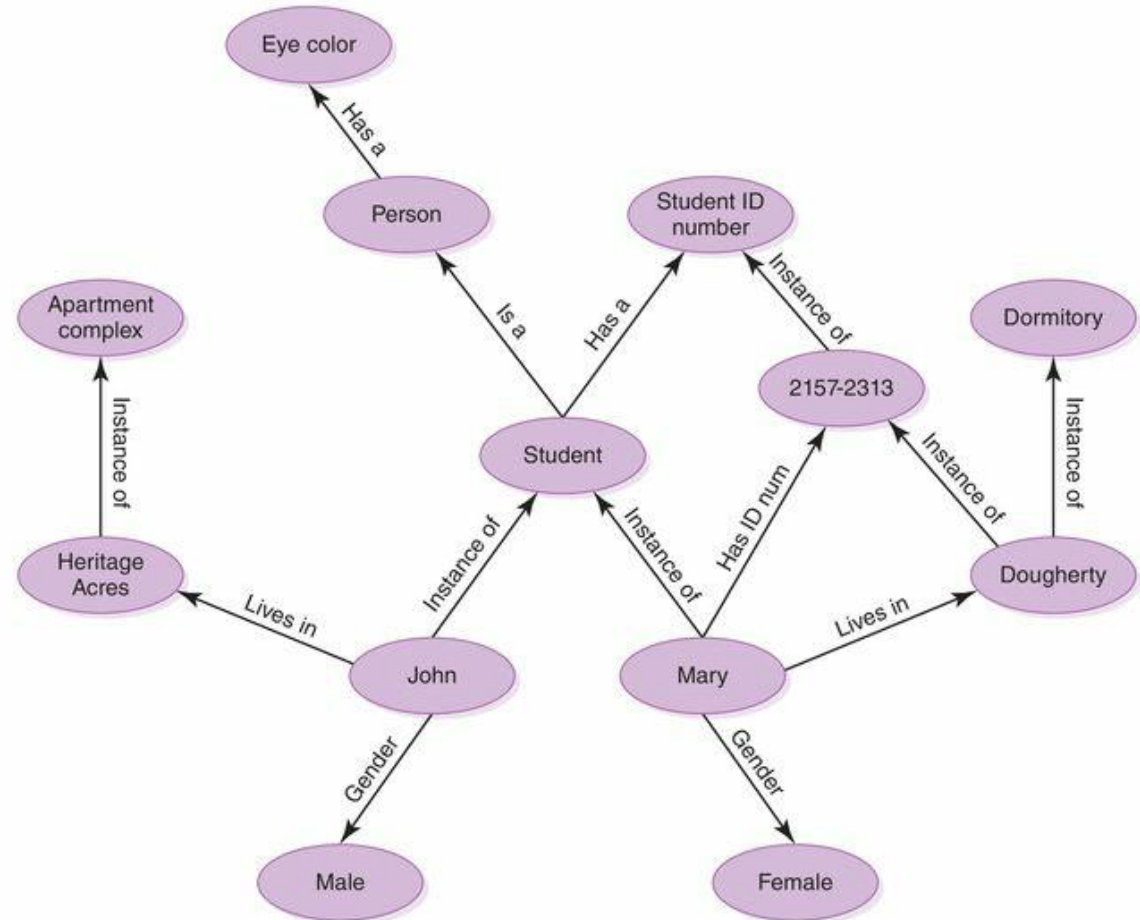
- ❖ **Knowledge representation:** the techniques used to represent knowledge so that a computer system can apply it to intelligent problem solving
- ❖ **Expert systems:** computer systems that embody the knowledge of human experts
- ❖ **Neural networks:** computer systems that mimic the processing of the human brain
- ❖ **Natural language processing:** the challenge of processing languages that humans use to communicate
- ❖ **Robotics:** the study of robots

# Knowledge Representation

## ❖ Semantic Networks:

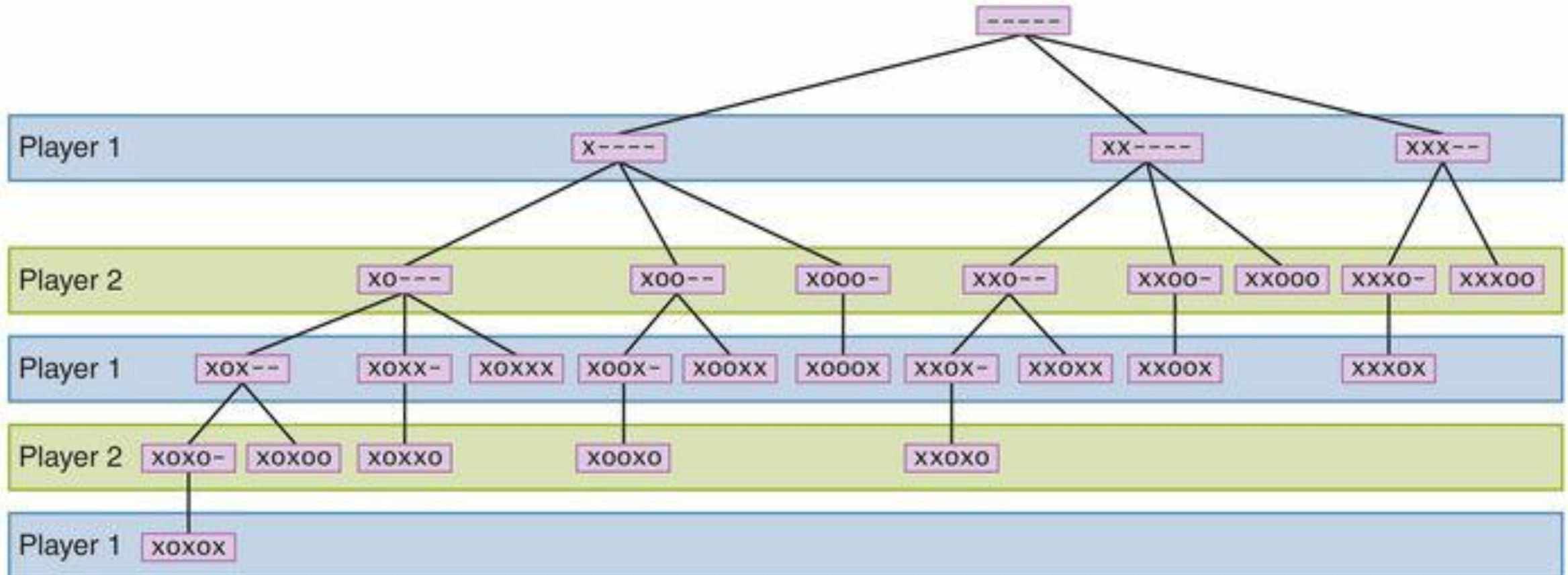
A knowledge representation technique that represents the relationships among objects.

What is semantic web?



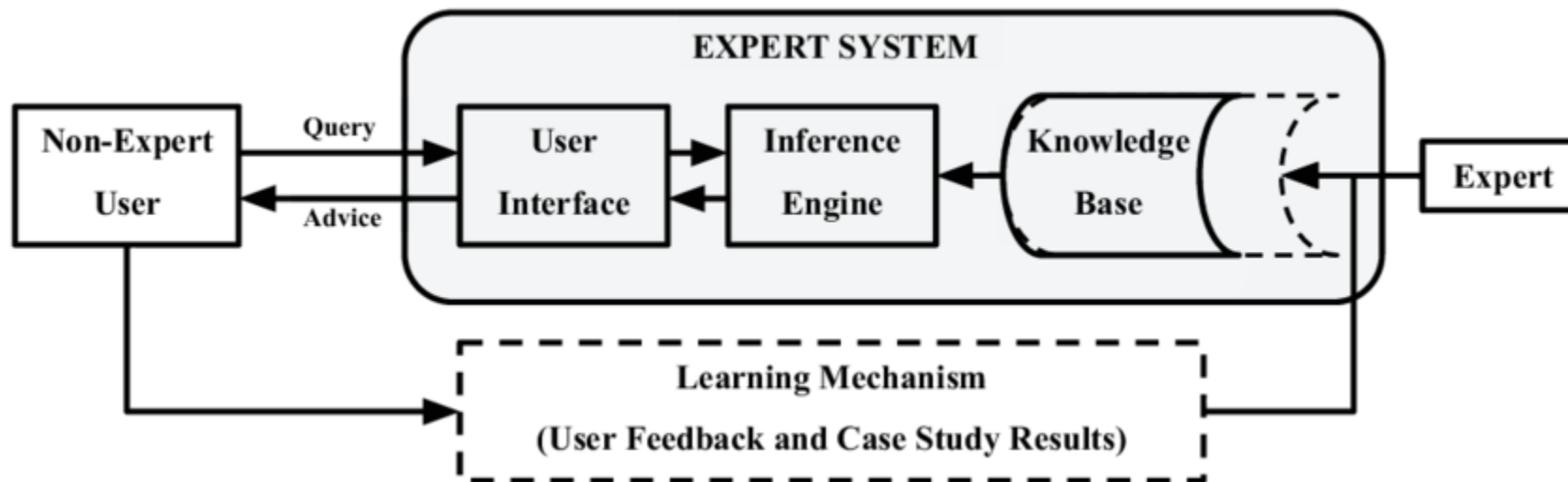
# Search tree

- ❖ A structure that represents alternatives in adversarial situations, such as game playing



# Expert Systems

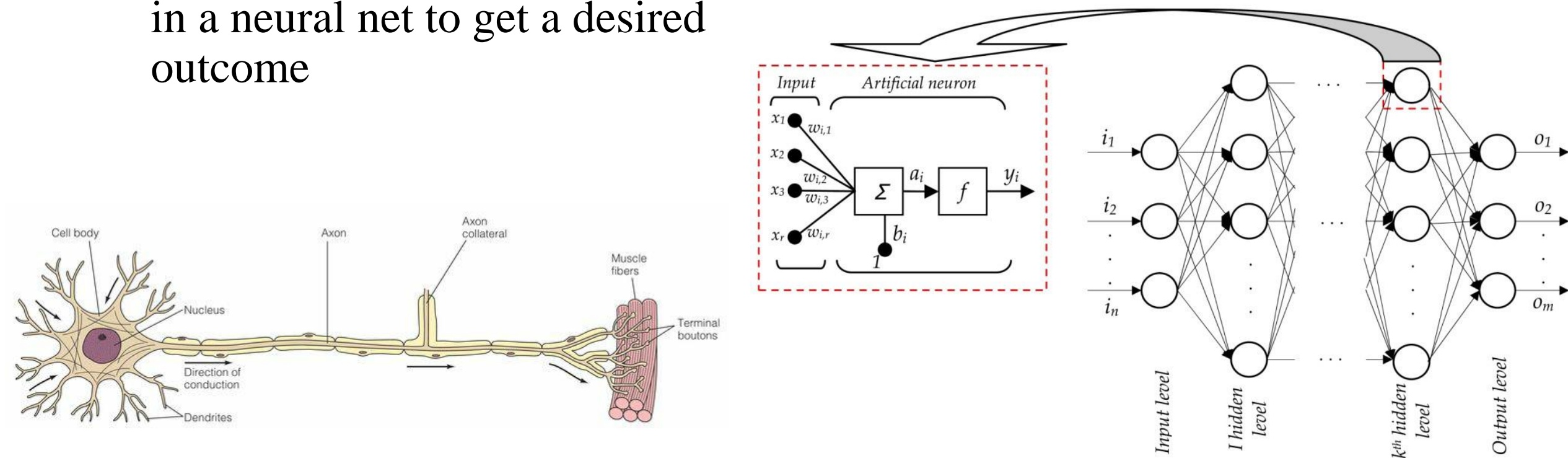
- ❖ **Knowledge-based system:** Software that uses a specific set of information
- ❖ **Expert system:** A software system based on the knowledge of human experts. E.g., software that helps doctors diagnose some diseases.





# Artificial neural network

- ❖ **Artificial neural network:** A computer representation of knowledge that attempts to mimic the neural networks of the human body
- ❖ **Training:** The process of adjusting the weights and threshold values in a neural net to get a desired outcome





# Natural Language Processing (NLP)

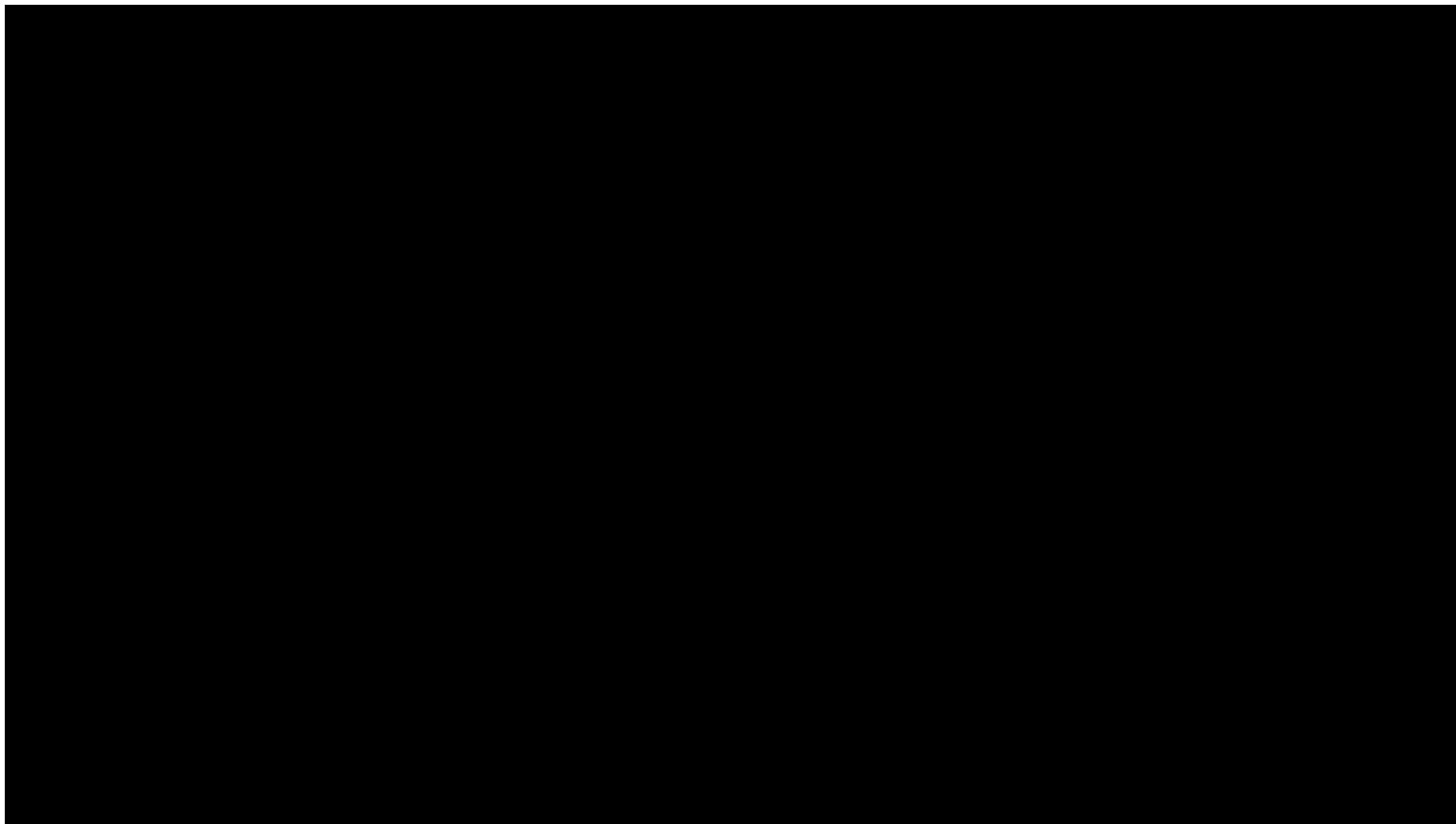
- ❖ **Voice recognition** Using a computer to recognize the words spoken by a human
- ❖ **Natural language comprehension:** Using a computer to apply a meaningful interpretation to human communication
- ❖ **Voice synthesis:** Using a computer to create the sound of human speech
- ❖ Jeopardy challenge 2011  
(<https://www.youtube.com/watch?v=P18EdAKuC1U>)

# Eliza

...from your company. I was  
with your prompt delivery. I  
opened the package, I found  
either in the box or with the  
it is essential that our account  
department have the invoice by  
the first quarter. It would be  
accountants and I if you want  
other invoice as soon as possible

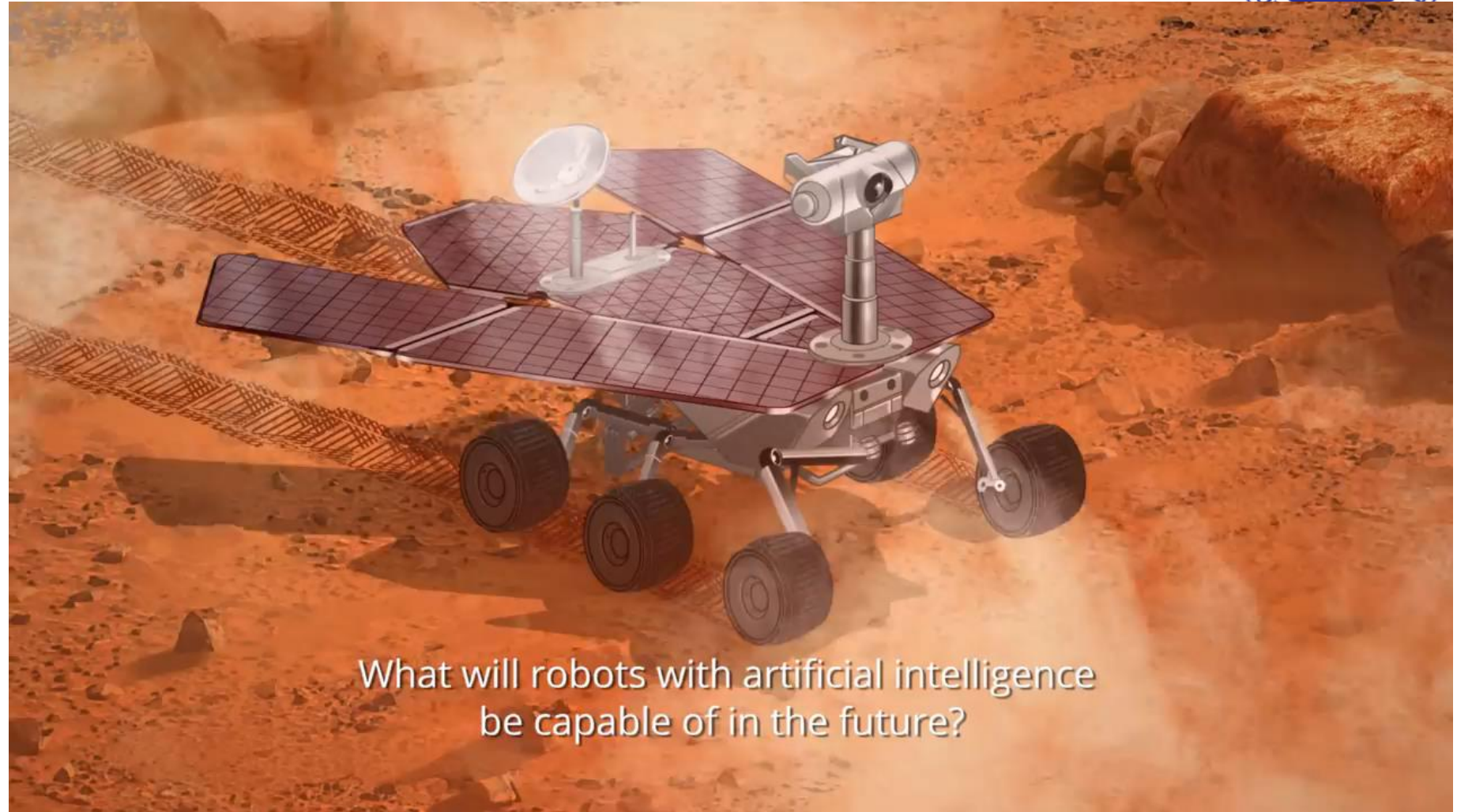


# Watson and the Jeopardy! Challenge



# Robotics

Sense–Plan–Act  
Paradigm  
e.g., self-driving  
car



Simulation, Graphics, Gaming,  
and Other Applications



# Simulation

- ❖ **Simulation** Developing a model of a complex system and experimenting with the model to observe the results
- ❖ **Model:** An abstraction of a real system; a representation of objects within a system and the rules that govern the behavior of the objects
  - ❑ **Continuous Simulation:** continuous time, differential equations represents interactions between features and changes of features, e.g., weather models such as Weather Forecasting, Hurricane Tracking
  - ❑ **Discrete-Event Simulation:** discrete events. E.g., NS-3, OPNET, OMNET

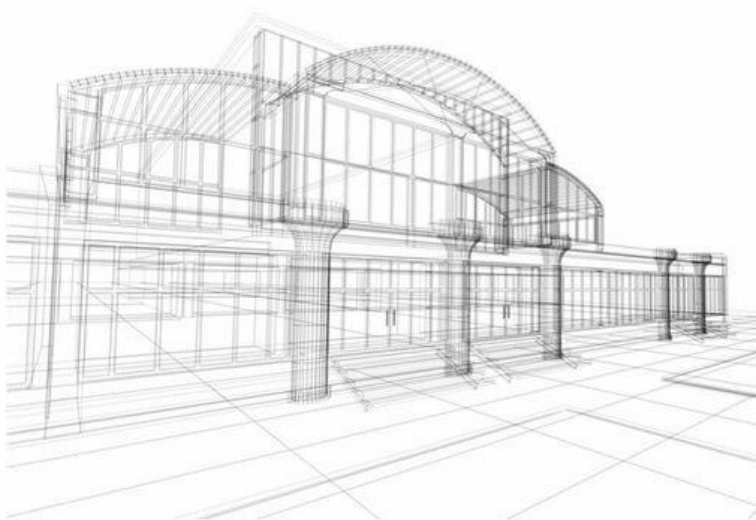


# Computer Graphics

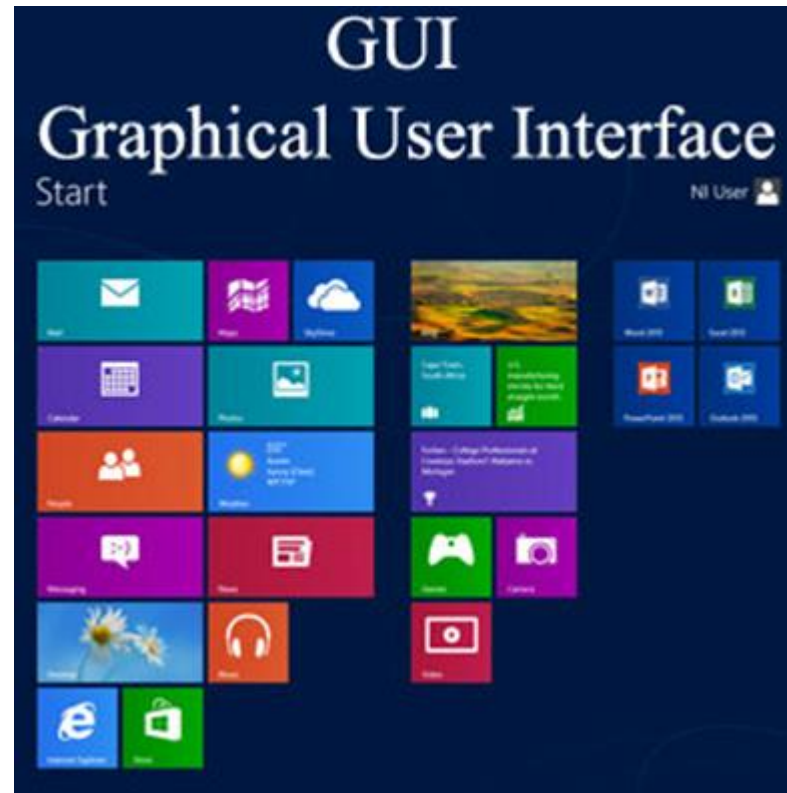
- ❖ Create pictures and films using computers
- ❖ Some apps: Graphical user interface, 3D modelling, vector graphic
- ❖ Huge impacts on animation, movies, advertising, video games, and graphic design.



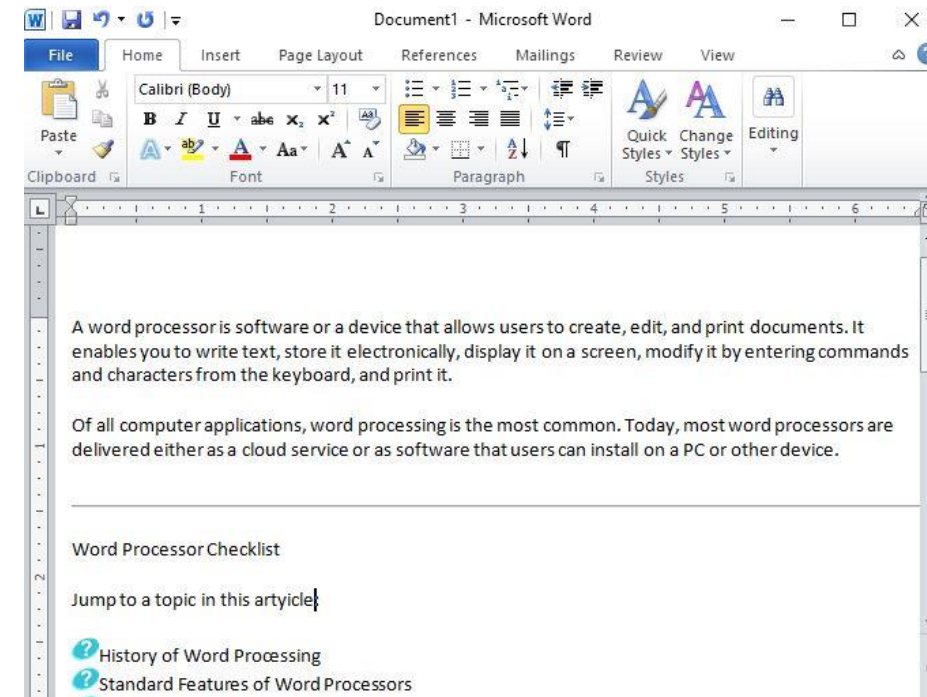
# Computer Graphics



Computer-aided design  
(CAD)

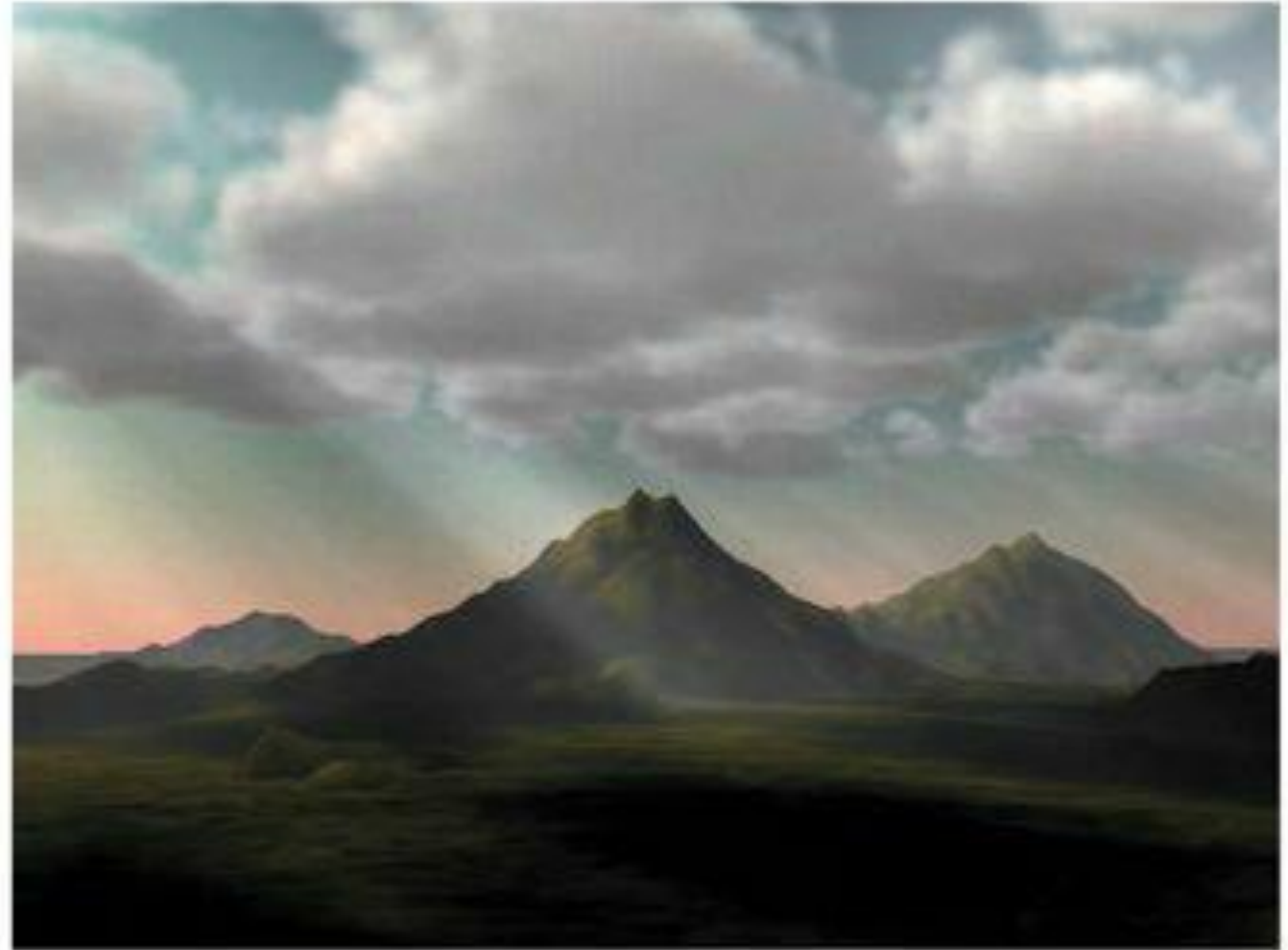


Graphical user interface  
(GUI)



Word processors

# Modeling Complex Objects





# Modeling Complex Objects



# Gaming

❖ **Game engine:** A software system within which computer games are created

- ❑ A rendering engine for graphics
- ❑ A physics engine to provide a collision detection system and dynamics simulation to solve the problems related to forces affecting the simulated objects
- ❑ A sound-generating component
- ❑ A scripting language apart from the code driving the game
- ❑ Animation
- ❑ Artificial intelligence algorithms (e.g., path-finding algorithms)
- ❑ A scene graph, which is a general data structure to hold the spatial representation in a graphical scene



# Game Design and Development

## ❖ Game Programming

- ☐ Java is typically used for Android games
- ☐ Objective C for IOS mobile game
- ☐ C# JavaScript, and Lua
- ☐ Some specific language of particular engine: Epic Game's Unreal Script for the Unreal engine and Unity 3D



# Thought question

Do you see video gaming as a problem for you or your friends? Has it affected your own or a friend's schoolwork?

Thank you <3