

## CH 13 Simulation & Modeling

1. A group of researchers from the Physics department at MIT tracked the evolution of the cosmos from a few hundred thousand years after the Big Bang up to the current time, 13.8 billion years later using a model called Illustris.
2. Ultimately, a computational model is translated into a computer program written in a high-level language and executed on a Von Neumann computer.
3. Data presentation determines the optimal format for presenting data.
4. A typical laptop computer executes roughly 2 billion instructions per second.
5. A physical system that is modeled using a set of equations and algorithms that capture the properties and behaviors of the system is referred to as which of the following? simulation model
6. The massively parallel Chinese Tianhe-2 supercomputer, which runs at a rate of 34 petaflops, will be executing computational models in the area of fluid dynamics.  $34 \times 10^{15}$
7. The National Energy Research Scientific Computing Center climate model was executed on a massively parallel IBM-SP supercomputer containing 6,086 processors, with the peak computation rate of 6 teraflops.  $6 \times 10^{12}$
8. The field of computer graphics is concerned with the technical issues involved in information display.
9. The time that a body takes to fall through space is modeled as continuous.
10. The scientific method entails observing behavior of a system & formulating a hypothesis that tries to explain its behavior.
11. Data extraction determines which values are important and should be included and which values can safely be omitted.
12. A simulation can easily model fractions of a second or billions of years, because time is simply a parameter in an equation.
13. Scientific visualization- important part of computational modeling; without it, no interpretation of a model's results.
14. Data manipulation converts data to other forms / units so that information is easier to understand / interpret.
15. The process of one event can cause new events to occur at some time in the future.
16. Parts of a system that display random behavior are known as stochastic components.
17. In a model of a store, customers purchasing an item is an example of a(n) event.
18. One of the most powerful and useful forms of scientific visualization is image animation.
19. Testing a model airplane in a wind tunnel to see how the full-sized aircraft behaves is an example of a physical model.
20. An event is any activity that changes the state of a system.

### 13.2 Computational Modeling 13.2.1 Introduction to Systems and Models

**-Model**-An abstract mathematical, computational, or physical representation of an actual system

**-Computational models**-A model constructed using algorithmic procedures implemented as computer programs; also called **simulation model**

Why construct a simulation model? Why not simply study the system itself, or a physical replica of the system?

- **Existence**—The system might not yet exist, may help us with the construction of the system.
- **Physical realization**—The system cannot be represented by physical objects. EX: A social system (welfare policies or labor practices) that can only be simulated on a computer.
- **Safety**—Too dangerous to experiment on the actual system or a physical replica.
- **Speed of construction**—Takes too much time to construct a physical model. Faster to design / build a simulation.
- **Time scale**—Some physical systems change too slowly or too quickly. Can easily model fractions of a second or billions of years because time is simply a parameter in an equation.
- **Ethical behavior**—Some physical models have serious moral and ethical consequences. EX: Animals in medical research. In this case, eliminate a great deal of suffering.
- **Ease of modification**—Not happy with the design of a physical model? Construct a new one in a simulation & only change some numerical parameters and rerun the existing model.

**-Computational Steering**- Procedure for using a computational model to improve the design of an actual system by continually resetting model parameters to improve system performance

### 13.2.2 Computational Models, Accuracy, and Errors

-The first issue is achieving the proper balance between **accuracy** and **complexity**.

**-Continuous Model**-Model of a system using mathematical equations. Describes system performance as a continuous function of time  $t$

**-Stochastic Components**-Parts of a model that display random behavior. *Statistical approximations* rather than exact equations.

### 13.2.3 An Example of Model Building

**-Discrete event simulation**-construct a model using a method that is relatively easy to understand and does not require a lot of complex mathematics. Computational modeling technique that simulates the behavior of a system only at (explicit, finite) discrete points in time

**-Event**- Activity that will cause a change in the state of the system being modeled

**-Stochastic, or random, component** of a simulation model.

**-Statistical Distribution**- Mathematical function that describes the probability of a random quantity taking on certain values

**-Uniform Random Number**- Random # in range  $a$  to  $b$ , in which each possible value from  $a$  to  $b$  has the same chance of occurring.

**-Garbage In, Garbage Out**- Output is as Accurate as the Data / Assumptions used to build the model

### 13.3 Running the Model and Visualizing Results

**-Scientific Visualization**- Use of images / visualization techniques to make scientific data easier to interpret.

**Data Presentation**—determining optimal format for presenting data; **Data Extraction**—determining values are included or omitted; **Data Manipulation**—converting the data to other forms / different units so information is easier to understand and interpret.

**-Computer Graphics**- Field of CS, examines Technicalities of displaying visual images on Screen or Printer.

**-Image Animation**- Using multiple images at discrete points in time to produce an animation of a system's behavior over time

## CH 14 Ecommerce, Databases, & Data Science

1. **\*\*Middleware** is software that allows separate, existing programs to communicate and work together seamlessly.
2. **\*\*Using multiple tables** in a single database decreases redundant information that must be stored.
3. **\*\*A primary key** is an attribute or combination of attributes that uniquely identifies a tuple.
4. **\*\*A company sells products / materials to other companies**, NOT general public, you might maintain a **B2B** presence.
5. **\*\*A DBMS manages files** in a database.
6. **\*\*Database management systems usually require specialized query languages** that enable the user to ask questions of a database to retrieve information.
7. **\*\* Authentication** is the process of verifying the identity of the receiver of the data.
8. **\*\* Cybersquatting** is the practice of registering a domain name that uses the name or trademark of an existing business, with the intent to sell the name to that business at a profit or to capitalize on that name for some other purpose.
9. **\*\*In the eCommerce arena, the first major decision** is choosing between in-house development and **outsourcing**.
10. **\*\*A retail business, might maintain a(n) B2C website to advertise and sell** your products.
11. **\*\* eBay facilitates peer-to-peer relationships** in an "auction" mode.
12. **\*\*In a stateless transmission, no information about the exchange is permanently retained** by the server.
13. **\*\*The Internet didn't have much impact until the World Wide Web** in the early 1990s.
14. **\*\*Your website taxonomy describes how information is classified and organized** so customers can find what they want.
15. **\*\*SQL is a nonprocedural language**.
16. **SQL is a very high-level language** in which a single instruction is quite powerful.
17. **\*\*The referential integrity rule specifies that any value of a foreign key attribute in a given table must match a value in the corresponding primary keys of the related table**.
18. **\*\*When choosing a domain name**, make sure it relates so closely to your business name that potential customers can easily guess it if they don't have it in front of them.
19. **\*\*In a database management system a table represents information about a(n) entity**, which is a fundamental distinguishable component.
20. **\*\* Encryption encodes data to be transmitted into a scrambled form**, using a scheme agreed W/ sender & receiver.

**14.2 Ecommerce**- term to any use of computers and networking to support the paperless exchange of goods, information, and services in the commercial sector

### 14.2.1 Decisions, Decisions

**\*\*1st question is: What is the business objective you are trying to achieve?**

-- major decision is choosing between ***in-house development*** (doing the work within your own company)

|| ***outsourcing*** (hiring an outsider to do the work)

**-ASP (application service provider)** An organization that, for a fee, provides software services over the web, such as hosting a website.

-Personnel? / Hardware? / Software?

## 14.2.2 Anatomy of a Transaction

Steps 1-9: 1. Getting There (Url) 2. Create a friendly, personalized atmosphere 3. Committing an Online Purchase

4&5. Payment Processing 6-9. Order Fulfillment (Shipping)

**\*\* The number-one attraction is probably *convenience*.**

**\*\*GOALS:**

-Draw potential customers to your site / Keep them there /

Set up optimum conditions for them to complete a purchase.

**\*\*how do your potential customer learn your URL in the first place?**

There are many possibilities:

--***Conventional advertising***—You post your homepage URL on flyers, in print and TV advertisements, on letterhead

-- ***Obvious domain name***—homepage URL. Easy enough to guess.

**-ICANN (Internet Corporation for Assigned Names and Numbers)** A nonprofit corporation that handles domain name management

--***Search engine***— pay for a “sponsored link” so a search will bring up links to your website in a prominent spot on the search.

--**Portal-** An entry point webpage with links to other webpages on some topic &&|| purchase a ***banner ad*** (a graphical ad, often with animation, placed in a prominent position on a webpage)

**-Cybersquatting** is the practice of registering a domain name that uses the name or trademark of an existing business, with the intent to sell the name to that business. A 1999 federal law called the Anti-Cybersquatting Consumer Protection Act (ACPA) makes cybersquatting illegal in the United States.

**-Cookie-** A small text file that gets stored on a user’s device when he or she visits a website, allowing a more customized page to be presented on the user’s next visit

-security comes in two pieces: **encryption** and **authentication**.

### 14.2.3 Designing Your Website

-website ***taxonomy***—how information is classified and organized so customers can easily find what they want.

**-Site Map-** Overview of website organization, so visitors can tell where they are / easily move about the site

**-Navigation Bar-** Graphical set of links to the major parts of a website. Visitors can easily move about the site

-Good Rules of thumb: Customer should be able to get from any page in your website to any other page in <5 clicks & be able to search the site for a specific item, either by name or by product number.

-Online ***CRM (customer relationship management)*** strategy- Extra Website features: Tracking an item / Add a **FAQ**

### 14.2.4 Behind the Scenes

**-Middleware-** Software that allows separate, existing programs to communicate and work together seamlessly

**-Disaster Recovery Strategy-** plan for recovering data / getting computer systems back up after some emergency event.

### 14.2.5 Other Ecommerce Models

**eBay-** One of the most successful alternative ecommerce models is *eBay*, founded in 1995. Facilitates peer-to-peer relationships in an “auction” mode. Was a precursor to the growing **peer-to-peer (collaborative consumption) economy** that now includes companies such as Uber, Lyft, Airbnb, and others.

**-Peer-to-peer (collaborative consumption) economy-** Individual buyers and sellers communicate directly without going through a middleman.

**Craigslist-** an online classified ad site. W/sense of local community and people-to-people trust.

**Groupon-** Business specifies a minimum number of purchased coupons. If that number is not met, the deal is off;

### 14.2.6 Electronic Payment Systems

**PayPal-** an account is tied to a credit card, debit card, or bank account; funded by a bank transfer.

**Apple Pay-** Apple Pay, and similar systems such as Android Pay and Samsung Pay, are mobile payment systems. Apple Pay is a **digital wallet**. To use Apple Pay at a merchant with a contactless card reader: hold phone || watch near the reader & an image of your card appears on the screen / Use Touch ID or your passcode to authenticate your transaction.

**Bitcoin-** Form of Cybercurrency. All transactions are recorded anonymously in a public verifiable ledger called the **blockchain**. Bitcoin is accepted as legitimate currency in large part because of the security obtained from two mechanisms: **Public-key encryption & Hashing**, managed by a decentralized network of computers. **-bitcoin miners-** pick up new transactions on the network, validate them, and eventually include them in a new block to be added to the blockchain.

To sum up, here are the advantages of bitcoin:

- Transactions are anonymous but completely transparent (verifiable).
- No “middle man,” such as a credit card or a bank, with associated fees.
- Results are immutable (tamper-proof).

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### 14.3 Databases & 14.3.1 Data Organization

Field -> Record -> Data File -> Database

- Field-** Group of bytes that represents one piece of information in a data file, such as a name
- Record-** Collection of related fields in a data file, for example, all information about a single employee
- Data File-** Collection of related records
- Database-** Collection of related data files

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### 14.3.2 Database Management Systems

- database management system (DBMS)** Software that manages the files in a database
- Relational Database Model-** Conceptual representation of a data file as a two-dimensional table
- Entity-** Database term: person, place, thing, or event about which data is captured and stored
- Tuple (Rows)-** One row in a relational database table.
- Attribute (Columns)-** Name of one field in a database tuple in the relational database model
- Primary Key-** 1+ attributes that uniquely identifies a tuple within a relational database table
- SQL (Structured Query Language)** An international standard database query language
- Composite Key-** a set of more than one **key** that, together, uniquely identifies each record.
- Foreign Key-** An attribute in a relational database table that is a primary key in another table, used to establish a relationship between the tables
- Join-** Relational database operation that matches tuples from 2 different relational tables w/ a common attribute
- Restrict** Relational database operation that picks out tuples that meet a certain condition
- Project-** Relational database operation that picks out certain attributes from a set of tuples

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### 14.3.3 Other Considerations

*-Integrity of the data must be preserved.*

3 integrity rules: Entity / Data / Referential

- Entity Integrity-** DB constraint: No tuple can be missing any of its primary key values
- Data Integrity-** DB constraint: Any attribute in a tuple must contain a data value appropriate for that attribute
- Referential Integrity-** DB constraint: Any Foreign Key Attribute value in a given table must match a value in the corresponding primary keys of the related table
- SQL:** Various connections between "related" tables, and queries are processed
- NoSQL-** High performance on massive clusters of data and rely on various structures other than tables
- NewSQL-** Combination of the two; Rely on SQL / achieve the Consistency required for traditional transaction-process activities W/ featuring the scalability of NoSQL systems.

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## 14.4 Data Science



- “**global datasphere**,” Amount of data that existed in the world in 2017 = 25 zettabytes. by 2025 = 160 zettabytes.
- **Data science**—**Data science** incorporates many of the tasks of data analysis, but also involves knowledge of the enterprise in order to formulate useful queries, along with the use of sophisticated statistics and visualization techniques. Data science also involves interpreting the results in terms of the enterprise and predicting future strategies likely to achieve a desired goal.
- **Data warehouse**—A data warehouse is a collection of databases that contain current and archived data used for research and analysis purposes rather than to manage day-to-day business transactions such as inventory control or payroll data.

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• **Big Data**—Huge amounts of data available.

• **Data analysis**—Process of finding the right data sets / putting the data into the right format / writing queries to extract information from the data.

• **Data science**—Incorporates Data Analysis W/ Knowledge of the enterprise in order to formulate useful queries W/ Use of sophisticated statistics & visualization techniques. Also involves interpreting the results in terms of the enterprise & predicting good, future strategies.

• **Data warehouse**—Collection of databases W/ current & archived data for research & analysis, rather than day-to-day business transactions: inventory control || payroll data.

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#### 14.4.1 Tools

**-Data Mining**- Automatically analyzing large amounts of data to discover and interpret previously hidden patterns contained therein

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Data mining is part of an overall process consisting of several steps:

1. Determine what problem you are trying to solve or information to gain w/ large data set?
  2. Review the condition of the data you have. Several data sets? Have the same structure?  
EX: does each tuple have the same attributes? Any tuples with missing or obvious “outlier” attribute values that should be eliminated?
  3. Determine a model to represent your data to bring out patterns / Use patterns to classify your existing data & determine which attributes are the strongest predictors of a given outcome. It is this step that is the data mining part: creation of a model.
  4. Evaluate your model. Are the results predicted borne out by further data? Would a different model give better results?
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#### 14.4.2 Personal Privacy

**-Data Brokers**- Company that collects data on many people & sells that data to clients

-use it primarily to target consumers with “personalized” advertising.

Data brokers get their data from

- **Public records** (birth certificates, marriage certificates, death certificates, property records, bankruptcies, courthouse records, business ownership, professional listings, voter registrations, auto registrations);
  - **Publicly available data** (telephone directories, business directories, newspapers, website tracking data, social networking sites, résumé sites, online forums)
  - **Nonpublic data** (consumer transaction data; cell phone records; information from mobile apps),
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### What Your Smartphone Photo Knows

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**-Metadata**- Data about data. EX: data about photos on your smartphone like: Time/Location/Camera Specs

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## CH 15 Artificial Intelligence

1. \*\*The “instance” relationship shows that something is an object of a **class**.
2. \*\*A **drone** is an aircraft under autonomous control via a computer system on board or controlled by a human controller at a remote site.
3. \*\*The algorithmic approach, **ACO**, has been used commercially in vehicle routing, job scheduling, and sensing biological or chemical contaminants.
4. \*\*A **brute force** approach for finding a solution path traces all branches of the state-space graph so that all possible choices are tested and no test cases are repeated.
5. \*\*Information can be stored in **pictorial** form as an image, which is a grid of pixels that have attributes of shading and color.
6. \*\* **Push** technology can download updates to personalized information, such as the weather conditions in your geographic area, to your cell phone.

7. \*\*The human brain uses a **Connectionist** architecture, characterized by a large number of simple "processors" with multiple interconnections.
8. \*\*A **decision tree** for a binary search reflects the fact that if the current item is not the target, there are only two next choices: the midpoint of the sublist before the node or the midpoint of the sublist after the node.
9. \*\*When reading a **natural** language, we use our understanding of the richness of the language's vocabulary to extract the meaning.
10. \*\*All of the following are characteristics that must be contained in any knowledge representation scheme EXCEPT **comprehensiveness**.
11. \*\*Artificial intelligence seeks ways to improve a computer's capabilities in **recognition** and reasoning tasks.
12. \*\***Artificial intelligence**- branch of CS, explores techniques for incorporating aspects of intelligence into computer systems.
13. \*\*IBM recently announced a new computer chip, called **TrueNorth**, that mimics the way the brain works through the use of "neurosynaptic" cores.
14. \*\*A(n) **rule-based system** must contain the following components: a knowledge base and an inference engine.
15. \*\*The term **robot** implies a device that can gather sensory information from its surroundings and to autonomously perform mechanical actions in response.
16. \*\*A **neural** network can learn from experience by modifying the weights on its connections.
17. \*\*The **swarm** intelligence model captures the behavior of an ant colony by using simple agents that operate independently.
18. \*\*A **Semantic Net** is a graph with nodes and connecting arcs.
19. \*\*At the end of its training, the **neural network** is ready to go to work on new recognition problems that are similar to the training data but for which the answers are unknown.
20. \*\*The axon of a neuron sends signals over small gaps called **synapses**.

### 15.1 Introduction

**-Artificial intelligence**- branch of CS, explores techniques for incorporating aspects of intelligence into computer systems.

**-Turing test**- Test for intelligent behavior of machines, Alan Turing 1950; if a human can interrogate a person and a computer and not be able to detect which is which, then the computer has passed the test.

*-2 Kinds of AI: 1. GENERAL ARTIFICIAL INTELLIGENCE 2. NARROW ARTIFICIAL INTELLIGENCE.*

**-General artificial intelligence**- models all aspects of human intelligence, as possible. Capability for understanding natural language & nuances of meaning // Ability to accumulate knowledge & adapt that knowledge to apply it to new situations or problems;

**-Winograd schema**- Test for intelligent behavior of machines in which contestants (human and computer) are given a sentence that involves two entities and a pronoun that refers back to one of the entities, and must determine to which entity the pronoun refers

### 15.2A Division of Labor

**-Computational tasks / Recognition tasks / Reasoning tasks**

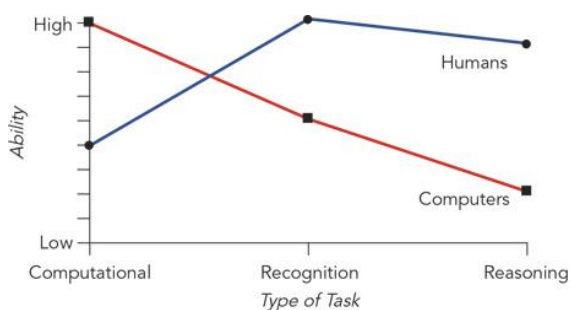
**\*\*Computational tasks**- asks for which accurate answers must be found. *EX:* Adding a column of numbers / Sorting a list of numbers into numerical order / Searching for a given name in a list of names / Managing a payroll / Calculating trajectory adjustments for a space shuttle

**\*\*Recognition tasks**- sensory/recognition/motor-skills tasks *EX:* Recognizing your best friend / Understanding the spoken word / Finding the tennis ball in the grass in your back yard

**\*\*Reasoning tasks**- Tasks w/ no "right" answer *EX:*

Planning what to wear today / Deciding on the strategic direction a company should follow for the next five years / Running the triage center in a hospital emergency room after an earthquake

**- Knowledge** - images, memories, past experiences



### 15.3 Knowledge Representation

**-Languages for Knowledge: Natural / Formal / Pictorial / Graphical**

**-Natural language**—Paragraph || page of text. Contains all the knowledge we are trying to capture is written in English, Chinese, Spanish, or some other natural language.

- Formal language**—Sacrifices richness of expression for precision of expression. Attributes & cause-and-effect relationships are more explicitly stated. EX: All dogs have 4 Legs:
  - Formal Language**- Language of formal symbolic logic, NOT natural languages like: English || Japanese, etc. Cause-and-effect relationships are translated into “if-then” statements. Used to represent 1 of the major approaches to building AI.
  - Pictorial**—Info stored in pictorial form, image-> grid of pixels W/ attributes of shading & color.
  - Graphical**—Not “visual”. In the mathematical sense of a Graph with Nodes and Connecting Arcs.
  - Semantic Net**- Graphical representation of classes, objects, properties, and relationships
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- Any Knowledge Representation scheme must have these 4 characteristics:
- Adequacy / Efficiency / Extendability / Appropriateness
- Adequacy**—Captures all of the relevant knowledge.
  - Efficiency**—Concise W/ no redundant information wherever possible.
  - Extendability**—Be easy to include new knowledge as acquired.
  - Appropriateness**—Appropriate for the knowledge domain being represented.
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### 15.4 Recognition Tasks

- Connectionist Architecture**- System w/ large number of simple processors & heavily interconnected; Like a human brain w/ interconnected neurons
  - Neural Networks**- Massively parallel Network of Devices Simulating biological neurons || a software system that simulates an interconnected arrangement of biological neurons; Called an **Artificial neural network**
  - Training Data**- Sets of input values for a neural network for which correct output values are known; weights & thresholds in neural network are repeatedly adjusted until output is close to the correct output
  - Back Propagation Algorithm**- Training algorithm for neural networks, Passes error estimates from the output layer back to earlier neurons so they can adjust connection weights
  - Machine Learning**- Process w/o specific step-by-step programming.  
Computing agents learn & improve from past errors made on known training data
  - **TrueNorth**- new IBM computer chip that mimics the way the brain works. Consists of 4,096 “neurosynaptic” cores arranged in a grid 64x64 & 256 programmable neurons. Was the Basis of a new Deep Learning algorithm.
  - Deep learning**- Simulates neural networks w/ Multiple Layers & Back Propagation from Output layer--> back to input layer to improve accuracy.
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### 15.5 Reasoning Tasks-

- The ability to Parse a large body of Facts & Past experience for a conclusion.
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#### 15.5.1 Intelligent Searching

- Decision Tree**- A search algorithm w/ possible next items to search if Current item isn't the Target.
  - State-Space Graph**- Representation of a set of “states” w/ Different configurations in a problem.
  - State-Space Search**- Finding **Solution path** through a state-space graph from Initial state to Goal state.
  - brute force approach**- All possible choices are tested & no tests are repeated.
  - Heuristic**-“Educated Guess” / Informal method of solving a problem based on past experience / Not Exact but good enough for the problem at hand
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#### 15.5.2 Swarm Intelligence- acquire “knowledge” that is greater than the sum of its parts.

- Swarm Intelligence Model**- Model of AI based on a group of simple agents (like an ant colony) that operate independently but can communicate in some way to perform cooperative tasks. **Ant Colony Optimization (ACO)**
  - Possible Robot swarms uses: Environmental cleanup, Search & rescue, or even in noninvasive micromedicine.
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#### 15.5.3 Intelligent Agents

- Intelligent agent**- Software designed to interact collaboratively with a user as a personal assistant
- Intelligent agent doesn't just wait for user commands / begins to initiate communication/ anticipate what is required / take action / perform tasks on its own / -> on the basis of its growing knowledge of your needs and preferences.
- Push Technology**- Form of Internet-based communication where info is regularly & automatically sent by the web server to the user, based on the user's preferences VS having the user request such info from the server
- Recommendation Software**- Makes Autonomous Suggestions to users based on their past behaviors

With Sufficient Level of Trust in intelligent agent technology & Human users let software make Independent Decisions, we will take applications like the following for granted:

- **Financial agents**- that negotiate with one another over the web for the sale and purchase of goods and services, using price/cost parameters set by the sellers and buyers (sort of an automated eBay)
- **Travel and tourism agents**- (electronic, not human) that book airline flights, rent automobiles, and make hotel reservations for you on the basis of your destination, schedule, price range, and preferences
- **Office manager agents** that screen incoming email, put meetings on their users' schedules, and draft replies

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**15.5.4 Expert Systems**-Software that mimics a Human Expert. Using Facts & Rules of inference to draw conclusions from those facts

Expert systems' 2 components:

- **Knowledge base**—Set of facts about a Specific Subject
- **Inference engine**—Mechanism for logically selecting Relevant facts & Reasoning

**Rule**- Fact type. *if... then...* statement

**Learning**- when knowledge base has been extended

**Modus ponens**= "method of assertion."

**Backward chaining**- begins with Conclusion & Finds "then" rules / Matches 'If' Rules

**-Explanation Facility**- Expert System Process. Allows user to see Logic of Assertions & Rules

**-Knowledge Engineering**- Consulting Human Experts to construct Knowledge Base for an Expert System.

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### **15.5.5 The Games We Play -> Board Games.**

-Google's AlphaGo learned through playing Go against itself (Machine Learning) to be the best Go player ever.

**Quiz Games.** -Jeopardy had an IBM supercomputer 'Watson' in 2011.

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## **15.6 Robots and Drones**

**15.6.1 Robots**- Device, maybe humanlike, W/ Ability to gather sensory information from surroundings & autonomously perform mechanical actions in response. **robot**- slavlike labor (Czechoslovakian). Tasks= too repetitive || dangerous for humans.

- Uber began testing its own autonomous vehicles in Pittsburgh in September 2016.

2 Approaches to Robotic Research: (Used in Combination)

**-Deliberative Strategy**- Approach to robotics 'a robot must have an internal representation of its environment that guides a reasoned response to some stimulus from that environment' (Like Expert System)

**-Reactive Strategy**- Approach to robotics 'a robot should respond directly to environmental stimuli using heuristics but no chain of reasoning'

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### **15.6.2 Drones** - properly called a **UAV = Unmanned Aerial Vehicle**

**-Drone**- Aircraft under autonomous control via a computer system on board || human controller at a remote site

-Used primarily for military / law enforcement But ALSO used in:


-Agricultural-related aerial photography / Delivery of medical supplies or blood to remote areas / etc

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## **CH 16 Computer Graphics and Entertainment: Movies, Games, and Virtual Communities**

1. A(n) **GPU** executes instructions in parallel with the CPU and carries out all of the graphics operations, including **modeling, motion, rendering, and display**.
2. The **GPU** W/ dedicated RAM, referred to as **video memory**, is located on a **graphics card**.
3. Animating an object containing thousands of **vertices** can require billions of arithmetic operations.
4. Some of the first computer games were created in the early 1970s by college students experimenting after hours to see what the new **Minicomputers** were capable of doing.
5. **Minicomputer** is a term coined in the mid-1960s to describe a computer system that was smaller and less expensive than the unwieldy mainframes of the 1950s and early 60s.



6. Because of the many technical complexities, the cost of developing a sophisticated **MMOG** can run to tens of millions of dollars and take hundreds or thousands of person-years to design and implement.
7. In a **MMOG**, the virtual world in which the game is played is **persistent**
8. The branch of computer graphics that studies methods for creating images at a rate matching that of the real world is called **real-time graphics**.
9. In object modeling, once an object's surface is tessellated, information about the polygons is stored in memory in the form of a **vertex list**.
10. **Rendering** means taking an object stored as a mathematical model and converting it into a fully formed, visually pleasing **three-dimensional image**.
11. Imaging speed is known as the **frame rate**.
12. The **client** software used to log on to a MMOG game server may either be proprietary code purchased from the gaming company or a publicly available program such as a web browser.
13. Extremely high-quality, lifelike images are known by the term **photorealistic** animation.
14. **Cut-ins**= pre-prepared objects that can be dropped into a frame as is, producing a significant speedup in frame creation.
15. There is a sequence of operations, termed the **graphics pipeline**, which must be completed successfully to produce a realistic three-dimensional image.
16. **King Kong** was the first feature-length film to have its central character generated using animation.
17. A video card is connected to the main CPU and memory through a plug-in expansion slot or through the **system bus**.
18. Both hand-drawn frames and **stop-motion** animation are manual techniques that require a great deal of time.
19. All of the following are **technical problems that the designers of MMOG** must address and solve **EXCEPT** \_\_\_\_\_.
  - Responsible for : keeping track of each user's activity to ensure his actions do not incorrectly affect the actions of other players / Making sure the database can be accessed quickly enough to provide real-time response to user actions / Implementing the network protocols to support a vast communications array /
  -  **NOT responsible** for: Ensuring the game's visualizations are not too sophisticated for the user community
20. Using a CGI technique called **keyframing**, a human animator only needs to produce the first frame, the last frame, & the elapsed time in order for a computer to automatically generate the required intermediate frames called **tweeners**.

## 16.2 Computer-Generated Imagery (CGI) 16.2.1 Introduction to CGI –

-CGI reduces costs and speed up the animation process. Vs. Hand-drawn or Physical Modeling

**-Stop-motion Animation-** Involves building a small scale mockup (Clay-mation). You then take a picture, move the model, take another picture, etc. to create the illusion of motion

**-Frame-** 1 image, combined with other images in sequence, is used to produce the effect of animation

-30 frames per second (the standard rate for video; film uses 24)

Two groundbreaking movies of the early 1990s quickly changed Hollywood's mind:

- *Terminator 2: Judgment Day* (1991) & *Jurassic Park* (1993)

**-Computer-generated Imagery ( CGI )** - Using computers to produce an image on a frame

**-Photorealistic Animation-** Extremely high-quality lifelike images produced by computers

### 16.2.2 How It's Done: The Graphics Pipeline

**-Graphics Pipeline-** Sequence of steps to produce a realistic computer-generated three-dimensional image

-3 stages in the simplified graphics pipeline: Object Modeling, object Motion, & Rendering & Display.

### 16.2.3 Object Modeling

**-Object Modeling-** Creation of a mathematical || algorithmic model of an object that is stored in memory and manipulated by the computer

**-Motion Capture-** object modeling technique in which actors wear motion capture suits with visible markers that the computer translates into stick figures that mimic the actions of the actors

- Tight-fitting **motion capture suit** contains visible markers, such as: white dots or lights

**-Wireframe Modeling-** modeling technique that involves covering the surface of the object with non-overlapping polygons. Representing the object's surface, not its interior

**-Tessellation-** Algorithm used for building a wireframe model of an object

-Using special CGI software & **tessellation**, the image is subdivided into a set of plane figures that completely covers its surface.

- **Polygon mesh-** polygonal outline on the surface

- Vertex list**- Data structure that stores information about the polygons used to cover the structure of an object
  - Need to know **origin** to make an (x,y,z) Coordinate of (0,0,0) [For Reference]
- 

#### 16.2.4 Object Motion

- Rigid motion**- Motion that does not bend or deform an object
  - 3 Types of Rigid motion**- **translation, rotation, reflection**
  - Translation**- Movement of every point in an object by the same amount and in the same direction
  - Rotation**- Circular movement around a fixed axis of rotation
  - Reflection**- Movement that produces a mirror image of an object such that every point in the reflected image is the same distance from the mirror but on the opposite side
  - Motions that **deform** or **change** the shape of an object: scaling, squeezing, stretching, or ripping
  - Transformation Matrix**- Mathematical structure to implement the different types of rigid motion of an object
  - in CGI-> **Motion** is defined in terms of matrix multiplication, an algorithm easily programmed on a computer that multiplies the current coordinates by the (EX:  $4 \times 4$ ) **translation matrix**
  - Advantages of CGI**:
    1. Computer can automatically perform many operations without the assistance of a human designer, greatly speeding up the animation process
    - 2.
  - Keyframing**- Using a computer to generate all necessary intermediate frames between a first frame and a last frame so that they do not have to be provided by a human animator
  - Out of 30 Fps: Computer auto-generate 28 required intermediate frames, called **in-between frames** or **tweeners**
  - Control Point (animation variable)**- A point or axis used to control an objects motion in animation;
- 

#### 16.2.5 Rendering and Display

- The final step in the graphics pipeline is rendering and displaying the final image
  - Rendering**- Converting a mathematical model of an object in memory to a fully formed, pleasing 3D image.
  - Rendering farm**- A large collection of computers used to carry out rendering tasks
  - Issues during Rendering: Lighting / Color Shading / Shadows / Texture Mapping / Blur
  - **Lighting**—Location & Intensity of all light sources illuminating the image and determine the effect these light sources have on the final appearance.
  - **Color shading**—Initially assign 1 color or gray level to each vertex in the model & blend / shade those colors across the face of the polygon. Also determine if there are any modifications to the intensity or appearance of that color due to the incidence of light falling on that plane.
  - **Shadows**—Modify color & brightness of each plane figure because shadows cast on that plane by opaque objects.
  - **Texture mapping**—1<sup>st</sup> 2 stages of CGI, Assume that each plane is a homogeneous, detail-free surface. Allows us to add surface details (bumps, grain, indentations) to each of the plane figures.
  - **Blur**—If an object is moving rapidly from one frame to the next, we might choose to blur the final image to represent that motion.
  - Ray Tracing**- One of the most used rendering algorithms. Based on tracing rays of light from a light source
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#### 16.3 Video Gaming

- Interaction = one huge difference between CGI and video gaming
  - Static Environment**- (Movie) Visual environment w/ no interaction w/ viewer to decide what to display next
  - Dynamic Environment**- (Game) Visual environment, w/ input from user to determine frames to be shown
  - Real-time graphics**- ability to create images at a rate that matches that of the real world
  - Frame Rate**- rate with which a computer can produce individual frames
  - Graphics processing unit(GPU)**- Separate processor in a computer, handles all graphics operations
  - GPU along with this dedicated RAM= **image memory** or **video memory**, Located on a **video card**, or **Graphics card** or **graphics board**.
  - Culling**- Process of rendering planes only visible in next frame. Done to speed up the rendering process
  - Cut-ins**- Pre-rendered objects stored in a video library in video memory, to be used in a frame. Speedy effect.
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#### 16.4 Multiplayer Games and Virtual Communities

**-Massively Multiplayer Online Games (MMOG)-** Online games accessed via a network by thousands of players at the same time

**-Game Servers** A computer that helps to manage the operation of MMOGs

-In an MMOG, the virtual world in which the game is played is **Persistent** = Continuous Game State.

-Designers of MMOG must address & solve the following technical problems:

- **Registration management**—With hundreds of thousands of new || existing users at various points in the game, Responsibilities of the Server Software that manages user base include: Ensuring New users correctly join the community / Saving **Game State** of existing users on log off / Restoring Game state on log in
- **Client/server protocols**—With millions of users simultaneously accessing dozens || hundreds of game servers across multiple communication channels, Designers must implement network protocols to Support this vast communications array.
- **Game security**—Must keep track of each user's activity to ensure that his or her actions do not incorrectly or inappropriately affect the actions of other players & Must ensure all users adhere to the rules of the game and do not attempt to carry out illegal operations.
- **Database design**—The world database can be truly massive, w/ many terabytes of data. Designers responsible for: Implementing this database / Making it accessed quick enough to provide real-time response to user actions.

**-Non-Competitive MMOG-** Simulated world which users can live, browse, shop, and play; called **Metaverse**  
No winning or losing



-approximately 1.1 million active residents of **Second Life**

-Businesses began to use graphics in the form of **computer-aided design (CAD)** tools that gave architects and manufacturers the power to create and edit designs online.

Soon visualization had become an integral part of virtually every popular application.

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## CH 17 Making Decisions about Computers, Information, and Society

1. **\*Ethics**- study of how to decide if something is morally right or wrong.
2. **\*Which of the following is a popular form of cyberbullying?** impersonation
3. **\*Hacker**: Someone who breaks into computer systems & launches Worms, Viruses, and other computer-related vandalism.
4. **\*U.S. banks are required to keep detailed records on all transactions and to notify the U.S. Department of the Treasury whenever they detect unusual or suspicious transactions.**
5. **\*Utilitarian arguments focus on consequences to determine if an act is ethical.**
6. **\*Which of the following statements is NOT true?**  Privacy is an absolute right guaranteed by the U.S. constitution.
7. **\*Which of the following is NOT an important question you should ask yourself when you recognize an ethical problem?**  
 Most efficient way to resolve the dilemma
8. **\*Ancient Greek philosopher Plato used 'gadfly' to describe Socrates and the political establishment of their day.**
9. **\*In a dialectic, what is the ultimate goal? for both sides to win by moving closer to the truth**
10. **\*Gaining unauthorized access to someone else's computer system to obtain & publish secret information is hacking.**
11. **\*Social networks are highly persistent, once documents || images is posted, there is no way to get them all back.**
12. **Cyberbullying- humiliating, taunting, threatening, or invading someone's privacy using the Internet, web, or other type of electronic technology.**
13. **\*In a dialectic argument that uses analogies, one of them may support a particular view of the situation being discussed and the other may support an opposing view of the exact same situation.**
14. **\*When a(n) analogy fits well, it helps us take advantage of decisions we have made in the past because if two situations are sufficiently similar we can apply the solution to the new problem.**
15. **Deontological arguments focus on the duties of the person acting and the way the act impinges on the rights of others.**
16. **\*WikiLeaks is a site that specializes in protecting government and corporate whistle-blowers.**
17. **\*What is the best way to ensure personal privacy with regard to online information? don't post it**
18. **Anonymous is a group of hackers that seem primarily interested in freedom of speech.**
19. **\*WikiLeaks has published nearly 1,000,000 confidential or secret U.S. government documents.**
20. **DRM is a technology that encrypts a computer file so it can only be used properly for the copyright holder.**

**-Ethics**- study of how to decide if something is morally right or wrong

### 17.2 Case Studies

#### 17.2.1 Case 1: Is It Sharing or Stealing?

-First successful peer-to-peer file sharing system, Napster.

**-Peer-to-peer file sharing (P2P)-** Sharing files between two equal participants on a network. Different from the client-server model, two sides serve very different roles—Sending info (Server) / only receiving info (client)

**-Fair Use-** Legal doctrine, allows for excerpts of copyrighted material to be copied or quoted under certain restricted circumstances.

**-Ethical questions, Special attention:**

1. Okay to swap copyrighted music / books, download / copyrighted videos, use copyrighted photos w/o permission?
2. Okay to provide a search engine w/ purpose of allowing users to search each other's databases of copyrighted music and book files, videos, and photos?

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#### Asking Ethical Questions.

**-Consequentialism-** School of ethics, focuses on consequences of an act to determine if the act is good/bad

**-Utilitarianism-** Theory that ethically correct actions to maximizes total happiness / benefit of society

**-Good:** HAPPINESS\_AFTER > HAPPINESS\_BEFORE & **Bad:** HAPPINESS\_AFTER < HAPPINESS\_BEFORE

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#### Utilitarian Argument #1: Copying Is OK.

**-Virgin Megastores** in New York City's Times Square / Union Square were 2 largest music stores in the world

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#### Utilitarian Argument #2: Copying Is Not OK.

**-Dialectic-** Discussion moving back & forth between viewpoints, criticizing and trying to learn from each

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#### 17.2.2Case 2: Legalized Snooping—Privacy vs. Security

-Modern telecommunications networks have problems for law enforcement w/ “**wiretaps**”

-Landline-based phone vs Cellular phone & Internet phone technology (**Voice over Internet Protocol**, or **VoIP**)

**-Lawful intercept (LI)-** Right to access private network communications, calls, by request of law enforcement, & Technology required to carry this out.

-Everyone involved in telecommunications **MUST** cooperate w/ law enforcement / build LI capabilities in all systems.

**-Analogy-** Comparing problems to related problems, in terms of its ethical implications and consequences

**Analogy #1: Lawful Intercept Is Like Requiring Everyone to Record Their Face-to-Face Conversations.**

**Analogy #2: Lawful Intercept Is Like Suspicious Activity Reporting in Banking.**

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#### Making a Decision.

1. Identify interested parties / how this decision might affect their happiness and well-being.

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#### 17.2.3Case 3: Hackers—Public Enemies or Gadflies?

**-Hacktivism-** Hacking for political activism

-2 main groups: **WikiLeaks** and **Anonymous**

-WikiLeaks- Specializes in protecting the Identity of government and corporate whistle-blowers.

-Anonymous- Group of hacktivists interested in freedom of speech.

**Analogy: Breaking into a Computer Is Like Breaking into Someone's House.**

**Utilitarian Argument: Costs and Benefits of Hacking.**

2 challenges using a utilitarian argument in a dialectic about hacking:

1. It is sometimes hard to predict consequences with any accuracy.
2. Distinction between “good hackers” (act in the public interest) and “bad hackers” (who want to do damage or steal things for self-interested or pathological reasons).

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#### Deontological Argument: Hacking with a Golden Heart.

**-Deontology-** Study of the duties of the person acting / How the person's acts impinge on the rights of others

- Never treat a fellow human merely as a means to an end.

2 out of 6 components of “Hacker ethic.”:

1. “All Information Should Be Free”—Info sharing is a powerful positive. It's not possible to make good decisions if important info is hidden from the public. Ethical duty: Facilitate access to information whenever possible.
2. “Mistrust Authority—Promote Decentralization”—Strict rules & Hierarchical management structures like government and corporate bureaucracies prevent people from getting things done, rather than solving problems. **MOSTLY:** public's best interest, and ignore the rules.

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#### 17.2.4Case 4: Genetic Information and Medical Research

#### “Paramedic Ethics” for Technology.



With an ethical problems, 5 important questions you should ask yourself:

1. Identify the stakeholders in this situation?
  2. What's at Stake? What does each stakeholder have to gain or lose? (utilitarian step.)
  3. Identify duties & responsibilities that are important to the stakeholders? (deontological step.)
  4. Can you think of an analogous situation that doesn't involve computing? If so, does that analogous situation clarify the situation that does involve computing? (reasoning by analogy.)
  5. Either make a decision or revisit the above steps.
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### 17.3 Personal Privacy and Social Media

-4 issues that demonstrate Computing & Ethics: illegal file sharing, surveillance, hacktivism, & medical privacy.

-4 methods of reasoning about ethical cases: utilitarian analysis, reasoning by analogy, deontological analysis, & paramedic method.

-**Cyberbullying**- Humiliating, taunting, threatening || invading someone's privacy using the Internet, Web, or other electronic technology

- One popular form of cyberbullying is *impersonation*.

-**"Megan's Law"**- it's a felony to use the Internet / electronic media to harass or frighten a child under the age of 17.

-**Sexting**- Transmission of sexually explicit messages or images, usually via smart phones or tablet computers, between consenting individuals

-**Go Viral**- When material posted online becomes widely read and widely distributed via social media

-If you don't want a large number of people to read something, ***don't post it.***

-**Victim blaming**- when the victim, rather than the perpetrator, of a crime or harassment is held responsible.

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### 17.4 Fake News, Politics, and Social Media

-**Fake News (Yellow Journalism)**- info false or misleading widely distributed under the guise of news

-**Unmoderated**- State where a website or social media site is not monitored for inappropriate content nor fact-checked for accuracy

Most malicious types of Fake News is:

- **Imposter sites**. Uses URLs to mimic the addresses of legitimate news sources w/ screen layout that mimics the logos and fonts of the real site. It's to get readers to believe they are reading information from a credible news source & Content will most likely be totally false / unrelated to anything on the actual news site being copied.
  - **Manipulated content**. Actual news stories or photographs are doctored to make them look like they are legitimate coverage of an actual event. Using Photoshop manipulation for Political gain. Real news stories can add or omit information that provides important facts and context for understanding the significance of what has happened.
  - **Fabricated content**. Typical fake news. Has info that is 100% fabricated w/ no reality. It's the imagination of its creator who is concerned w/ increasing advertising revenue or moving political opinions in a particular direction.
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Techniques to spot fake news:

- **Check the author**- Pumped up credibility / importance of the author w/ numerous false claims—EX: Pulitzer prizes won / prestigious university positions held. When fact-checked it's all fabricated.
- **Check the supporting links**- Using official-sounding websites  
WhiteHouseDocumentCenter.com. but supporting sites are phony as the origin.
- **Look at who else is reporting the story**. Breaking news stories are required to fact-check their authenticity. CREDIBLE: Appears in major news outlets: television, radio, newspapers, and large online news websites. If story can't be found, it's bogus.
- **Consider the apparent intent of the story**. Story is heavily biased? Does it contain overly emotional appeals for the "correctness" of that point of view?

### CH 13

- Why do we use a Model (Physical)? cost/time/safety
- Benefits of Virtual Model vs. Physical Model
- Accuracy vs complexity= Garbage IO.
- Types of Models (Discrete..)
- Discrete simulation works
- Scientific visualization- Easier to Analyze (Color / 3D)

### CH 14

- eCommerce sites – Benefits / Practices / Hazards(Privacy) / Cookies
- Steps of Online Transactions
- eCommerce Model
- Payment Methods- Venmo,Paypal
- Databases- What are they? Why are they powerful? Use of Tables for Queries? SQL Usage (Non-Procedural Language)
- Data Mining / Warehousing / Brokers / Science (Engineering)

### CH 15

- 2 Types of AI
- Pros/Cons of Knowledge Represenation
- What is Neural Network?
- State based Search algorithms / Decision Trees
- What is Swarm / Intelligent Agents / Expert Systems (Inference Engines[Forward Trainings])?

### CH 16

- Changes in Movie Industry
- Steps of Graphics Pipeline-> Object Modeling (Tessellation / Transformation Matrix) / Motion / Rendering (Challenges- Lighting / Shading)
- GPUs – Own Memory & Processors. Used for Graphics Calculations
- 2 Techniques of Real-time Graphics for Videos(No Real Time) & Games
- What is a MMOG?

### CH 17

- Tool for Ethics=
- What's Napster? File-sharing?
- Tradeoffs of Privacy & Safety
- Hackers / Cyberbully
- Dangers of Social Media
- Understand the Scenarios (Paramedic Paradigm)(Impacted Parties/Analogies) w/ Key Terms
- Analogies

Python – OOP Question HW 8