

Computational Thinking Cases in ECT 250

1. Overview

Case discussions will be used to discuss the following four computational thinking concepts: 1) automation, 2) coordination, 3) data mining, and 4) search and query, in ECT 250. The case discussion starts with a presentation of a real case example many students (if not all) have experienced or heard of and then the instructor uses a list of predesigned questions to guide the discussions. Active student participation is required. Finally, the instructor summarizes the discussions and reiterates the underlying concepts/issues.

2. Case 1: An Online Order Processing System

2.1. Computational Thinking Concept to Be Introduced

On a typical online retailing website, orders are taken through online forms, payment information is collected, inventories are updated, and products are made ready for shipping. The entire order fulfillment process is automatically handled by computers with minimum human intervention. In computational thinking, this is the concept of automation.

2.2. Case Description

Dell is one of the top sellers of PC computers. In the first quarter of 2007, Dell shipped about 8 million units based on Gartner and IDC (International Data Corporation) reports. It is evident that the number of orders was huge. How did Dell process the orders? Let's look at Dell's order processing system at <http://www.dell.com/>.

2.3. Discussion Questions

Q1. What characteristics did you notice during the order process? (standardized procedure, repetitive, etc.)

Q2. Did you perceive any human intervention during this process? Are humans good at processing this type of orders? Why? (benefits of human information processing?) Why not? (limits of human information processing)

Q3. Who actually handled all the orders? (computers). Define the term "automation" in computational thinking.

Q4. What are the benefits of automation (consistent, error free, fast, efficient, cost-effective, etc.)

Q5. Can you think of some other examples of automation?

Q6. What characteristics of order processing make automation helpful? (Large number of orders, standardized procedure, repetitive, etc.)

3. Case 2: A Supply Chain Management System

3.1. Computational Thinking Concept to Be Introduced

When a manufacturing firm collaborates with one of its material suppliers, information about inventories, production schedule, and forecasting must be exchanged. A supply chain management system could be developed to synchronize the timing and information sharing to maximize the production efficiency and dramatically cut back inventories. The goal is to get the right materials for production at the right time and in the right place. Interacting processes, communication protocols, and concurrency are involved. In computational thinking, this is the concept of coordination.

3.2. Case Description

One best practice in supply chain reengineering is demonstrated with Gate Gourmet, one of the largest airline catering firms. For the airlines, Gate Gourmet makes it very easy to do business, taking over work from the airlines that Gate Gourmet can do much more effectively. For example, it is Gate Gourmet that decides on menus, on the basis of whatever can be purchased most effectively to provide best value/cost to the airline passengers. All billing comes directly from the customer's passenger manifests. That is, the number of meals billed on a particular flight comes directly from the airline passenger record for that flight. There is little "forecasting," since Gate Gourmet knows which flights leave each city at specified times each day. There are no extra transactions for the customer firms and no need to check invoices since all billing is based on existing customer records. How can Gate Gourmet provide these services?

3.3. Discussion Questions

Q1. If you were the CEO of Gate Gourmet, what would you do to collaborate with other airlines? (interacting processes, synchronizing information)

Q2. What are the characteristics of this collaboration? (Interacting processes, concurrency, sharing dependencies, etc.)

Q3. How did Gate Gourmet collaborate with the airlines? (A manufacturing, planning, and control (MPC) system to coordinate information sharing). Define the term coordination in computational thinking (interacting processes, communication protocols, synchronization, concurrency, events and event handling, flow and share dependencies).

Q4. What are the benefits of coordination? (Concurrent, fast, accurate, cost-effective, etc.)

Q5. Can you think of some other examples when computing systems can be used to address real life problems?

Q6. What characteristics of the Gate Gourmet system make coordination helpful? (Complex systems, large amount of information to be exchanged on a synchronized manner, the need of communication protocols, etc.)

4. Case 3: A Forecasting System

4.1. Computational Thinking Concept to Be Introduced

Demand forecasting used to be heavily dependent on decision maker's experience. With help of the data mining technique, a company could analyze a large amount of historical sales data gathered in the previous years or even decades. It is now possible to find new sales patterns that

were difficult to identify in the past and these findings are more objective and reliable than subjective judgments. Storage media, data organization, and data manipulation are involved. In computational thinking, this is the data mining process.

4.2. Case Description

In order to maximize the revenue on a flight, the number of seats available for sale is typically higher than the physical seat capacity (overbooking). To optimize the overbooking rate, an accurate estimation of the number of no-show passengers (passengers who hold a valid booking but do not appear at the gate to board for the flight) is essential. Currently, no-shows on future flights are estimated from the number of no-shows on historical flights averaged on booking class level. Researchers developed predictive models by applying Data Mining techniques. Because these predictive models take into consideration of various passenger information, these models improve forecasting accuracy in the airline business.

4.3. Discussion Questions

Q1. Why is the current estimation of the number of no-show passengers inaccurate? (Not enough information was used, no consideration of other passenger information, lack of understanding of complex patterns hidden in a large amount of data, etc.)

Q2. Why is it difficult to incorporate various passenger information into the estimation of the number of no-show passengers? (uncertain about the relationship, too much information, unorganized, the need of large storage media, complexity of data manipulation/organization, etc.)

Q3. What can be done using computing technologies? Define the term "data mining" in computational thinking (storage media, data organization, data manipulation).

Q4. What are the benefits of using data mining techniques? (Making sense out of nonsense data, discovering new patterns, working with a huge amount of information, etc.)

Q5. Can you think of some other real life examples when data mining techniques can be used?

Q6. What characteristics of airline forecasting make data mining helpful? (Large amount of data, unstructured data, complex relationships, a large data storage, etc.)

5. Learning Goals of Assessment

Learning Goal 1: Students are able to analyze a process and argue whether it has the properties (can be described using a clear algorithm, exhibits repetitions, etc) that make it amenable to automation; students understand, in context, the benefits (error-free, consistency, speed, low-cost) automation brings.

Assessment: The following question will be added to an assignment:

The registrar's office at a community college is short of people handling course registrations due to the recent surge of student enrollment. This results in students waiting in a line for hours and employees working for long hours. They decide to develop a Web-

based course registration system to automate this process. Please answer the following questions:

- 1) Please use a flow chart and your own language to describe a common registration process.
- 2) What characteristics of the registration process make it suitable for automation?
- 3) What are the benefits of using automation?

Learning Goal 2: Students are able to recognize characteristics of the coordination concept, apply this concept in a realistic system, and understand the benefits.

Assessment: The following question will be added to an assignment:

The Operations Department at a community college is responsible for finding and assigning classrooms, providing proper technical support, and working with different academic units to assign instructors for all the classes. Recently the college has dramatically increased the number of course offerings due to strong demand. This increase has caused some glitches in the operations: some classrooms were too small to fit the designed classes while some bigger rooms were assigned to small classes, students/instructors went to the wrong classrooms, and etc. To solve these problems, the college decides to develop a computer application to organize the logistics among different units by sharing real-time information and synchronizing various activities. Please answer the following questions:

- 1) Please give some examples of the information needed to be coordinated among different units.
- 2) What characteristics of this logistics system make it suitable for collaboration?
- 3) What are the benefits of using collaboration?

Learning Goal 3: Students understand that (large) data sets can be mined for patterns; they can provide high-level explanations on what data is relevant to a particular question and interpretations on data mining results.

Assessment: The following question will be added to an assignment:

A community college has been experiencing problems in finding instructors and classrooms due to the fluctuating student enrollment. They must determine whether to hire more faculty, how many more to hire, and whether to build more classrooms. They decide to apply a computer application to analyze their enrollment data for the last 30 years which they have recently digitized and to make forecasts of future enrollments of different classes based on the findings from the historical data. The following are the data they were able to collect:

- 1) Student demographic information (gender, age, education, occupation, etc.)
- 2) Faculty demographic information (gender, age, education, specialty, etc.)
- 3) Demographic information for the region
- 4) Regional employment statistics
- 5) Enrollments of all the classes

Please answer the following two questions:

- A) Please explain what data in the above list could be used in the data mining process to provide a useful and meaningful forecast? And why?
- B) Suppose the data mining analysis finds that enrollment of classes in a certain area increased by a similar percentage whenever the demand of workers in the same area increased. If current regional employment statistics show that the job demand for software engineers have increased by 10% in the last six years. What recommendations would you make to the college?