Large Scale Systems Design  
G52LSS

Lecture 17 – Process Specification

- Structured English
- Decision Tables
- Decision Trees
- Specifying Decision Logic

Learning outcomes: write structured English to describe decision logic; create decision tables to describe decision logic; create decision trees to describe decision logic; compare the three methods of describing decision logic.

Structured English

- Use four types of structures: sequences, decisions, cases and iterations to express decision-making logic
- Use capitalised keywords: IF, THEN, WHILE, etc.
- Adequate indentation should be used for clarity
- Careful use or some logical and relational words such as: AND, OR, GREATER THAN, etc.

Sequences
- AverageCost = Total / Items
- Fine = AverageCost x 0.15
- Print “Fine to pay” Fine

Decisions
- IF price less than credit
- THEN print “You have credit”
- ELSE print “You have no credit”

Cases
- CASE
  - IF day is 5
    - THEN print “Saturday”
  - IF day is 6
    - THEN print “Sunday”
  - ELSE print “Weekday”

Iterations
- DO
  - Print “Enter password”
  - Get Pswd
  - WHILE Pswd ≠ ActivePswd
  - i = 1
  - DO WHILE i < 10
    - j = i × i
    - i = i + 1
    - print (j, j)
  - END DO

Example 17.1 Assume that the decision logic of process ‘enrol student in module’ (process 2.4 in Lecture 15) of the University Registrations System is described as follows.

If the number of credits in the student’s schedule does not exceed the maximum credits per term (MCT), then enrol student in selected module. Otherwise calculate the excess of credits in the schedule. If the excess of credits is less than 15% of the average credits taken in previous years, then enrol student in selected module. If the excess of credits is less than 10% of the maximum credits per term (MCT), then enrol student in selected module only if the average mark is higher than 68.

The above textual description is ambiguous and inaccurate.

- How to determine average credits taken in previous years?
- What happens if it is a first year student?
**Example 17.1 (cont.)** Description in structured English.

**Name:** P 2.4 – Enrol Student in Module

**Description:** If requested enrollment is valid then accept and record it.

**Input Data:**
- User registration
- Module enrolment

**Output Data:**
- Module request
- Module enrolment

**Decision Logic:**
- ScheduleCredits = GetScheduleCredits(user registration) + GetModCredits(module enrolment)
- IF ScheduleCredits ≤ MCT
  THEN AcceptEnrolment(add module request, enrolment)
- ELSE
- StudentYear = GetStudentYear(user registration)
  IF StudentYear > 1
    THEN AcceptEnrolment
    ELSE
      AverageCredits = GetScheduleCredits(user registration)
      AverageCredit = GetPreviousCredits(average credits)
      IF AverageCredit ≤ 0.15(AverageCredit)
        THEN AcceptEnrolment
        ELSE
          AverageMark = GetAverageScore(user registration)
          IF AverageMark ≤ 0.10(MCT) AND AverageMark > 60
            THEN AcceptEnrolment
            ELSE RejectEnrolment

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**Decision Tables**

- Use conditions, rules and actions arranged in a table to express decision-making logic
- Determine adequate number of conditions, condition alternatives and actions
- Eliminate redundancy by combining rules (condition alternatives + actions)
- Eliminate impossibilities and contradictions
- Re-arrange the table if required to achieve clarity
- Four main problems that can occur in developing decision tables: incompleteness, impossible situations, contradictions, redundancy

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**Eliminating Redundancy in Decision Tables**

Redundant rules result on the same action for different combinations of conditions and have one condition that makes them different from other non-redundant rules.

**Identify redundant rules**

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>condition 1</td>
<td>Y Y Y N N N</td>
</tr>
<tr>
<td>condition 2</td>
<td>Y Y N N Y N</td>
</tr>
<tr>
<td>condition 3</td>
<td>Y N N Y N N</td>
</tr>
</tbody>
</table>

**Combine redundant rules**

<table>
<thead>
<tr>
<th>Actions</th>
<th>action 1</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>action 2</td>
<td>X X</td>
<td></td>
</tr>
<tr>
<td>action 3</td>
<td>X X X X</td>
<td></td>
</tr>
</tbody>
</table>

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**Example 17.2** Construct a decision table using only alternatives Y and N for the Process 2.4 – Enrol student in module.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>ScheduleCredits &lt; MCT</td>
<td>Y N N N N N</td>
</tr>
<tr>
<td>Year of study &gt; 1</td>
<td>= N Y Y Y Y Y</td>
</tr>
<tr>
<td>Excess credits ≤ 13% Average Credits</td>
<td>= Y N N N</td>
</tr>
<tr>
<td>Excess credits ≤ 10% MCT</td>
<td>= Y N N N</td>
</tr>
<tr>
<td>Average Mark &gt; 68</td>
<td>= Y N N</td>
</tr>
</tbody>
</table>

**Actions**

| action 1 | X |
| action 2 | X X |
| action 3 | X X |
| action 4 | X X X X |
**Decision Trees**

- Used to reflect the sequence of decision-making logic
- Use conditions (circles) and actions (squares) in a branching tree to express decision-making logic
- Determine conditions, actions and their sequence
- List all required possibilities when drawing the tree
- Construct the tree from left to right
- The order of checking conditions and executing actions is immediately noticeable in decision trees
- Compared to decision tables, decision trees are more readily understood by others in the organization

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**Exercise 17.1 Problem 4 (Kendall & Kendall, chapter 9).**

A computer supplies firm will give discounts if payments are made within 18 days. The discounting policy is as follows: If the amount of the order for computer supplies is greater than £1,000, give a 4% discount; if the amount is between £500 and £1,000, give a 2% discount; if the amount is less than £500, do not apply any discount. All orders made via the Web automatically receive an extra 5% discount. Any special order (computer furniture, for example) is exempt from all discounting.

Develop a decision tree, decision table (alternatives Y and N only) and structured English descriptions for this decision-logic.
Exercise 17.1 (cont.) Description in structured English.

Name: PS – Determine discount

Description: Determines if customer is entitled to a discount and for how much

Input data flows: order details, payment details

Output data flows: discount details

Process Logic:

IF order details.special order = TRUE
THEN No discount
ELSE
IF payment details.early payment = FALSE
THEN No discount
ELSE
IF order details.order amount < 500 THEN No discount
ELSE
IF order details.web order = TRUE
THEN discount += 5
ELSE discount = 0
IF order details.order amount < 1000 THEN discount += discount + 2
ELSE discount += discount + 4

Exercise 17.4 Create structured English, decision tree and decision table to represent following the decision-making logic.

The decision-making logic of a bank to approve or reject loan applications is as follows. If the loan is for less than £2000 the loan officer checks the applicants credit report. If the credit report is rated good or excellent, the loan officer approves the loan. If the credit report is rated fair, the officer checks to see if the applicant has an account at the bank. If the applicant holds an account, the application is approved; otherwise, the application is denied. If the credit report is rated poor, the application is denied. Loan applications for amounts between £2000 and £200000 are divided into four categories: car, mortgage, educational, and other. For car, mortgage and other loan requests, the applicants credit report is reviewed and an employment check is made to verify the applicants reported salary income. If the credit report rating is poor, the loan is denied. If the credit report rating is fair, good or excellent and the salary income is verified, the loan is approved.

Exercise 17.5 (cont.)

If the salary income is not verifiable, the applicant is contacted and additional information is requested. In this case, the loan application along with the additional information is sent to the bank’s vice-president for review and a final loan decision. For educational loans, the educational institution to which the applicant will attend is contacted to determine the estimated cost of attendance. This amount is then compared to the amount of the loan requested in the application. If the requested amount exceeds the cost of attendance, the loan is denied. Otherwise, educational loan requests for amounts between £2000 and £34999 are approved if the applicants credit rating is fair, good, or excellent. Education loan applications requesting amounts from £35000 to £200000 are approved only if the credit rating is good or excellent. All loan applications for amounts greater than £200000 are sent to the bank’s vice-president for review and approval.
Exercise 17 (cont.)

Name: PAX – Determine loan approval decision
Description: Determines if loan application is approved, denied or referred
Input data: LoanAmount, LoanType, CreditStatus, SalaryVerified, BankAccount
Output data: Decision
Process Logic:
To Be Completed by Student Following the Decision Tree or Decision Table

Exercise 17 (cont.)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>loan &lt; 20000</td>
<td>Y Y Y Y N N N N N N N N</td>
</tr>
<tr>
<td>20000 ≤ loan &lt; 30000</td>
<td>N N N N Y Y Y Y Y Y</td>
</tr>
<tr>
<td>20000 ≤ loan &lt; 35000</td>
<td>N N N N − − − − Y Y Y N</td>
</tr>
<tr>
<td>35000 ≤ loan &lt; 200000</td>
<td>N N N N N N N N N N N N</td>
</tr>
<tr>
<td>loan &gt; 20000</td>
<td>N N N N Y N N N N Y Y</td>
</tr>
<tr>
<td>educational loan</td>
<td>− − − − − − − − − −</td>
</tr>
<tr>
<td>loan &gt; attendance cost</td>
<td>− − − − − − − − − −</td>
</tr>
<tr>
<td>poor credit</td>
<td>N N N N Y N − − − −</td>
</tr>
<tr>
<td>fair credit</td>
<td>N N Y Y Y N − − − −</td>
</tr>
<tr>
<td>good/excellent credit</td>
<td>Y N N N N − − − −</td>
</tr>
<tr>
<td>salary verified</td>
<td>− − N − − − − − −</td>
</tr>
<tr>
<td>account in bank</td>
<td>− − − − − − − −</td>
</tr>
</tbody>
</table>

Actions
- denied loan: X X X X X
- approved loan: X X X X X
- refer to vice-president: X X X

Additional Reading
Chapter 9 of (Kendall and Kendall, 2005)
Chapter 8 of (Hoffer et al., 2005)