I (We saw earlier that…) Business rules describe properties of an application.

A business rule can be associated to a class, to define common properties of instances, or to an operation, to define its effects.

The types of rules we will discuss in this unit include:

- **Integrity constraints** on the data of the application;
- **Derivation rules**, whereby information can be derived from other information;
- **Operation rules** that describe the effects of an operation.
Examples of Business Rules

Constraints

(BR1) The manager of a department must belong to that department.
(BR2) An employee cannot earn more than her manager.
(BR3) A department of the Toronto office can only be managed by an employee who has ≥ 10 yrs experience.
(BR4) An employee can only participate in projects associated with her department.

Derivations

(BR5) The budget of a project is the sum of all salaries of participating employees, multiplied by 3.

Operation Rules

(BR6) Before a withdrawal, the balance of the account must be greater than the amount being withdrawn.
(BR7) After the withdrawal, the balance will be equal to the balance before, minus the amount that has been withdrawn.

Specifying Business Rules

How do we specify more precisely business rules?

✓ Natural Language -- use unrestricted natural language...but such descriptions can be highly ambiguous;

✓ Structured English -- use a subset of a natural language (both syntactically and vocabulary-wise) to minimize ambiguities...this has been used with some success;

✓ Decision Tables -- use table representation of alternative outcomes (similar to truth tables);

✓ Decision Trees -- use tree representation of alternative outcomes

We need representations that are precise, but also understandable by end user
Structured English

Looks a lot like pseudocode. Here is an operation rule:

For each LOAN ACCOUNT NUMBER in the LOAN ACCOUNT FILE
do the following steps:
    If the AMOUNT PAST DUE is greater than $0.00 then
    while there are LOAN ACCOUNT NUMBERS for the CUSTOMER
    NAME do the following:
        sum the OUTSTANDING LOAN BALANCES
        sum the MINIMAL PAYMENTS
        sum the PAST DUE AMOUNTS
        report the CUSTOMER NAME, LOAN ACCOUNT on OVERDUE
        CUSTOMER, LOAN ANALYSIS

Takes some effort to specify, not very readable,
too close to an implementation

Another Example

do while there are more staff in the list
    calculate staff bonus
    store bonus amount
begin case
    case bonus > £250
        add name to StarOfTheMonth list
    case bonus < £25
        print warning letter
end case
end do
Some Rules for Structured English

- Use only nouns and terms defined in the project dictionary
- Avoid compound sentences because they can be highly ambiguous
- Avoid undefined adjectives and adverbs (such as “good”, “nice” etc.) unless clearly defined in the dictionary in terms of value ranges (e.g., “good” ↔ 65-75%)
- Avoid language that destroys the natural flow of control within the process (i.e., goto’s)
- Use a limited set of flow constructs, such as sequencing, if-then-else, while do etc.

Decision Tables

- If there are $n$ parameters (or, conditions) to a decision, each of which can take $k_1, k_2,...k_n$ values, then make up a table with $k_1 * k_2 *... * k_n$ columns and as many rows as there are possible actions (or, outcomes).
- Consider conditions “married?” and “under 30?”, and outcomes “send promotion letter!”, “remove from list!”:

<table>
<thead>
<tr>
<th>Married?</th>
<th>N</th>
<th>N</th>
<th>Y</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 30?</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Send letter!</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove from list!</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example

For example: “If the plane is more than half full and the flight costs more than $350 per seat, serve free cocktails, unless it is a domestic flight. Charge for cocktails in all domestic flights where cocktails are served, i.e., those that are more than half full”

<table>
<thead>
<tr>
<th>conditions</th>
<th>Domestic?</th>
<th>≥ half full?</th>
<th>≥ $350/seat?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Y Y Y Y N N N</td>
<td>Y Y N N Y Y N</td>
<td>Y N Y N Y N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>outcomes</th>
<th>Serve cocktails</th>
<th>Free cocktails</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X X</td>
<td>X X ? ?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
### Completion and Simplification of a Decision Table

#### Completion (includes additional external input)

<table>
<thead>
<tr>
<th></th>
<th>Domestic</th>
<th>≥ half full</th>
<th>≥ $350/seat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic</td>
<td>Y Y Y Y N N N N</td>
<td>Y Y N N Y Y N N</td>
<td>Y N Y N Y N Y N</td>
</tr>
<tr>
<td>≥ half full</td>
<td>Y Y N * Y N</td>
<td>Y N N Y Y N N</td>
<td>Y Y N N Y N</td>
</tr>
<tr>
<td>≥ $350/seat</td>
<td>* * Y Y N</td>
<td>* Y N N Y N N</td>
<td>* Y N Y N</td>
</tr>
<tr>
<td>Serve cocktails</td>
<td>X X X X X</td>
<td>X X X X X</td>
<td>X X X X</td>
</tr>
<tr>
<td>Free cocktails</td>
<td>X X X X X</td>
<td>X X X X X</td>
<td>X X X X</td>
</tr>
<tr>
<td>Charge cocktails</td>
<td>X X X X X</td>
<td>X X X X X</td>
<td>X X X X</td>
</tr>
<tr>
<td>No cocktails</td>
<td>X X X X X</td>
<td>X X X X X</td>
<td>X X X X</td>
</tr>
</tbody>
</table>

#### Simplification

### Going Places

<table>
<thead>
<tr>
<th></th>
<th>Y Y Y Y Y N N N</th>
</tr>
</thead>
<tbody>
<tr>
<td>In town?</td>
<td>Y Y Y Y Y N N N</td>
</tr>
<tr>
<td>Short distance?</td>
<td>Y Y Y N N Y N N</td>
</tr>
<tr>
<td>Good weather?</td>
<td>Y N N * * * * *</td>
</tr>
<tr>
<td>Can afford?</td>
<td>* Y N Y N * Y N</td>
</tr>
<tr>
<td>Walk!</td>
<td>X</td>
</tr>
<tr>
<td>Take TTC!</td>
<td>X X</td>
</tr>
<tr>
<td>Take taxi!</td>
<td>X X</td>
</tr>
<tr>
<td>Take train!</td>
<td>X X</td>
</tr>
<tr>
<td>Fly!</td>
<td>X</td>
</tr>
</tbody>
</table>
Another Example

<table>
<thead>
<tr>
<th>Is budget likely to be overspent?</th>
<th>N</th>
<th>Y</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is overspent likely to be over 2%?</td>
<td></td>
<td>*</td>
<td>N</td>
</tr>
<tr>
<td>No action!</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Write letter!</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Set up meeting!</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Decision Trees

- Nodes of a decision tree represent partial outcomes, successors of a node represent mutually exclusive alternatives.
Decision Trees: An Example

Note: This is a real example (...):

“Air shipping charges are set depending on the weight of a parcel. The basic rate is $3/lb, reducing to $2/lb for excess over 20 lb, with a minimum of $6. Surface freight is $2/lb for express delivery. However, this rate only applies in the local delivery area. If the shipping address is outside the local area and the parcel weighs more than 20lb, or express delivery is not required, the surface rate is the same as for local delivery (express). Normal delivery of packages is $2/lb up to 20lb is $2/lb, with $1 express surcharge (per pound).

Notwithstanding the provisions of the previous paragraph, air freight to destinations west of the Mississippi is charged at double rate.”

Clarifications

- **Question:** Is there a difference between freight shipping and handling?
  - **Answer:** No, all rates include freight and handling.
- **Question:** The description mentions “up to 20lbs” and “over 20lbs”. Which rate applies for exactly 20lbs?
  - **Answer:** It’s generally understood that “up to 20lbs” means “up to and including 20lbs”.
- **Question:** The fourth sentence could be read in two ways: “both outside the local area and also over 20lbs, or, alternatively, express not required” or “outside the local area and, in addition, either over 20lbs or express not required”. Which is correct?
  - **Answer:** The second one.
The Freight Decision Tree

Area
- East of Miss.
  - ≤2 lb: $6 flat rate
  - 2 lb ≤ ... ≤ 20 lb: $3/lb
  - > 20 lb: $6/lb
- West of Miss.
  - ≤2 lb: $12 flat rate
  - 2 lb ≤ ... ≤ 20 lb: $6/lb
  - > 20 lb: $120 flat + $2/lb over 20

Weight
- ≤2 lb: $6 flat rate
- 2 lb ≤ ... ≤ 20 lb: $3/lb
- > 20 lb: $60 flat + $2/lb over 20

Method
- Local area
  - Express: $2/lb
  - Normal: $3/lb
- Outside local area
  - Express: $2/lb
  - Normal: $2/lb

Destination
- Express
  - ≤ 20 lb: $3/lb
  - > 20 lb: $60 flat + $2/lb over 20
- Normal
  - ≤ 20 lb: $2/lb
  - > 20 lb: $120 flat + $2/lb over 20

Service
- Express
  - ≤ 20 lb: $3/lb
  - > 20 lb: $60 flat + $2/lb over 20
- Normal
  - ≤ 20 lb: $2/lb
  - > 20 lb: $120 flat + $2/lb over 20

It costs $57 to send 19 lbs outside local area, express, but only $42 to do the same for 21 lbs...

Summary

- Decision trees are best used with applications involving up to 15-20 outcomes
- Decision tables are more appropriate for problems involving complex combinations of up to 5-6 conditions (but can handle much larger number of outcomes)
- Structured English (and state-oriented models) are most appropriate for problems involving sequential considerations of alternative steps.
Additional Readings