Module 40.5

Objectives & Outlines

I/O Specs

Description of LMS

Identification of Classes

Extraction of Nouns

QC

Identification of Attributes

Structural Clustering

QC

Behavioral Clustering

QC

Identified Classes

Responsibility Identification

Extraction of Verbs

Verbs with Classes

QC

Collaboration

Module 40.5: Analysis, Design and UML

An Exploratory Exercise

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Slides taken from NPTEL course on Object-Oriented Analysis & Design

by **Prof. Partha Pratim Das**

Module Objectives

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Collaboration

- Perform an exploratory exercise to identify potential classes, objects, and relationships for the Leave Management System (LMS)
- The following will be used as primary source of information for LMS (as received from the client)
  - Written English description of LMS (PDF document as shared)

Module Outline

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Collaboration

1. Input and Output Specification
2. Informal English Description of LMS
3. Identification of Classes
   - Extraction of Nouns
     - QC
   - Identification of Attributes
   - Structural Clustering
     - QC
   - Behavioral Clustering
     - QC
   - Identified Classes
4. Identification of Responsibilities
   - Extraction of Verbs
   - Verbs with Classes
   - QC
5. Collaboration
6. Hierarchy
   - Employee Hierarchy
7. Relationship

Input and Output Specification

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Collaboration

Input

Informal English Description ⇒

Output

- Classes
- Attributes
- Responsibilities

Class Name	
Attributes	Responsibilities
•	•
•	•
•	•

Informal English Description of LMS

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Collaboration

A Company wants to manage the attendance and leave of its employees through LMS. The requirement specifications are:

[1] The company has three categories of employees:

- *Executive*: Employees who work as individual contributors and report to a Lead.
- *Lead*: Every Executive reports to a Lead who approves / regrets her / his leave. A Lead reports to the Manager.
- *Manager*: Every Lead reports to the Manager who approves / regrets her / his leave. There is *only one* Manager.

Identification of Noun

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Collaboration

- Linguistic analysis of the problem description - extraction of Nouns
- Rules of thumb[1] :
  - Elimination of irrelevant terms
  - Elimination of names of values
  - Elimination of vague terms
  - Identification of attributes
  - Identification of operations
  - Elimination of terms which are in fact relationships

[1] Source: R.J. Abbott, Program Design by Informal English Descriptions, CACM, Vol.26, No.11, 1983

Identification of Noun

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Collaboration

A Company wants to manage the attendance and leave of its employees through LMS. The requirement specifications are:

- The company has three categories of employees:
  - *Executive*: Employees who work as individual contributors and report to a Lead.
  - *Lead*: Every Executive reports to a Lead who approves / regrets her / his leave. A Lead reports to the Manager.
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Identification of Noun

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Collaboration

- The company has provisions for the following categories of leave associated with the respective leave rules:
  - *Casual Leave (CL)*:
    - 10 CL's are available in a calendar year. All CL's are credited to an employee on 01-Jan. For employees joining in the middle of the year, the number of CL's are prorated. CL's cannot be carried over to the next calendar year.
    - More than 2 CL's cannot be availed at a time. CL's cannot be clubbed with other types of leave. Total period of absence including holidays cannot be more than 4 days. Holidays intervening the absence are not counted as leave.
    - CL's do not need pre-approval; but must be approved within 2 days of its availing.

List of all Identified Nouns

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Collaboration

Company	Attendance	Leave	Employees
Contributors	Lead	Executive	Manager
Leave Rules	Days	Year	Name
Type of Leave	Period	Absence	Holiday
PL	CL	EL	DL
SL	ML	LWP	UL
Pre-approval	Month	Service	Quarter
Medical Certificate	Parenthood Certificate	Disciplinary Action	Administration Function
Daily Attendance	Personal Details	Calender Year	Batch Task
Account	Balance	Designation	SysAdmin
Parent	Salary	Week	List
Privilege	Right	Login ID	Leave Status
Employee Code			

Quality Check

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Collaboration

- The Metrics at this Stage
  - [1] **Coupling**: Very low
  - [2] **Cohesion**: Very low
  - [3] **Sufficiency**: Unclear
  - [4] **Completeness**: Unclear
  - [5] **Primitiveness**: Unclear
- Actions required
  - Identify Attributes
  - Perform Structural Clustering

Attributes

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Collaboration

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Contributors	Lead	Executive	Manager
Leave Rules	Days	Year	Name
Type of Leave	Period	Absence	Holiday
PL	CL	EL	DL
SL	ML	LWP	UL
Pre-approval	Month	Service	Quarter
Medical Certificate	Parenthood Certificate	Disciplinary Action	Administration Function
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Account	Balance	Designation	SysAdmin
Parent	Salary	Week	List
Privilege	Right	Login ID	Leave Status
Employee Code			

Noun used only as value should be treated as attribute

- Login ID
- Name
- Employee Code
- Personal details
- Designation
- Salary

Structural Clustering

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Collaboration

Company	Attendance	Leave	Employees
Contributors	Lead	Executive	Manager
Leave Rules	Days	Year	Name
Type of Leave	Period	Absence	Holiday
PL	CL	EL	DL
SL	ML	LWP	UL
Pre-approval	Month	Service	Quarter
Medical Certificate	Parenthood Certificate	Disciplinary Action	Administration Function
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Account	Balance	Designation	SysAdmin
Parent	Salary	Week	List
Privilege	Right	Login ID	Leave Status
Employee Code			

- People
  - Manager, Lead, Executive
  - SysAdmin
- Organizations
  - Company
- Things (Documents)
  - Medical Certificate, Parenthood Certificate

Structural Clustering

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Collaboration

Company	Attendance	Leave	Employees
Contributors	Lead	Executive	Manager
Leave Rules	Days	Year	Name
Type of Leave	Period	Absence	Holiday
PL	CL	EL	DL
SL	ML	LWP	UL
Pre-approval	Month	Service	Quarter
Medical Certificate	Parenthood Certificate	Disciplinary Action	Administration Function
Daily Attendance	Personal Details	Calender Year	Batch Task
Account	Balance	Designation	SysAdmin
Parent	Salary	Week	List
Privilege	Right	Login ID	Leave Status
Employee Code			

- Events
  - Holiday, Disciplinary Actions
  - CL, ML, UL ...etc
- Temporal Nouns
  - Date, Year, Time, Days, Calender year, Week, Month
- Incidental Nouns
  - Leave Rule, Administrative Functions, Period

Quality Check

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Collaboration

- The Metrics at this Stage
  - [1] **Coupling**: **Low** (was Very low)
  - [2] **Cohesion**: **Low** (was Very low)
  - [3] **Sufficiency**: Unclear (was Unclear)
  - [4] **Completeness**: Unclear (was Unclear)
  - [5] **Primitiveness**: Unclear (was Unclear)
- Actions required
  - Perform Behavioral Clustering

Behavioral Clustering

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Collaboration

- What takes place in the system
  - Leaves – CL, ML, UL ...etc
- Initiator and Participant
  - Initiator – Lead and Manager; SysAdmin
  - Participant – Executive, Lead and Manager

Abstractions Summary from Linguistic Analysis

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Collaboration

- **Key Abstractions**: Leave, Employee, CL, EL, ...
- **Non-Key (Supporting) Abstractions**: Medical Certificate, Parenthood Certificate, Disciplinary Actions, ...
- **Incidental Abstractions**: Leave Status, Administrative Functions, ...
- **Attribute (Property) Abstractions**: name, personal details, employee code, ...

Quality Check

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Collaboration

- The Metrics at this Stage
  - [1] **Coupling**: Low (was Low)
  - [2] **Cohesion**: **Moderate** (was Low)
  - [3] **Sufficiency**: Unclear (was Unclear)
  - [4] **Completeness**: **Very low** (was Unclear)
  - [5] **Primitiveness**: **Very low** (was Unclear)
- Actions required
  - Decide on Classes (first level)

Resultant Classes

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Collaboration

[1] Company
[2] Employee
[3] Executive
[4] Lead
[5] Manager
[6] Leave
[7] SL
[8] ML
[9] PL
[10] CL
[11] EL
[12] DL
[13] LWP
[14] UL
[15] SysAdmin

Identification of Responsibilities

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Collaboration

- We now use the Linguistic analysis of verbs and repeatedly refine these to identify responsibilities

Identification Verb

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Collaboration

- Linguistic analysis of the problem description - extraction of verbs
- Rules of thumb[2]:
  - Which operations can be executed by a certain object
  - Not only the current requirements should be considered, but also re-usability should be taken into account
  - Which events are expected
  - Which objects can react to these events
  - Which other events are raised in turn

[2] Source: R.J. Abbott, Program Design by Informal English Descriptions, CACM, Vol.26, No.11, 1983

Identification Verb

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Collaboration

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[1] The company has three categories of employees:

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- *Lead*: Every Executive reports to a Lead who approves / regrets her / his leave. A Lead reports to the Manager.
- *Manager*: Every Lead reports to the Manager who approves / regrets her / his leave. There is *only one* Manager.

List of all Identified Verbs

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Collaboration

Wants	Manage	Work	Report
Approve	Regret	Credit	Join
Prorate	Cross	En-cash	Paid
Allow	Send	Need	Become
Enjoy	Avail	Proceeding	Employ
Consider	Deduct	Provide	Request
Cancel	Check	Export	Revoke
Debit	Adjust	Perform	Hire
Fire	Generate	Leave En-cashment	Can be Availed
Can be Clubbed	Can't be Availed	Can't be Carried forward	Can't be Clubbed
Can't be Continued	Accumulated Up	Proposed for	Join Back
Doesn't Draw	Can be Revoked	Leave Credited	

Many extracted verbs are in derived forms – so we extract the unique stems

List of all Identified Verbs (Stem Only)

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Collaboration

Wants	Manage	Work	Report
Approve	Regret	Credit	Join
Prorate	Cross	En-cash	Pay
Allow	Send	Need	Become
Enjoy	Avail	Proceed	Employ
Consider	Deduct	Provide	Request
Cancel	Check	Export	Revoke
Debit	Adjust	Perform	Hire
Fire	Generate	Club	Carry forward
Continue	Accumulate	Propose	Join Back
Draw			

Relation of the Verbs with Classes

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Collaboration

Class	Related Verbs / Responsibilities	
Employee	• Work • Record • Request • Cancel • Avail	• Check • Export • Report • Approves • Regret
Casual Leave	• Credit • Prorate • Approve • Cannot be availed • cannot be clubbed	

Relation of the Verbs with Classes

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Collaboration

Class	Responsibilities	
Employee	• Work • Record • Request • Cancel • Avail	• Check • Export • Report • Approves • Regret
Casual Leave	• Credit • Prorate • Approve • Cannot be availed • cannot be clubbed	

Blue responsibilities are core – common for all employees

Quality Check

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Collaboration

- The Metrics at this Stage
  - [1] **Coupling**: Low (was Low)
  - [2] **Cohesion**: Moderate (was Moderate)
  - [3] **Sufficiency**: **Very low** (was Unclear)
  - [4] **Completeness**: **Low** (was Very low)
  - [5] **Primitiveness**: Very low (was Very low)
- Actions required
  - Explore Association

Collaboration

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Collaboration

Class Name	Responsibilities	Collaborators
Company	• Manage	• Employee • Leave
Employee	• Record Daily Attendance • Request for Leave ...	• Leave
Executive	• Record Daily Attendance • Request for Leave ...	• Leave • Lead
Lead	• Approve Leave • Request for Leave ...	• Leave • Executive • Manager
Manager	• Credit, Debit, Adjust Leave • Hire, Fire Employee • Force-execute ...	• Leave • Executive • Lead • SysAdmin
Leave	• Validity Check • Accounting	• Employee

Employee Hierarchy

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Collaboration

Class: Employee
Attributes: • Name • ID • DoB
Responsibilities: • Record Daily Attendance • Request for Leave • Cancel an Approved Leave • Avail Leave, if approved

IS-A

Class: Executive
Attributes: • Reporting_Lead • ...
Additional Responsibilities: • Report to Lead

Class: Lead
Attributes: • Reporting_Manager • List of Reporting Executives
Additional Responsibilities: • Approve Leave (Executive) • Regret Leave (Executive) • Revoke Leave (Executive) • Report to Manager • Take Reporting (Executive)

Class: Manager
Attributes: • List of Reporting Leads • ...
Additional Responsibilities: • Approve Leave (Lead) • Regret Leave (Lead) • Revoke Leave (Lead) • Take Reporting (Lead)

- *For brevity, all characteristics and all responsibilities are not shown*
- **Suggest refinements to Employee hierarchy**

Employee Hierarchy

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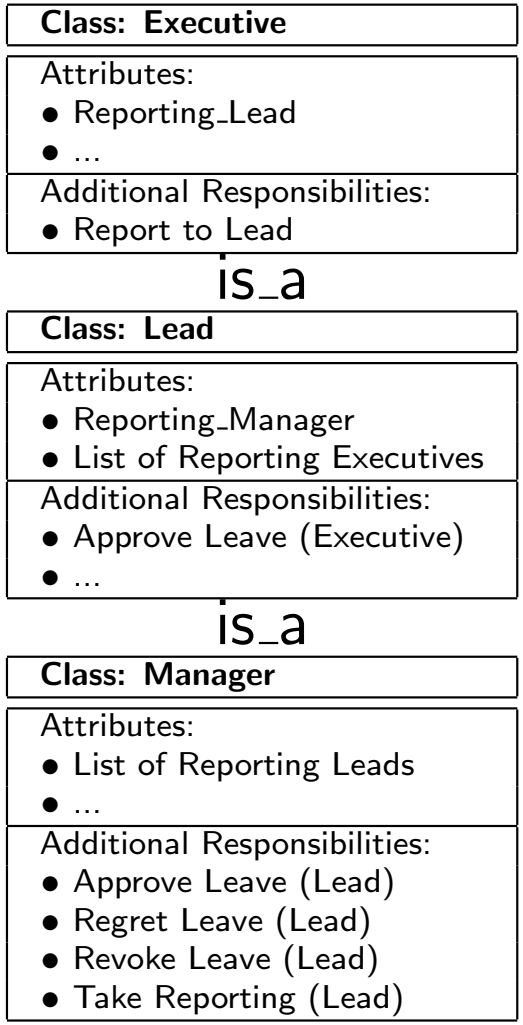

Relationship among Classes

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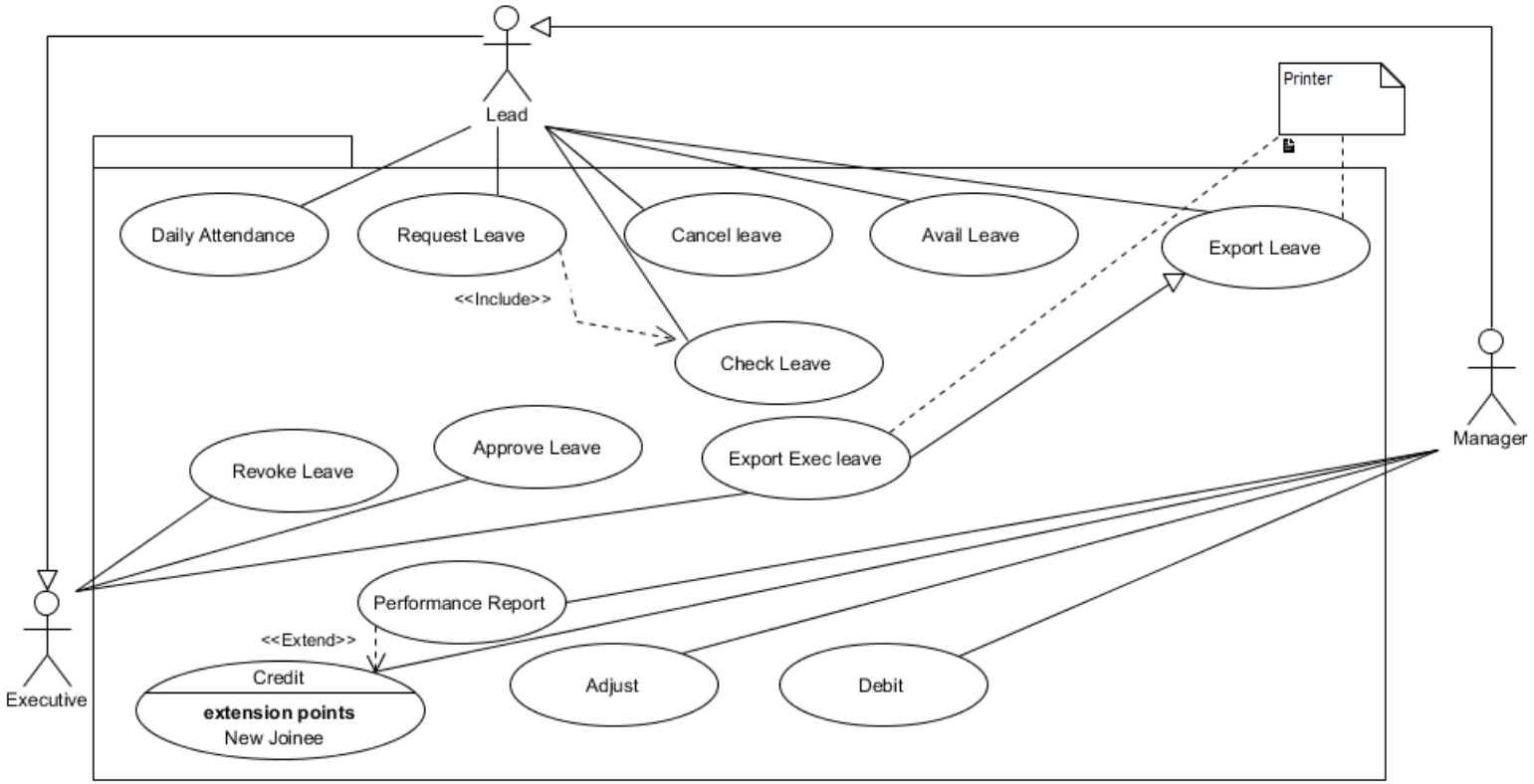

Employees and Leave Actions are Related