Discrete Mathematics

Dr. Han Huang

South China University of Technology

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Chapter 3. Relations

Mathematical Modeling and Application

Section 3.7

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Relational Database

Introduction

- There are many sources of data such as travel records, consumption records, web pages records, messages records, and so on.

- In order to store hundreds of millions of data, databases are essential.

- If databases store data randomly, the efficiency of the query will be very low.
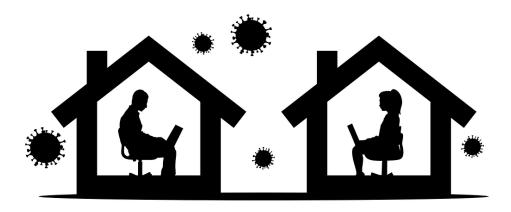
Modeling

Hotel engagement message can be modeling as the following Relational Database.

Customers

CustomerID	CustFirstName	CustLastName	CustPhone	<<其他列>>
10001	Doris	Hartwig	555−2671	...
10002	Deb	Waldal	555−2496	...
10003	Peter	Brehm	555−2501	...

Engagements (链接表)

EngagementID	CustomerID	EntertainerID	StartDate	<<其他列>>
43	10001	1001	2007−10−21	...
58	10001	1002	2007−12−01	...
62	10003	1005	2007−12−09	...
71	10002	1003	2007−12−22	...
125	10001	1003	2008−02−23	...

Entertainers

EntertainerID	EntertainerName	EntertainerPhone	<<其他列>>
1001	Carol Peacock Trio	555−2691	...
1002	Topazz	555−2591	...
1003	JV & the Deep Six	555−2511	...

■ Using the relational model to build a database allows for quick querying of relevant data based on key transitivity.
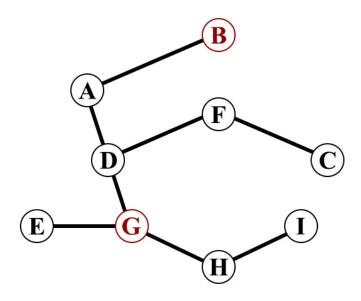
Epidemic Prevention

Introduction

■ In the face of large-scale epidemic spread, the epidemic shows the characteristics of rapid spread, complex morbidity and strong infectivity, isolation is a useful way to stop the spread of the epidemic.

■ How to determine the size of the control range is a problem that must be faced.

Modeling

Example: Assuming that nine persons *A-I* are in contact with each other, *B* and *G* are known to be infected, persons in close contact with these two persons are at risk of infection, and suitable control ranges need to be constructed to avoid further spread of the outbreak.

■ Based on transitivity, the appropriate isolation range can be quickly constructed. Only *C* and *I* do not need to be isolated
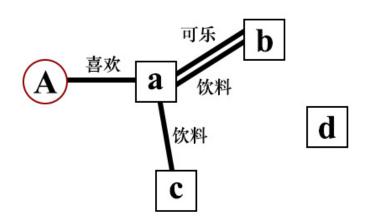
Recommender System

Introduction

- The recommendation system records the user's interested content according to the user's click frequency, reading time and other information.
- The recommendation system take into account the similarity between users' purchasing behaviors and between items.

Modeling

Example: Suppose the purchase history shows that user *A* has only bought Coke *a* in large quantities on the platform. The platform is currently promoting Coke *b*, Milk Tea *c*, and Fat Loss Package *d.* Please make a recommended list for the user *A.*

■ Based on the relational model, the similarity value is obtained through the difference of the relationship, and the items with high similarity are recommended to the user. The list is *b c d*.

Equivalence Class Division

Introduction

- Software testing is an important part of the software development process. Designing software test cases through equivalence class is the most basic method.
- Equivalence class divides the input domain into parts, and then selects a few representative data from each part to be used as test case input data.

Modeling

Example: Assume that the park ticketing system stipulates the following:

children under 1.2m in height are exempted from admission;
children between 1.2m and 1.4m in height are half-admission (including 1.2m);
seniors between 60-69 years old are half-admission (including 60 years old);
seniors over 70 years old are exempted from admission (including 70 years old).

A suitable test case needs to be constructed to examine the park ticketing system.

编号	输出	输入	测试用例
1	免票	身高1.2m以下儿童	身高为1.1m的儿童
		年龄在70岁以上的老人	74岁的老人
2	半票	身高1.2m-1.4m儿童	身高为1.3m的儿童
		年龄在60-69岁之间的老人	64岁的老人
3	全票	身高1.4m以上儿童	身高为1.5m的儿童

Scheduling Issues

Introduction

- A scheduling issue is a problem of arranging resources among multiple tasks to maximize some metric (e.g., completion time, profit, or efficiency, etc.).

- In scheduling issues, tasks often have some specific requirements, such as the sequential execution order requirements between tasks.

- The scheduling issue with order requirements is essentially a classical example of the application of partial order relations.

Modeling

Example: Suppose there are 8 tasks *A-H* with 3 factories.
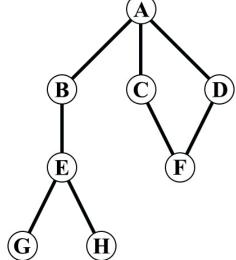
B,C,D must be completed before executing A;
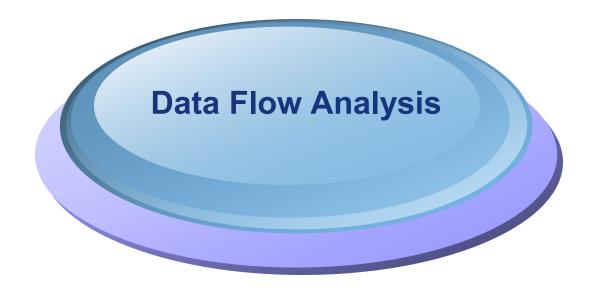E must be completed before executing B;
F must be completed before executing C and D;
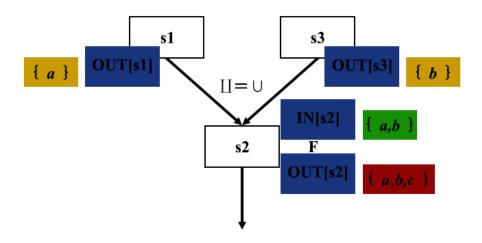G and H must be completed before executing E.

If each plant can complete *A-H* and each task takes the same amount of time, please give a plan that takes the shortest time.

- Constructing the plan using topological ordering.

- Factory 1 executes *G-E-B-A*,
  Factory 2 executes *H-C*,
  Factory 3 executes *F-D*.

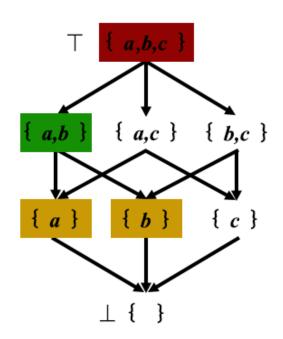**Data Flow Analysis**

Introduction

- Data flow analysis is a common analysis method to determine whether the variables are constants through iterations. However, there are some questions such as whether it converges, when it converges.
- To answer such questions, scholars constructed a framework for the data flow analysis method using lattice and realized the answers to these questions.
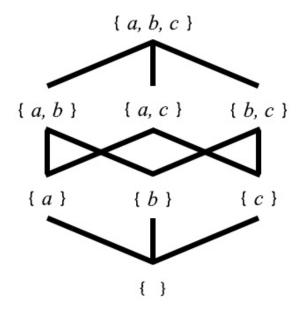
Modeling

- Since the transferability of data flow can be constructed as a partial order relationship, the data flow analysis method can be represented as the following lattice.

- Based on the monotonicity of functions on the lattice and the fixed point theory, it can be proved that the data flow algorithm must converge to a solution and the solution must be one of the optimal solutions.

$\top$ { a,b,c }

{ a,b }   { a,c }   { b,c }

{ a }   { b }   { c }

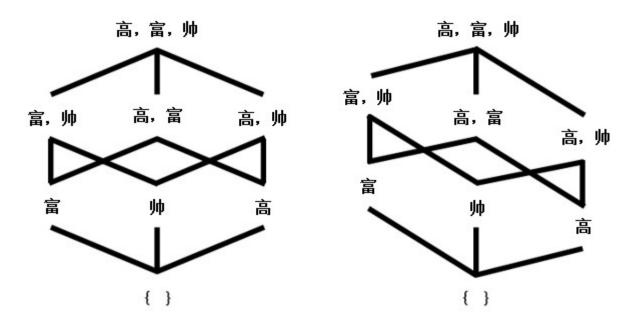$\bot$ { }

**Discrimination
Analysis**

Introduction

- The world is full of conflicts, and discrimination is extremely common. There are various perspectives to understand the argument of discrimination, and one of them is to understand and analyze and experience discrimination through the Hasse in partial order.

Modeling

- In a Hasse diagram, there is no relationship of partial order between elements of the same height, so there is not a distinction between these elements. However, it may not be really. Based on Hasse diagram, some erroneous assertions can be judged.

第三章课堂活动

➢ 请各组同学寻找生活中能够用**关系**表示的案例，并制作一个PPT。各组的PPT会进行评分，优秀的PPT会推荐在课堂上展示并给予奖励。

➢ PPT需要包括:
   1、问题描述
   2、模型分析（问题所需的本章知识点）
   3、应用效果（问题建模后的公式或推理过程）
   4、总结（知识点应用的总结）

➢ 各组课下完成**PPT**，准备时间为一周（下周二11.12之前提交到指定链接）。

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End of Section 3.7