# 需求分析

设计一个排课系统，能够从文本文件导入教室情况、培养方案和约束条件，系统能够最终生成课表或给出无法排课的错误提示。

# 概要和详细设计

程序功能：

能够根据输入的教室大小数量，老师、课程、专业、年级，以及老师能教授的课程，每个专业的应学课程，为每个专业安排出四个年级的本年的课程安排，并且为给出的所有专业及其年级排出课表，若不能排出课表，会给以无法排课的反馈。

概要设计：

首先，教室是固定的而且大多都相差不多，所以把教室容量和种类都预先写在程序（roomCapacity数组就是保存每类教室的容量）中，只需要读取相应的教室名即可。此外，教室（一般）只跟上课人数有关，所以先预处理出每种人数对应的所有教室id（即所有容量大于等于它的教室）(当然，保证小教室排在前面以免浪费)。(vector<int>room[type]按容量从小到大存储所有容量大等于roomCapacity[type]的教室id)

我通过map和数组的相互关系，将读入的老师名(tName,tid)、课程名(cName,cid)、教室名(rName,rid)、年级、专业都映射成Int方便程序内部运作，输出时再通过int找对应名称数组的值。此外，我还将年级和专业合并成一个进行处理，即年级相同专业不同或专业相同年级不同，映射到的id也不同。(gName,gid)。在将来安排课表时，我是将课程和专业年级两个元素合并（使用typedef pair<int,int> pii） (vector<pii> cg，cg[i].fist保存第i个元素的课程，second保存专业年级）给这样一个整体安排老师和教室。

对于每个课程的任课老师(vector<int> ct[course]存储course的任课老师id),直接读取即可。但对于每个专业的应修课程(cname)、课时(cTime)、先后修关系(edges)以及最后的安排(每个年应修课)（plan[i]对应第i年要修的科目）都放在了Topo结构体中集中进行安排和处理。

课程安排：

进行一次拓扑排序，首先每个关系的先修科目向后修科目连一条边，统计下每个点的入度。然后一次安排每一年:每一年把now队列中的科目安排在这一年里，同时将他的直接后修科目的入度--，若入读变成了0，将他加入nex队列中，在每年最后将nex中每个元素放到now中，nex清空。最后只要判断，若还有某门课没有上过，那么就不存在可行的安排（有环或是有长度>4的链），报错返回。

如果能够安排，就将安排(plan)的表逐项保存到cg中。这里还有一个关于课时的问题，由于代码实现较为复杂，我这里只考虑了每周1课时和2课时的情况，对于2课时的，每周的两门课会安排给相同的老师）。由于2课时比较特殊，所以用isDouble[i]标记cg第i个元素是双课时。

课表安排：

首先我们要保存课表，定义结构体Node纪录老师(tea)、房间(roo)和上课学生专业年级(gcid)，然后我们假定每周课表都是一样的，定义vector<Node> table[day][les]保存周day第les节课的时间段的每节课信息。另开了set<int> teaBusy\graBusy\rooBusy [day][les]纪录周day第les节课没有时间（或是已经有课，或是有别的事情）的老师\年级\房间,在排课前先将根本没空的老师\年级\房间插入对应的set,此外在安排课程的过程中维护和更新set，并在dfs返回true的时候将对应的课程信息存入table，从而得到课程表。

排课采用回溯法，顺序考虑cg中每个二元组<课程，专业年级>，给他们安排时间、地点、老师，由于课时的不同分两类考虑：

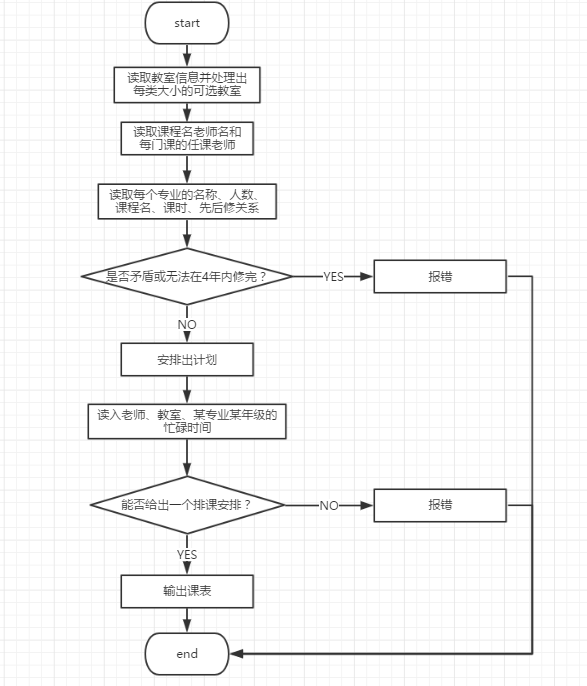
1. 单课时：

枚举les，枚举day知道找到一个时间点该年级有空，有适合的房间，然后枚举能够授课的老师，维护teaBusy,rooBusy,graBusy，然后考虑下一个二元组，若回溯时返回true,则将该课程信息加入课表table，否则删除加入到teaBusy\rooBusy\graBusy的元素，继续枚举。若全部枚举完都找不到合适的，就返回false;

1. 双课时：

与单课时很像，但是需要枚举两节的时间，出于教学效果的考虑，我让他们起码间隔2天，同一老师，其他和单课时类似。

# 程序结构



# 代码解释

Line 33 to 65:void getPoint()读入房间、课程和老师信息，并为他们标号。

Line 43,44:处理出每类房间容量的所有适合房间号

Line 70 to 82:void teachCourse()读取每门课的老师

Line 83 to 156:Topo结构体，读取每个专业的教学计划，为其安排课程，

Bool albeArrange()：

Line 113 to 130:读取教学计划，

Line 131 to 147:拓扑排序

Line 149 to 151:判断是否所有点（课程）已被安排

Void buildCG():将二元组<课程，专业+年级>加入vector cg

Line 157 to 182:bool arrangeGrade()

读取专业名的信息。

Line 200 to 204:（类似封装）了一个纪录某个时间段忙碌的老师的数据结构，

Bool teacherFree(int teacher,int day,int les)返回teacher号老师在周day第les节课是否有空

Void addTeacher(int teacher,int day,int les)将teacher号老师插入周day第les节课的忙碌表中

Void cancleGrade(int teacher,int day,int les)将teacher号老师从周day第les节课的忙碌表中删掉

rooBusy\graBusy等类似

Line 219 to 258:void getConstraint分别获取老师、房间和学生没空的时间。

Line 258 to 261:void outputNode()格式化Node类的输出

Line 262 to 270:void outputDay()输出课表一天的课程。

Line 272 to 339:boo dfs(int cgi)考虑安排cg[cgi]这门<课程，专业年级>二元组

# 测试

注释掉的为输出结果

(第一组)

20

A101 0

A102 1

A103 2

A104 2

A105 0

A106 1

A107 2

A108 2

A109 1

A110 2

A201 0

A202 1

A203 2

A204 2

A205 0

A206 1

A207 2

A208 2

A209 1

A210 2

23

read1 read2 say1 say2 listen1 listen2

gaoshu gailv lisan xiandai

c shuluo c# java jiyuan caozuoxitong

structure algorithm picture database

network web android

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huangxi1 huangxi2 huangxi3

hanyueli guofei liao gailvt xiandait

lisen lichun ligang zhangyi wangjianrong weijianguo

chenjinyan qupengyu zhangyaping pangang liyoumeng zhangyikui

3 huangxi1 huangxi2 huangxi3

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2 hanyueli guofei

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4 ligang zhangyi wangjianrong weijianguo

1 wangjianrong

2 liyoumeng zhangyikui 1 chenjinyan

2 liyoumeng zhangyikui

1 ligang 1 lichun 1 qupengyu 1 weijianguo 1 lisen 1 zhangyaping 1 zhangyaping 1 pangang

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maths 105 210 303 222

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gaoshu 2 lisan 2 xiandai 1 gailv 2

gaoshu lisan

gaoshu gailv

english 50 48 60 100

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read1 1 read2 1 say1 1 say2 1 listen1 1 listen2 1

read1 read2 say1 say2 listen1 listen2

software 105 180 220 260

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shuluo 1 c 2 c# 1 java 1 jiyuan 2 structure 2 picture 1 network 1 caozuoxitong 1 algorithm 1 database 1 web 1 android 1

shuluo jiyuan

c jiyuan

c structure

c# picture

java picture

java network

jiyuan caozuoxitong

structure algorithm

picture database

network database

network web

network android

no

no

no

/\* The 0th day:

the 0th lesson:

ligang-software2016-A106-caozuoxitong

weijianguo-software2015-A102-picture

wangjianrong-software2014-A205-shuluo

huangxi2-english2015-A201-read2

huangxi1-english2014-A105-read1

xiandait-maths2014-A101-xiandai

the 1th lesson:

the 2th lesson:

the 3th lesson:

the 4th lesson:

The 1th day:

the 0th lesson:

qupengyu-software2016-A106-algorithm

zhangyaping-software2015-A102-network

liyoumeng-software2014-A201-c#

huangxi2-english2015-A105-say2

huangxi1-english2014-A101-say1

the 1th lesson:

the 2th lesson:

the 3th lesson:

the 4th lesson:

The 2th day:

the 0th lesson:

lisen-software2016-A102-database

chenjinyan-software2014-A201-java

huangxi2-english2015-A105-listen2

huangxi1-english2014-A101-listen1

the 1th lesson:

the 2th lesson:

the 3th lesson:

lichun-software2015-A106-structure

gailvt-maths2015-A102-gailv

the 4th lesson:

liyoumeng-software2015-A106-jiyuan

ligang-software2014-A105-c

liao-maths2015-A102-lisan

hanyueli-maths2014-A101-gaoshu

The 3th day:

the 0th lesson:

zhangyaping-software2016-A102-web

the 1th lesson:

the 2th lesson:

the 3th lesson:

the 4th lesson:

The 4th day:

the 0th lesson:

pangang-software2016-A102-android

the 1th lesson:

the 2th lesson:

the 3th lesson:

lichun-software2015-A106-structure

gailvt-maths2015-A102-gailv

the 4th lesson:

liyoumeng-software2015-A106-jiyuan

ligang-software2014-A105-c

liao-maths2015-A102-lisan

hanyueli-maths2014-A101-gaoshu

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A101 0

A102 1

A103 2

A104 2

A105 0

A106 1

A107 2

A108 2

A109 1

A110 2

A201 0

A202 1

A203 2

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A205 0

A206 1

A207 2

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shuluo jiyuan

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**liyoumeng 1 4 4**

no

**A105 1 4 4**

no

**maths2014 1 4 4**

no

/\*测试getConstraint()

The 0th day:

the 0th lesson:

ligang-software2016-A106-caozuoxitong

weijianguo-software2015-A102-picture

wangjianrong-software2014-A205-shuluo

huangxi2-english2015-A201-read2

huangxi1-english2014-A105-read1

xiandait-maths2014-A101-xiandai

the 1th lesson:

the 2th lesson:

the 3th lesson:

the 4th lesson:

The 1th day:

the 0th lesson:

qupengyu-software2016-A106-algorithm

zhangyaping-software2015-A102-network

liyoumeng-software2014-A201-c#

huangxi2-english2015-A105-say2

huangxi1-english2014-A101-say1

the 1th lesson:

the 2th lesson:

the 3th lesson:

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The 2th day:

the 0th lesson:

lisen-software2016-A102-database

chenjinyan-software2014-A201-java

huangxi2-english2015-A105-listen2

huangxi1-english2014-A101-listen1

the 1th lesson:

the 2th lesson:

the 3th lesson:

lichun-software2015-A106-structure

gailvt-maths2015-A102-gailv

the 4th lesson:

liyoumeng-software2015-A106-jiyuan

ligang-software2014-A105-c

liao-maths2015-A102-lisan

hanyueli-maths2014-A101-gaoshu

The 3th day:

the 0th lesson:

zhangyaping-software2016-A102-web

the 1th lesson:

the 2th lesson:

the 3th lesson:

the 4th lesson:

The 4th day:

the 0th lesson:

pangang-software2016-A102-android

the 1th lesson:

the 2th lesson:

the 3th lesson:

liyoumeng-software2015-A106-jiyuan

gailvt-maths2015-A102-gailv

hanyueli-maths2014-A101-gaoshu

the 4th lesson:

lichun-software2015-A106-structure

ligang-software2014-A101-c

liao-maths2015-A102-lisan\*/

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**java jiyuan**

**jiyuan structure**

//the plan of software has some problem

有长度超过4的链，4年内上不完

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A210 2

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**c java**

**java c**

//the plan of sofaware has some problem

有环，无法拓扑排序

第四组

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gaoshu 2 lisan 2 xiandai 1 gailv 2

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english 50 48 60 100

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shuluo 1 c 2 c# 1 java 1 jiyuan 2 structure 2 picture 1 network 1 caozuoxitong 1 algorithm 1 database 1 web 1 android 1

shuluo jiyuan

c jiyuan

c structure

c# picture

java picture

java network

jiyuan caozuoxitong

structure algorithm

picture database

network database

network web

network android

no

no

no

//such table doesn't exist.，房间不够多