

# Class Enrollment Mechanism Design

Mechanism Design and Applied Math

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1. Mechanism Design Algorithms
2. SKKU class enrollment system analysis
3. Suggestion for NEW mechanism design

# Mechanism Design Algorithms

- DA(Deferred Acceptance) Algorithm
- SD(Serial Dictatorship) Algorithm
- RSD(Random Serial Dictatorship) Algorithm
- TTC(Top Trading and Cycle) Algorithm

## What is DA?

DA algorithm is a stable matching algorithm in which one side proposes their preferred options, and the other side holds onto the best offer until all proposals are received before making a final decision.

## Examples

### **Proposing system**

There are 3 men and women. Each man and woman have their own preference.

Choose one group and that group member will propose to another group according to their preference.

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There are 3 men and women. Each man and woman have their own preference.

Choose one group and that group member will propose to another group according to their preference.

## Questions

Could you find any stable matches?

## What is SD?

An allocation algorithm where a single individual, the "dictator," makes choices first, and subsequent individuals make choices from the remaining options in a predetermined order.

## Examples

There are 3 people - A, B, C.

There are 3 gifts - D, E, F

Each person has preference for each gift.

They will choose their most preferred gifts 'available' with given order.

## Questions

Could you find the consequence of this algorithm?

## What is RSD?

A variation of serial dictatorship where the order of choice is determined by a random lottery, making it a fair mechanism for allocating goods or positions.

## Examples

There are 3 people - A, B, C.

There are 3 gifts - D, E, F

Each person has preference for each gift.

They will choose their most preferred gifts 'available' with given order.

BUT the order is determined randomly.

## What is TTC?

An algorithm for reallocating indivisible goods by having individuals point to their most preferred good, forming cycles of trades that are then executed simultaneously.

# TTC Algorithm

## Examples

There are 3 people - A, B, C, and also are 3 gifts - D, E, F.

They already got some gift randomly.

However, each person has preference for each gift.

So they can make trading cycle each other.

## Questions

Could you find the consequence of this algorithm?

- **GRADE**
  - 1st grade: First come, First served
  - 2nd-4th grade: Pre-registration and First Come, First Served
- **Course**
  - Major, General Education: on the same day

## Algorithms Guess

Serial Dictatorship, Random Serial Dictatorship

**What if TTC or DA is applied?**

# Applying DA

Let us apply DA algorithms to the SKKU course registration system.

Professors' preference standard: GPA, Major, Grade etc

## Students DA

In this system, students will propose according to their preference.

Each professor will accept students' proposal by considering their own standard.

Repeat this process until all available course slots are filled.

## Professor DA

In this system, professor will propose to students by considering their own standard.

Also, student can accept or not according to their preference.

Repeat this process until all available course slots are filled.

# Applying TTC

Let us apply TTC algorithms to the SKKU course registration system.

## TTC

In this system, students who are already enrolled in a course can trade their seats.

Each student points to their most preferred course that is currently held by another student.

This creates trading cycles, where students in a cycle swap their courses simultaneously.

The process is repeated until no more mutually beneficial trades can be made.

## Limitation

### **Random Assignment for All Courses**

When all courses are assigned randomly: This can lead to low trading efficiency because a student's major is not taken into consideration.

### **Random Assignment for Major-Specific Courses**

When major-specific courses are assigned randomly: This could result in students being assigned to courses they have already taken or lack the necessary prerequisites for.

# Applying TTC

Let's directly experience the limitations of TTC!

Especially for four students! **EXCLUSIVE EXPERIENCE!**

## COURSE

|      |        |          |        |
|------|--------|----------|--------|
| 해석학2 | 집합론    | 선형대수2    | 미분기하학2 |
| 확률론  | 현대대수학2 | 위상수학2    | 복소해석학2 |
| 해석학1 | 선형대수1  | 자연과학과인문학 | 고급금융수학 |

# New algorithm for SKKU

Standard of the new algorithm for SKKU course registration

- Each student should be guaranteed to get at least one course they want.
- The course registration results should not be determined by factors like internet speed or clicking skills.

# The Token Auction System

By using **token auction**, students will be guaranteed fairness.

## Rule

Students will have 20 tokens and can distribute these tokens across the available course to indicate their preference (Maximum course is 6).

Tokens must be distributed as positive integers between 0 and 20.

The total number of tokens used must not exceed 20.

Submitting fewer than 5 tokens is also allowed.

# The Token Auction System

What should students do if they **fail** to win an auction or if they need to enroll additional courses after the first auction?

In this case, another class auction could be held for the remaining courses.

## Auction

With each new round of the token auction, the number of courses a student can bid on is reduced by one, and their token count decreases by 10.

Token auction rounds are conducted until 3rd round.

After this 3rd round, any remaining courses can be added or swapped on a first-come, first-served system.

**Thank You! Feel free to ask questions!**