Day 1
Discrete maths:
The first chapter

Lecturer: Msc. Le Minh Tan

Introduction

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So what’s the plan?

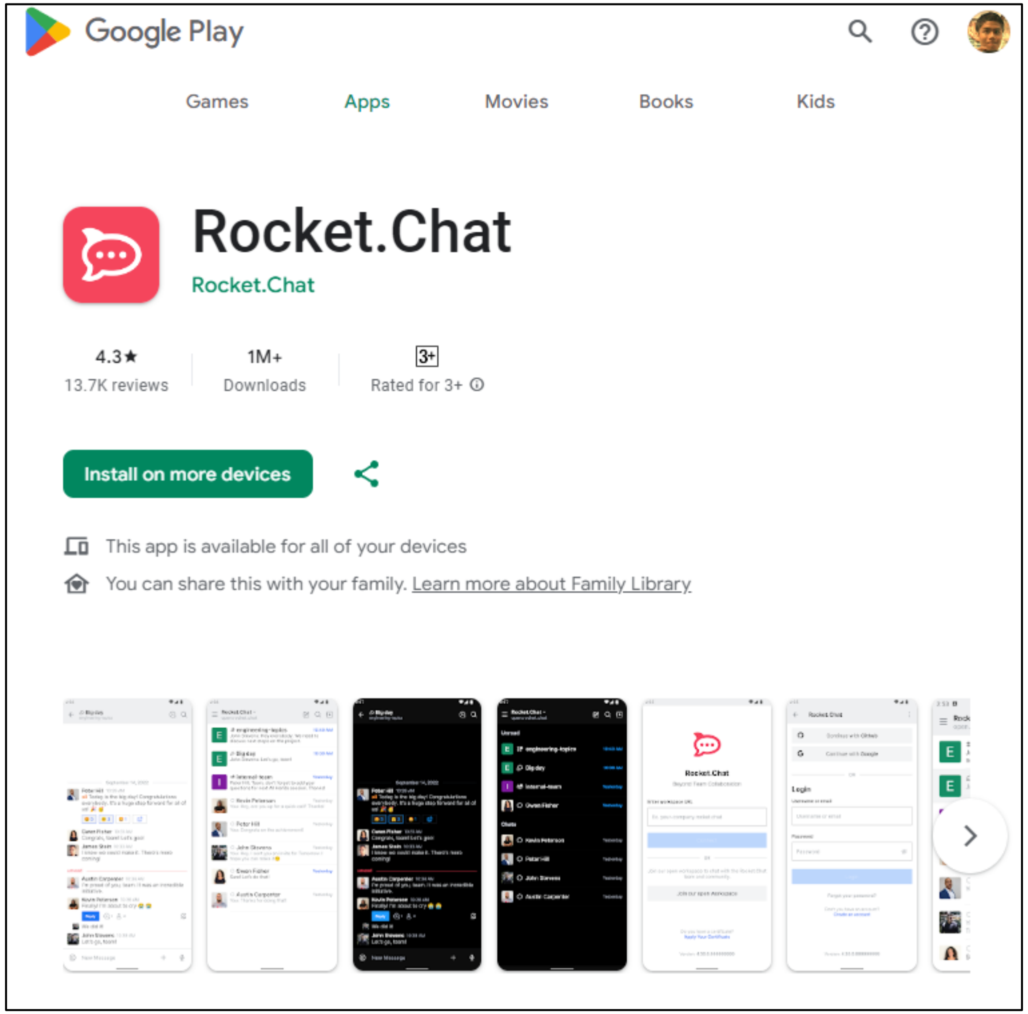
- Progress score: Weekly homework + 2 tests (each x2)
- Final score: Exam
- Preparation: Laptop (**VS C++, Python >= 3.10**), e. socket
- Please check out the **subject curriculum on UTEx**.

Textbooks

- Nguyễn Hữu Anh "Toán rời rạc“
- Đặng Trường Sơn & Lê Văn Vinh et al. “Giáo trình lý thuyết đồ thị”
- Nguyễn Thành Sơn & Đặng Trường Sơn et al. “Giáo trình toán rời rạc và lý thuyết đồ thị”
- Kenneth H. Rosen & Kamala Krithivasan “Discrete Mathematics and Its Applications“
- Adrian Bondy & U.S.R. Murty "Graph theory“

How we work

- By chatting platform:
  - **Website**: https://chat.cntt.io
  - **Android/iOS**: Rocket.Chat
  - **Desktop**: https://github.com/RocketChat/Rocket.Chat.Electron/releases



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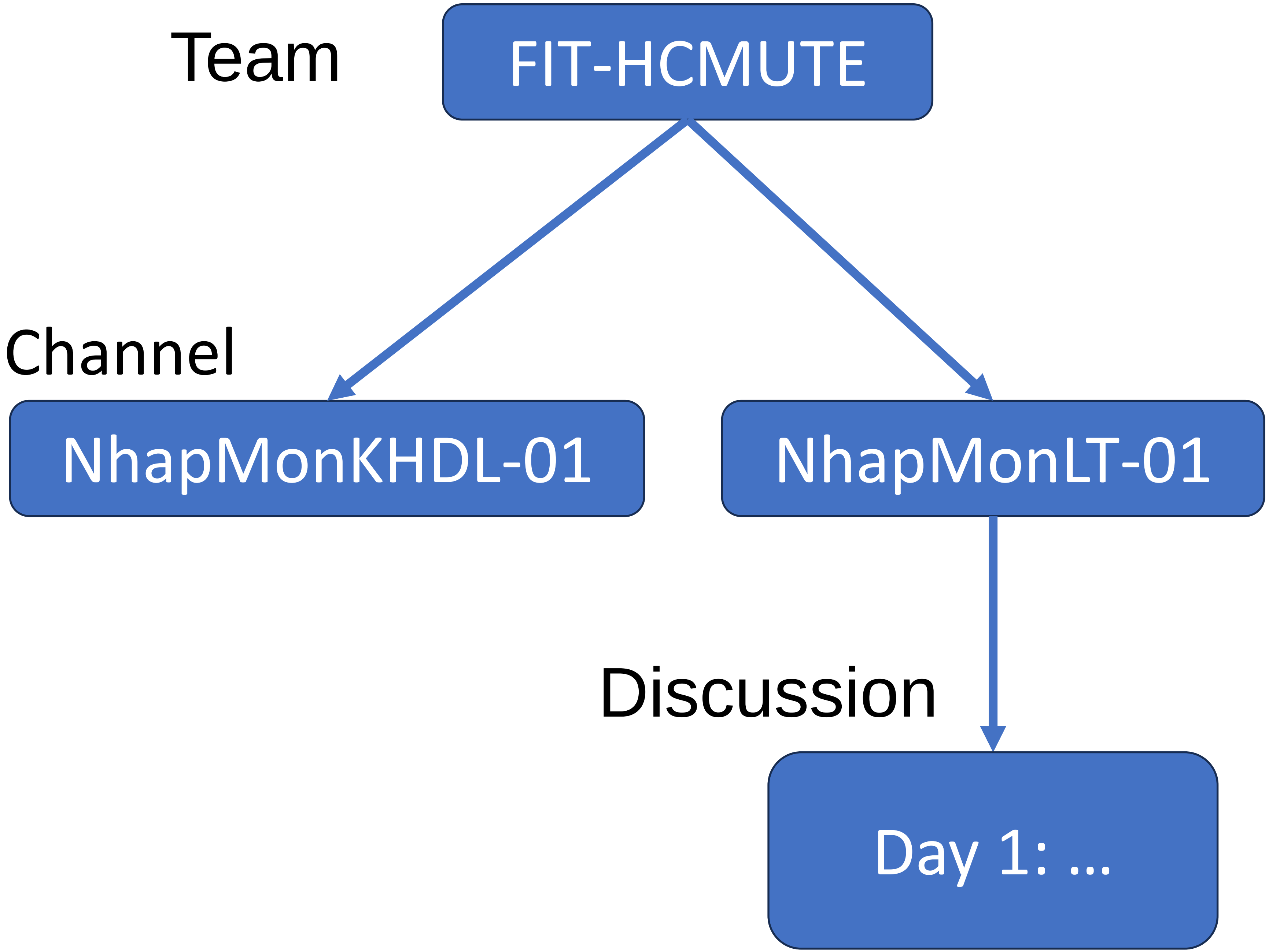

Team
FIT-HCMUTE
Channel
NhapMonKHDL-01
NhapMonLT-01
Discussion
Day 1: ...

You all need a group!

- Yes, each needs to be in a group for some activities.
- Steps:
  1. Gather 2-3 members.
  2. Vote for a leader.
  3. Post the list of members (ids + full names), leader id to FB group.
- Rules:
  1. No multiple groups per student.
  2. The smaller size, the better.
  3. Deadline: Before class ends.
  4. Those with no group need to contact me in one week.


GUY WHO DOES MOST OF THE WORK IN THE GROUP PROJECT
ME TRYING TO LOOK USEFUL

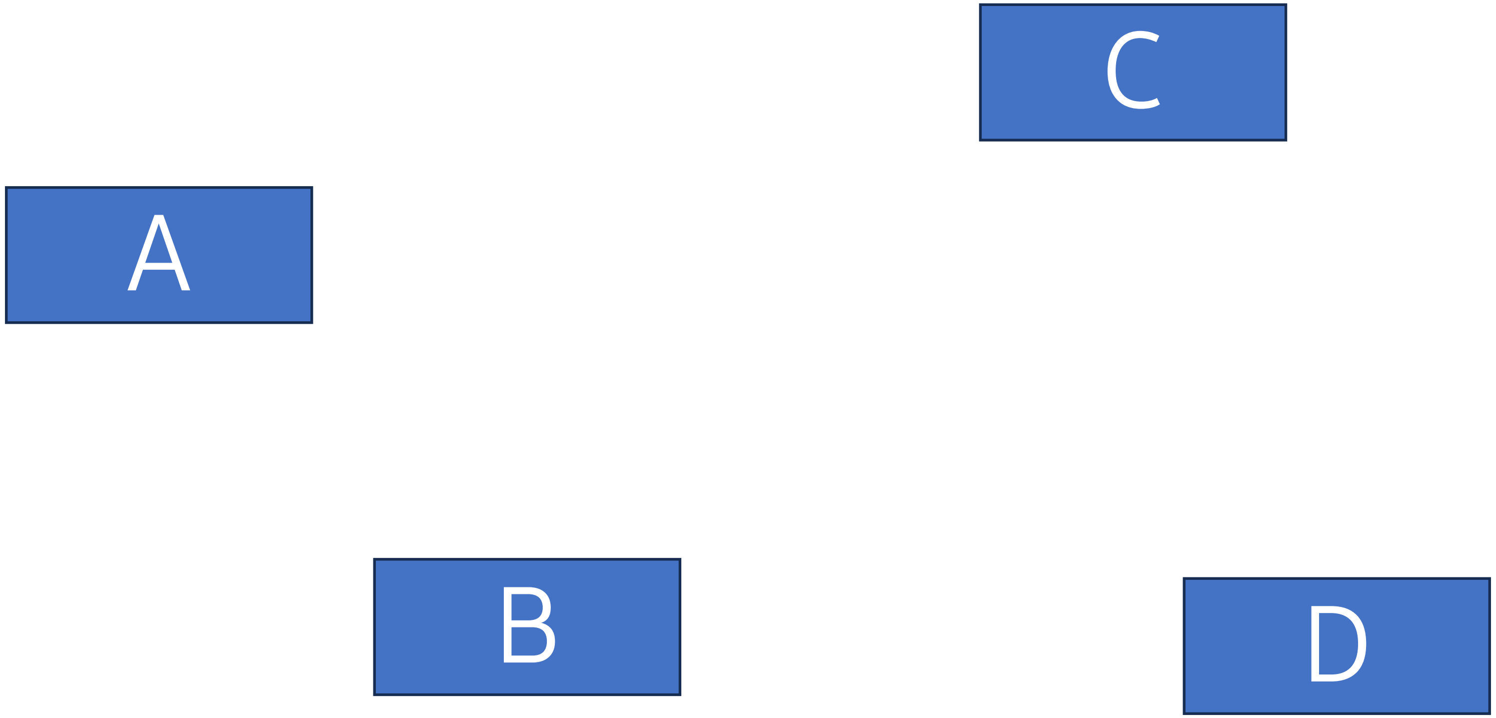
Outline

I. Discrete mathematics
II. Propositional logic: Concepts
III. Logical equivalences and rules of inference

I. Discrete mathematics

A	B	C	D

A	B
C	D



Discrete objects

Discrete maths problems

1. How many ways are there to choose a valid password on a computer system?
2. What is the probability of winning a lottery?
3. Is there a link between two computers in a network?
4. How can I identify spam e-mail messages?

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Kenneth H. Rosen & Kamala Krithivasan "Discrete Mathematics and Its Applications"

Discrete maths problems

1. How many ways are there to choose a valid password on a computer system? **Quantity**
2. What is the probability of winning a lottery? **Events**
3. Is there a link between two computers in a network? **Yes/No**
4. How can I identify spam e-mail messages? **Spam/Not spam**

Discrete mathematics is used when ever <u>objects are counted</u>, when <u>relationships between finite (or countable) sets</u> are studied, and when <u>processes involving a finite number of steps</u> are analyzed.

II. Propositional logic: Concepts

- A **proposition** is a declarative sentence (that is, a sentence that **declares a fact**) that is either **true or false, but not both**.
- Some easy examples:
  - Joe Biden is the president of the United States. ✓
  - $1 + 1 = 2$ ✓
  - What time is it? ✗
  - Read this carefully. ✗
  - $x + 1 = 2$ ✗

- *“In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the two other sides“*
- *“If $a > c$ then $a + b > c$”*
- *“Every even integer greater than 2 can be written as the sum of two primes”*

1. What are the above statements about?
2. Can you prove them?
3. Is conjecture a proposition?

In discrete maths, we don't work with sentences, but variables and symbols:

Order	Symbol	Feature	Expression
1	$\neg, -$	NOT (Negation)	$\neg p, \bar{p}$
2	$\wedge$	AND/but	$p \wedge q$
3	$\vee$	OR (inclusive or)	$p \vee q$
4	$\oplus, \underline{\vee}$	XOR (exclusive or)	$p \oplus q$
5	$\rightarrow$	Conditional statement/implication	$p \rightarrow q$
6	$\leftrightarrow$	Biconditional statement/bi-implication	$p \leftrightarrow q$
	$\equiv, \Leftrightarrow$	Equivalence	$p \equiv q$

Compound propositions

- Let p, q, r, s are the following propositions:
  - *I'm sick.*
  - *I finished my homework.*
  - *I am going to stay home.*
  - *I will attend today's class.*

1. How can you express these in sentence?
   - $\neg p$
   - $p \wedge q$
   - $q \rightarrow r$
2. Is there anything illogical?

- A proposition always has a true value: True or false.
- Truth table helps determine the truth of compound propositions.

p	q	$\neg q$	$p \wedge q$
T	T	F	T
T	F	T	F
F	T	F	F
F	F	T	F

- 1/0 can also be interpreted as T/F.
- True table can be useful as a proof.

Exercise: Proving the below equivalence is always true

$$p \oplus q \equiv (p \vee q) \wedge \neg(p \wedge q)$$

Tips: A truth table could help.

*Exercise: Proving the below **equivalence** is always true*

$$p \oplus q \equiv (p \vee q) \wedge \neg(p \wedge q)$$

Tips: A truth table could help.

$\boldsymbol{p}$	$\boldsymbol{q}$	$\boldsymbol{p \oplus q}$	$\boldsymbol{r := p \vee q}$	$\boldsymbol{s := p \wedge q}$	$\boldsymbol{r \wedge \neg s}$
1	0	1	1	0	1
0	1	1	1	0	1
0	0	0	0	0	0
1	1	0	1	1	0

III. Logical equivalences and rules of inference

No.	Law	Expression
1	Double negation	$\neg\neg p \equiv p$
2	De Morgan	$\neg(p \land q) \equiv \neg p \lor \neg q$ $\neg(p \lor q) \equiv \neg p \land \neg q$
3	Commutative	$p \land q \equiv q \land p$ $p \lor q \equiv q \lor p$
4	Associative	$p \land (q \land r) \equiv (p \land q) \land r$ $p \lor (q \lor r) \equiv (p \lor q) \lor r$
5	Distributive	$p \land (q \lor r) \equiv (p \land q) \lor (p \land r)$ $p \lor (q \land r) \equiv (p \lor q) \land (p \lor r)$

No.	Law	Expression
6	Idempotent	$\neg\neg p \equiv p$
7	Identity	$p \land 1 \equiv p$ $p \lor 0 \equiv p$
8	Negation	$p \land \neg p \equiv 0$ $p \lor \neg p \equiv 1$
9	Domination	$p \land 0 \equiv 0$ $p \lor 1 \equiv 1$
10	Absorption	$p \land (p \lor q) \equiv p$ $p \lor (p \land q) \equiv p$

- End of logical equivalences -

No.	Law	Expression
1	Substitution	$p \to q \equiv \neg p \vee q$
2	Modus Ponens	$(p \wedge (p \to q)) \to q$
3	Modus Tollens	$(\neg q \wedge (p \to q)) \to \neg p$
4	Hypothetical syllogism	$\big((p \to q) \wedge (q \to r)\big) \to (p \to r)$
5	Disjuctive syllogism	$\big((p \vee q) \wedge \neg p\big) \to q$
6	Addition	$p \to (p \vee q)$
7	Simplification	$(p \wedge q) \to p$
8	Resolution	$\big((p \vee q) \wedge (\neg p \vee r)\big) \to (q \vee r)$
9	Contradictory	$[(p_1 \wedge p_2 \wedge \cdots \wedge p_n) \to q] \equiv [(p_1 \wedge p_2 \wedge \cdots p_n \wedge \neg q) \to 0]$
10	Conditionally proving	$((p \to r) \wedge (q \to r)) \to ((p \vee q) \to r)$

- rules of inference -

Bài tập tại lớp

Xác định suy diễn sau là đúng hay sai:

- Nếu Toàn tới lớp kịp lúc, bạn ấy sẽ không bị đánh vắng.
- Nếu Toàn tới lớp kịp lúc, bạn ấy sẽ hiểu bài hơn.
- Vậy, nếu Toàn tới lớp kịp lúc, bạn ấy sẽ không bị đánh vắng và sẽ hiểu bài hơn.

P	Q	$P \rightarrow Q$
0	0	1
0	1	1
1	0	0
1	1	1

P	Q	$P \leftrightarrow Q$
0	0	1
0	1	0
1	0	0
1	1	1

Homework

- Homework: 27, 28, 29, 30, 31/80 (2pts each)
- Work in group
- Deadline: 1 week
- **At least one student per group** must submit a docx file containing the answers. Copying from other group is strictly prohibited.