

A1: Mathematical Modeling

Today

- Discuss what, why, and when?
- Observe the **logic-structure** connection at the heart of mathematical modeling
- Discuss more examples of logic-structure connections
- Take-home exercises

Module A: Informal, i.e., no math symbols

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Section 1

What, Why, and When?

- Barbie dolls
- El Farol problem

The Irishmen in the area (say, 100 of them) like to go to the local pub when Irish music is played (Thursday evenings) only if the pub is not crowded (say, up to 60 people). How could they predict the pub is not crowded?

- Weather
- Drug trafficking

What is important?

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Good Modeling

- **Precise**
 - No room for different interpretations
- **Correct (accurate)**
 - Describes the *intended* object/phenomenon
 - Excludes *unintended ones*
- **Concise**
 - Not including unnecessary information

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Section Summary

- Real-world problem
 - ⇒ Computational problem
 - Mathematical Modeling**
- Quality
 - Precision, Correctness, Conciseness
- Behind mathematical modeling
 - Logic-structure connection [next]

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Section 2

Barbie Dolls

- Two dolls: **Doll1** and **Doll2**
- Five shirts: **Shirt1** through **Shirt5**
- Four pairs of pants: **Pants1** through **Pants4**
- **Doll1** wears **Shirt1** and **Pants4**, etc.
- There are many possible names: **Ken**, **Naomi**, etc.
- **Doll1** is called **Naomi**, and **Doll2**, **Ken**.

Precise, Correct, Concise?

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Conditions

- Every doll must wear a shirt and a pair of pants.
- (what else?)

Group Task

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Logic and Structure

- Information about essential components of the object/phenomenon \Rightarrow Organized as a “**structure**” of involved components
- Conditions on a structure \Rightarrow Expressed as “logical statements” or simply, “**logic**”
- Logic **specifies** a structure.

Logic-structure connection one-to-one?
Examples or counter-examples?

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Warning

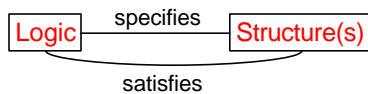
- There are many ways to say the same thing (a single structure may be specified by multiple sets of logical statements).
 - Exactly one \Leftrightarrow (at least one & at most one)
- A statement can mean multiple things (a single set of logical statements may specify multiple structures).
 - “Every doll has exactly one name.” \Rightarrow Can still be satisfied if there is no dolls.

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Section Summary

- Structure ~ Information about components and their connections
- Logic ~ Logical conditions on structure(s)



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Section 3

Other Problems

- El Farol problem
The Irishmen in the area (100 of them) like to go to the local pub when Irish music is played (Thursday evenings) only if the pub is not crowded (up to 60 people). How could they predict the pub is not crowded?
- Weather
- Drug trafficking

Structures?
Logical conditions?

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North Pole

1. Reindeer are not Santa Claus.
2. Reindeer must carry someone/something.
3. Santa Claus must be carried by reindeer.
4. Reindeer exists.

Group Task: Describe an example of North Pole consistent with these conditions?

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Dance

[Exam C, Spring 2003]

- Two basic steps of Tango: **Basico** and **Sentada**.
- **Rules**
 1. The dance must begin with **Basico**.
 2. The dance must end with **Sentada**.
 3. **Basico** can be used at any point and can be repeated as many times you want after itself
 4. **Sentada** cannot be repeated after itself.

A general mechanism to describe rules like this?

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Constraint-Satisfaction Problems

- Find a solution (structure) that would satisfy a set of constraints (logic)
 - Games/puzzles of all sorts
 - Scheduling problems
 - Traveling salesperson problem
 - Analog circuit analysis/synthesis
 - Option trading analysis
 - DNA sequencing

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Section Summary

- Logic-structure connection
 - Can be used to represent objects/phenomena in a precise manner
 - Can be found everywhere (even though you may not notice it)
 - Many aspects of this will be explored through the semester.
 - Theme of the mini project (new to this semester)

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Summary Exercise

Not graded; write at the end of your exercise

- Identify the most important point of today's lecture in a single sentence.
- List points that were difficult/confusing to understand, if any.
- Are you convinced that discrete math is useful? Why or why not?

Please bring scratch paper

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