Dependence Logic

September 3, 2019

Course Practicalities

Structure of the course:

- Lectures on Tuesday & Thursday, exercise class on Friday.
- 7 weeks lectures + 1 week break + 7 weeks lectures + exam
- Exam: Dec. 17 (Tue), or Dec. 19 (Thu), at 13:00 - 16:00
  (will decide later)

Evaluation:

- 70% of final grade: exam
- 30% of final grade: performance in exercise classes

Instructors:

Lectures:

- Fan Yang, fan.yang@helsinki.fi
- Miika Hannula, miika.hannula@helsinki.fi

Exercise classes:

- Davide Quadrellaro, davide.quadrellaro@gmail.com

Materials

- *Dependence Logic: A New Approach to Independence Friendly Logic*, J. Väänänen, Cambridge University Press (2007)
- Lecture notes (available on course webpage, will upload a new version every week)
- A website on the research in dependence logic: https://sites.google.com/site/dependencelogic/

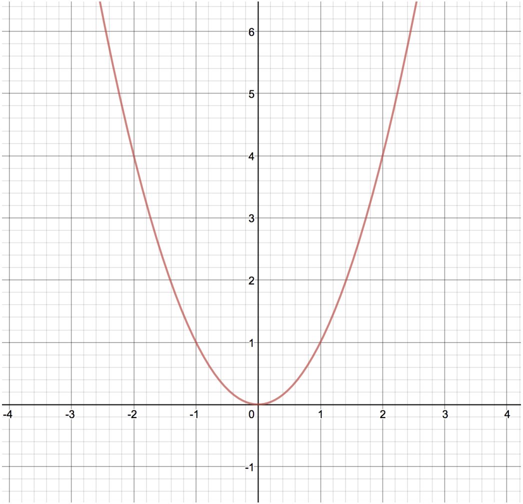
Prerequisites: first-order logic (e.g., Johdatus logiikkaan II, mathematical logic)

Dependence Logic

first-order logic + atomic formulas characterizing dependency notions (through team semantics)

Dependence and independence

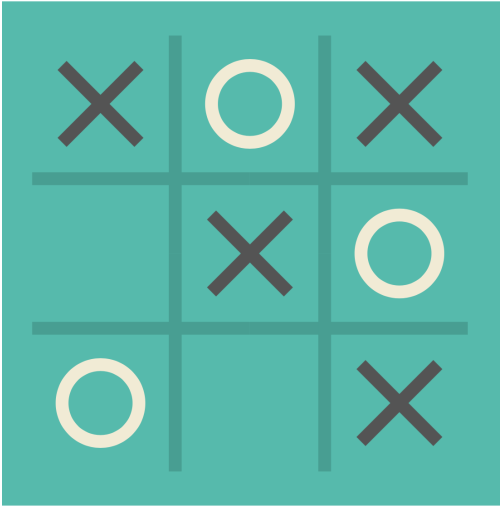
Example 1: function $y = f(x) = x^2$



The value of y is determined by the value of x (usually not the other way around).

Dependence and independence

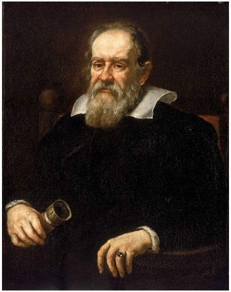
Example 2: Tic-tac-toe game



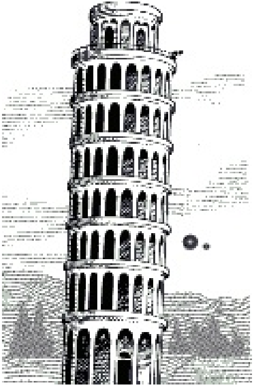
Both players' moves depend on the previous moves.

Dependence and independence

Example 3: In 1589 Galileo dropped two balls of different masses from the Leaning Tower of Pisa to demonstrate that their time of descent was independent of their mass.



Galileo Galilei



Dependence and independence

Example 4: Variable dependence in first-order logic

$$\forall u \, \exists v \, \forall x \, \exists y \, \phi$$

Dependence and independence

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$$\forall u\, \exists v\, \forall x\, \exists y\, \phi$$

$\forall u\, \exists v\, \forall x \exists y (\phi \wedge {=}(x, y))$

Dependence and independence

Example 4: Variable dependence in first-order logic

$$\forall u\, \exists v\, \forall x\, \exists y\, \phi$$

$\forall u\, \exists v\, \forall x \exists y (\phi \wedge =\!(x, y))$

$\exists f$

Dependence Logic

Dependence Logic: first-order logic + atomic formulas characterizing dependency notions
(through team semantics)

(Potential) applications in mathematics, game theory, database theory, (quantum) physics, statistics, social choice theory, linguistics, etc.