

# CS172: COMPUTER SYSTEMS II

## Lecture 1

# Introduction

James Power



# CS172 Overview

- Module: CS172 “Computer Systems 2” (7.5 credits)
- Lecturer:
  - **Kevin Casey** <kevin.casey@mu.ie>
  - Department of Computer Science

# CS172 Structure

- Lectures:

Three lectures a week:

- Tue @ 12.00
- Thu @ 09.00 (Starts week 2)
- Fri @ 14.00

- Lab & Tutorial:

- Tutorial: One 1-hour tutorial per week
- Lab: One 1-hour lab per week

- Two *streams*: theory and practice

- Tutorials start in week 2 (i.e. Monday 11th Feb)

Labs start in week 3(i.e. Monday 18th Feb)

# CS172 Topics

What is CS172 about?

# CS172 Topics

What is CS172 about?

- It's about developing a *language* to talk about computational structures
  - we want to be able to *reason* about them and *deduce* things about them.
- We could use:
  - A *natural* language: powerful enough, but too vague
  - A *programming* language: precise enough, but too detailed

# CS172 Topics

What is CS172 about?

- It's about developing a *language* to talk about computational structures
  - we want to be able to *reason* about them and *deduce* things about them.
- We could use:
  - A *natural* language: powerful enough, but too vague
  - A *programming* language: precise enough, but too detailed
- Instead we use: **Logic**
  - a *family* of languages that are as precise and as detailed as we want.

# CS172 Textbook

## *Logic in Action*

by Johan van Benthem, Hans van Ditmarsch,  
Jan van Eijck, Jan Jaspars,

[www.logicinaction.org](http://www.logicinaction.org)

November 23, 2016.



Slides &  
Tutorials

# Parts of the *Logic in Action* textbook we'll cover

## **Classical Systems**

- ✓ 2 Propositional Logic
- ✓ 3 Syllogistic Reasoning
- ✓ 4 Reasoning About Predicates and Classes

## **Knowledge, Action, Interaction**

- 5 Logic, Information and Knowledge
- 6 Logic and Action
- 7 Logic, Games and Interaction

## **Methods**

- ✓ 8 Validity Testing (Tableau)
- ✓ 9 Proofs (Natural Deduction)
- ✓ 10 Computation (Resolution)

## **Appendices**

- ✓ A Sets, Relations and Functions



# CS172 Tutorials

- Each week there will be a **tutorial sheet** posted on Moodle.
- You can try these questions in your own time.
- The tutorial is a chance to ask questions or get help on the questions.

Tutorials start in week 2

# CS172 Marks

Your CS172 marks will be calculated based on:

- 75% for the end of semester exam
- 25% for continuous assessment
- This continuous assessment is broken down as:
  - three tests (@ 7% each)
  - attendance marks (4%)

# Some History...

# From geometry to algebra



René Descartes  
1596-1650

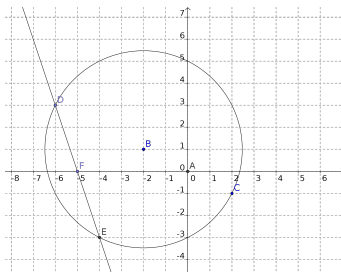
*La Géométrie*, 1637

# From geometry to algebra



René Descartes  
1596-1650

*La Géométrie*, 1637



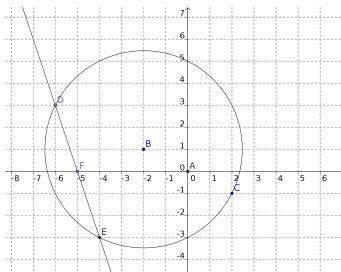
Find the length of the line segment  $DE$

# From geometry to algebra



René Descartes  
1596-1650

*La Géométrie*, 1637



Find the length of the line segment  $DE$

**Circle:** Center  $(-2, -1)$ , radius  $= \sqrt{20}$

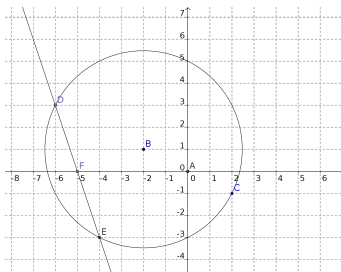
**Line:** through  $(-5, 0)$ , slope  $= -3$

# From geometry to algebra



René Descartes  
1596-1650

*La Géométrie*, 1637



Find the length of the line segment  $DE$

Circle:  $(x + 2)^2 + (y + 1)^2 = 20$

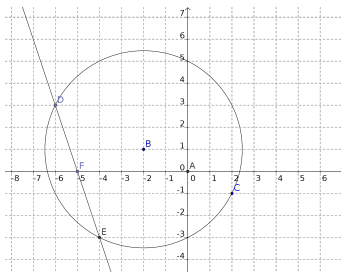
Line:  $3x + y = -15$

# From geometry to algebra



René Descartes  
1596-1650

*La Géométrie*, 1637



Find the length of the line segment  $DE$

Circle:  $(x + 2)^2 + (y + 1)^2 = 20$

Line:  $3x + y = -15$

Points:  $D = (-6, 3)$ ,  $E = (-4, -3)$

Distance:  $|DE| = \sqrt{(-6 - (-4))^2 + (3 - (-3))^2}$



# Calculating machines and binary numbers



Gottfried Leibniz  
1646-1716

# Calculating machines and binary numbers



Gottfried Leibniz  
1646-1716

- The *Step Reckoner* 1672  
machine to do addition, subtraction,  
multiplication and division

*[...] it is unworthy of excellent men to  
lose hours like slaves in the labour of  
calculation which could safely be  
relegated to anyone else if the machine  
were used.*

# Calculating machines and binary numbers



Gottfried Leibniz  
1646-1716

- *Explication de l'Arithmtique Binaire* 1703

*Explanation of the binary arithmetic,  
which uses only the characters 1 and  
0, with some remarks on its usefulness,  
and on the light it throws on the  
ancient Chinese figures of Fu Xi*

- Fu Xi is considered  
the originator of the *I Ching*

# Words for water

water

uisce

eau

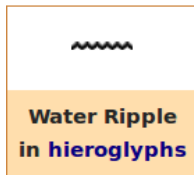
# Words for water

water



uisce

eau



# Words for water

water

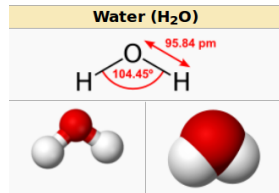
水

uisce

eau



**Water Ripple**  
in hieroglyphs



## ... and on to computation



Gottfried Leibniz  
1646-1716

## ... and on to computation



Gottfried Leibniz  
1646-1716

### Leibniz' Grand Programme:

- 1 An *encyclopedia* describing the topics in the full extent of human knowledge.
- 2 A *characteristica universalis*: symbols for the elements of human thought, a kind of universal concept language.
- 3 A *calculus ratiocinator*, a system for manipulating these symbols to implement rules of deduction.



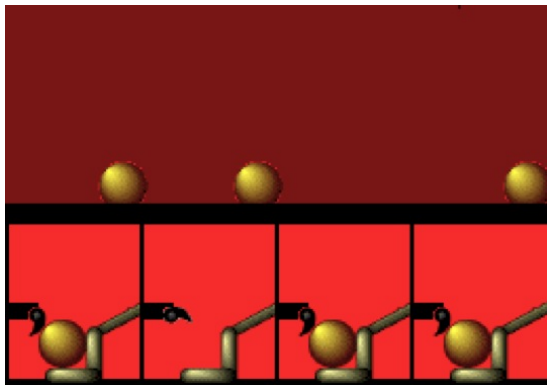
# Logic vs. computation

Uses of the *calculus ratiocinator*:

**Logic:** *The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: Let us calculate [**calculemus**], without further ado, to see who is right.*

**Computation:** *[...] it is unworthy of excellent men to lose hours like slaves in the labour of calculation which could safely be relegated to anyone else if the machine were used.*

# Leibniz' Mechanical Dyadica



See: <http://www.logicinaction.org/AUC/apps/java/leibniz>

# Phases in the development of Logic

Philosophical Logic 300 BC - 1850	Aristotle 384-322 BC Chrysippus 279-206 BC
Logic as Algebra 1850-1900	Augustus de Morgan 1806-1871 George Boole 1815-1864 John Venn 1834-1923
Foundations of Maths 1880-1930	Gottlob Frege 1848-1925 David Hilbert 1862-1943 Bertrand Russell 1872-1970
Computer Science 1930-	Kurt Gödel 1906-1978 Alonzo Church 1903-1995 Alan Turing 1912-1954