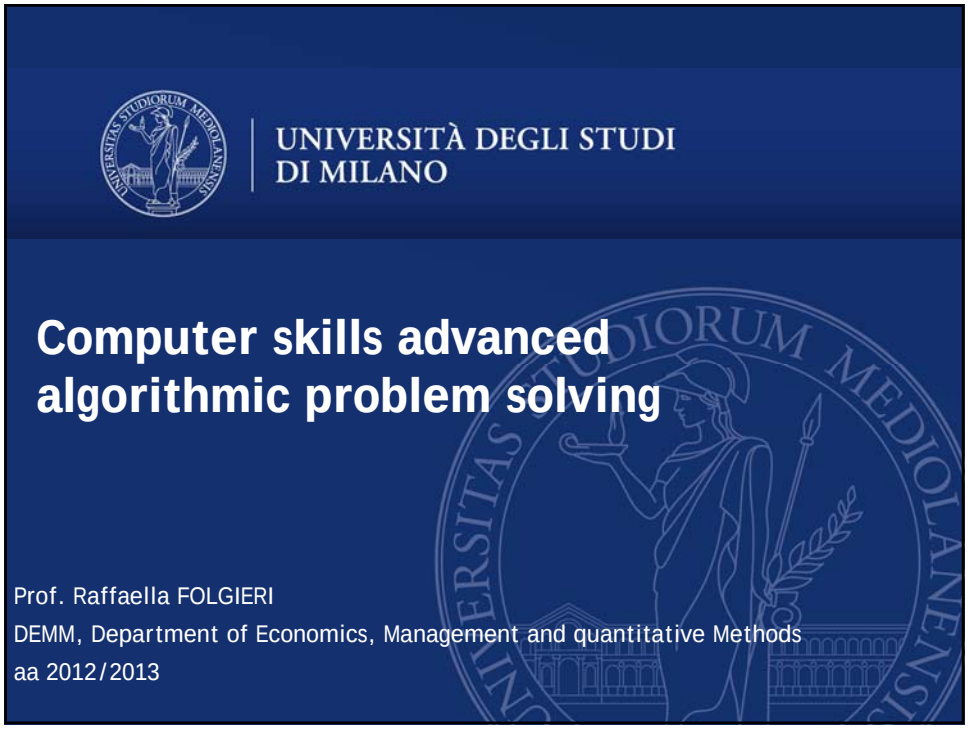
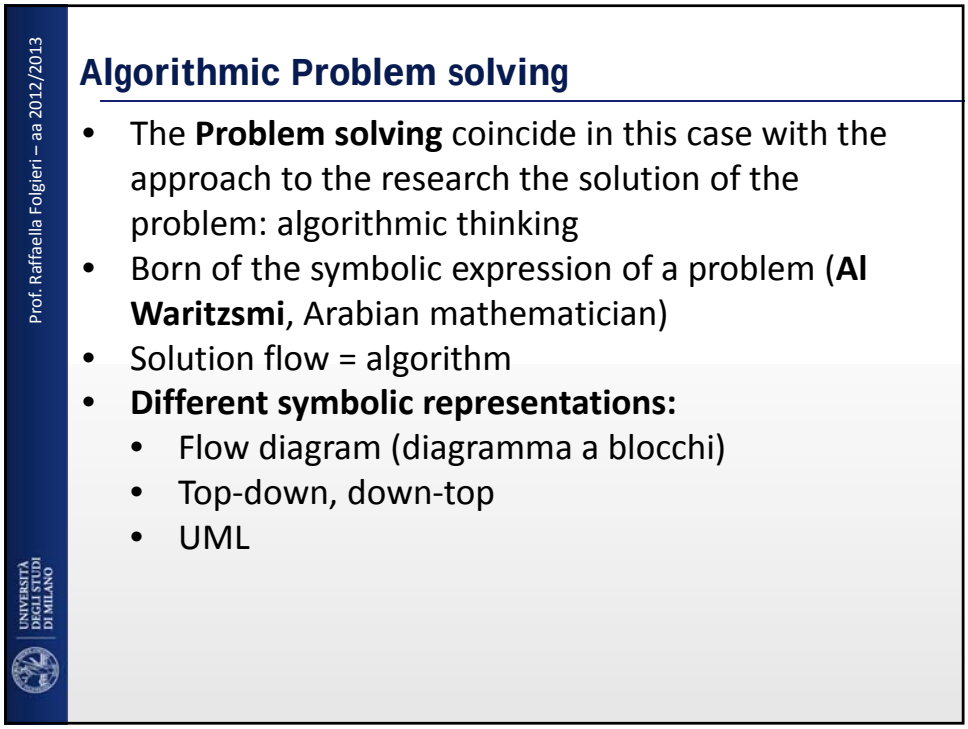

UNIVERSITÀ DEGLI STUDI
DI MILANO
Computer skills advanced
algorithmic problem solving
Prof. Raffaella FOLGIERI
DEMM, Department of Economics, Management and quantitative Methods
aa 2012/2013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Algorithmic Problem solving
• The **Problem solving** coincide in this case with the approach to the research the solution of the problem: algorithmic thinking
• Born of the symbolic expression of a problem (**Al Waritzsmi**, Arabian mathematician)
• Solution flow = algorithm
• **Different symbolic representations:**
• Flow diagram (diagramma a blocchi)
• Top-down, down-top
• UML

A metaphor

- **Also in this case it is important to specify clearly the requirements of the problem**
- **Telephone without threads**, a game played in the middle of '900 (when all the telephones had threads)
  - The game is simple. A queue or a circle of children.
  - The first child tells a sentence in the ear of the following child who do the same with the following one and so on. The last child in the queue must declare the sentence. Usually the last sentence is quite different from the first.
- The management of requirements works in a similar way. More the chain between the need and the solution is long, greater is the probability to misunderstand the requirements.
- It is important to formalize the problem to obtain
  - Consensus
  - Efficient communication
  - Correct translation of the problem into a solution algorithm
  - Validation of the result

Economic models

- Application of mathematics in economics
  - After the second world war
  - The **operational research (ricerca operativa)** assumed a specific physiognomy, as a special field of applied research. Some people from the R.A.F., English Royal Air Force, constituted a research group to study optimal systems for attack and defence – the so called "Blackett club" (*"Circolo Blackett")* from the name of the scientist directing it.
  - Today the operational research is used to solve organizational problems in many fields.

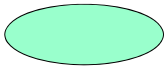
Formalization

- An **algorithm translates the formalization of a problem**
- Formalizing a problem means:
- Find a **symbolic representation**

A business process is the centre of the activities of a company… business logic

- We will see some simple symbolic representations (for general purposes, very used in IT and in business field)
  - **Flow diagram (Schema a blocchi)**
  - **Top-down, down-top** (natural language)

Flow diagram – blocks and instructions

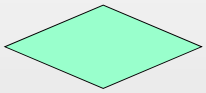


End or start

Flow control

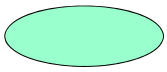
Process steps (instructions/commands)

Input/output



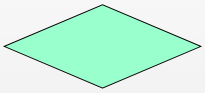
Decisions (control instructions)

Flow diagram - rules



No arrow enters in START and no arrow exit from the END

In each INSTRUCTION block can enter an arrow and exit an arrow



In each DECISION block enter an arrow and exit two arrows.

- Almost a path from START to END must exist

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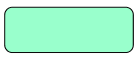
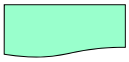
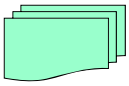
non-standard flow diagram



Alternative elaboration

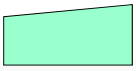
Document





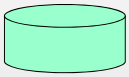
Multiple documents

Manual input



Manual operation

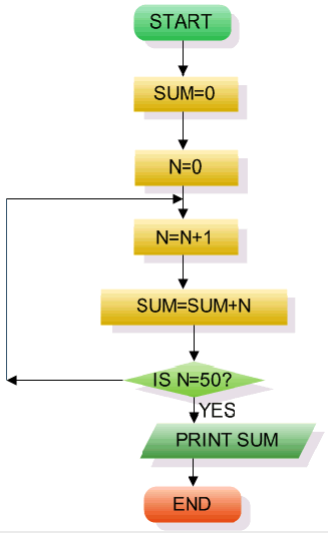
Saved data



Magnetic disk (data support/database)

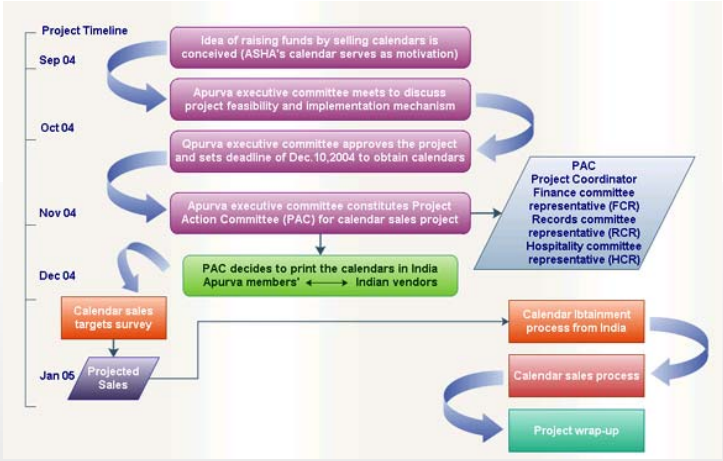
Flow diagram - example1

Sum of first n natural numbers



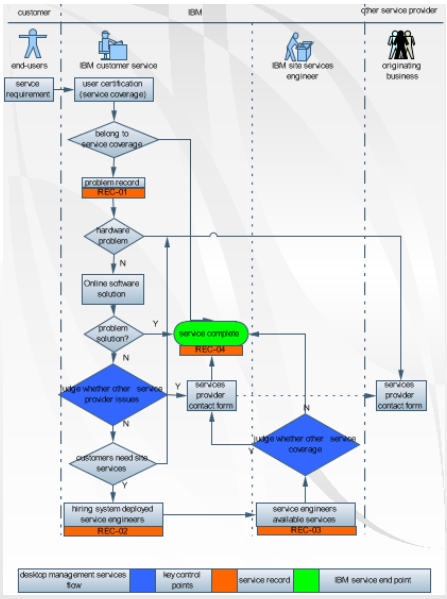
Flow diagram - example2

Variation with temporal indication



Flow diagram - example 3

- Schemata of a business service
- Users (use cases) have been added



Natural language

- The flow diagram (flowchart) is a simply way to scheme problems
- Another way (also used to analyse problems) is based on the use of natural language, describing the solution problem/process following the models:
  - **Top-down** (decomposing the main problem in simple sub-problems)
  - **Down-top** (starting from the bottom)

Do not confuse these terms with the financial ones:
Top down strategy. Investment strategy allowing to individuate sectors and industries from which we expect a good performance.
Bottom-up approach the investor concentrate own attention of a specific company instead of the sector in which the company operates or on the economy in its complex.

Tools to implement the methodologies

Some (not all):

- MS Visio
- Business Object (SAP)
- Various Case tool
- Many free softwares (search "flow diagram" or "business logic" on Internet)

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From theory to practice

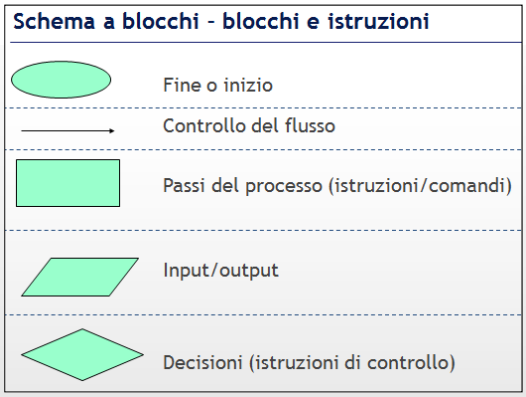
The PIL
(case study 6)

Case study 6

How to calculate the PIL

We can describe how to calculate the PIL with a block diagram, to identify the algorithm solving the problem of finding the process.

We will use the standard notation, following the symbols we have already seen.



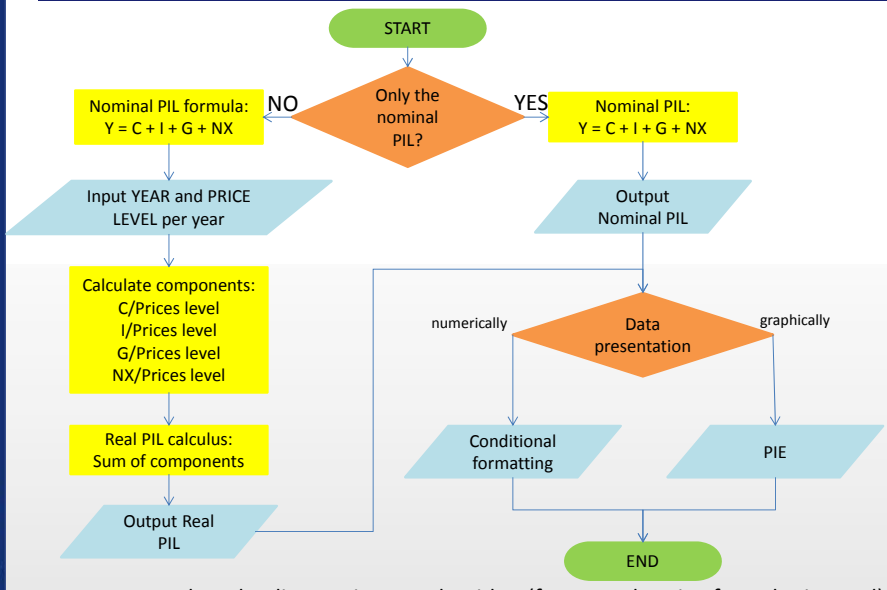
Case study 6

The PIL: theoretical summary

- We want to find the PIL in real terms, following the classic simplified model, where
  Y = C + I + G + NX
  where:
  - Y = PIL
  - C = consumptions
  - I = private investments
  - G = public expense
  - NX = net export

Case study 6

Flow diagram to calculate the PIL



Now we can translate the diagram into an algorithm (for example using formulas in Excel)

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Computer skills advanced problem solving and computational thinking

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Computational thinking

- New problem solving paradigm
- It takes its name from the extensive use of techniques from computer science
- The term *computational thinking* has been used for the first time by Seymour Papert (a mathematician at MIT) in 1996.
- The method can be used algorithmically to solve scale problems realizing strong improvements in efficiency
- Applied to all the disciplines
- Adopted by the scientific community after a famous article written by Jeannette M. Wing (computer science professor at Carnegie Mellon University)
- The paper suggests that it is a skill fundamental for all the people and not only for computer science scientists, and underlines the importance to integrate it with other disciplines

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The Centre for the Computational thinking

- At the Carnegie Mellon University.
- Main activity: PROBEs (**PROB**lem-oriented **E**xplorations), application of new concepts of the computational thinking to different disciplines.

- The centre's website: http://www.cs.cmu.edu/~CompThink/

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Computational thinking characteristics

The problem solving process is characterized by:

- Analysis and logical organization of data (data modelling and data abstraction) and simulations
- Formulating problems to which a PC can give support
- Identification, test and implementation of possible solutions
- Automation of solution through the algorithmic thinking
- Generalization and application of this process to other problems

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Computational thinking: web references

- Resources (particularly in social science): http://education.sdsc.edu/resources/CompThinking.pdf
- University of Eindburg, computational thinking: http://www.inf.ed.ac.uk/research/programmes/comp-think/ (especially http://www.inf.ed.ac.uk/research/programmes/comp-think/previous.html)
- Wing's paper: http://www.cs.cmu.edu/afs/cs/usr/wing/www/publications/Wing06.pdf
- Try to explore the computational thinking with Google: http://www.google.com/edu/computational-thinking/
- Based on computational thinking principles:

http://scalablegamedesign.cs.colorado.edu/wiki/Scalable_Game_Design_wiki (scalable game design)
http://www.cs4fn.org/ (computer science for fun)
http://www.ncwit.org/unplugged (computer science in a box)