
# DM536
# Introduction to Programming

Peter Schneider-Kamp

petersk@imada.sdu.dk

http://imada.sdu.dk/~petersk/DM536/

# COURSE ORGANIZATION

# Course Elements

- Lectures Monday 8-10 (every week)
- Lectures Thursday 8-10 (every 2nd week)

- 4 sections:
  - M1: Mathematics-Economy (2nd year)
  - S2: Psychology/Biology/Biochemistry/Mathematics / Applied Mathematics / Physics (2nd year)
  - S7 & S17: Computer Science (1st year)

- Exercises (marked "TE" in your schedule)
- Labs (marked "TE" in your schedule)

- Exam = 2 practical projects

# Course Goals

- **Solve problems by writing computer programs**

- To this end, you will learn
  - to view programming as a problem solving approach
  - principles of imperative & object-oriented programming
  - how to model, test, debug, and document programs

- Focus on general principles, NOT on the language Python

# Practical Issues / Course Material

- You need an IMADA account (≠ SDU account)

- Regularly check the course home page:
  - http://imada.sdu.dk/~petersk/DM536/
  - Slides, weekly notes, definite schedule, additional notes

- Reading material:
  - Allen B. Downey: *Think Python*, Green Tea Press, 2013.
  - Available as PDF and HTML from: http://greenteapress.com/thinkpython/thinkpython.html

# Course Contract

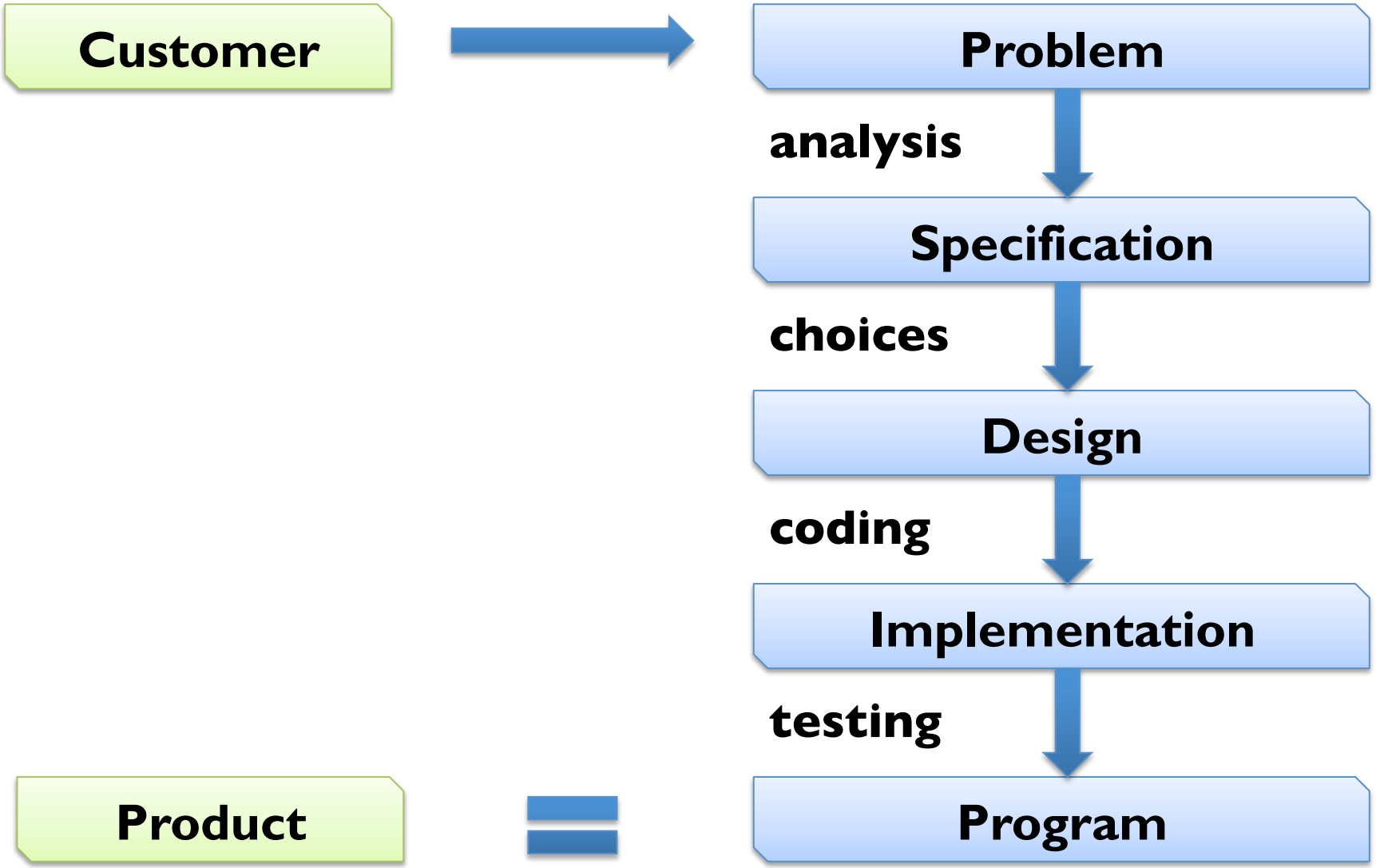
- I am offering you the following:
  1. I explain all needed concepts (as often as needed)
  2. I am available as much as possible and willing to help you
  3. I guide your learning by assigning exercises

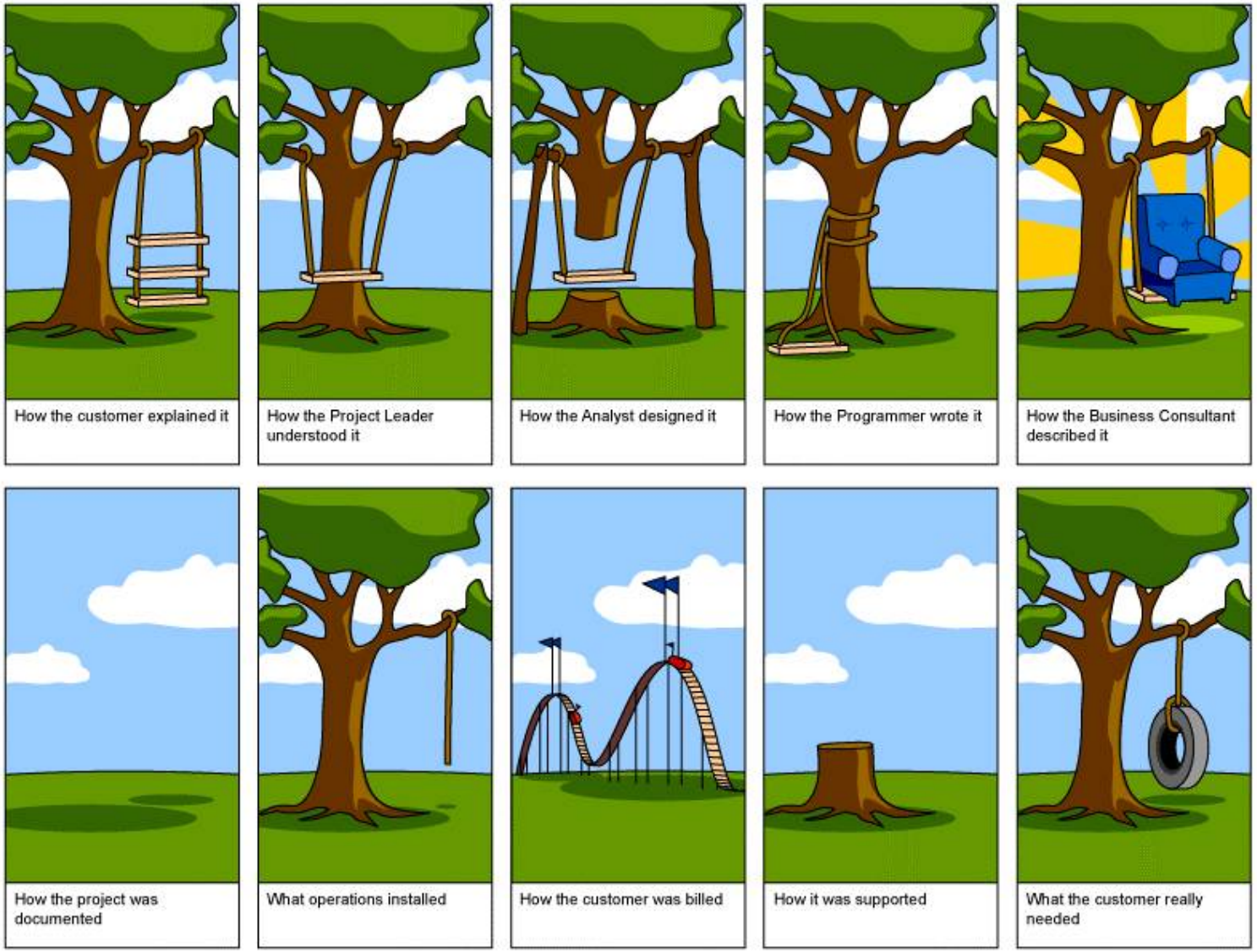
- From you I expect the following:
  1. You ask questions, when something is unclear
  2. You contact me (or a TA), when you need help
  3. You prepare for lectures and discussion sections

- You and I have the right and duty to call upon the contract!

# PROGRAMMING

# Programming as Problem Solving






# Real Life "Programming"

# Programming in a Nutshell

- Computers only have very limited abilities
- Computers are used to solve complex problems

- Programmers needed to break down complex problems into a sequence of simpler (sub-)problems

- program = sequence of simple instructions
- instructions = vocabulary of a programming language

- Programmers needed to express problems as sequence of instructions understandable to the computer

# Simple Instructions

- Administrative:

```
from math import sqrt
```

- Input:

```
a = input()
b = input()
```

- Arithmetic operations:

```
c = sqrt(a**2+b**2)
```

- Output:

```
print "Result:", c
```

- That is basically ALL a computer can do.

# Combining Instructions

- Sequence: <instr$_1$>; <instr$_2$>; <instr$_3$>
- Conditional Execution:

```
if <cond>:
    <instr1>; <instr2>
else:
    <instr3>; <instr4>; <instr5>
```

- Subprograms / Functions:

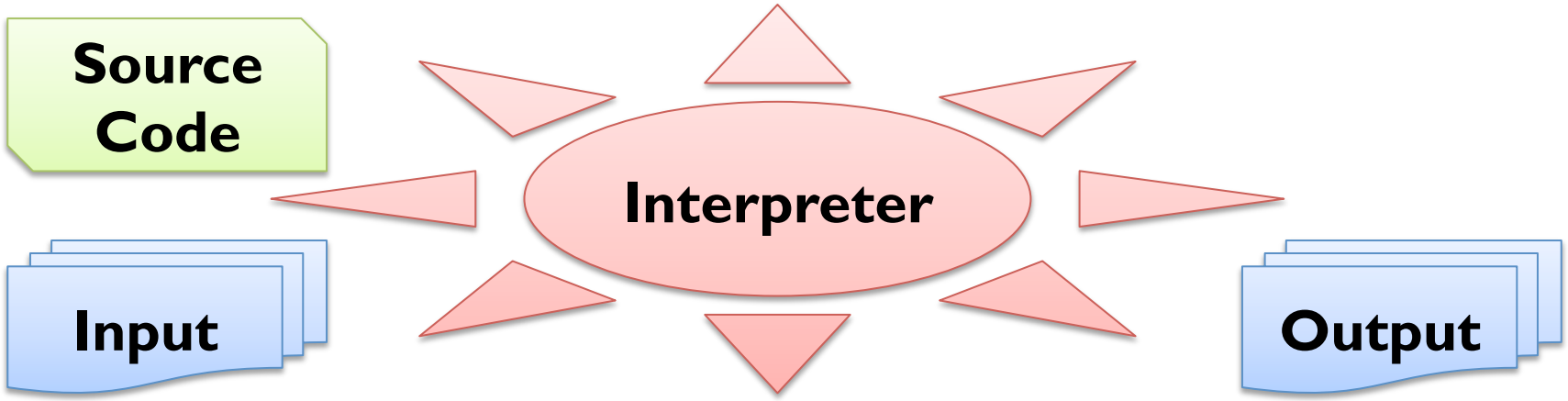
```
def <function>(<argument>):
    <instr1>; <instr2>
<var> = <function>(<input>)
```

- Repetition:

```
while <cond>:
    <instr1>; <instr2>; <instr3>
```

# Executing Programs

- Program stored in a file (*source code* file)
- Instructions in this file executed top-to-bottom
- Interpreter executes each instruction



# Debugging

- Any reasonably complex program contains errors
- Three types of errors (in Python)
  - Syntax Errors `a = input)(`
  - Runtime Errors `c = 42 / 0`
  - Semantic Errors `c = a**2+b**2`
- Debugging is finding out why an error occurred

# VARIABLES, EXPRESSIONS & STATEMENTS

# Values and Types

- Values = basic data objects — 42 — 23.0 — "Hello!"
- Types = classes of values — integer — float — string

- Values can be printed:
  - print <value> — print "Hello!"
- Types can be determined:
  - type(<value>) — type(23.0)
- Values and types can be compared:
  - <value> == <value> — type(3) == type(3.0)

# Variables

- variable = name that refers to a value
- program state = mapping from variables to values

- values are *assigned* to variables using "=":
  - <var> = <value> b = 4

- the value referred to by a variable can be printed:
  - print <var> print b

- the type of a variable is the type of the value it refers to:
  - type(b) == type(4)

# Variable Names

- start with a letter (convention: a-z)
- contain letters a-z and A-Z, digits 0-9, and underscore "_"

- can be any such name except for 31 reserved names:

| | | | | |
|---|---|---|---|---|
| and | del | from | not | while |
| as | elif | global | or | with |
| assert | else | if | pass | yield |
| break | except | import | print | |
| class | exec | in | raise | |
| continue | finally | is | return | |
| def | for | lambda | try | |

# Multiple Assignment

- variables can be assigned to different values at different times:
  - Example:
    ```
    x = 3
    x = 4
    ```
  - Instructions are executed top-to bottom => x refers to 4

- be careful, e.g., when exchanging values serially:
  - Example:
    ```
    x = y
    y = x
    ```
  - later x and y refer to the same value
  - Solution 1 (new variable): `z = y; y = x; x = z`
  - Solution 2 (parallel assign.): `x, y = y, x`

# Operators & Operands

- Operators represent computations: + * - / **
  - Example: 23+19 day+month*30 2**6-22

- Addition "+", Multiplication "*", Subtraction "-" as usual
- Exponentiation "**": x**y means $x^y$

- Division "/" rounds down integers:
  - Example 1: 21/42 has value 0, NOT 0.5
  - Example 2: 21.0/42 has value 0.5
  - Example 3: 21/42.0 has value 0.5

# Expressions

- Expressions can be:
  - Values: 42 23.0 "Hej med dig!"
  - Variables: x y name1234
  - built from operators: 19+23.0 x**2+y**2
- grammar rule:
  - <expr> => <value> |
    <var> |
    <expr> <operator> <expr> |
    ( <expr> )
- every expression has a value:
  - replace variables by their values
  - perform operations

# Operator Precedence

- expressions are evaluated left-to-right
  - Example: 64 - 24 + 2 == 42
- BUT: like in mathematics, "*" binds more strongly than "+"
  - Example: 2 + 8 * 5 == 42
- parentheses have highest precedence: 64 - (24 + 2) == 38
- PEMDAS rule:
  - Parentheses "( <expr> )"
  - Exponentiation "**"
  - Multiplication "*" and Division "/"
  - Addition "+" and Subtraction "-"

# String Operations

- Addition "+" works on strings:
  - Example 1: `print "Hello w" + "orld!"`
  - Example 2: `print "4" + "2"`

- Multiplication "*" works on strings, if 2nd operands is integer:
  - Example: `print "Hej!" * 10`

- Subtraction "-", Division "/", and Exponentiation "**" do NOT work on strings