Algorithms and Basics of Programming

Tasks

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Time

Learn what does time mean.

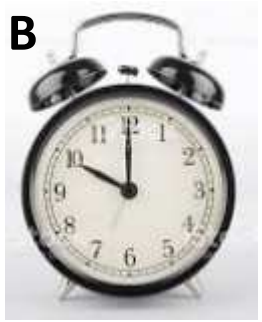
Learn to use watch/clock.

Be on time. Arrive to the lesson in correct time.

When does this class start?

A

B



C

D

E

F

Number systems: conversion

What is the equivalent value?

$986_{10} = ?_2$

$3.14_{10} = ?_2$

$1011011.01_2 = ?_{10}$

$100101011010_2 = ?_{16}$

$1BE_{16} = ?_2$

$986_{10} = ?_{16}$

$135_{16} = ?_{10}$

Sort the following numbers into increasing order:

100_2, 100_{16}, 100_{10}, 10000000000_2, 1000_{10}, $3FF_{16}$, 150_8

Number systems: arithmetic

What is the result of the following operations:

$10010101_2 + 1110100_2 = ?$

$1011_2 + 101_2 + 1001_2 + 1010_2 = ?$

$100101.01_2 + 11.01001_2 = ?$

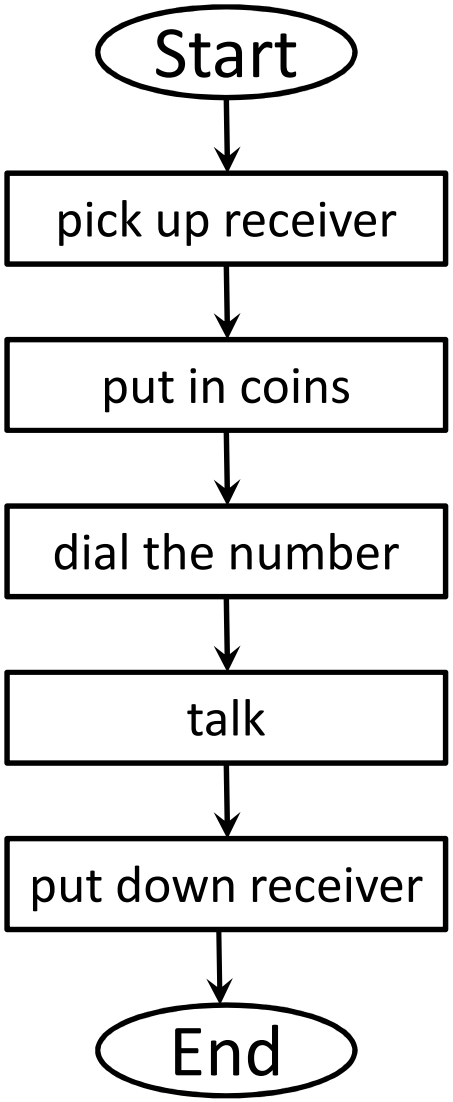
$10101101_2 - 1010110_2 = ?$

$1001010_2 * 101_2 = ?$

$10111010110_2 / 110_2 = ?$

$1101_2^{10_2} = ?$

Algorithm: using public coin phone



Problems:

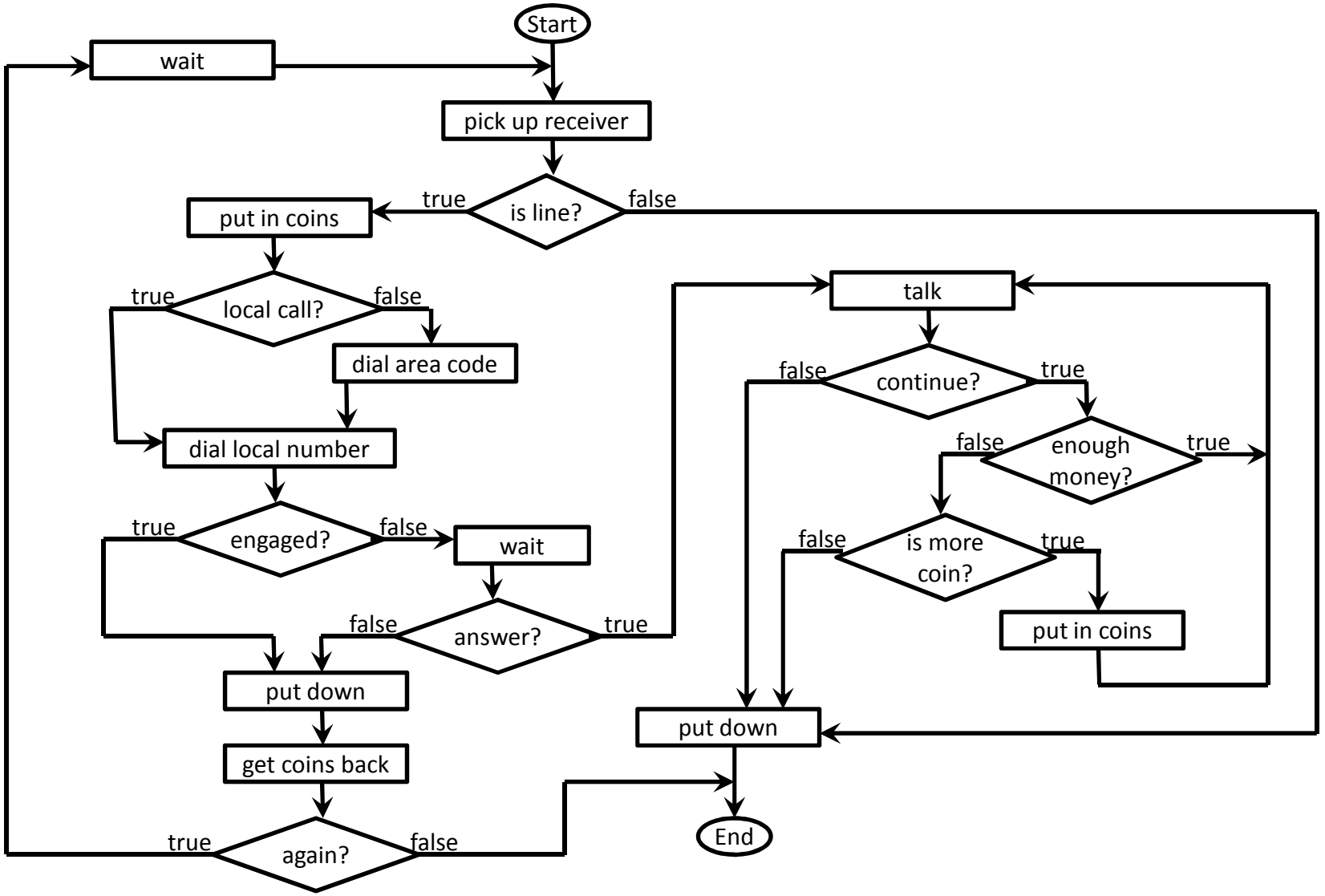
- Not complete
- Ambiguous

Modification:

- Generalizing
- Extending
- Foolproofing
- Completing

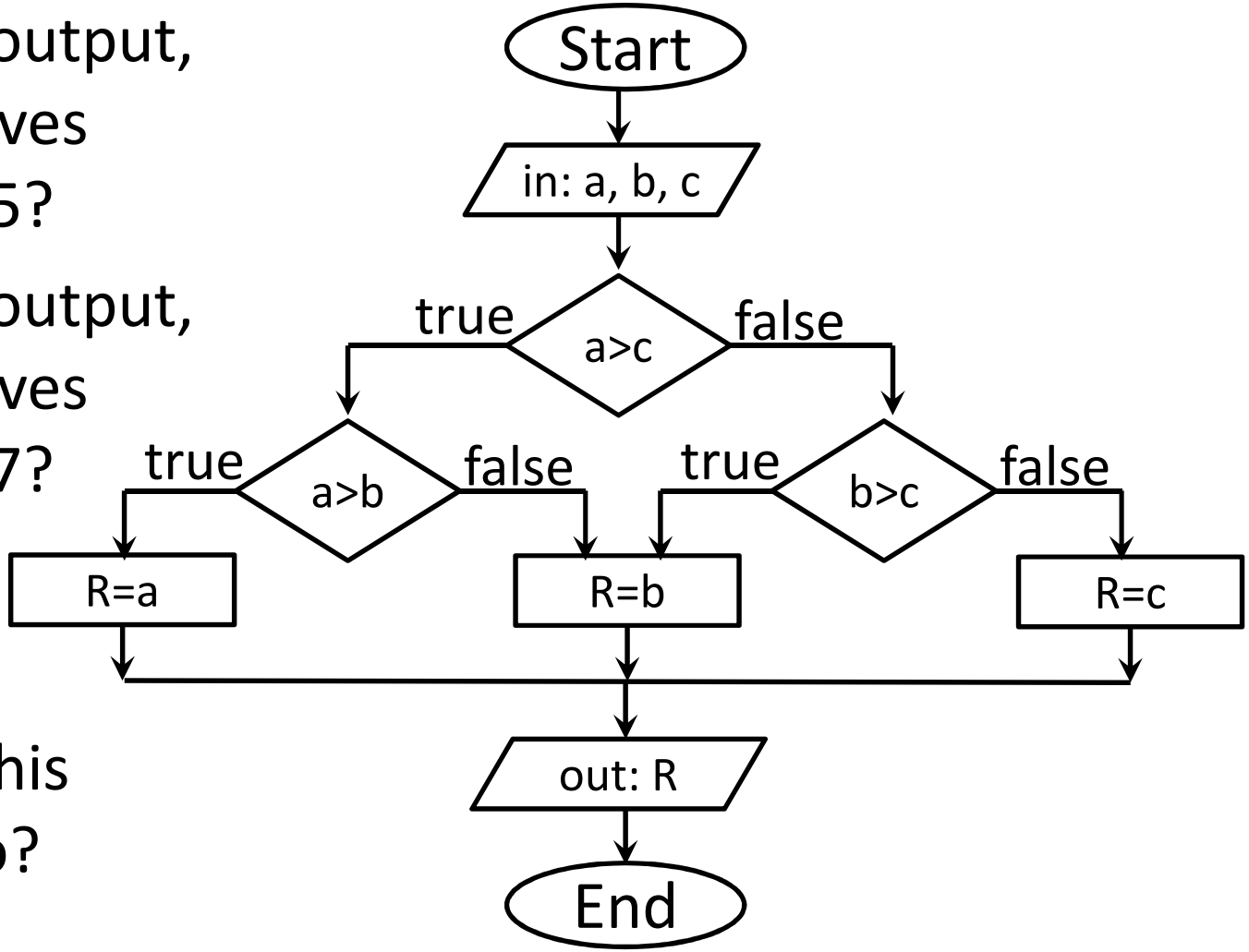
Create a more detailed algorithm.

Using public coin phone



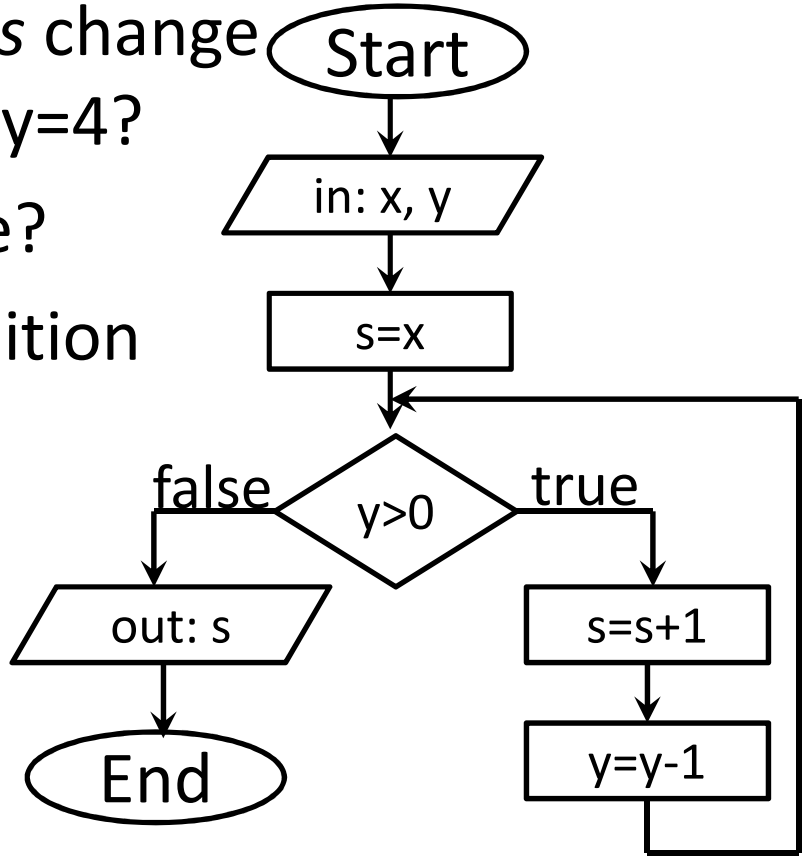
Flowchart exercises and examples

- What is the output, if the user gives a=3, b=9, c=5?
- What is the output, if the user gives a=5, b=2, c=7?
- What does this algorithm do?



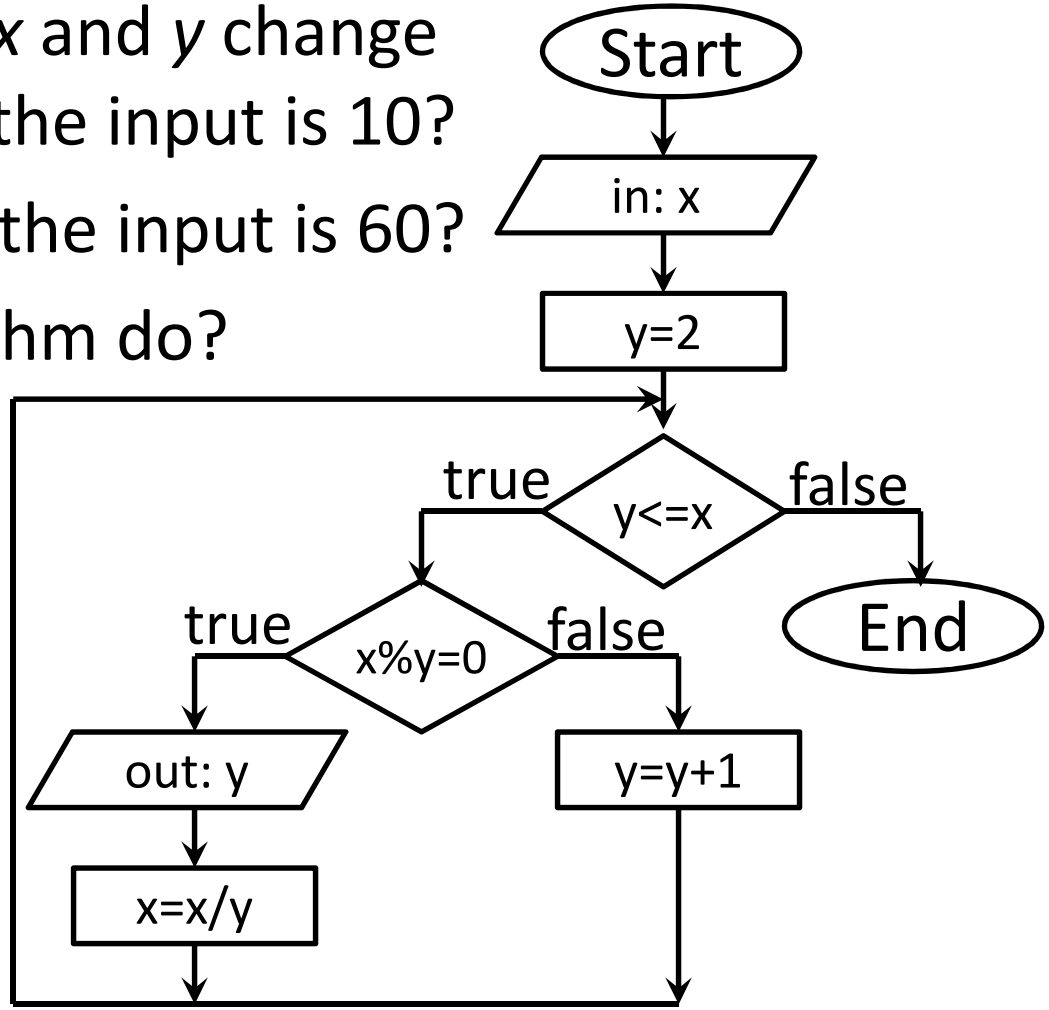
Flowchart exercises and examples

- How do the values of *x, y* and *s* change during the process, if x=5 and y=4?
- What is the output in this case?
- How many times will the condition evaluated?
- What does this algorithm do?
- How can you modify it to calculate the product of *x* and *y*?



Flowchart exercises and examples

- How do the values of *x* and *y* change during the process, if the input is 10?
- What is the output, if the input is 60?
- What does this algorithm do?
- Is it work, if x=1?
- If the input is 24, how many iterations will be executed?
- How can it faster?

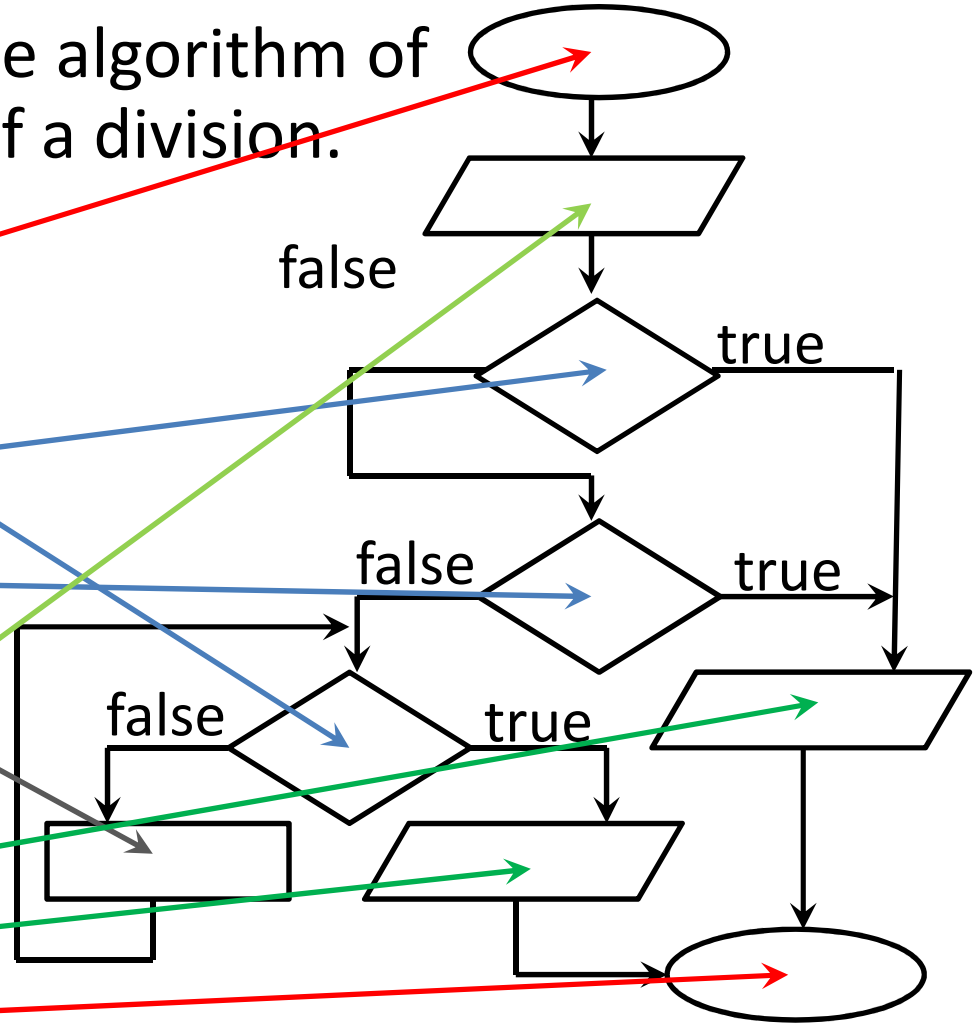


Legend: % is modulo operation

Flowchart exercises and examples

This flowchart describes the algorithm of calculation of the remain of a division. Complete it.

- Start
- a<=b
- a<0
- b<=0
- a=a-b
- in: a, b
- out: error
- out: a
- End



Flowchart exercises

Create flowcharts to the following problems

- Leap year
- Raising to power
- Calculating factorial
- Solving first degree equation
- Fibonacci sequence
- 3 values into increasing order
- Sum of all integers between `MIN` and `MAX`
- Conversion of decimal number to binary
- Incrementation of binary numbers
- Addition of binary numbers
- Searching in ordered binary tree

Pseudocode exercises

```
input a
if a<0 then
   b=-1*a
else
   b=a
endif
output b
```

- What is the output if a=10?
- What is the output if a=-4?
- What does the algorithm do?

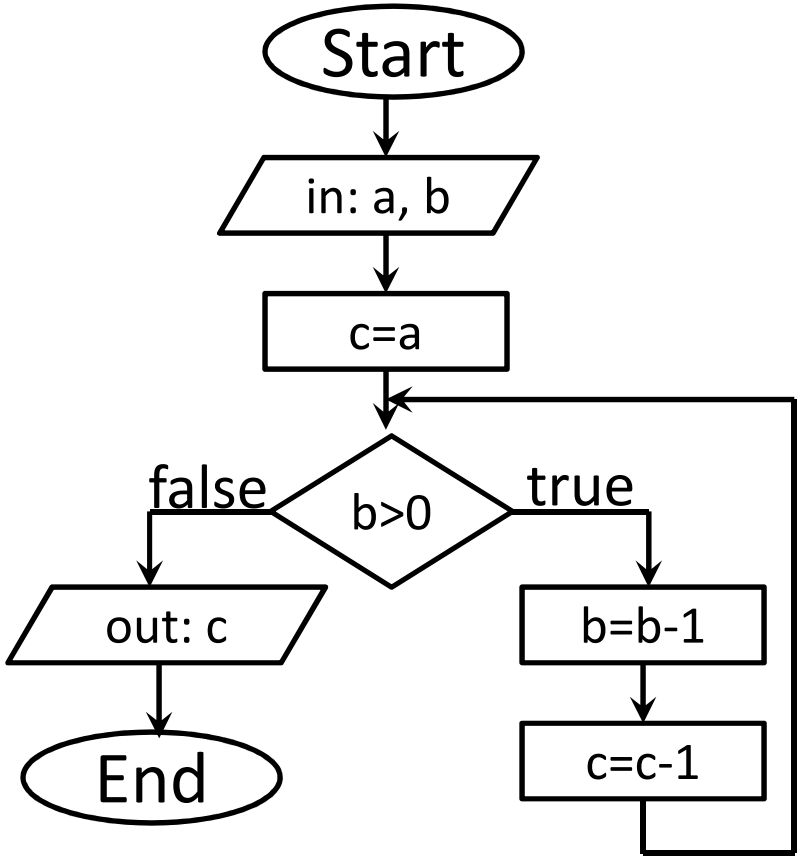
- What does this algorithm do?

```
input a
if a<0 then
   a=-1*a
endif
output a
```

Pseudocode exercises

```
input a
input b
c=a
if b>0 then
   b=b-1
   c=c-1
else
  output c
endif
```

- Do the pseudocode and the flowchart describe the same algorithm?



Pseudocode exercises

```
input a
input b
c=a
while b>0 do
  b=b-1
  c=c-1
enddo
output c
```

- How do the values of *a, b* and *c* change during the process, if a=7 and b=3?
- What is the output in this case?
- How many times will the condition evaluated?
- What does this algorithm do?
- Convert it to flowchart.

Pseudocode exercises

```
input N
R=0
while N>0 do
   R=R*10+N%10
   N=[N/10]
enddo
output R
```

- How do the values of *N* and *R* change during the process, if N=73251 initially?
- What is the output in this case?
- What does this algorithm do?

Legend:

%: modulo operation
(reminder after division)

[…]: integer part
(ignore fractional part)

Pseudocode exercises

```
input N
input B
R=0
P=1
while N<>0 do
   R=R+(N%B)*P
   P=P*10
   N=[N/B]
enddo
output R
```

- What is the output, if N=15, B=2?
- What is the output, if N=16, B=2?
- What is the output, if N=10, B=2?
- What is the output, if N=5, B=2?
- What is the output, if N=30, B=3?
- What is the output, if N=20, B=3?
- What is the output, if N=64, B=8?

- What does this algorithm do?

Pseudocode exercises

```
input A
input B
while B>0 do
   C=B
   B=A%B
   A=C
enddo
output A
```

- How do the values of *A*, B and *C* change during the process, if A=24 and B=18 initially?
- What is the output in this case?
- Try it with A=30 and B=105.
- Try it with A=165 and B=48.
- What does this algorithm do?

(Euclidean algorithm:
Greatest Common Divisor)

Pseudocode exercises

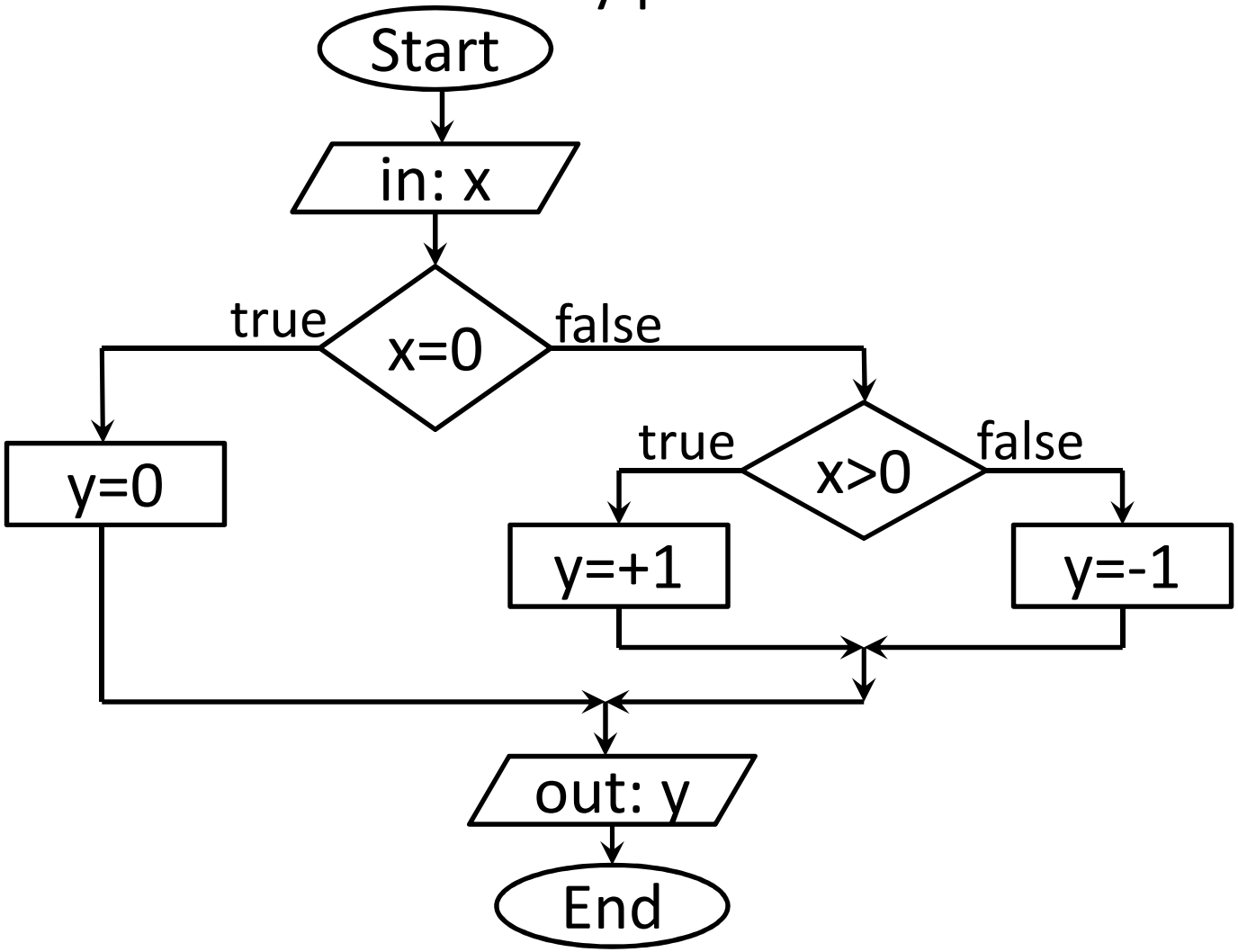
```
input A
input B
while A<>B do
  if A>B then
    A=A-B
  else
    B=B-A
  endif
enddo
output B
```

- How do the values of *A*, B and *C* change during the process, if A=24 and B=18 initially?
- What is the output in this case?
- Try it with A=30 and B=105.
- Try it with A=165 and B=48.
- What does this algorithm do?

- Create a flowchart for this algorithm.

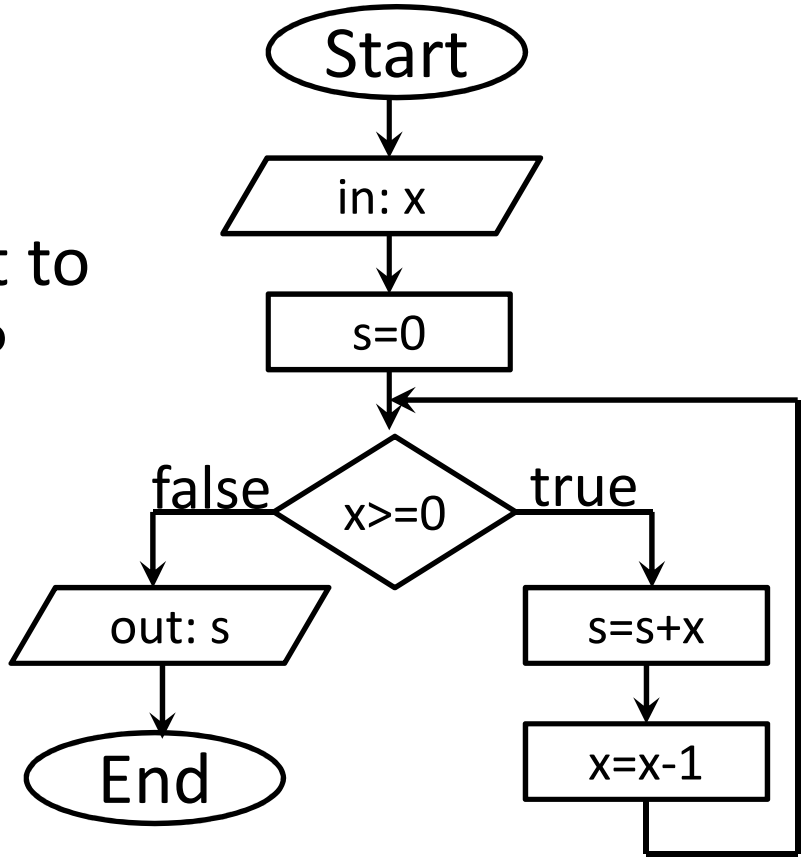
Pseudocode exercises

- Describe this flowchart by pseudocode.



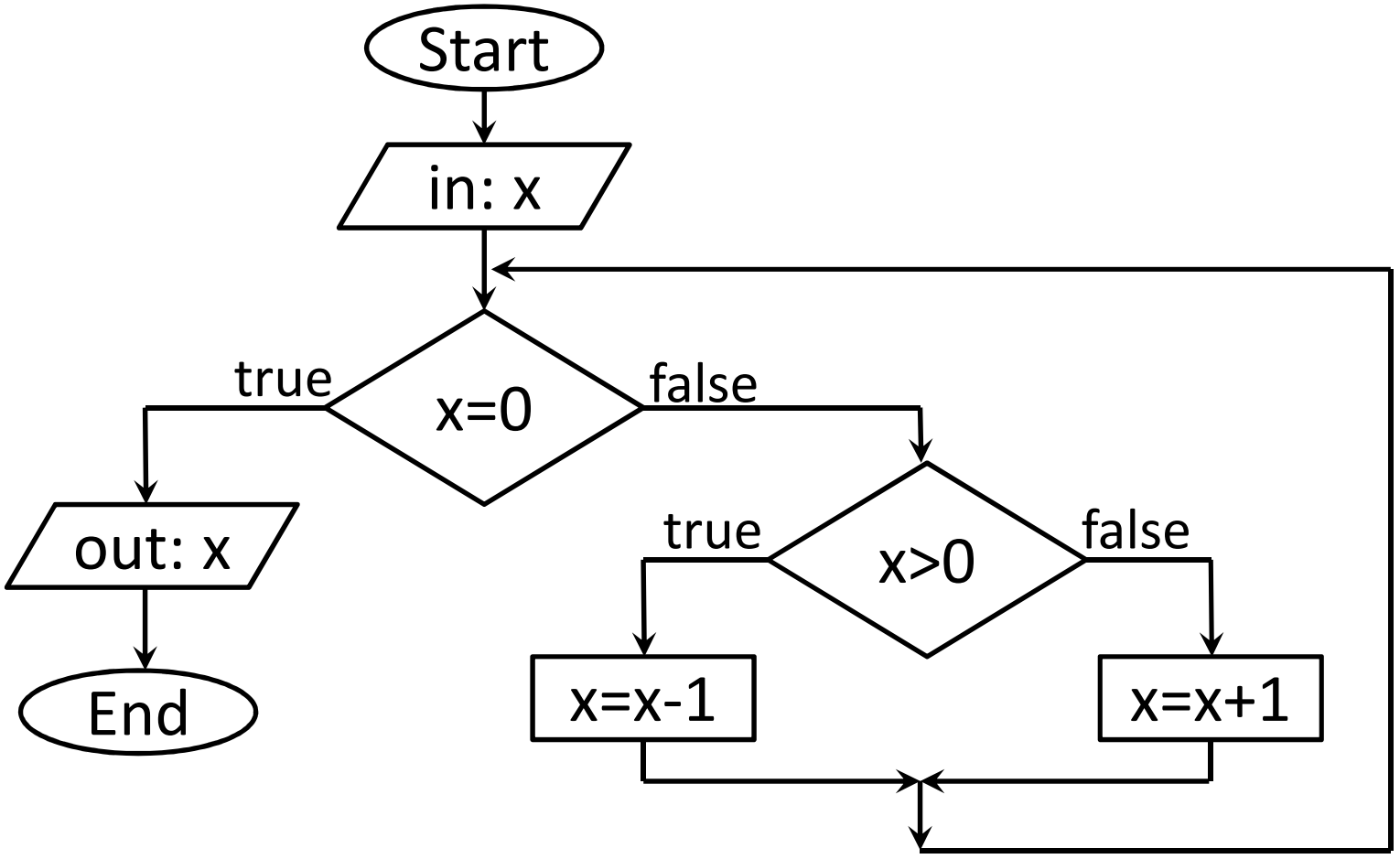
Pseudocode exercises

- Describe this flowchart by pseudocode.
- What does it do?
- How can you modify it to get the result quicker?



Pseudocode exercises

- Describe this flowchart by pseudocode!



Pseudocode exercises

Verbal represented algorithm:

1. Get a number.
2. Check that it is larger then one or not.
3. If it is larger, subtract two and continue with Step 2.
4. Otherwise check it zero or not.
5. If it is zero, write ‘E’.
6. Else write ‘O’.

Write this algorithm with flowchart.

Write this algorithm in pseudocode.

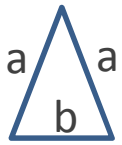
Pseudocode exercises

Write the following algorithms with pseudocode

- Absolute value
- Sum of numbers from 10 to 20
- Raising to power
- Solution of first degree equation
- Calculating factorial
- Prime or not
- Prime factorization
- *f(i)<100* elements of sequence: *f(1)=1; f(i)=f(i-1)+i*
- Fibonacci sequence

Pseudocode exercises

Write the following algorithms with pseudocode

- Leap year
- Day of year
- Triangle inequality
- Equilateral triangle
- Isosceles triangle 

- Maximum of given 3 numbers
- Right-angled triangle (Pythagorean theorem)
- Distance of 2 planar points

Pseudocode exercises

- Average of an array
- Finding a value in (ordered) list
  - with guard
- Minimum/maximum search
- Finding the place of maximum/minimum
- Replacement of two values
- Selection sort
- Insertion sort
- Bubble sort
- …

Subroutine exercises

```
function CHANGE ( a )
  return 1-a
end function

input Max
i=0
j=0
while j<=Max do
  i = CHANGE (i)
  j=j+i
  output j
enddo
```

- What does this algorithm do?
- What is the role of the function?

Subroutine exercises

```
procedure NUMS ( N )
   while N>0 do
      output N
      N=N-1
   enddo
   output NEWLINE
end function
NUMS (3)
NUMS (4)
NUMS (5)
NUMS (4)
NUMS (3)
```

- What is the output of the algorithm?

Legend

- NEWLINE: is special thing to create a new line (line feed + carriage return) on the output

Subroutine exercises

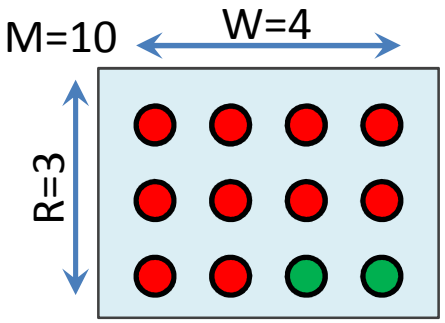
- Write an algorithm in pseudocode containing a function to determine average of two values (given as parameters).
- Write an algorithm in pseudocode containing a procedure to write the NxN multiplication table. For example if N=4:

1	2	3	4
2	4	6	8
3	6	9	12
4	8	12	16

Testing strategy

Seating order:
Chairs are placed as a square grid in a rectangular area.
Each row contains W chairs.
How many rows we need minimum for M people?

```
input M
input W
R = M/W
output R
```



- Create a testing strategy to the following algorithm.
- Which values of M and W are acceptable?
  (When the algorithm gives expected output?)

Testing strategy

Seating order:
Chairs are placed as a suqare grid in a rectangular area.
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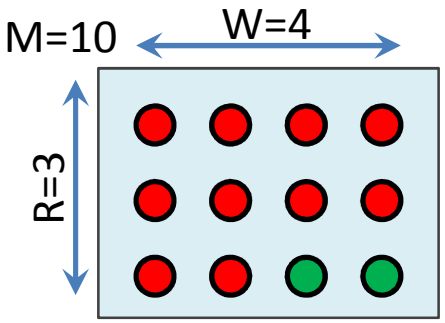

- Create a testing strategy to the following algorithm.

```
input M
input W
if W>0 then
   if M%W=0 then
      R = M/W
   else
      R = [M/W]+1
   endif
   output R
endif
```

Testing strategy

Number system conversion

- Create a testing strategy to the following algorithm.
- Which values of N and B are acceptable?
  (When the algorithm gives expected output?)

```
input N
input B
R=0
P=1
while N<>0 do
   R=R+(N%B)*P
   P=P*10
   N=[N/B]
enddo
output R
```

Syntax and semantics

- Find syntactic and semantic errors of the following algorithm written in pseudocode to determine the not negative integer (E) power of the base (B).

```
input B
R=0
wihle E>=0
   R=R*B
   E-1=E
endo
output R
```

Data representation

- Represent the (human) population of the Earth with 32-bit fixed-point representation.
- Represent the -1 value in 32-bit fixed-point form.
- Which 4 bytes long bit series means the fixed-point representation of 15908?
- Which 4 bytes long bit series means the fixed-point representation of -666?
- What is the meaning(s) of the following bit series in case of fixed-point representation?

```
10000000 00000000 00000010 01001001
```

Data representation

- Which bit series means greater value in case of signed/unsigned fixed-point representation?
  `00000000 00000000 00000000 10000000`
  `11111111 11111111 11111111 00000000`
- Give a 32 bit long series which means 0.0 by the standard floating point representation method.
- What is the meaning of the following bit series in case of floating point representation?
  `11000000 11000000 00010000 00000000`

Expressions

- What is the value of the following infix expression?
  `9+2*6/3>8-7`
- What is the value of the following infix expression?
  `2>3&&3*5-6/2>=11%2`
- What is the value of the following prefix expressions?
  `* + 1 2 - 9 6`
  `+ 1 - * 2 13 / 25 5`
- What is the value of the following prefix expressions and convert it into infix form?
  `30 2 15 4 6 + - * /`
  `1 2 13 * 25 5 / - +`

Python programming language

Find examples in this Python code part for the different occurrence of the following concepts.

- Keyword
- Comment
- Identifier
- Constant
- Variable
- Operator
- Expression
- Instruction

```
# some calculation
Sum=0
for i in range(N):
    Sum+=i
if(Sum==0):
    print(”Total”+Sum)
else:
    z=10%2+N/N+cos(90)
#return z
```

Integrated Development Environment

Open and try a real IDE.

Frequently used IDEs:

- Code::Blocks
- Dev-C++
- NetBeans
- Eclipse
- MS Visual Studio
- Jbuilder
- MPLAB
- PyCharm