Information technology – lecture 11

Basic algorithms and data structures. Scalars, arrays and lists.

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The use of global variables

```
function setval()
  global X
  X = 23;
end

global X=111;

setval();

X
```

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Calculating sum of vector elements

```
function [s] = vecsum(v)
  s = 0;
  for i = 1 : length(v)
    s = s + v(i);
  endfor
endfunction

x = [ 1 2 23 22 ]

xs = vecsum(x)
```

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Searching for vector maximum element

```
function [mx] = vecmax(x)
  mx = x(1);
  for i=2:length(x)
    if mx < x(i)
      mx = x(i);
    endif
  endfor
endfunction

z = [1,4,5,2,-1,28,3]

mz = vecmax(z)
```

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Reversing order of vector elements

```
v = [1, 3, 4, 24]
n = length(v);
for i=1:n/2
  swp = v(i);
  v(i) = v(n-i+1);
  v(n-i+1) = swp;
endfor

v
```

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Reversing order of vector elements

```
v = [1,3,4,24]

v(end:-1,1) = v
```

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Recursive algorithms – calculating factorial

```
function [s] = vecsum(v)
  s = 0;
  for i = 1 : length(v)
    s = s + v(i);
  endfor
endfunction

x = [ 1 2 23 22 ]

xs = vecsum(x)
```

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Fibonacci sequence

$$F_n = F_{n-1} + F_{n-2},$$
$$F_0 = 0 \quad \text{and} \quad F_1 = 1.$$

```
function v = fib(n)
  if n < 3
    v = 1;
  else
    v = fib(n-2) + fib(n-1);
  endif
endfunction

for i=1:10
  fib(i)
endfor
```

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Chebyshev polynomials of the first kind

The Chebyshev polynomials of the first kind are defined by the recurrence relation

$$T_0(x) = 1 \tag{1}$$

$$T_1(x) = x \tag{2}$$

$$T_{n+1}(x) = 2xT_n(x) - T_{n-1}(x). \tag{3}$$

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chebyschev polynomials of the first kind

```
function y = chebychev(n, x)
   if n == 0
     y = 1;
   elseif n == 1
     y = x;
   else
     y = 2*x*chebychev(n-1,x)-chebychev(n-2,x);
   endif
endfunction

x = linspace(-1,1);
for n = 0:5
  y = []
  for xk = x
  y = [y, chebychev(n,xk)];
  end
  hold on;
  ft = sprintf("%d;%d;",n,n);
  plot(x,y, ft, "linewidth", 3);
end
pause();
print ("chebyshev.png")
```

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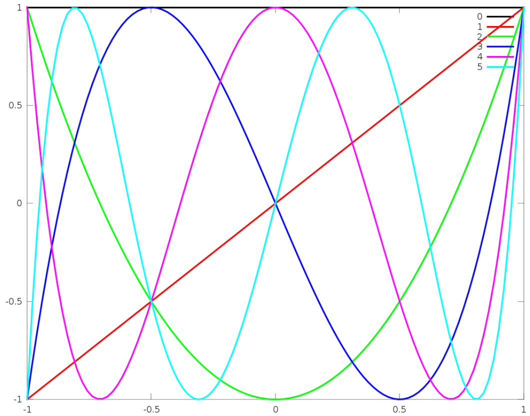
Chebyshev polynomial of the first kind



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Sorting vector – bubble sort algorithm

```
v = [1,2,4,23,2,23,2,4,56];

n = length(v);
for i=2:n
  for j=n:-1:i+1
    if v(j) < v(j-1)
      v([i,j]) = v([j,i]);
    endif
  endfor
endfor

v
```

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Swapping values

Solution 1: using extra variable:

```
octave:12> a = 22;
octave:13> b = 111;
octave:14> swp = a;
octave:15> a = b;
octave:16> b = swp;
octave:17> a,b
a = 111
b = 22
```

Solution 1: using `swap()` function from `control` package:

```
octave:21> a = 12;
octave:22> b = 111;
octave:23> [a,b] = swap(a,b);
octave:24> a,b
a = 111
b = 12
```

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Rearranging vectors

Exchanging value of two elements:

```
octave:25> v = [10, 1, 888];
octave:26> v([1,3]) = v([3,1])
v =
   888  1  10
```

Reversing order of vector elements

```
octave:33> v = [1,2,3,4]
v =
   1  2  3  4
octave:34> v = v([end:-1:1])
v =
   4  3  2  1
```

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Creating lists

```
octave:40> l = list(1,2,3,4);
octave:41> append(l, 22,44)
ans =
(
  [1] = 1
  [2] = 2
  [3] = 3
  [4] = 4
  [5] = 22
  [6] = 44
)
```

The use of list objects is deprecated and instead cell arrays should be used.

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Simulating lists with cell arrays

```
octave:45> lst = {1,2,3};
octave:46> lst = [lst, {111,222}];
octave:47> lst = [{0},lst];
octave:48> lst
lst =
{
  [1,1] = 0
  [1,2] = 1
  [1,3] = 2
  [1,4] = 3
  [1,5] = 111
  [1,6] = 222
}
```

The lists created as cell arrays can hold elements of any type, however some functions do not work on them, e.g. sort, min, max.

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Simulating lists with vectors

```
octave:60> v = [1,2,3];
octave:61> v = [v, 100];
octave:62> v = [333, v];
octave:63> v
v =
   333 1 2 3 100
octave:64> at = 3
at = 3
octave:65> v = [v(1:at-1), 777, v(at:end)]
v =
   333 1 777 2 3 100
```

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Sorting vectors

```
octave:66> v
v =
   333 1 777 2 3 100
octave:67> v = sort(v)
v =
     1 2 3 100 333 777
octave:69> v = sort(v, "descend")
v =
   777 333 100 3 2 1
```

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Finding vector's extreme values

```
octave:70> v
v =
   777 333 100 3 2 1

octave:71> max(v)
ans = 777
octave:72> min(v)
ans = 1
```

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Looking-up vector's values

```
octave:56> v = [10,22,300];
octave:57> lookup(v,22)
ans = 2
octave:58> lookup(v,[22,10])
ans =
   2 1
```

CAUTION: The vector should be strictly monotonic.

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Calculating sums and products

$$sum = \sum_{i=1}^{N} v_i = v_1 + v_2 + \ldots + v_N$$

$$prod = \prod_{i=1}^{N} v_i = v_1 \cdot v_2 \cdot \ldots \cdot v_N$$

```
octave:76> v = [1,2,3,4]
v =
   1 2 3 4
octave:77> sum(v)
ans = 10
octave:78> prod(v)
ans = 24
```

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Simulating associative arrays

```
octave:79> stud.name = "Jan";
octave:80> stud.surname = "Kowalski";
octave:81> stud.id = 978272;
octave:82> stud.note = 5.0;
stud =
{
  name = Jan
  surname = Kowalski
  id = 978272
  note = 5
}
octave:83> getfield(stud, "name")
ans = Jan
```

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Looping over structure fields

```
for [key, val] = stud
  key,val
endfor

key = Jan
val = name
key = Kowalski
val = surname
key = 978272
val = id
key = 5
val = note
```

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More complex data structures

In the absence of pointers more complex data structures like trees and graphs can be implemented either by composing structures or by using cell arrays. The alternative is to code those structures in C++ and expose it to Octave as extension packages.

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