Information technology – lecture 6

Introduction to algorithmic problem solving. Basic algorithms for sequences of numbers: summation, extreme elements, sub-sequences.

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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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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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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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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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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's polynomials of the first kind

The Chebyshev's 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's 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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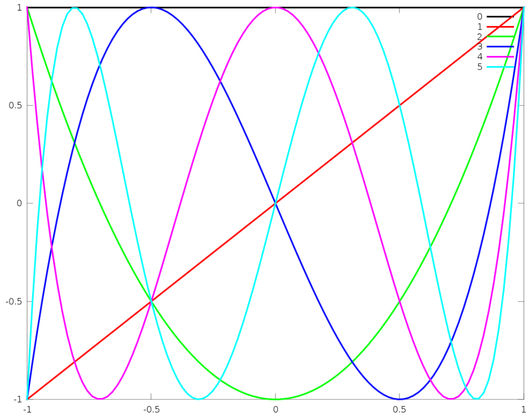
Chebyshev's polynomials of the first kind



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