САНКТ-ПЕТЕРБУРГСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ
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ОТЧЕТ

по лабораторной работе №2

по дисциплине «Вычислительная математика»

Вариант 6

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Санкт-Петербург
2018

Постановка задачи

Задана система алгебраических уравнений $Ax_1 = b$, где матрица A зависит от параметра. Используя программы DECOMP и SOLVE, решить систему, изменяя параметр следующим образом: $p = 1, 0.1, 0.01, 0.0001, 0.000001$. Осуществить левую трансформацию Гаусса ($A^T Ax_2 = A^T b$) и вновь решить систему. Проанализировать связь числа обусловленности cond и величины $\delta = \|x_1 - x_2\|/\|x_1\|$.

p–3	–4	–4	7	2	3	8	7	2p+54
0	–15	–1	5	–3	6	6	–6	–72
–4	2	–16	7	0	8	–7	6	–33
0	8	–5	–11	1	0	4	5	–15
8	6	–8	4	27	–7	–1	5	180
–4	–2	1	2	–8	10	7	0	–5
0	–1	5	2	–8	2	–2	0	–14
0	–8	–7	3	–7	–4	–8	5	–131

Исходный код программы на языке FORTRAN

```
program Lab2
    integer i
    real x
    call decompsolve(1.0)
    call decompsolve(0.1)
    call decompsolve(0.01)
    call decompsolve(0.0001)
    call decompsolve(0.000001)
    write(*,*) "============================================================"

    contains
    subroutine decompsolve(p)
      implicit none
      real, intent(in) :: p
      real, dimension(8) :: b,b1,z,z1,w,w1,atb,ab
      real, dimension(8,8) :: a,a1,at,ata,x1
      integer, dimension(8) :: ni,ma,ip,ip1
      integer i,j
      real cond, c, cond1, p1, norma1, norma2, bbb

      a(1,1) = p-3
      a(1,2) = -4
      a(1,3) = -4
      a(1,4) = 7
      a(1,5) = 2
      a(1,6) = 3
      a(1,7) = 8
      a(1,8) = 7

      a(2,1) = 0
      a(2,2) = -15
      a(2,3) = -1
      a(2,4) = 5
      a(2,5) = -3
      a(2,6) = 6
      a(2,7) = 6
      a(2,8) = -6

      a(3,1) = -4
      a(3,2) = 2
      a(3,3) = -16
      a(3,4) = 7
      a(3,5) = 0
      a(3,6) = 8
      a(3,7) = -7
      a(3,8) = 6

      a(4,1) = 0
      a(4,2) = 8
      a(4,3) = -5
      a(4,4) = -11
```

a(4,5) = 1
a(4,6) = 0
a(4,7) = 4
a(4,8) = 5

a(5,1) = 8
a(5,2) = 6
a(5,3) = -8
a(5,4) = 4
a(5,5) = 27
a(5,6) = -7
a(5,7) = -1
a(5,8) = 5

a(6,1) = -4
a(6,2) = -2
a(6,3) = 1
a(6,4) = 2
a(6,5) = -8
a(6,6) = 10
a(6,7) = 7
a(6,8) = 0

a(7,1) = 0
a(7,2) = -1
a(7,3) = 5
a(7,4) = 2
a(7,5) = -8
a(7,6) = 2
a(7,7) = -2
a(7,8) = 0

a(8,1) = 0
a(8,2) = -8
a(8,3) = -7
a(8,4) = 3
a(8,5) = -7
a(8,6) = -4
a(8,7) = -8
a(8,8) = 5

b(1) = 2*p+54
b(2) = -72
b(3) = -33
b(4) = -15
b(5) = 180
b(6) = -5
b(7) = -14
b(8) = -131

a1 = a
b1 = b

```
   call transponmatr(8,a1,at)
   call umatm(8,8,8,at,a1,ata)
   call umatv(8,8,1,at,b1,atb)
   call decomp(8,8,a,cond,ip,w)

   write(*,*) "============================================================="
   print 111, cond
   111 FORMAT(' Cond = ', F20.2)
   write(*,*) "   Solution"
   call solve(8,8,a,b,ip)

   do i = 1, 8
      print 112, i, b(i)
   end do

   112 FORMAT(' X[', I1, ']=', F9.5)

   call decomp(8,8,ata,cond1,ip1,w1)

   print 113, cond1
   113 FORMAT(' Cond1 = ', F20.2)
   write(*,*) "  Solution"

   call solve(8,8,ata,atb,ip1)

   do i = 1, 8
      print 114, i, atb(i)
   end do

   114 FORMAT(' X[', I1, ']=', F9.5)

   call vchtv(8,b,atb,ab)
   call vnorma(8,ab,norma1)
   call vnorma(8,atb,norma2)

   bbb = norma1/norma2

   write(*,*)
   print 115, bbb
   115 FORMAT(' BBB = ', F9.5)
   write(*,*)
end subroutine decompsolve

subroutine vnorma(n, a, max)
   implicit none
   integer :: n
   real :: max
   real :: a(n)
   integer i

   max = abs(a(1))
   do i = 1, n
      if(abs(a(i))>max) then
```

```
            max = abs(a(i))
        endif
    end do
end subroutine vnorma

subroutine transponmatr(n, AA, BB)
    implicit none
    integer :: n
    real :: AA(n,n)
    real :: BB(n,n)
    integer i,j
    real Summa,x

    BB = AA
    do i = 1,n
        do j = i+1,n
            x = BB(i,j)
            BB(i,j) = BB(j,i)
            BB(j,i) = x
        end do
    end do
end subroutine transponmatr

subroutine umatm(nn,kk,mm,AA,BB,CC)
    implicit none
    integer :: nn, kk, mm
    real :: AA(nn,kk),BB(kk,mm),CC(nn,mm)
    integer ii, jj, ll
    real Summa

    do ii = 1, nn
        do jj = 1, mm
            Summa = 0
            do ll = 1, kk
                Summa = Summa + AA(ii,ll)*BB(ll,jj)
            end do
            CC(ii,jj) = Summa
        end do
    end do
end subroutine umatm

subroutine umatv(nn,kk,mm,AA,BB,CC)
    implicit none
    integer :: nn, kk, mm
    real :: AA(nn, mm), BB(kk), CC(nn)
    integer ii, jj, ll
    real Summa

    do ii = 1, nn
        do jj = 1, mm
            Summa = 0
            do ll = 1, kk
                Summa = Summa + AA(ii,ll)*BB(ll)
```

```
            end do
            CC(ii) = Summa
          end do
        end do
    end subroutine umatv

    subroutine vchtv(n, a, b, c)
        implicit none
        integer, intent(in) :: n
        real :: a(n), b(n), c(n)
        integer i
        do i = 1, n
          c(i) = a(i) - b(i)
        end do
    end subroutine vchtv
end program lab2
```

Результаты выполнения программы

```
================================================================================
Cond =               652.61
   Solution
X[1]=  2.00001
X[2]=  7.00001
X[3]=  4.99999
X[4]=  7.00001
X[5]=  4.99999
X[6]=  0.99999
X[7]=  4.00001
X[8]=  1.99999
Cond1 =            222326.12
  Solution
X[1]=  2.00426
X[2]=  7.00396
X[3]=  4.99602
X[4]=  7.00381
X[5]=  4.99604
X[6]=  0.99626
X[7]=  4.00376
X[8]=  1.99589

BBB =   0.00061

--------------------------------------------------------------------------------
```

```
================================================================================
Cond =              6955.32
   Solution
X[1]=  1.99999
X[2]=  6.99999
X[3]=  5.00001
X[4]=  6.99999
X[5]=  5.00001
X[6]=  1.00001
X[7]=  3.99999
X[8]=  2.00001
Cond1 =          24976470.00
  Solution
X[1]=  1.44429
X[2]=  6.44830
X[3]=  5.55189
X[4]=  6.45032
X[5]=  5.55172
X[6]=  1.54883
X[7]=  3.45095
X[8]=  2.55367

BBB =   0.08615

--------------------------------------------------------------------------------
```

```
==========================================================================
Cond =             69981.77
   Solution
X[1]=  2.00231
X[2]=  7.00231
X[3]=  4.99769
X[4]=  7.00231
X[5]=  4.99769
X[6]=  0.99769
X[7]=  4.00231
X[8]=  1.99769
Cond1 =        8932134912.00
  Solution
X[1]=-12.00521
X[2]= -6.99505
X[3]= 18.99552
X[4]= -6.98995
X[5]= 18.99511
X[6]= 14.98778
X[7]= -9.98836
X[8]= 16.00000

BBB =   0.73741
```

```
==========================================================================
Cond =           6265785.50
   Solution
X[1]=  1.97701
X[2]=  6.97701
X[3]=  5.02299
X[4]=  6.97701
X[5]=  5.02299
X[6]=  1.02299
X[7]=  3.97701
X[8]=  2.02299
Cond1 =         812924032.00
  Solution
X[1]= -9.09098
X[2]= -4.09088
X[3]= 16.09088
X[4]= -4.09084
X[5]= 16.09088
X[6]= 12.09081
X[7]= -7.09083
X[8]= 13.09091

BBB =   0.68784
```

```
================================================================================
Cond =          64132712.00
   Solution
X[1]=  3.52941
X[2]=  8.52941
X[3]=  3.47059
X[4]=  8.52941
X[5]=  3.47059
X[6]= -0.52941
X[7]=  5.52941
X[8]=  0.47059
Cond1 =         241682016.00
  Solution
X[1]=  3.13513
X[2]=  8.13513
X[3]=  3.86486
X[4]=  8.13513
X[5]=  3.86487
X[6]= -0.13514
X[7]=  5.13514
X[8]=  0.86486

BBB =   0.04847

================================================================================
```

Вывод

В ходе выполнения лабораторной работы была решена система алгебраических уравнений с использованием программ DECOMP и SOLVE при изменяющихся значениях p и сделан вывод, что чем больше число обусловленности cond, тем больше будут изменения.