Μέλλιου Αικατερίνη
1115 2007 00 095
Επιστημονικοί Υπολογισμοί
2016-2017
Άσκηση 1η

Αποτελέσματα εφαρμογών

1.Τριγωνική Διαχώριση LU με μερική οδήγηση

A. Επίλυση γραμμικού συστήματος

```
>> ask1_LU_1_a_1()

A =

     2     1    -3     4     2
    -3     2     5    -3     1
     8     1    -3     2     4
    -4     2     3    -1     5
     6     2     1    -5     9


condition_number =

   33.1109


B =

     3
    15
    11
    18
    26


L =

    1.0000         0         0         0         0
   -0.5000    1.0000         0         0         0
    0.2500    0.3000    1.0000         0         0
    0.7500    0.5000   -0.9259    1.0000         0
   -0.3750    0.9500   -0.9074   -0.2841    1.0000


U =

    8.0000    1.0000   -3.0000    2.0000    4.0000
         0    2.5000    1.5000         0    7.0000
         0         0   -2.7000    3.5000   -1.1000
         0         0         0   -3.2593    1.4815
         0         0         0         0   -4.7273


P =

     0     0     1     0     0
     0     0     0     1     0
     1     0     0     0     0
     0     0     0     0     1
     0     1     0     0     0


X =

    1.0000
    2.0000
    3.0000
    1.0000
    2.0000


t2 =

     0
```

```
>> ask1_LU_1_a_2()

A =

    10    -2    -1     2     3     1    -4     7
     5    11     3    10    -3     3     3    -4
     7    12     1     5     3   -12     2     3
     8     7    -2     1     3     2     2     4
     2   -15    -1     1     4    -1     8     3
     4     2     9     1    12    -1     4     1
    -1     4    -7    -1     1     1    -1    -3
    -1     3     4     1     3    -4     7     6


condition_number =

   13.5051


B =

    25
    75
    37
    46
     5
    93
   -16
    41


L =

    1.0000         0         0         0         0         0         0         0
    0.2000    1.0000         0         0         0         0         0         0
    0.4000   -0.1918    1.0000         0         0         0         0         0
    0.5000   -0.8219    0.3074    1.0000         0         0         0         0
   -0.1000   -0.2603   -0.7904   -0.0420    1.0000         0         0         0
    0.7000   -0.9178    0.1044    0.4382    0.4643    1.0000         0         0
    0.8000   -0.5890   -0.1807   -0.0202    0.4146   -0.0287    1.0000         0
   -0.1000   -0.1918    0.4052    0.1264   -0.0025    0.2601    0.3221    1.0000


U =

   10.0000   -2.0000   -1.0000    2.0000    3.0000    1.0000   -4.0000    7.0000
         0  -14.6000   -0.8000    0.6000    3.4000   -1.2000    8.8000    1.6000
         0         0    9.2466    0.3151   11.4521   -1.6301    7.2877   -1.4932
         0         0         0    9.3963   -5.2259    2.0148    9.9926   -5.7259
         0         0         0         0   11.0167   -0.4161    7.0702   -3.3043
         0         0         0         0         0  -14.3209    4.4540    3.7678
         0         0         0         0         0         0    9.0994    0.4352
         0         0         0         0    0.0000         0         0    7.2068


P =

     1     0     0     0     0     0     0     0
     0     0     0     0     1     0     0     0
     0     0     0     0     0     1     0     0
     0     1     0     0     0     0     0     0
     0     0     0     0     0     0     1     0
     0     0     1     0     0     0     0     0
     0     0     0     1     0     0     0     0
     0     0     0     0     0     0     0     1


X =

    1.0000
    2.0000
    3.0000
    4.0000
    4.0000
    3.0000
    2.0000
    1.0000


t2 =

     0
```

```
>> ask1_LU_1_a_3()

A =

    1.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556    0.0526


condition_number =

   1.6025e+13


B =

   -0.4960
   -0.6148
   -0.5718
   -0.5186
   -0.4711
   -0.4305
   -0.3961
   -0.3666
   -0.3412
   -0.3191


L =

    1.0000         0         0         0         0         0         0         0         0         0
    0.3333    1.0000         0         0         0         0         0         0         0         0
    0.1250    0.5833    1.0000         0         0         0         0         0         0         0
    0.5000    1.0000   -0.8571    1.0000         0         0         0         0         0         0
    0.2000    0.8000    0.7837   -0.2857    1.0000         0         0         0         0         0
    0.1000    0.4909    0.9818    0.1469   -0.8811    1.0000         0         0         0         0
    0.2500    0.9000    0.5143   -0.2857    0.7500    0.2837    1.0000         0         0         0
    0.1667    0.7143    0.9184   -0.1984    0.8333   -0.2579   -0.5051    1.0000         0         0
    0.1111    0.5333    0.9974    0.0808   -0.4569    0.4444    0.1740   -0.7000    1.0000         0
    0.1429    0.6429    0.9796   -0.0952    0.4545   -0.2579   -0.3497    0.9643   -0.5204    1.0000


U =

    1.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
         0    0.0833    0.0889    0.0833    0.0762    0.0694    0.0635    0.0583    0.0539    0.0500
         0    0.0000    0.0065    0.0110    0.0139    0.0156    0.0165    0.0170    0.0172    0.0172
         0    0.0000         0    0.0011    0.0024    0.0034    0.0043    0.0049    0.0053    0.0056
         0   -0.0000         0         0   -0.0000   -0.0001   -0.0002   -0.0003   -0.0003   -0.0004
         0   -0.0000         0         0         0    0.0000    0.0000    0.0000    0.0000    0.0001
         0    0.0000         0         0         0         0   -0.0000   -0.0000   -0.0000   -0.0000
         0   -0.0000         0         0         0         0         0    0.0000    0.0000    0.0000
         0   -0.0000         0         0         0         0         0         0   -0.0000   -0.0000
         0   -0.0000         0         0         0         0         0         0         0   -0.0000


P =

     1     0     0     0     0     0     0     0     0     0
     0     0     1     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     1     0     0
     0     1     0     0     0     0     0     0     0     0
     0     0     0     0     1     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     1
     0     0     0     1     0     0     0     0     0     0
     0     0     0     0     0     1     0     0     0     0
     0     0     0     0     0     0     0     0     1     0
     0     0     0     0     0     0     1     0     0     0
```

```
X =

    1.0000
   -2.0000
    1.0000
   -2.0000
    0.9999
   -1.9997
    0.9995
   -1.9995
    0.9997
   -1.9999


t2 =

     0



>> ask1_LU_1_a_4(10)

A =

   10.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000   10.0000    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500   10.0000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667   10.0000    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250   10.0000    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000   10.0000    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833   10.0000    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714   10.0000    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625   10.0000    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556   10.0000


condition_number =

    1.1879


x =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1


B =

   11.9290
   11.6865
   11.4032
   11.2039
   11.0571
   10.9440
   10.8538
   10.7800
   10.7184
   10.6661


L =

    1.0000         0         0         0         0         0         0         0         0         0
    0.0500    1.0000         0         0         0         0         0         0         0         0
    0.0333    0.0234    1.0000         0         0         0         0         0         0         0
    0.0250    0.0188    0.0154    1.0000         0         0         0         0         0         0
    0.0200    0.0157    0.0133    0.0115    1.0000         0         0         0         0         0
    0.0167    0.0135    0.0116    0.0103    0.0092    1.0000         0         0         0         0
    0.0143    0.0118    0.0104    0.0093    0.0084    0.0076    1.0000         0         0         0
    0.0125    0.0105    0.0094    0.0084    0.0077    0.0071    0.0066    1.0000         0         0
    0.0111    0.0095    0.0085    0.0078    0.0071    0.0066    0.0061    0.0057    1.0000         0
    0.0100    0.0086    0.0078    0.0072    0.0066    0.0062    0.0058    0.0054    0.0051    1.0000
```

```
U =

   10.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
         0    9.9750    0.2333    0.1875    0.1567    0.1345    0.1179    0.1049    0.0944    0.0859
         0         0    9.9834    0.1539    0.1325    0.1163    0.1036    0.0934    0.0850    0.0780
         0    0.0000         0    9.9879    0.1150    0.1026    0.0926    0.0844    0.0775    0.0716
         0   -0.0000         0         0    9.9905    0.0918    0.0838    0.0770    0.0712    0.0662
         0   -0.0000         0         0         0    9.9922    0.0764    0.0708    0.0659    0.0616
         0   -0.0000   -0.0000         0   -0.0000         0    9.9933    0.0655    0.0613    0.0576
         0   -0.0000    0.0000         0    0.0000         0         0    9.9942    0.0573    0.0540
         0   -0.0000    0.0000         0    0.0000         0   -0.0000         0    9.9949    0.0509
         0   -0.0000   -0.0000         0    0.0000    0.0000    0.0000         0         0    9.9954


P =

     1     0     0     0     0     0     0     0     0     0
     0     1     0     0     0     0     0     0     0     0
     0     0     1     0     0     0     0     0     0     0
     0     0     0     1     0     0     0     0     0     0
     0     0     0     0     1     0     0     0     0     0
     0     0     0     0     0     1     0     0     0     0
     0     0     0     0     0     0     1     0     0     0
     0     0     0     0     0     0     0     1     0     0
     0     0     0     0     0     0     0     0     1     0
     0     0     0     0     0     0     0     0     0     1


X =

    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000


t2 =

     0
```

```
>> ask1_LU_1_a_5(10)

A =

    9.8147    0.1576    0.6557    0.7060    0.4387    0.2760    0.7513    0.8407    0.3517    0.0759
    0.9058    9.9706    0.0357    0.0318    0.3816    0.6797    0.2551    0.2543    0.8308    0.0540
    0.1270    0.9572    9.8491    0.2769    0.7655    0.6551    0.5060    0.8143    0.5853    0.5308
    0.9134    0.4854    0.9340    9.0462    0.7952    0.1626    0.6991    0.2435    0.5497    0.7792
    0.6324    0.8003    0.6787    0.0971    9.1869    0.1190    0.8909    0.9293    0.9172    0.9340
    0.0975    0.1419    0.7577    0.8235    0.4898    9.4984    0.9593    0.3500    0.2858    0.1299
    0.2785    0.4218    0.7431    0.6948    0.4456    0.9597    9.5472    0.1966    0.7572    0.5688
    0.5469    0.9157    0.3922    0.3171    0.6463    0.3404    0.1386    9.2511    0.7537    0.4694
    0.9575    0.7922    0.6555    0.9502    0.7094    0.5853    0.1493    0.6160    9.3804    0.0119
    0.9649    0.9595    0.1712    0.0344    0.7547    0.2238    0.2575    0.4733    0.5678    9.3371


x =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1
```

B =

```
   14.0684
   13.3993
   15.0671
   14.6082
   15.1857
   13.5338
   14.6134
   13.7715
   14.8077
   13.7443
```

L =

1.0000	0	0	0	0	0	0	0	0	0
0.0923	1.0000	0	0	0	0	0	0	0	0
0.0129	0.0959	1.0000	0	0	0	0	0	0	0
0.0931	0.0473	0.0888	1.0000	0	0	0	0	0	0
0.0644	0.0794	0.0649	0.0041	1.0000	0	0	0	0	0
0.0099	0.0141	0.0764	0.0889	0.0402	1.0000	0	0	0	0
0.0284	0.0419	0.0737	0.0733	0.0348	0.0929	1.0000	0	0	0
0.0557	0.0911	0.0364	0.0302	0.0599	0.0256	-0.0026	1.0000	0	0
0.0976	0.0780	0.0603	0.0969	0.0585	0.0494	-0.0119	0.0446	1.0000	0
0.0983	0.0948	0.0111	-0.0039	0.0742	0.0135	0.0099	0.0331	0.0402	1.0000

U =

9.8147	0.1576	0.6557	0.7060	0.4387	0.2760	0.7513	0.8407	0.3517	0.0759
0	9.9560	-0.0248	-0.0333	0.3411	0.6542	0.1858	0.1767	0.7984	0.0469
0	0	9.8430	0.2710	0.7271	0.5888	0.4784	0.7865	0.5041	0.5253
0	0	0.0000	8.9580	0.6737	0.0537	0.5779	0.0871	0.4345	0.7232
0	0	-0.0000	0	9.0816	0.0109	0.7944	0.8097	0.7967	0.8884
0	0	-0.0000	0	0	9.4362	0.8294	0.2388	0.1619	-0.0116
0	0	-0.0000	0	0	0	9.3358	0.0506	0.6020	0.4432
0	0	-0.0000	0	0	0	0	9.1024	0.5796	0.3681
0	0	-0.0000	0	0	0	0	0	9.1381	-0.1634
0	0	-0.0000	0	0	0	0	0	-0.0000	9.2464

P =

1	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0
0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	1

X =

```
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
```

error =

```
   4.4409e-16
```

remainder =

```
   1.7764e-15
```

condition_number =

```
    1.7796
```

```
t2 =

     0
```

```
>> ask1_LU_1_a_5(100)
>> ask1_LU_1_a_5(500)
>> ask1_LU_1_a_5(1000)
```

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	2.3315e-15	2.2737e-13	1.5636	0.0781
500	6.1062e-15	2.9559e-12	1.5290	0.8906
1000	9.3259e-15	1.0004e-11	1.5203	11.3750

>> Τυχαίος Πίνακας του Moler

```
>> ask1_LU_1_a_6(100)
>> ask1_LU_1_a_6(500)
>> ask1_LU_1_a_6(1000)
```

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	6.9373e-12	1.8190e-12	5.7458e+03	0.0625
500	1.4030e-10	4.9113e-11	1.7063e+04	0.8438
1000	4.0866e-10	1.0550e-10	2.1989e+04	10.8750

Β. Υπολογισμός Αντιστρόφου

```
>> ask1_LU_1_b_1()

A =

     5     7     6     5
     7    10     8     7
     6     8    10     9
     5     7     9    10


condition_number =

   2.9841e+03


IA =

  -41.0000  -17.0000   10.0000   68.0000
   25.0000   10.0000   -6.0000  -41.0000
   10.0000    5.0000   -3.0000  -17.0000
   -6.0000   -3.0000    2.0000   10.0000


t2 =

     0
```

```
>> ask1_LU_1_b_2(10)

A =

    10     1     1     1     1     1     1     1     1     1
     1    10     1     1     1     1     1     1     1     1
     1     1    10     1     1     1     1     1     1     1
     1     1     1    10     1     1     1     1     1     1
     1     1     1     1    10     1     1     1     1     1
     1     1     1     1     1    10     1     1     1     1
     1     1     1     1     1     1    10     1     1     1
     1     1     1     1     1     1     1    10     1     1
     1     1     1     1     1     1     1     1    10     1
     1     1     1     1     1     1     1     1     1    10
```

```
condition_number =

    2.1111


IA =

    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053

t2 =

     0




>> ask1_LU_1_b_3(10)

A =

    1.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556    0.0526


IA =

   1.0e+12 *

    0.0000    0.0000   -0.0000   -0.0000    0.0000   -0.0000   -0.0000   -0.0000    0.0000    0.0000
   -0.0000   -0.0000    0.0008    0.0000   -0.0002    0.0001    0.0000    0.0005   -0.0004   -0.0008
    0.0000    0.0001   -0.0166   -0.0000    0.0043   -0.0018   -0.0010   -0.0112    0.0085    0.0178
   -0.0000   -0.0010    0.1529    0.0000   -0.0379    0.0171    0.0082    0.1010   -0.0788   -0.1616
    0.0000    0.0043   -0.7358   -0.0002    0.1767   -0.0832   -0.0379   -0.4772    0.3820    0.7712
   -0.0000   -0.0112    2.0376    0.0005   -0.4772    0.2330    0.1010    1.3014   -1.0643   -2.1208
    0.0000    0.0178   -3.3636   -0.0008    0.7712   -0.3883   -0.1616   -2.1208    1.7659    3.4803
   -0.0000   -0.0166    3.2675    0.0008   -0.7358    0.3804    0.1529    2.0376   -1.7231   -3.3636
    0.0000    0.0085   -1.7231   -0.0004    0.3820   -0.2021   -0.0788   -1.0643    0.9122    1.7659
   -0.0000   -0.0018    0.3804    0.0001   -0.0832    0.0449    0.0171    0.2330   -0.2021   -0.3883

t2 =

     0


C =

   1.0e+12 *

    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000
   -0.0000    0.0000   -0.0000    0.0000   -0.0002    0.0005   -0.0008    0.0008   -0.0004    0.0001
    0.0000   -0.0000    0.0001   -0.0010    0.0043   -0.0112    0.0178   -0.0166    0.0085   -0.0018
   -0.0000    0.0000   -0.0010    0.0082   -0.0379    0.1010   -0.1616    0.1529   -0.0788    0.0171
    0.0000   -0.0002    0.0043   -0.0379    0.1768   -0.4772    0.7713   -0.7359    0.3821   -0.0832
   -0.0000    0.0005   -0.0112    0.1010   -0.4772    1.3015   -2.1210    2.0378   -1.0644    0.2330
    0.0000   -0.0008    0.0178   -0.1616    0.7713   -2.1210    3.4807   -3.3640    1.7661   -0.3884
   -0.0000    0.0008   -0.0166    0.1529   -0.7359    2.0378   -3.3640    3.2679   -1.7233    0.3804
    0.0000   -0.0004    0.0085   -0.0788    0.3821   -1.0644    1.7661   -1.7233    0.9123   -0.2021
   -0.0000    0.0001   -0.0018    0.0171   -0.0832    0.2330   -0.3884    0.3804   -0.2021    0.0449
```

```
ans =

    1.0000   -0.0000    0.0048    0.0000   -0.0011    0.0006    0.0002    0.0029   -0.0025   -0.0049
   -0.0000   -0.0000    0.0037    1.0000   -0.0009    0.0004    0.0002    0.0023   -0.0020   -0.0038
   -0.0000    1.0000    0.0031    0.0000   -0.0007    0.0004    0.0001    0.0019   -0.0017   -0.0032
   -0.0000   -0.0000    0.0027    0.0000   -0.0006    0.0003    1.0001    0.0016   -0.0014   -0.0027
   -0.0000   -0.0000    0.0024    0.0000    0.9995    0.0003    0.0001    0.0014   -0.0012   -0.0024
   -0.0000   -0.0000    0.0021    0.0000   -0.0005    0.0002    0.0001    1.0013   -0.0011   -0.0022
   -0.0000   -0.0000    0.0019    0.0000   -0.0004    0.0002    0.0001    0.0012   -0.0010    0.9980
   -0.0000   -0.0000    1.0017    0.0000   -0.0004    0.0002    0.0001    0.0010   -0.0009   -0.0018
   -0.0000   -0.0000    0.0016    0.0000   -0.0004    0.0002    0.0001    0.0010    0.9992   -0.0017
   -0.0000   -0.0000    0.0015    0.0000   -0.0003    1.0002    0.0001    0.0009   -0.0008   -0.0015


error =

    1.1637


remainder =

   9.1450e+12


condition_number =

   1.6025e+13


t2 =

     0


>> ask1_LU_1_b_4(10)

A =

    9.1141    0.5633    0.0171    0.9693    0.7313    0.3075    0.3789    0.1919    0.5377    0.2685
    0.7960    9.3203    0.4566    0.1229    0.3759    0.0974    0.1975    0.4279    0.2504    0.2884
    0.1802    0.1313    9.3103    0.8030    0.7398    0.1362    0.1556    0.3071    0.2776    0.4379
    0.6593    0.5260    0.5428    9.9896    0.8429    0.7079    0.0860    0.5179    0.9721    0.6899
    0.8975    0.5582    0.3033    0.9367    9.7127    0.4836    0.5680    0.0691    0.2813    0.8236
    0.9818    0.2644    0.6574    0.6651    0.7226    9.7843    0.9443    0.7203    0.7949    0.6862
    0.0888    0.6283    0.9960    0.7258    0.4088    0.4762    9.3978    0.2837    0.7747    0.7903
    0.5306    0.8065    0.4209    0.8224    0.6401    0.0610    0.4982    9.0421    0.8310    0.9550
    0.0229    0.5331    0.3999    0.3216    0.4888    0.6526    0.1951    0.9437    9.7956    0.2193
    0.7712    0.6735    0.6824    0.0880    0.5631    0.9565    0.3461    0.8167    0.9853    9.8825


condition_number =

    1.7756


IA =

    0.1119   -0.0051    0.0017   -0.0097   -0.0069   -0.0019   -0.0036   -0.0008   -0.0043   -0.0011
   -0.0087    0.1087   -0.0047    0.0007   -0.0027   -0.0003   -0.0013   -0.0044   -0.0015   -0.0020
   -0.0004   -0.0000    0.1086   -0.0076   -0.0071   -0.0001   -0.0010   -0.0027   -0.0014   -0.0033
   -0.0051   -0.0038   -0.0044    0.1025   -0.0067   -0.0058    0.0010   -0.0036   -0.0083   -0.0053
   -0.0084   -0.0044   -0.0014   -0.0083    0.1054   -0.0033   -0.0053    0.0012   -0.0003   -0.0072
   -0.0095    0.0000   -0.0051   -0.0037   -0.0050    0.1044   -0.0091   -0.0064   -0.0056   -0.0046
    0.0013   -0.0057   -0.0097   -0.0063   -0.0021   -0.0034    0.1076   -0.0009   -0.0064   -0.0070
   -0.0042   -0.0074   -0.0028   -0.0076   -0.0050    0.0019   -0.0050    0.1132   -0.0071   -0.0091
    0.0020   -0.0046   -0.0030   -0.0016   -0.0037   -0.0065   -0.0007   -0.0099    0.1039   -0.0002
   -0.0066   -0.0054   -0.0058    0.0022   -0.0034   -0.0091   -0.0017   -0.0072   -0.0084    0.1036


ans =

    1.0000   -0.0000   -0.0000    0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000
   -0.0000    1.0000   -0.0000   -0.0000    0.0000    0.0000   -0.0000    0.0000   -0.0000         0
   -0.0000    0.0000    1.0000   -0.0000    0.0000         0   -0.0000    0.0000    0.0000         0
   -0.0000    0.0000   -0.0000    1.0000    0.0000    0.0000   -0.0000    0.0000   -0.0000         0
   -0.0000   -0.0000   -0.0000   -0.0000    1.0000    0.0000   -0.0000         0    0.0000         0
   -0.0000    0.0000    0.0000   -0.0000   -0.0000    1.0000   -0.0000   -0.0000   -0.0000   -0.0000
   -0.0000   -0.0000   -0.0000   -0.0000   -0.0000         0    1.0000   -0.0000   -0.0000   -0.0000
   -0.0000   -0.0000   -0.0000   -0.0000    0.0000    0.0000    0.0000    1.0000   -0.0000    0.0000
   -0.0000   -0.0000   -0.0000    0.0000   -0.0000    0.0000    0.0000   -0.0000    1.0000    0.0000
         0   -0.0000   -0.0000    0.0000         0   -0.0000   -0.0000         0         0    1.0000
```

```
t2 =

     0
```

```
>> ask1_LU_1_b_2(100)
>> ask1_LU_1_b_2(500)
>> ask1_LU_1_b_2(1000)
```

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	1.1795e-15	66.3317	2.0101	0.0625
500	1.7929e-15	332.9997	2.0020	1.1406
1000	2.0481e-15	666.3332	2.0010	12.2969

2. Τριγωνική Διαχώριση Cholesky LL^T

Α. Επίλυση γραμμικού συστήματος

```
>> ask1_LLT_2_a_1()

A =

     5     7     6     5
     7    10     8     7
     6     8    10     9
     5     7     9    10


condition_number =

   2.9841e+03


B =

    23
    32
    33
    31

Given Matrix is Positive definite

L =

    2.2361         0         0         0
    3.1305    0.4472         0         0
    2.6833   -0.8944    1.4142         0
    2.2361         0    2.1213    0.7071


IL =

    2.2361    3.1305    2.6833    2.2361
         0    0.4472   -0.8944         0
         0         0    1.4142    2.1213
         0         0         0    0.7071


X =

    1.0000
    1.0000
    1.0000
    1.0000


t2 =

    0.0156
```

```
>> ask1_LLT_2_a_2()

A =

     2    -1    -1    -1    -1
    -1     2     0     0     0
    -1     0     3     1     1
    -1     0     1     4     2
    -1     0     1     2     5


condition_number =

   11.1504


B =

    -2
     1
     4
     6
     7

Given Matrix is Positive definite



L =

    1.4142         0         0         0         0
   -0.7071    1.2247         0         0         0
   -0.7071   -0.4082    1.5275         0         0
   -0.7071   -0.4082    0.2182    1.8127         0
   -0.7071   -0.4082    0.2182    0.7093    1.9449


IL =

    1.4142   -0.7071   -0.7071   -0.7071   -0.7071
         0    1.2247   -0.4082   -0.4082   -0.4082
         0         0    1.5275    0.2182    0.2182
         0         0         0    1.8127    0.7093
         0         0         0         0    1.9449


X =

    1.0000
    1.0000
    1.0000
    1.0000
    1.0000


t2 =

     0



>> ask1_LLT_2_a_3()

A =

     1     1     1     1     1
     1     2     3     4     5
     1     3     6    10    15
     1     4    10    20    35
     1     5    15    35    70


condition_number =

   8.5175e+03


B =

     5
    15
    35
    70
   126
```

```
Given Matrix is Positive definite

L =

     1     0     0     0     0
     1     1     0     0     0
     1     2     1     0     0
     1     3     3     1     0
     1     4     6     4     1


IL =

     1     1     1     1     1
     0     1     2     3     4
     0     0     1     3     6
     0     0     0     1     4
     0     0     0     0     1


X =

     1
     1
     1
     1
     1


t2 =

     0




>> ask1_LLT_2_a_4()

A =

           1           1           1           1           1           1           1           1
           1           2           3           4           5           6           7           8
           1           3           6          10          15          21          28          36
           1           4          10          20          35          56          84         120
           1           5          15          35          70         126         210         330
           1           6          21          56         126         252         462         792
           1           7          28          84         210         462         924        1716
           1           8          36         120         330         792        1716        3432


condition_number =

   2.0645e+07


B =

           8
          36
         120
         330
         792
        1716
        3432
        6435

Given Matrix is Positive definite

L =

     1     0     0     0     0     0     0     0
     1     1     0     0     0     0     0     0
     1     2     1     0     0     0     0     0
     1     3     3     1     0     0     0     0
     1     4     6     4     1     0     0     0
     1     5    10    10     5     1     0     0
     1     6    15    20    15     6     1     0
     1     7    21    35    35    21     7     1
```

```
IL =

     1     1     1     1     1     1     1     1
     0     1     2     3     4     5     6     7
     0     0     1     3     6    10    15    21
     0     0     0     1     4    10    20    35
     0     0     0     0     1     5    15    35
     0     0     0     0     0     1     6    21
     0     0     0     0     0     0     1     7
     0     0     0     0     0     0     0     1


X =

     1
     1
     1
     1
     1
     1
     1
     1


t2 =

     0
```

```
>> ask1_LLT_2_a_5(10)

A =

    1     1     1     1     1     1     1     1     1     1
    1     2     3     4     5     6     7     8     9    10
    1     3     6    10    15    21    28    36    45    55
    1     4    10    20    35    56    84   120   165   220
    1     5    15    35    70   126   210   330   495   715
    1     6    21    56   126   252   462   792  1287  2002
    1     7    28    84   210   462   924  1716  3003  5005
    1     8    36   120   330   792  1716  3432  6435 11440
    1     9    45   165   495  1287  3003  6435 12870 24310
    1    10    55   220   715  2002  5005 11440 24310 48620


condition_number =

   4.1552e+09


x =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1


B =

    10
    55
   220
   715
  2002
  5005
 11440
 24310
 48620
 92378

Given Matrix is Positive definite
```

```
L =

     1     0     0     0     0     0     0     0     0     0
     1     1     0     0     0     0     0     0     0     0
     1     2     1     0     0     0     0     0     0     0
     1     3     3     1     0     0     0     0     0     0
     1     4     6     4     1     0     0     0     0     0
     1     5    10    10     5     1     0     0     0     0
     1     6    15    20    15     6     1     0     0     0
     1     7    21    35    35    21     7     1     0     0
     1     8    28    56    70    56    28     8     1     0
     1     9    36    84   126   126    84    36     9     1


IL =

     1     1     1     1     1     1     1     1     1     1
     0     1     2     3     4     5     6     7     8     9
     0     0     1     3     6    10    15    21    28    36
     0     0     0     1     4    10    20    35    56    84
     0     0     0     0     1     5    15    35    70   126
     0     0     0     0     0     1     6    21    56   126
     0     0     0     0     0     0     1     7    28    84
     0     0     0     0     0     0     0     1     8    36
     0     0     0     0     0     0     0     0     1     9
     0     0     0     0     0     0     0     0     0     1


X =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1


t2 =

     0



>> ask1_LLT_2_a_6(10)

A =

   10.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000   10.0000    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500   10.0000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667   10.0000    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250   10.0000    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000   10.0000    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833   10.0000    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714   10.0000    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625   10.0000    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556   10.0000


condition_number =

    1.1879


x =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1
```

```
B =

   11.9290
   11.6865
   11.4032
   11.2039
   11.0571
   10.9440
   10.8538
   10.7800
   10.7184
   10.6661

Given Matrix is Positive definite

L =

    3.1623         0         0         0         0         0         0         0         0         0
    0.1581    3.1583         0         0         0         0         0         0         0         0
    0.1054    0.0739    3.1597         0         0         0         0         0         0         0
    0.0791    0.0594    0.0487    3.1604         0         0         0         0         0         0
    0.0632    0.0496    0.0419    0.0364    3.1608         0         0         0         0         0
    0.0527    0.0426    0.0368    0.0325    0.0291    3.1610         0         0         0         0
    0.0452    0.0373    0.0328    0.0293    0.0265    0.0242    3.1612         0         0         0
    0.0395    0.0332    0.0296    0.0267    0.0244    0.0224    0.0207    3.1614         0         0
    0.0351    0.0299    0.0269    0.0245    0.0225    0.0208    0.0194    0.0181    3.1615         0
    0.0316    0.0272    0.0247    0.0227    0.0210    0.0195    0.0182    0.0171    0.0161    3.1616


IL =

    3.1623    0.1581    0.1054    0.0791    0.0632    0.0527    0.0452    0.0395    0.0351    0.0316
         0    3.1583    0.0739    0.0594    0.0496    0.0426    0.0373    0.0332    0.0299    0.0272
         0         0    3.1597    0.0487    0.0419    0.0368    0.0328    0.0296    0.0269    0.0247
         0         0         0    3.1604    0.0364    0.0325    0.0293    0.0267    0.0245    0.0227
         0         0         0         0    3.1608    0.0291    0.0265    0.0244    0.0225    0.0210
         0         0         0         0         0    3.1610    0.0242    0.0224    0.0208    0.0195
         0         0         0         0         0         0    3.1612    0.0207    0.0194    0.0182
         0         0         0         0         0         0         0    3.1614    0.0181    0.0171
         0         0         0         0         0         0         0         0    3.1615    0.0161
         0         0         0         0         0         0         0         0         0    3.1616


X =

    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000


t2 =

     0




>> ask1_LLT_2_a_7(10)

A =

    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584
    0.5584    1.3118    0.8702    0.8702    0.8702    0.8702    0.8702    0.8702    0.8702    0.8702
    0.5584    0.8702    1.6236    1.1820    1.1820    1.1820    1.1820    1.1820    1.1820    1.1820
    0.5584    0.8702    1.1820    1.9354    1.4938    1.4938    1.4938    1.4938    1.4938    1.4938
    0.5584    0.8702    1.1820    1.4938    2.2472    1.8056    1.8056    1.8056    1.8056    1.8056
    0.5584    0.8702    1.1820    1.4938    1.8056    2.5590    2.1174    2.1174    2.1174    2.1174
    0.5584    0.8702    1.1820    1.4938    1.8056    2.1174    2.8708    2.4292    2.4292    2.4292
    0.5584    0.8702    1.1820    1.4938    1.8056    2.1174    2.4292    3.1826    2.7410    2.7410
    0.5584    0.8702    1.1820    1.4938    1.8056    2.1174    2.4292    2.7410    3.4944    3.0528
    0.5584    0.8702    1.1820    1.4938    1.8056    2.1174    2.4292    2.7410    3.0528    3.8062
```

```
x =

     1
     1
     1
     1
     1
     1
     1
     1
     1
     1


B =

    6.0255
    8.8316
   11.3260
   13.5086
   15.3794
   16.9383
   18.1855
   19.1209
   19.7445
   20.0563

Given Matrix is Positive definite

L =

    1.0000         0         0         0         0         0         0         0         0         0
    0.5584    1.0000         0         0         0         0         0         0         0         0
    0.5584    0.5584    1.0000         0         0         0         0         0         0         0
    0.5584    0.5584    0.5584    1.0000         0         0         0         0         0         0
    0.5584    0.5584    0.5584    0.5584    1.0000         0         0         0         0         0
    0.5584    0.5584    0.5584    0.5584    0.5584    1.0000         0         0         0         0
    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    1.0000         0         0         0
    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    1.0000         0         0
    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    1.0000         0
    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    1.0000


IL =

    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584
         0    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584
         0         0    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584
         0         0         0    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584    0.5584
         0         0         0         0    1.0000    0.5584    0.5584    0.5584    0.5584    0.5584
         0         0         0         0         0    1.0000    0.5584    0.5584    0.5584    0.5584
         0         0         0         0         0         0    1.0000    0.5584    0.5584    0.5584
         0         0         0         0         0         0         0    1.0000    0.5584    0.5584
         0         0         0         0         0         0         0         0    1.0000    0.5584
         0         0         0         0         0         0         0         0         0    1.0000


X =

    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000
    1.0000


error =

   4.4409e-15


remainder =

   3.5527e-15


condition_number =

   31.7276
```

```
t2 =

     0
```

```
>> ask1_LLT_2_a_7(100)
>> ask1_LLT_2_a_7(500)
>> ask1_LLT_2_a_7(1000)
```

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	2.0188e-12	6.8212e-13	1.2654e+03	0.0469
500	1.0719e-10	3.4561e-11	1.2701e+04	6.7656
1000	1.2483e-08	2.4447e-09	1.1540e+06	75.4219

Β. Υπολογισμός Αντιστρόφου

```
>> ask1_LLT_2_b_1()

A =

     5     7     6     5
     7    10     8     7
     6     8    10     9
     5     7     9    10


condition_number =

   2.9841e+03

Given Matrix is Positive definite

IA =

   68.0000  -41.0000  -17.0000   10.0000
  -41.0000   25.0000   10.0000   -6.0000
  -17.0000   10.0000    5.0000   -3.0000
   10.0000   -6.0000   -3.0000    2.0000


t2 =

     0
```

```
>> ask1_LLT_2_b_2(10)

A =

    10     1     1     1     1     1     1     1     1     1
     1    10     1     1     1     1     1     1     1     1
     1     1    10     1     1     1     1     1     1     1
     1     1     1    10     1     1     1     1     1     1
     1     1     1     1    10     1     1     1     1     1
     1     1     1     1     1    10     1     1     1     1
     1     1     1     1     1     1    10     1     1     1
     1     1     1     1     1     1     1    10     1     1
     1     1     1     1     1     1     1     1    10     1
     1     1     1     1     1     1     1     1     1    10


condition_number =

    2.1111

Given Matrix is Positive definite
```

```
IA =

    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053


t2 =

     0


C =

    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053   -0.0058
   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058   -0.0058    0.1053


ans =

    1.0000   -0.0000   -0.0000   -0.0000    0.0000   -0.0000   -0.0000   -0.0000   -0.0000         0
    0.0000    1.0000    0.0000    0.0000    0.0000    0.0000    0.0000   -0.0000   -0.0000    0.0000
   -0.0000    0.0000    1.0000    0.0000    0.0000    0.0000    0.0000   -0.0000   -0.0000    0.0000
   -0.0000   -0.0000   -0.0000    1.0000    0.0000   -0.0000    0.0000   -0.0000   -0.0000    0.0000
   -0.0000    0.0000   -0.0000    0.0000    1.0000   -0.0000    0.0000   -0.0000   -0.0000    0.0000
   -0.0000   -0.0000   -0.0000    0.0000   -0.0000    1.0000    0.0000   -0.0000   -0.0000    0.0000
   -0.0000   -0.0000   -0.0000    0.0000    0.0000    0.0000    1.0000    0.0000         0    0.0000
   -0.0000   -0.0000   -0.0000   -0.0000    0.0000    0.0000    0.0000    1.0000   -0.0000         0
    0.0000         0    0.0000    0.0000    0.0000    0.0000    0.0000   -0.0000    1.0000    0.0000
   -0.0000   -0.0000         0         0         0    0.0000         0   -0.0000   -0.0000    1.0000


error =

   2.3072e-16


remainder =

    6.3158


condition_number =

    2.1111


t2 =

     0




>> ask1_LLT_2_b_3(10)

A =

    1.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556    0.0526
```

```
condition_number =

   1.6025e+13

Given Matrix is Positive definite

IA =

   1.0e+12 *

    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000
   -0.0000    0.0000   -0.0000    0.0000   -0.0002    0.0005   -0.0008    0.0008   -0.0004    0.0001
    0.0000   -0.0000    0.0001   -0.0010    0.0043   -0.0112    0.0178   -0.0166    0.0085   -0.0018
   -0.0000    0.0000   -0.0010    0.0082   -0.0379    0.1010   -0.1616    0.1529   -0.0788    0.0171
    0.0000   -0.0002    0.0043   -0.0379    0.1767   -0.4772    0.7712   -0.7358    0.3820   -0.0832
   -0.0000    0.0005   -0.0112    0.1010   -0.4772    1.3014   -2.1208    2.0375   -1.0642    0.2330
    0.0000   -0.0008    0.0178   -0.1616    0.7712   -2.1208    3.4802   -3.3636    1.7659   -0.3883
   -0.0000    0.0008   -0.0166    0.1529   -0.7358    2.0375   -3.3636    3.2675   -1.7231    0.3804
    0.0000   -0.0004    0.0085   -0.0788    0.3820   -1.0642    1.7659   -1.7231    0.9122   -0.2021
   -0.0000    0.0001   -0.0018    0.0171   -0.0832    0.2330   -0.3883    0.3804   -0.2021    0.0449


t2 =

     0


C =

   1.0e+12 *

    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000    0.0000   -0.0000
   -0.0000    0.0000   -0.0000    0.0000   -0.0002    0.0005   -0.0008    0.0008   -0.0004    0.0001
    0.0000   -0.0000    0.0001   -0.0010    0.0043   -0.0112    0.0178   -0.0166    0.0085   -0.0018
   -0.0000    0.0000   -0.0010    0.0082   -0.0379    0.1010   -0.1616    0.1529   -0.0788    0.0171
    0.0000   -0.0002    0.0043   -0.0379    0.1768   -0.4772    0.7713   -0.7359    0.3821   -0.0832
   -0.0000    0.0005   -0.0112    0.1010   -0.4772    1.3015   -2.1210    2.0378   -1.0644    0.2330
    0.0000   -0.0008    0.0178   -0.1616    0.7713   -2.1210    3.4807   -3.3640    1.7661   -0.3884
   -0.0000    0.0008   -0.0166    0.1529   -0.7359    2.0378   -3.3640    3.2679   -1.7233    0.3804
    0.0000   -0.0004    0.0085   -0.0788    0.3821   -1.0644    1.7661   -1.7233    0.9123   -0.2021
   -0.0000    0.0001   -0.0018    0.0171   -0.0832    0.2330   -0.3884    0.3804   -0.2021    0.0449


ans =

    1.0000   -0.0000    0.0000   -0.0001    0.0005   -0.0014    0.0023   -0.0022    0.0011   -0.0003
    0.0000    1.0000    0.0000   -0.0001    0.0004   -0.0011    0.0019   -0.0019    0.0009   -0.0002
    0.0000   -0.0000    1.0000   -0.0001    0.0004   -0.0010    0.0016   -0.0016    0.0008   -0.0002
    0.0000   -0.0000    0.0000    0.9999    0.0003   -0.0009    0.0015   -0.0015    0.0007   -0.0002
    0.0000   -0.0000    0.0000   -0.0001    1.0003   -0.0008    0.0013   -0.0013    0.0007   -0.0001
    0.0000   -0.0000    0.0000   -0.0001    0.0003    0.9993    0.0012   -0.0012    0.0006   -0.0001
    0.0000   -0.0000    0.0000   -0.0000    0.0002   -0.0006    1.0010   -0.0011    0.0005   -0.0001
    0.0000   -0.0000    0.0000   -0.0000    0.0002   -0.0006    0.0010    0.9990    0.0005   -0.0001
    0.0000   -0.0000    0.0000   -0.0000    0.0002   -0.0005    0.0009   -0.0009    1.0005   -0.0001
    0.0000   -0.0000    0.0000   -0.0000    0.0002   -0.0005    0.0008   -0.0009    0.0004    0.9999


error =

   1.2410e-04


remainder =

   9.1448e+12


condition_number =

   1.6025e+13


t2 =

     0
```

```
>> ask1_LLT_2_b_4

A =

     1     1     1     1     1     1     1     1
     1     2     3     4     5     6     7     8
     1     3     6    10    15    21    28    36
     1     4    10    20    35    56    84   120
     1     5    15    35    70   126   210   330
     1     6    21    56   126   252   462   792
     1     7    28    84   210   462   924  1716
     1     8    36   120   330   792  1716  3432


condition_number =

   2.0645e+07

Given Matrix is Positive definite

IA =

   1.0e+03 *

    0.0080   -0.0280    0.0560   -0.0700    0.0560   -0.0280    0.0080   -0.0010
   -0.0280    0.1400   -0.3220    0.4340   -0.3640    0.1880   -0.0550    0.0070
    0.0560   -0.3220    0.8120   -1.1620    1.0160   -0.5410    0.1620   -0.0210
   -0.0700    0.4340   -1.1620    1.7420   -1.5790    0.8650   -0.2650    0.0350
    0.0560   -0.3640    1.0160   -1.5790    1.4760   -0.8300    0.2600   -0.0350
   -0.0280    0.1880   -0.5410    0.8650   -0.8300    0.4780   -0.1530    0.0210
    0.0080   -0.0550    0.1620   -0.2650    0.2600   -0.1530    0.0500   -0.0070
   -0.0010    0.0070   -0.0210    0.0350   -0.0350    0.0210   -0.0070    0.0010


t2 =

     0


>> ask1_LLT_2_b_5(10)

A =

     1     1     1     1     1     1     1     1     1     1
     1     2     3     4     5     6     7     8     9    10
     1     3     6    10    15    21    28    36    45    55
     1     4    10    20    35    56    84   120   165   220
     1     5    15    35    70   126   210   330   495   715
     1     6    21    56   126   252   462   792  1287  2002
     1     7    28    84   210   462   924  1716  3003  5005
     1     8    36   120   330   792  1716  3432  6435 11440
     1     9    45   165   495  1287  3003  6435 12870 24310
     1    10    55   220   715  2002  5005 11440 24310 48620


condition_number =

   4.1552e+09

Given Matrix is Positive definite

IA =

   1.0e+04 *

    0.0010   -0.0045    0.0120   -0.0210    0.0252   -0.0210    0.0120   -0.0045    0.0010   -0.0001
   -0.0045    0.0285   -0.0870    0.1638   -0.2058    0.1770   -0.1035    0.0395   -0.0089    0.0009
    0.0120   -0.0870    0.2892   -0.5754    0.7512   -0.6645    0.3970   -0.1541    0.0352   -0.0036
   -0.0210    0.1638   -0.5754    1.1934   -1.6083    1.4585   -0.8889    0.3507   -0.0812    0.0084
    0.0252   -0.2058    0.7512   -1.6083    2.2252   -2.0626    1.2804   -0.5131    0.1204   -0.0126
   -0.0210    0.1770   -0.6645    1.4585   -2.0626    1.9490   -1.2305    0.5005   -0.1190    0.0126
    0.0120   -0.1035    0.3970   -0.8889    1.2804   -1.2305    0.7890   -0.3255    0.0784   -0.0084
   -0.0045    0.0395   -0.1541    0.3507   -0.5131    0.5005   -0.3255    0.1361   -0.0332    0.0036
    0.0010   -0.0089    0.0352   -0.0812    0.1204   -0.1190    0.0784   -0.0332    0.0082   -0.0009
   -0.0001    0.0009   -0.0036    0.0084   -0.0126    0.0126   -0.0084    0.0036   -0.0009    0.0001


t2 =

     0
```

```
>> ask1_LLT_2_b_6(10)

A =

   10.0000    0.5000    0.3333    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000
    0.5000   10.0000    0.2500    0.2000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909
    0.3333    0.2500   10.0000    0.1667    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833
    0.2500    0.2000    0.1667   10.0000    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769
    0.2000    0.1667    0.1429    0.1250   10.0000    0.1000    0.0909    0.0833    0.0769    0.0714
    0.1667    0.1429    0.1250    0.1111    0.1000   10.0000    0.0833    0.0769    0.0714    0.0667
    0.1429    0.1250    0.1111    0.1000    0.0909    0.0833   10.0000    0.0714    0.0667    0.0625
    0.1250    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714   10.0000    0.0625    0.0588
    0.1111    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625   10.0000    0.0556
    0.1000    0.0909    0.0833    0.0769    0.0714    0.0667    0.0625    0.0588    0.0556   10.0000


cond_num =

    1.1879

Given Matrix is Positive definite

IA =

    0.1005   -0.0048   -0.0031   -0.0023   -0.0018   -0.0015   -0.0013   -0.0011   -0.0010   -0.0009
   -0.0048    0.1004   -0.0022   -0.0018   -0.0015   -0.0013   -0.0011   -0.0010   -0.0009   -0.0008
   -0.0031   -0.0022    0.1003   -0.0015   -0.0013   -0.0011   -0.0010   -0.0009   -0.0008   -0.0007
   -0.0023   -0.0018   -0.0015    0.1002   -0.0011   -0.0010   -0.0009   -0.0008   -0.0007   -0.0007
   -0.0018   -0.0015   -0.0013   -0.0011    0.1001   -0.0009   -0.0008   -0.0008   -0.0007   -0.0006
   -0.0015   -0.0013   -0.0011   -0.0010   -0.0009    0.1001   -0.0008   -0.0007   -0.0006   -0.0006
   -0.0013   -0.0011   -0.0010   -0.0009   -0.0008   -0.0008    0.1001   -0.0006   -0.0006   -0.0006
   -0.0011   -0.0010   -0.0009   -0.0008   -0.0008   -0.0007   -0.0006    0.1001   -0.0006   -0.0005
   -0.0010   -0.0009   -0.0008   -0.0007   -0.0007   -0.0006   -0.0006   -0.0006    0.1001   -0.0005
   -0.0009   -0.0008   -0.0007   -0.0007   -0.0006   -0.0006   -0.0006   -0.0005   -0.0005    0.1000


t2 =

    0.0313



>> ask1_LLT_2_b_7(10)

A =

    1.0000    0.7277    0.7277    0.7277    0.7277    0.7277    0.7277    0.7277    0.7277    0.7277
    0.7277    1.5295    1.2572    1.2572    1.2572    1.2572    1.2572    1.2572    1.2572    1.2572
    0.7277    1.2572    2.0590    1.7867    1.7867    1.7867    1.7867    1.7867    1.7867    1.7867
    0.7277    1.2572    1.7867    2.5885    2.3162    2.3162    2.3162    2.3162    2.3162    2.3162
    0.7277    1.2572    1.7867    2.3162    3.1180    2.8457    2.8457    2.8457    2.8457    2.8457
    0.7277    1.2572    1.7867    2.3162    2.8457    3.6475    3.3752    3.3752    3.3752    3.3752
    0.7277    1.2572    1.7867    2.3162    2.8457    3.3752    4.1770    3.9047    3.9047    3.9047
    0.7277    1.2572    1.7867    2.3162    2.8457    3.3752    3.9047    4.7065    4.4342    4.4342
    0.7277    1.2572    1.7867    2.3162    2.8457    3.3752    3.9047    4.4342    5.2360    4.9637
    0.7277    1.2572    1.7867    2.3162    2.8457    3.3752    3.9047    4.4342    4.9637    5.7655


condition_number =

   62.9612

Given Matrix is Positive definite

IA =

    1.5719   -0.5719   -0.1558   -0.0424   -0.0116   -0.0031   -0.0009   -0.0002   -0.0001   -0.0000
   -0.5719    1.5719   -0.5719   -0.1558   -0.0424   -0.0116   -0.0031   -0.0009   -0.0002   -0.0001
   -0.1558   -0.5719    1.5719   -0.5719   -0.1558   -0.0424   -0.0116   -0.0032   -0.0009   -0.0003
   -0.0424   -0.1558   -0.5719    1.5719   -0.5719   -0.1558   -0.0424   -0.0116   -0.0032   -0.0011
   -0.0116   -0.0424   -0.1558   -0.5719    1.5719   -0.5719   -0.1558   -0.0425   -0.0118   -0.0040
   -0.0031   -0.0116   -0.0424   -0.1558   -0.5719    1.5719   -0.5720   -0.1560   -0.0433   -0.0147
   -0.0009   -0.0031   -0.0116   -0.0424   -0.1558   -0.5720    1.5717   -0.5728   -0.1589   -0.0540
   -0.0002   -0.0009   -0.0032   -0.0116   -0.0425   -0.1560   -0.5728    1.5688   -0.5835   -0.1982
   -0.0001   -0.0002   -0.0009   -0.0032   -0.0118   -0.0433   -0.1589   -0.5835    1.5295   -0.7277
   -0.0000   -0.0001   -0.0003   -0.0011   -0.0040   -0.0147   -0.0540   -0.1982   -0.7277    1.0000


t2 =

     0
```

```
>> ask1_LLT_2_b_2(100)
>> ask1_LLT_2_b_2(500)
>> ask1_LLT_2_b_2(1000)
```

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	1.3997e-15	66.3317	2.0101	0.1406
500	1.8660e-15	332.9997	2.0020	7.4219
1000	2.1452e-15	666.3332	2.0010	76.0938

<u>Συμπεράσματα</u>

1. *Επίλυση γραμμικού συστήματος, πίνακας Α τυχαίος Moler*

- LU με μερική οδήγηση

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	6.9373e-12	1.8190e-12	5.7458e+03	0.0625
500	1.4030e-10	4.9113e-11	1.7063e+04	0.8438
1000	4.0866e-10	1.0550e-10	2.1989e+04	10.8750

- Cholesky

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	2.0188e-12	6.8212e-13	1.2654e+03	0.0469
500	1.0719e-10	3.4561e-11	1.2701e+04	6.7656
1000	1.2483e-08	2.4447e-09	1.1540e+06	75.4219

Παρατηρούμε ότι, παρά το πλεονέκτημα του αλγορίθμου Cholesky για τους συμμετρικούς πίνακες έναντι του απλού LU, ο LU με μερική οδήγηση φαίνεται να υπερτερεί χρονικά, ενώ τα σφάλματα κειμένονται στα ίδια επίπεδα. Ο Cholesky επιβαρύνεται και με τον έλεγχο του πίνακα για το αν είναι θετικά ορισμένος και συμμετρικός.

2. *Αντιστροφή πίνακα του Pei*

- LU με μερική οδήγηση

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	1.1795e-15	66.3317	2.0101	0.0625
500	1.7929e-15	332.9997	2.0020	1.1406
1000	2.0481e-15	666.3332	2.0010	12.2969

- Cholesky

Διάσταση πίνακα	Απ. Σχ. Σφάλμα	Απ. Σχ. Υπόλοιπο	Αρ. Συνθήκης	Χρόνος
100	1.3997e-15	66.3317	2.0101	0.1406
500	1.8660e-15	332.9997	2.0020	7.4219
1000	2.1452e-15	666.3332	2.0010	76.0938

Παρομοίως και για την αντιστροφή πίνακα, ο Cholesky εμφανίζει πολύ μεγαλύτερους χρόνους εκτέλεσης, ενώ τα σφάλματα είναι σχεδόν πανομοιότυπα.