POLYBENCH

ΑΞΙΟΛΟΓΗΣΗ ΠΟΛΥΩΝΥΜΙΚΩΝ ΥΠΟΛΟΓΙΣΤΙΚΩΝ ΠΑΚΕΤΩΝ

ΣΤΟΧΟΙ ΤΗΣ ΕΡΓΑΣΙΑΣ

- ΑΝΑΠΤΥΞΗ ΛΟΓΙΣΜΙΚΟΥ ΑΞΙΟΛΟΓΗΣΗΣ (BENCHMARKING SOFTWARE)
- ΔΗΜΙΟΥΡΓΙΑ ΠΛΑΙΣΙΟΥ ΣΧΟΛΙΑΣΜΟΥ ΑΠΟΤΕΛΕΣΜΑΤΩΝ ΑΞΙΟΛΟΓΗΣΗΣ

ΠΟΛΥΩΝΥΜΙΚΕΣ ΜΕΘΟΔΟΙ

- ΒΑΣΙΚΟ ΕΡΓΑΛΕΙΟ ΣΤΗ ΣΧΕΔΙΑΣΗ ΣΥΣΤΗΜΑΤΩΝ ΕΛΕΓΧΟΥ & ΣΤΗΝ ΕΠΕΞΕΡΓΑΣΙΑ ΣΗΜΑΤΟΣ
- ΑΠΕΙΚΟΝΙΣΗ ΓΡΑΜΜΙΚΩΝ ΣΥΣΤΗΜΑΤΩΝ ΜΕ ΚΛΑΣΜΑΤΙΚΕΣ ΣΥΝΑΡΤΗΣΕΙΣ ΜΕΤΑΦΟΡΑΣ
- ΜΕΛΕΤΗ ΑΛΓΕΒΡΙΚΩΝ ΙΔΙΟΤΗΤΩΝ ΠΟΛΥΩΝΥΜΙΚΩΝ ΠΙΝΑΚΩΝ

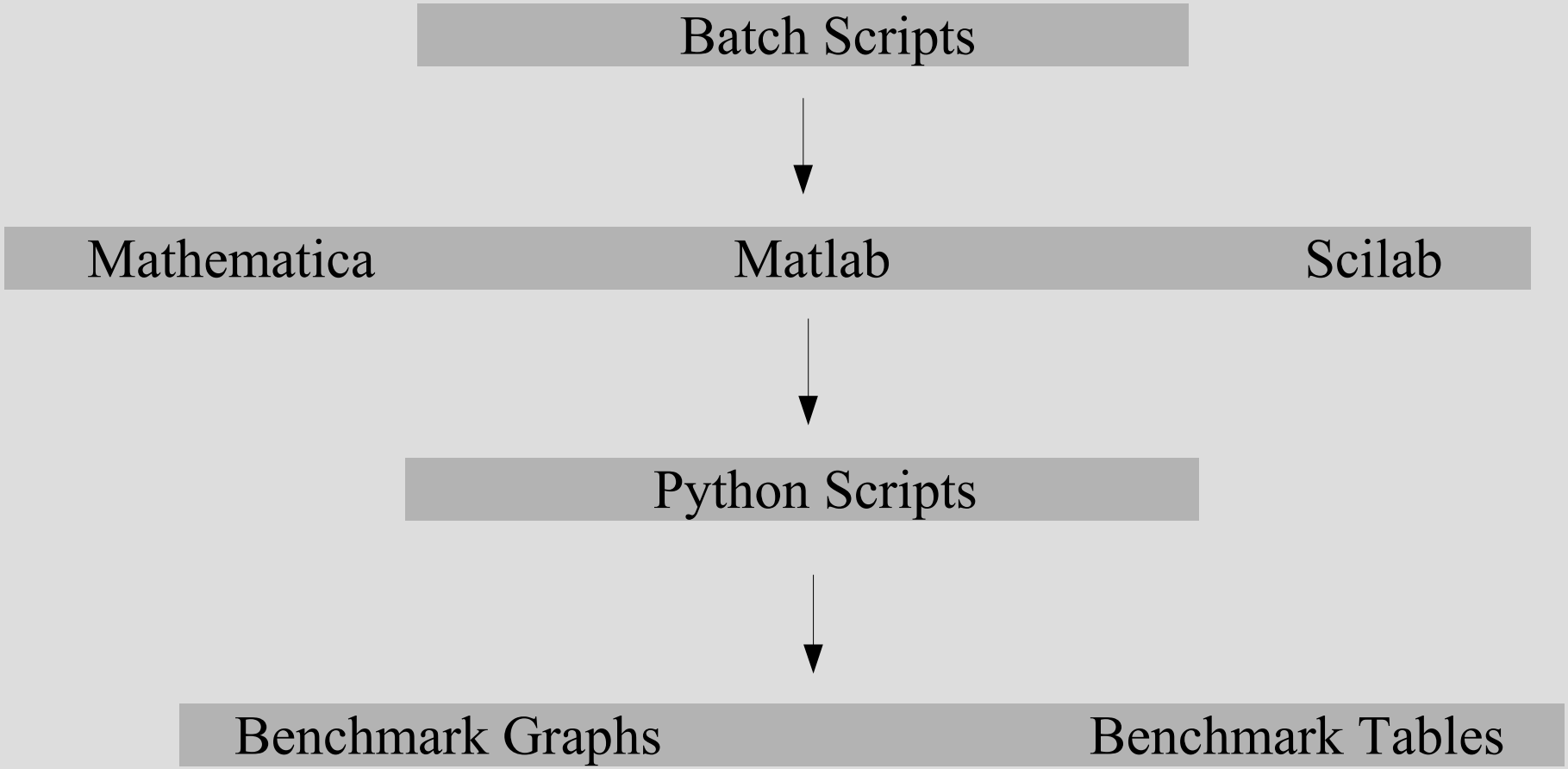
ΑΞΙΟΛΟΓΗΣΗ - BENCHMARK

- ΓΕΝΙΚΗ ΕΝΝΟΙΑ
- 1ο ΒΗΜΑ ΒΕΛΤΙΣΤΟΠΟΙΗΣΗΣ
  (OPTIMIZING PROCESS)
- ΕΦΑΡΜΟΓΗ ΣΤΟ SOFTWARE & HARDWARE Η/Υ

ΛΟΓΙΣΜΙΚΟ - SOFTWARE

- Γλώσσες Προγραμματισμού: Matlab 7.0.0, Mathematica 5.1.0, Scilab unstable 3.0, Python 2.3.4
- Πολυωνυμικά Πακέτα: Polynomial Toolbox 3.0.19, Polynomial Package 2.1, Scilab unstable 3.0
- Πακέτα Λογισμικού: Pylab 0.74, Karrigell 2.1.2, Papi 3.0

ΣΧΕΔΙΑΣΜΟΣ POLYBENCH



ΔΙΑΔΙΚΑΣΙΕΣ ΑΞΙΟΛΟΓΗΣΗΣ

- C(s) = A(s) B(s)
- C(s) = A(s) + B(s)
- Det(s)
- Inv(s)
- A(s) X(s) = B(s)
- A(s) X(s) + B(s) Y(s) = C(s)

ΔΙΑΔΙΚΑΣΙΕΣ ΑΞΙΟΛΟΓΗΣΗΣ

- $a(s)\, x(s) + b(s)\, y(s) = c(s)$
- $A'(s)\, X(s) + X'(s)\, A(s) = B(s)$
- $a'(s)\, x(s) + x'(s)\, a(s) = b(s)$
- $X'(s)\, X(s) = A(s)$
- $X'(s)\, J(s)\, X(s) = A(s)$
- $N(s) = D(s)\, Q(s) + R(s)$

ΜΕΤΡΗΤΕΣ - COUNTERS

- CPU time
- MFLOPS
- Error

CPU time

- Computer Hardware
- Χρόνος Επεξεργασίας σε Δευτερόλεπτα
- Πρόσβαση μέσω υπολογιστικών περιβάλλοντων: Matlab, Mathematica, Scilab

MFLOPS

- Computer Hardware
- Floating Point Operations / Second (Διαδικασίες Κινητής Υποδιαστολής)
- Πρόσβαση μέσω λογισμικού αξιολόγησης: PAPI (Performance Application Programming Interface)

ERROR

- Computer software
- Πολυωνυμικές εξισώσεις
- 10^10 * (Norm[residue] / Norm[input])

ΠΟΛΛΑΠΛΑΣΙΑΣΜΟΣ ΠΙΝΑΚΩΝ - MATLAB

```
pinit
f = fopen(' file ', ' w ');
fprintf( f, ' %12s  %12s  %12s  \n\n ' , ' Mflops ' , ' Size ' , ' CPU_time ' );
deg=2 ; ao=100 ; st=100 ; fin=2000 ;
for n=ao : st : fin,
A=prand(d , n) ; B=prand(d , n);
t1=cputime ; flops(0);
C=mtimes(A , B);
t2=cputime – t1 ;  [ops , mflops]=flops;
    if t2>200
    fprintf(f , ' %12.2f  %12d  %12.2f   \n ' , mflops , n , t2);
            for  n=n+st : st : fin,
            t2=0 ;  mflops=0 ;
            fprintf(f, ' %12d  %12d   %12d   \n' , mflops , n , t2);
            end
     exit
     end
fprintf(f, ' %12f  %12d   %12.2f   \n', mflops , n , t2);
end
exit
```

ΑΠΟΤΕΛΕΣΜΑΤΑ (.txt)

Mflops	Size	CPU_time
300.423187	100	0.52
822.757080	200	0.33
930.676758	300	0.94
997.171570	400	2.18
1038.650146	500	3.86
1066.616821	600	6.42
1132.823608	700	9.59
1152.533569	800	14.10
1173.952026	900	19.56
1186.645874	1000	26.25
1196.620728	1100	34.80
1205.652832	1200	44.94
1206.982910	1300	57.70
1213.879150	1400	79.34
1208.971680	1500	98.38
1215.899170	1600	117.60
1224.181641	**1700**	**155.65**
1218.500610	1800	201.17
461.559296	1900	254.06
0	2000	0

ΦΑΣΜΑΤΙΚΗ ΠΑΡΑΓΟΝΤΟΠΟΙΗΣΗ - MATLAB

```
f=fopen(' file ' , ' w ' ) ;
fprintf(f, ' %12s  %12s  %12s  %12s  \n\n' ,' Mflops  ' ,
   'Size ' , ' CPU_time ', ' Error ');
d=2 ; ao=10 ; st=10 ; fin=180 ;
 for n=ao : st : fin,
   B1=prand( d , n ) ; B=B1 * B1' ;
   t1=cputime ; flops( 0 ) ;
   [ A , J ]=spf( B ) ;
   t2=cputime - t1;
   [ops , mflops]=flops ;
   ac = norm( A' * A - B ) / norm(B) ;
    if t2>200
          fprintf(f, ' %12.2f  %12d  %12.2f  %12.3f  \n ' ,
              mflops, n , t2 , 10^10 * ac) ;
          for n=n+st : st : fin,
          t2=0 ; mflops=0 ; ac=0 ;
          fprintf(f,' %12d  %12d  %12d  %12d  \n ' ,
    mflops , n , t2 , ac) ;
          end
          exit
     end
fprintf(f, ' %12.2f  %12d  %12.2f  %12.3f  \n ' ,
      mflops, n , t2 , ac) ;
end
exit
```

```
f=fopen(' file ' , ' w ' ) ;
fprintf(f, ' %12s  %12s  %12s  %12s  \n\n ' ,
       'Mflops ' , ' Size ' , ' CPU_time ' , ' accuracy ') ;
d=2 ; ao=10 ; st=10 ;  fin=180 ;
 for n=ao : st : fin,
   B1=prand( d , n ) ;  B2=diag( randsrc (1,n,[1,-1] ) ) ;
  B=B1' * B2 * B1 ;
   t1=cputime ; flops( 0 ) ;
   [ A , J ]=spf( B ) ;
   t2 = cputime - t1;  [ops , mflops]=flops ;
   ac=norm( A' * J * A - B) / norm(B);
    if t2>200
          fprintf(f,'  %12.2f  %12d  %12.2f  %12.3f  \n ',
                  mflops , n , t2 , 10^10 * ac) ;
          for n=n+st : st : fin,
          t2=0 ; mflops=0 ; ac=0 ;
          fprintf(f,' %12d  %12d   %12d  %12d  \n ',
         mflops , n , t2 , ac) ;
          end
          exit
     end
fprintf(f, ' %12.2f  %12d  %12.2f   %12.3f   \n ' ,
        mflops , n , t2 , ac) ;
end
exit
```

ΔΙΟΦΑΝΤΙΚΗ ΕΞΙΣΩΣΗ – MATLAB

```
pinit
f=fopen('file','w');
fprintf(f,' %12s  %12s  %12s  %12s  \n\n', 'Mflops','Size','CPU_time','Error');
d=2;fin=200;st=5;ao=5;
for n=ao:st:fin,
    A=prand(d,n); B=prand(d,n); C=prand(d,n);
    t1=cputime; flops(0);
    [XO,YO]=axbyc(A,B,C,1);
    t2=cputime-t1; [ops,mflops]=flops;
  ac=norm(A*XO+B*YO-C)/norm(A);
 if t2>200
   fprintf(f,'%12.2f  %12d  %12.2f  %12.3f  \n', mflops,n,t2, 10^10*ac);
   for n=n+st:st:fin,
      t2=0; mflops=0;ac=0;
      fprintf(f,' %12d  %12d   %12d  %12d  \n', mflops,n,t2,ac);
      end
      exit
    end
   fprintf(f,'%12.2f  %12d  %12.2f  %12.3f  \n',mflops,n,t2, 10^10*ac);
   end
exit
```

ΠΟΛΛΑΠΛΑΣΙΑΣΜΟΣ ΠΙΝΑΚΩΝ - MATHEMATICA

```
<<Polynomial`  ;
SetDirectory[ dir ];
filename = " file.out " ;
strm = OpenWrite[ filename , FormatType -> OutputForm ] ;
Write[ strm , " Degree \t  Size  \t  CPU_time \n " ];
d = 2; ao=100; fin = 2000; st = 100;
Do[
    A = PMRandom[ d, n ] ;  B = PMRandom[ d, n ];
    t = Timing[ C= Dot [ A,B ] ; ] /. Second -> 1 ;
      If [ t[[1]] > 200,
         Write[ strm,  d , "\t ", n , "\t ", t[[1]] ] ;
         Do[
              Write[ strm,  d , "\t ", n , "\t ", 0] ;
              ,{ n , n+st , fin , st }
             ] ;
          Close[ strm ] ;
          Quit[ ] ;
      ] ;
   Write[ strm,  d , "\t ", n, "\t ", t[[1]] ] ;
   ,{ n , ao , fin , st }
];
Close[ strm ] ;
Quit[ ] ;
```

ΔΙΟΦΑΝΤΙΚΗ ΕΞΙΣΩΣΗ - MATHEMATICA

```
<<Polynomial`;
dir = "Directory"; SetDirectory[dir];
filename = "math.out";
strm = OpenWrite[filename, FormatType -> OutputForm];
Write[strm, "Degree \t Size \t CPU_time\tError\n"];
d = 2; ao=5; fin = 200; st = 5;
Do[
   a = PMRandom[d,n]; b = PMRandom[d,n]; c = PMRandom[d,n];
   t = Timing[DESolve[a.x+b.y==c,1];] /. Second -> 1;
    ac="-";
          If[t[[1]]>200,
          Write[strm, deg, "\t ", n , "\t ",t[[1]], "\t \t " , ac];
          Do[
          Write[strm, deg, "\t ", n , "\t ",0 , "\t \t " , ac];
          ,{n,n+st,fin,st}
          ];
          Close[strm];
          Quit[];
          ];
           Write[strm, deg, "\t ", n, "\t ", t[[1]],  "\t \t " , ac];
      , {n, ao, fin, st}
      ];
   Close[strm];
   Quit[];
```

ΠΟΛΛΑΠΛΑΣΙΑΣΜΟΣ ΠΙΝΑΚΩΝ - SCILAB

```
f=mopen( ' file ' , ' w ' ) ;
fprintf( f , " Degree    Size     CPU_time   \n\n  " )
s=poly( [ 1 , 2 ] , ' s ' ) ;
d=2 ; ao=100 ; fin=2000 ; st=100 ;
stacksize( 100000006 ) ;
lines( 0 ) ;
for n=ao:st:fin,
    A=s * rand(n,n) ;  B=s * rand(n,n) ;
    timer( ) ;
    C=A * B ;
    t=timer( );
    if  t > 200  then
    fprintf( f , " %i  \t  %i  \t  %f   \n " , d , n ,t ) ;
    for n = n+st : st : fin,
        t=0 ;
        fprintf( f , " %i  \t  %i   \t   %i  \n" , d , n , t ) ;
        end
        mclose(f);
        quit
    end
    fprintf( f , " %i  \t   %i   \t  %f   \n " , d , n , t ) ;
end
mclose( f ) ;
quit
```

ΑΝΤΙΣΤΡΟΦΟΣ ΠΙΝΑΚΑ - SCILAB

```
f=mopen('file', 'w');
fprintf(f,"Degree  Size     CPU_time  \n\n")
s=poly([1,2],'s');
d=2; fin=50; ao=10; st=2;
stacksize(100000006)
lines (0);
for n=ao:st:fin,
A=s*rand(n,n);
timer();
coffg(A);
t=timer();
if t>200 then
   fprintf(f,"%i  \t  %i  \t  %f  \n",d,n,t)
   for n=n+st:st:fin,
   t=0;
   fprintf(f,"%i  \t  %i  \t  %i  \n",d,n,t)
   end
   mclose(f);
   quit
end
fprintf(f,"%i \t %i \t  %f  \n",d,n,t)
end
mclose(f);
quit
```

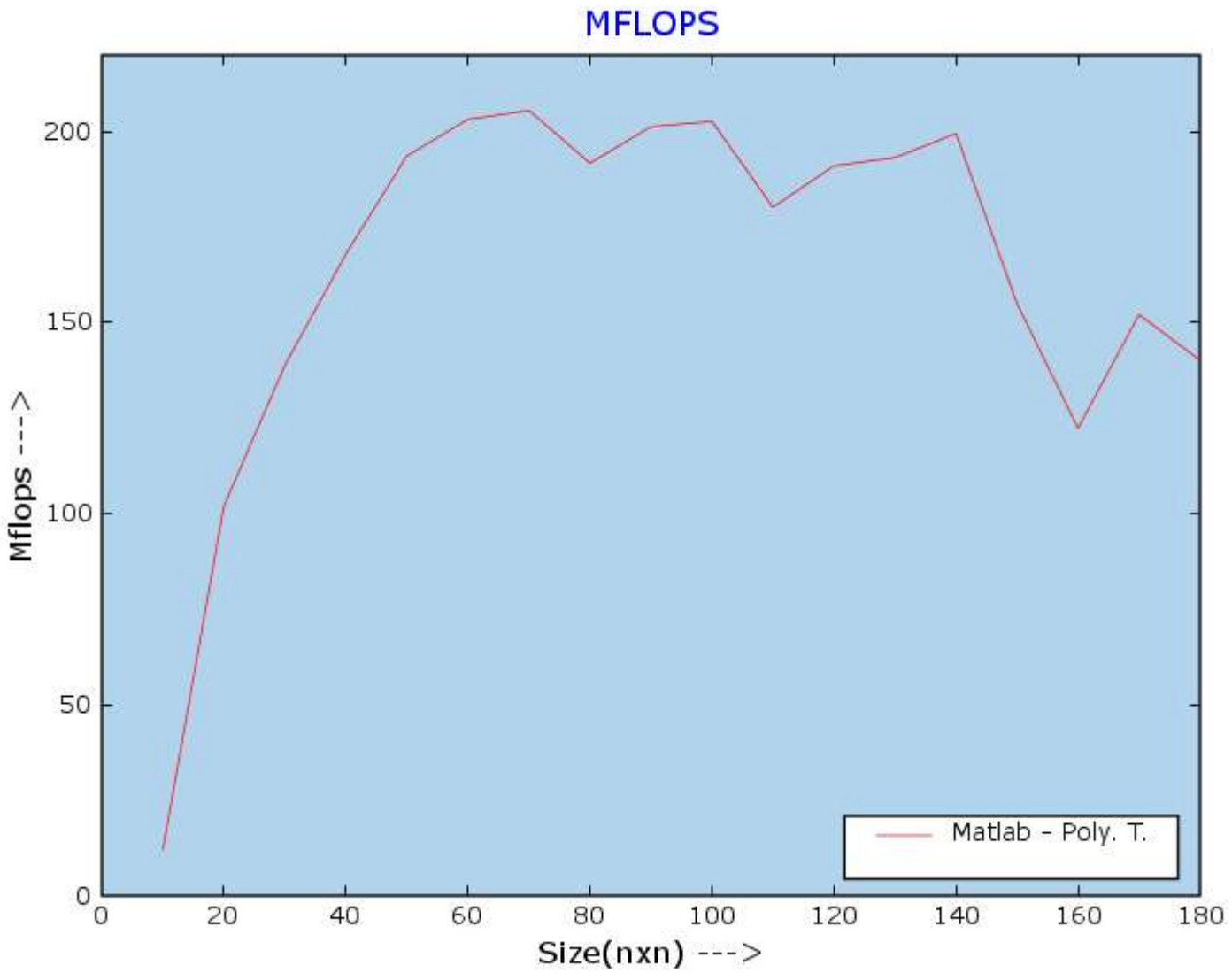
ΚΩΔΙΚΑΣ ΣΕ PYTHON

```
Import   re
from  pylab  import *
number = " ( \d* \ .{ 0 , 1 } \d * ) "
pattern =  re . Compile ( ' %( NUM  ) s\s  +  %( NUM ) s\s  +  %( NUM ) s '   % { ' NUM ' : number })
datalines = open ( '  text_file1 ' , ' r ' ) . readlines( )
d1 = [ ]
for   n   in    datalines :
   line = n . strip( )
   if  len ( line ) :
      if  ' degree '  in  line  :  continue
      numbers  =  pattern . Search ( line )
      if  numbers  :
         d1 . Append( numbers . Groups() )
datalines = open ( '  text_file2 ' , ' r ' ) . readlines( )
d2 = [ ]
for  n  in  datalines :
   line =  n . strip( )
   if   len ( line ) :
      if   ' degree '  in  line  :  continue
      numbers =  pattern . Search ( line )
      if   numbers :
         d2 . Append ( numbers . Groups( ) )
datalines = open ( ' text_file3 ' , ' r ' ) . readlines( )
d3 = [ ]
for  n  in  datalines :
   line =  n . strip( )
   if   len ( line ) :
      if   ' degree '  in  line  :  continue
      numbers =  pattern . Search ( line )
      if   numbers :
         d3 . Append ( numbers . Groups( ) )
```

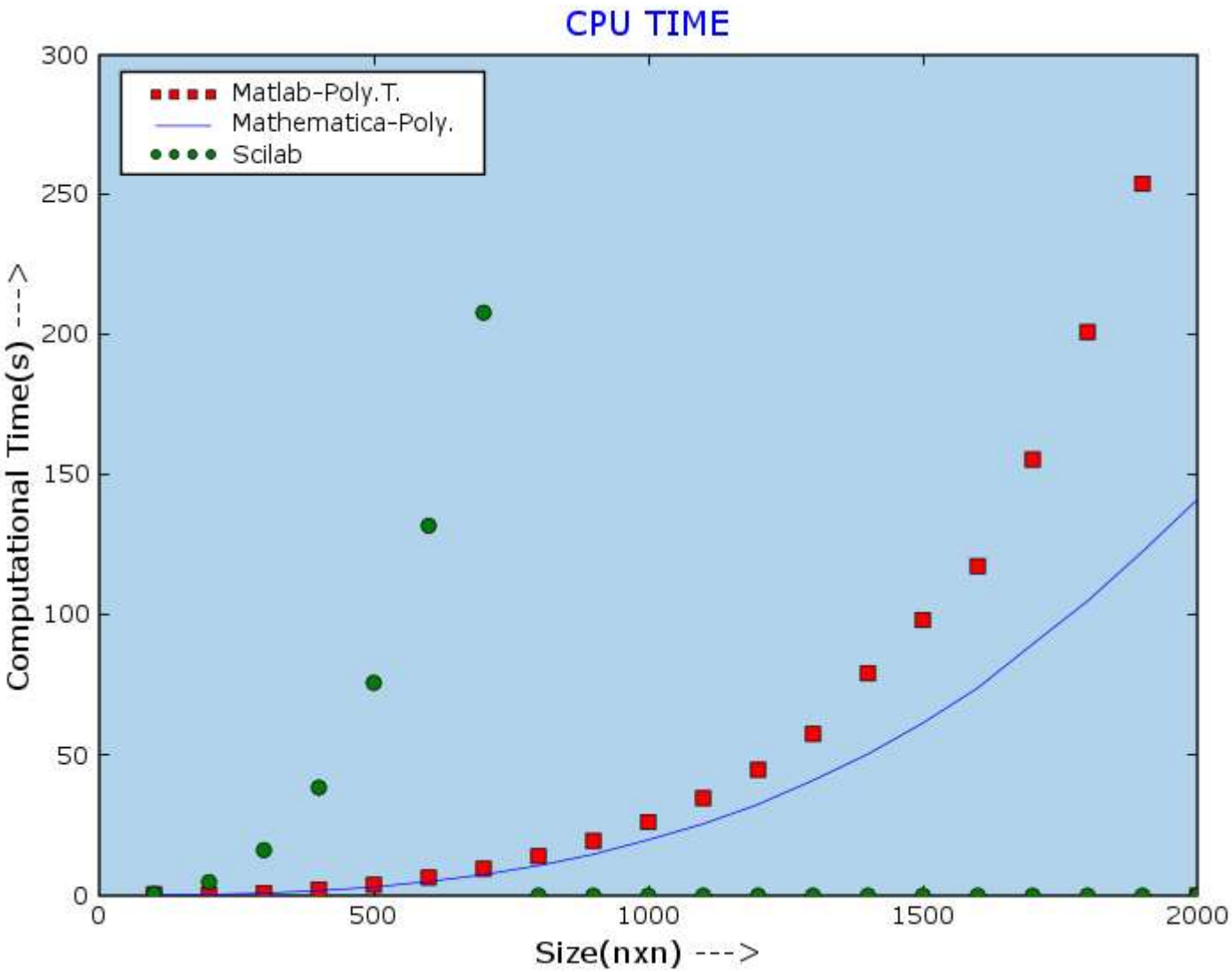
ΚΩΔΙΚΑΣ ΣΕ PYTHON (ΣΥΝΕΧΕΙΑ)

```
p11 = map ( float , [x[1] for x in d1[1:]] )
p12 = map ( float , [x[2] for x in d1[1:]] )
p10 = map ( float , [x[0]  for x in d1[1:]] )
p21 = map (float ,  [x[1]  for x in d2[1:]] )
p22 = map ( float , [x[2] for x in d2[1:]] )
p31 = map ( float , [x[1] for x in d3[1:]] )
p32 = map ( float , [x[2] for x in d3[1:]] )
figure(1)
subplot ( 111 , axisbg = ' lightskyblue ' )
plot( p11 , p12 , 'rs' , p21 , p22 , 'b--' , p31 , p32 , ' go ')
legend (( ' Matlab - Poly.T.' ,  ' Mathematica - Poly. ' , ' Scilab ' ), ' upper left ' )
xlabel ( ' Size (nxn)  ---> ' )
ylabel ( ' Computational Time (s) ---> ' )
t1 = title ( 'CPU TIME ' , color=' lightskyblue ' )
savefig ( ' MaMatSc1 ' , dpi=100 )
savefig( ' MaMatSc1sm ' , dpi=50)
figure(2)
subplot(111 , axisbg = ' lightskyblue ' )
plot( p11 , p10 , 'rs' )
legend (( 'Matlab - Poly. T.' , ' ' ) ,  ' upper left ' )
xlabel( ' Size(nxn) ---> ' )
ylabel( ' Mflops ---> ' )
t1 = title( ' MFLOPS ' , color=' lightskyblue ' )
savefig ( ' Fmat1 ' , dpi=100 )
savefig( ' Fmat1sm ' , dpi=50)
```

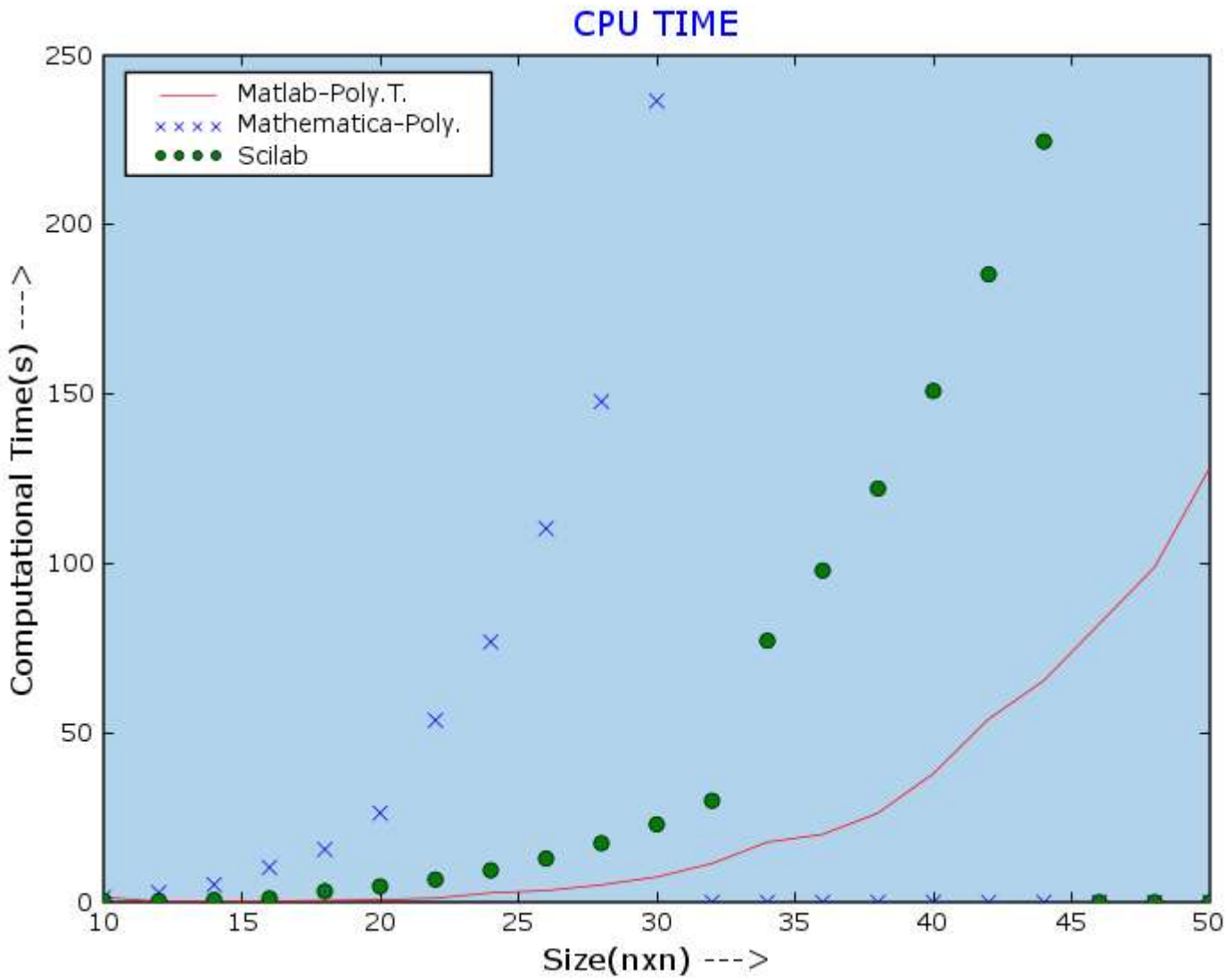
ΦΑΣΜΑΤΙΚΗ ΠΑΡΑΓΟΝΤΟΠΟΙΗΣΗ



ΠΟΛΛΑΠΛΑΣΙΑΣΜΟΣ ΠΟΛΥΩΝΥΜΙΚΩΝ ΠΙΝΑΚΩΝ



ΑΝΤΙΣΤΡΟΦΟΣ ΠΟΛΥΩΝΥΜΙΚΟΥ ΠΙΝΑΚΑ



APXEIO MS – DOS

```
:: Multiplication of two Polynomial matrices

cls

matlab -nosplash -nodesktop -minimize -r mat1

math <math1.txt

scilex -f sci1.sce

python  bench1.py
```

ΚΩΔΙΚΑΣ ΣΕ PYTHON - KARRIGELL

```
<head>
<title>PolyBench -- Multiplication</title>
<base target="_self">
<link rel="stylesheet" type="text/css"
href="general1.css" /> </head>
<body>
<h1>multiplication -- A(s)  B(s)</h1>
<hr noshade size=1>
<a href="graphs/MaMatSc1.png">
<img class='cpu' src="graphs/MaMatSc1sm.png"/> </a>
<a href="graphs/FMat1.png">
<img class="mflops" src="graphs/FMat1sm.png"> </a>
<% Include("C:\\Python23\\table1.py") %>
<table width="50%" border=1>  <tr>
  <th  rowspan=2>Matrix <br> Size</th>
  <th colspan=2>MATLAB <br> Polynomial Toolbox</th>
  <th>MATHEMATICA <br> Polynomial</th>
  <th>SCILAB</th>
  <tr>
    <th>MFLOPS </th>
    <th>CPU time<br>(sec) </th>
    <th>CPU time<br>(sec) </th>
    <th>CPU time<br>(sec) </th>
  </tr>
  <indent>
  <% for i in range(len(p1)): %>
    <tr>
    <td align="center"><% print p1[i] %></td>
    <td align="center"><% print p0[i] %></td>
    <td align="center"><% print p2[i] %></td>
    <td align="center"><% print p4[i] %></td>
    <td align="center"><% print p6[i] %></td>
```

ΚΩΔΙΚΑΣ ΣΕ PYTHON – KARRIGELL (ΣΥΝΕΧΕΙΑ)

```
</tr>
  </indent>
</table>
<div class="library">
<p align="center"><b><var>Library Functions :</var></b>  <var><br>
</var></p>
<ul type=square>
  <li><var>MATLAB-Polynomial Toolbox
    </var>
    <ul>
    <li><var> mtimes( )
    </var>
    </ul>
  <li><var>MATHEMATICA-Polynomial
    </var>
    <ul>
    <li><var> Dot( )
    </var>
    </ul>
  <li><var>SCILAB
    </var>
    <ul>
    <li><var> star( * )
    </var>
    </ul>
</ul>
</div>
<hr class="end">
</body>
```

POLYBENCH

http://users.auth.gr/~ntrian/index.htm