# JOSS: EXAMPLES OF THE USE OF AN EXPERIMENTAL ON-LINE COMPUTING SERVICE

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April 1965

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## INTRODUCTION

The following pages of this Paper present examples of the use of JOSS† (Johnniac Open-Shop System) for the solution of small numerical problems. This experimental on-line time-shared computing service is used daily by staff members of The RAND Corporation. The service has been available at ten remote consoles since January 1964.(1-3)

Since JOSS ignores input lines beginning with an asterisk, we use this device to interpose comments in the examples. On the original copy, output is in black, input is in green.

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This paper was presented at the Sixth Annual Symposium of The Professional Group on Human Factors in Electronics, The Institute of Electrical and Electronic Engineers, Boston, May 6-8, 1965.

†JOSS is the trademark and service mark of The RAND Corporation for its computer program and services using that program.

* Some elements of the language:

```
Type 2+2.
     2+2 =         4
Type 2+2+.
 Eh?
Type x.
 Error above:  x is undefined.
Set x=3.
Type x.
        x =        3
Type x+2, x-2, 2·x, x/2, x*2.
      x+2 =        5
      x-2 =        1
      2·x =        6
      x/2 =        1.5
      x*2 =        9
Type [(|x-5|·3+4)·2-15]·3+10.
 [(|x-5|·3+4)·2-15]·3+10 =  25
Type sqrt(144), log(10), exp(1), sin(.2), cos(.2), arg(3,3), 4·arg(3,3).
 sqrt(144) =      12
  log(10) =        2.30258509
   exp(1) =        2.71828183
  sin(.2) =         .198669331
  cos(.2) =         .980066578
 arg(3,3) =         .785398163
 4·arg(3,3) =      3.14159265
Type sgn(-3.5), sgn(0), sgn(3.5).
 sgn(-3.5) =      -1
   sgn(0) =        0
 sgn(3.5) =        1
Type max(6·x, 20, x*3).
 max(6·x, 20, x*3) =  27
Type min(6·x, 20, x*3).
 min(6·x, 20, x*3) =  18
Set y=123.456.
Type y, ip(y), fp(y), dp(y), xp(y).
        y =      123.456
    ip(y) =      123
    fp(y) =         .456
    dp(y) =        1.23456
    xp(y) =        2
Type 1.23456·10*2.
 1.23456·10*2 =  123.456
Type all values.

        x =        3
        y =      123.456

Delete all values.
```

```
*  Stored program for computing the hypotenuse:

1.1 Set c=sqrt(a*2+b*2).
1.2 Type a,b,c in form 1.
Form 1:
a = __    b = __    c = ___.______
2.1 Do part 1 for b=1(1)a.
2.2 Line.
Type all steps.

 1.1 Set c=sqrt(a*2+b*2).
 1.2 Type a,b,c in form 1.

 2.1 Do part 1 for b=1(1)a.
 2.2 Line.

Type form 1.
 a = __    b = __    c = ___.______

Do part 2 for a=1(1)4.
 a =  1    b =  1    c =   1.414214

 a =  2    b =  1    c =   2.236068
 a =  2    b =  2    c =   2.828427

 a =  3    b =  1    c =   3.162278
 a =  3    b =  2    c =   3.605551
 a =  3    b =  3    c =   4.242641

 a =  4    b =  1    c =   4.123106
 a =  4    b =  2    c =   4.472136
 a =  4    b =  3    c =   5.000000
 a =  4    b =  4    c =   5.656854

*  Modification to type only integral c's:

Delete step 2.2.
1.2 Type a,b,c in form 1 if fp(c)=0.
Do part 2 for a=1(1)25.
 a =  4    b =  3    c =   5.000000
 a =  8    b =  6    c =  10.000000
 a = 12    b =  5    c =  13.000000
 a = 12    b =  9    c =  15.000000
 a = 15    b =  8    c =  17.000000
 a = 16    b = 12    c =  20.000000
 a = 20    b = 15    c =  25.000000
 a = 21    b = 20    c =  29.000000
 a = 24    b =  7    c =  25.000000
 a = 24    b = 10    c =  26.000000
 a = 24    b = 18    c =  30.000000

Delete all.
```

```
*  Integration of 1/x by Gauss two-point rule:

1.1 Type X,Y in form 1 if fp(X)=0.
1.2 Do part 2 for x=X+p·h, X+q·h.
2.1 Set y=1/x.
2.2 Set Y=Y+.5·h·y.
Form 1:
__    _.______
Set p=.5-.5/sqrt(3).
Set q=.5+.5/sqrt(3).
Set Y=0.
Set h=.1.
Do part 1 for X=1(h)10.
  1     .00000
  2     .69315
  3    1.09861
  4    1.38629
  5    1.60944
  6    1.79176
  7    1.94591
  8    2.07944
  9    2.19722
 10    2.30259
Type 10, log(10) in form 1.
 10    2.30259
*  Notice above that JOSS allows backspacing and strikeovers.
Type all.

 1.1 Type X,Y in form 1 if fp(X)=0.
 1.2 Do part 2 for x=X+p·h, X+q·h.

 2.1 Set y=1/x.
 2.2 Set Y=Y+.5·h·y.


 Form 1:
 __    _.______


          h =         .1
          p =         .211324866
          q =         .788675134
          x =       10.0788675
          y =         .0992174964
          X =       10
          Y =        2.31253534

Delete all.
Type users.
 6
```

```
*  Root finding:

1.1 Set w=y.
1.2 Do part 2 for x=x+d.
1.3 Set d=d·y/(w-y).
1.4 To part 1 if |y|≥e.
1.5 Type "Root".

2.1 Set y=exp(x)-20·log(x).
2.2 Type x,y in form 1.

Form 1:
x = ___.______     y = ___.______

Type step 1.4.
 1.4 To part 1 if |y|≥e.
Do part 2 for x=.5(.5)3.
 x =    .500000    y = 15.511665
 x =   1.000000    y =  2.718282
 x =   1.500000    y = -3.627613
 x =   2.000000    y = -6.473888
 x =   2.500000    y = -6.143321
 x =   3.000000    y = -1.886709
Do part 2 for x=3.5, 4.
 x =   3.500000    y =  8.060193
 x =   4.000000    y = 26.872263
Do part 2 for x=1.2.
 x =   1.200000    y =   -.326314
Do part 1 for d=-.05.
 x =   1.150000    y =    .362954
 Error at step 1.4:  e is undefined.
Set e=.00005.
Go.
 x =   1.176329    y =  -.005521
 x =   1.175934    y =  -.000092
 x =   1.175928    y =   .000000
 Root
Do part 2 for x=3.1.
 x =   3.100000    y =  -.430091
Do part 1 for d=.1.
 x =   3.200000    y =  1.269514
 x =   3.125305    y =  -.023794
 x =   3.126680    y =  -.001278
 x =   3.126758    y =   .000001
 Root
Do part 2 for x=x-.000001.
 x =   3.126757    y =  -.000015
Delete all.
```

```
*  Matrix inversion with simple pivoting on the diagonal.

1.1 Set p=a(n,n).
1.2 Set a(n,n)=1.
1.3 Do part 2 for j=1(1)N.
1.4 Do part 3 for i=1(1)N.

2.1 Set a(n,j)=a(n,j)/p.

3.1 Done if i=n.
3.2 Set q=a(i,n).
3.3 Set a(i,n)=0.
3.4 Do part 4 for j=1(1)N.

4.1 Set a(i,j)=a(i,j)-a(n,j)·q.

*  JOSS can help with the input:

11.1 Demand a(i,j).
12.1 Do part 11 for j=1(1)N.

*  For the output:

21.1 Type a(i,1), a(i,2), a(i,3), a(i,4) in form 1.
Form 1:
___.______   ___.______   ___.______   ___.______

Do part 12 for *
*  An asterisk at the end can kill the line... I forgot something:
Set N=4.
Do part 12 for i=1(1)N.
   a(1,1) = 3.582
   a(1,2) = -.670
   a(1,3) = .873
   a(1,4) = 1.055
   a(2,1) = -.251
   a(2,2) = 4.569
   a(2,3) = .675
   a(2,4) = -.497
   a(3,1) = 1.675
   a(3,2) = -.764
   a(3,3) = 2.781
   a(3,4) = .778
   a(4,1) = .564
   a(4,2) = -.466
   a(4,3) = 1.387
   a(4,4) = 4.965
Do part 21 for i=1(1)4.
  3.58200    -.67000     .87300    1.05500
  -.25100    4.56900     .67500    -.49700
  1.67500    -.76400    2.78100     .77800
   .56400    -.46600    1.38700    4.96500
```

```
Do part 1 for n=1(1)N.
Do part 21 for i=1(1)4.
  .32861      .02877    -.08326    -.05390
  .04839      .21513    -.07921     .02366
 -.19033      .04018     .42024    -.02139
  .02038      .00570    -.11537     .21573

*  Invert the matrix back again:

Do part 1 for n=1(1)N.
Do part 21 for i=1(1)N.
 3.58200    -.67000     .87300    1.05500
 -.25100    4.56900     .67500    -.49700
 1.67500    -.76400    2.78100     .77800
  .56400    -.46600    1.38700    4.96500
Delete all.

*  From Litton Industries' "Problematical Recreations" we get:
*  Problem:  Find four digits A, T, O and M such that
*            sqrt(ATOM) = A+TO+M.
*  C. L. Baker's solution:

Form 1:
ATOM = ____    sqrt(ATOM) = __
1 Type x*2, x in form 1 if x*2-9·ip(x*2/10)-99·ip(x*2/1000) = x.
Do step 1 for x=32(1)99.
ATOM = 1296    sqrt(ATOM) = 36
ATOM = 6724    sqrt(ATOM) = 82
Delete all.
```

* Production of a formatted table:

```
1.1 Do part 2 if fp(x/20) = 1/20.
1.2 Line if fp(x/5) = 1/5.
1.3 Type x, x*2, x*3, sqrt(x), log(x), exp(x) in form 1.

2.1 Page.
2.2 Type "Table of elementary functions:".
2.3 Line.
2.4 Line.
2.5 Type form 2.

Form 1:
__   ___   _____   __.______   __.______   ...........

Form 2:
 x   x*2    x*3     sqrt(x)     log(x)       exp(x)

Type all.

1.1 Do part 2 if fp(x/20) = 1/20.
1.2 Line if fp(x/5) = 1/5.
1.3 Type x, x*2, x*3, sqrt(x), log(x), exp(x) in form 1.

2.1 Page.
2.2 Type "Table of elementary functions:".
2.3 Line.
2.4 Line.
2.5 Type form 2.


Form 1:
__   ___   _____   __.______   __.______   ...........

Form 2:
 x   x*2    x*3     sqrt(x)     log(x)       exp(x)

Do part 1 for x=1(1)20.
```

Table of elementary functions:

| x | x*2 | x*3 | sqrt(x) | log(x) | exp(x) |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1.00000 | .00000 | 2.71828 00 |
| 2 | 4 | 8 | 1.41421 | .69315 | 7.38906 00 |
| 3 | 9 | 27 | 1.73205 | 1.09861 | 2.00855 01 |
| 4 | 16 | 64 | 2.00000 | 1.38629 | 5.45982 01 |
| 5 | 25 | 125 | 2.23607 | 1.60944 | 1.48413 02 |
| 6 | 36 | 216 | 2.44949 | 1.79176 | 4.03429 02 |
| 7 | 49 | 343 | 2.64575 | 1.94591 | 1.09663 03 |
| 8 | 64 | 512 | 2.82843 | 2.07944 | 2.98096 03 |
| 9 | 81 | 729 | 3.00000 | 2.19722 | 8.10308 03 |
| 10 | 100 | 1000 | 3.16228 | 2.30259 | 2.20265 04 |
| 11 | 121 | 1331 | 3.31662 | 2.39790 | 5.98741 04 |
| 12 | 144 | 1728 | 3.46410 | 2.48491 | 1.62755 05 |
| 13 | 169 | 2197 | 3.60555 | 2.56495 | 4.42413 05 |
| 14 | 196 | 2744 | 3.74166 | 2.63906 | 1.20260 06 |
| 15 | 225 | 3375 | 3.87298 | 2.70805 | 3.26902 06 |
| 16 | 256 | 4096 | 4.00000 | 2.77259 | 8.88611 06 |
| 17 | 289 | 4913 | 4.12311 | 2.83321 | 2.41550 07 |
| 18 | 324 | 5832 | 4.24264 | 2.89037 | 6.56600 07 |
| 19 | 361 | 6859 | 4.35890 | 2.94444 | 1.78482 08 |
| 20 | 400 | 8000 | 4.47214 | 2.99573 | 4.85165 08 |

## REFERENCES

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3. Shaw, J. C., "JOSS: A Designer's View of an Experimental On-Line Computing System," AFIPS Conference Proceedings (1964 FJCC), v. 26, Spartan Books, Baltimore, Maryland, 1964, pp. 455-464.