```
clear all;
close all;
%Condition of the Vandermonde system.
%Experiment1
n1 = [2:30]';
C = zeros(29,1);
for n = 2:30
   m = n;
   A = vandermonde(m,n);
   C(n-1) = cond(A)
%Experiment2
C2 = zeros(29,1);
for n = 2:30
   m = 2*n - 1;
   A = vandermonde(m,n);
   C2(n-1) = cond(A)
end
%plot of the two-norm condition number of {\tt A}
semilogy(n1,C,'-*')
hold on
semilogy(n1,C2,'-o')
title('Condition number against n');
xlabel('n');ylabel('Condition number');
legend('for m=n', 'for m = 2n-1', 'Location', 'northwest');
fprintf('For m = n, A is a square matrix, and gives large condition numbers as n increases, compared to when \n m=2n-1. Hence the dimension of the matrix
function A = vandermonde(m,n)
   t = zeros(m,n);
   for i = 1:n
       for j = 1:m
           t(j,i) = ((j-1)/(m-1))^(n-i);
       end
   end
   %fliping the vandermonde matrix t to form A
   A = fliplr(t);
end
```

```
2.618033988749895
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                0
                 0
                0
                 0
                0
                0
                0
                0
                0
2.618033988749895
15.099657722502098
                Ω
                0
                0
                0
```

C =

C =

2.618033988749895 15.099657722502098 98.867738507227628

C =

1.0e+02 \*

0.026180339887499 0.150996577225021 0.988677385072276 6.864349418185958

C =

1.0e+03 \*

0.002618033988750 0.015099657722502 0.098867738507228 0.686434941818596 4.924371056611024 

C =

1.0e+04 \*

0.000261803398875 0.001509965772250 0.009886773850723 0.068643494181860 0.492437105661102 3.606116088020551 

C =

1.0e+05 \*

0.000026180339887 0.000150996577225 0.000988677385072 0.006864349418186 0.049243710566110 0.360611608802055 2.678167009076525 

C =

1.0e+06 \*

C =

1.0e+07 \*

```
1.0e+08 *
0.000000026180340
0.000000150996577
0.000000988677385
0.000006864349418
0.000049243710566
0.000360611608802
0.002678167009077
0.020093963800216
0.151932296765620
1.155752445094539
               0
                0
                0
               0
                0
                0
                0
                0
                0
                0
```

C =

1.0e+08 \*

0.000000026180340 0.000000150996577 0.000000988677385 0.000006864349418 0.000049243710566 0.000360611608802 0.002678167009077 0.020093963800216 0.151932296765620 1.155752445094539 8.834786881942920 0 0 0 0 0 0 0 0 0 0

0

C =

1.0e+09 \*

0.000000002618034 0.00000015099658 0.000000098867739 0.000000686434942 0.000004924371057 0.000036061160880 0.000267816700908 0.002009396380022 0.015193229676562 0.115575244509454 0.883478688194292 6.780588417474486 0 0 0 0 0 0

C =

1.0e+10 \*

0.000000000261803
0.000000001509966
0.000000009886774
0.00000068643494
0.0000492437106
0.00003606116088
0.00026781670091
0.000200939638002
0.001519322967656
0.001557524450945
0.088347868819429
0.678058841747449
5.221492889311785
0

0

C =

1.0e+11 \*

0.000000000026180 0.00000000150997 0.000000000988677 0.000000006864349 0.000000049243711 0.000000360611609 0.000002678167009 0.000020093963800 0.000151932296766 0.001155752445095 0.008834786881943 0.067805884174745 0.522149288931178 4.032354940271632 0 0 0 0 0 0

C =

1.0e+12 \*

0.000000000002618 0.000000000015100 0.000000000098868

0.000000000686435 0.000000004924371 0.000000036061161 0.000000267816701 0.000002009396380 0.000015193229677 0.000115575244509 0.000883478688194 0.006780588417474 0.052214928893118 0.403235494027163 3.121681002097844 0 0 0 0 0 0 0 0 0 0 0 0 0

C =

1.0e+13 \*

0.000000000000262 0.000000000001510 0.000000000009887 0.000000000068643 0.000000000492437 0.000000003606116 0.000000026781670 0.000000200939638 0.000001519322968 0.000011557524451 0.000088347868819 0.000678058841747 0.005221492889312 0.040323549402716 0.312168100209784 2.421931852593987 0 0 0 0 0 0 0 0 0 0 0

C =

1.0e+14 \*

0.0000000000000026 0.000000000000151 0.000000000000989 0.000000000006864 0.000000000049244 0.00000000360612 0.000000002678167 0.000000020093964 0.00000151932297 0.000001155752445 0.000008834786882 0.000067805884175 0.000522149288931 0.004032354940272 0.031216810020978 0.242193185259399 1.882589670306160 0 0 0 0 0

```
0
C =
   1.0e+15 *
  0.0000000000000003
   0.0000000000000015
   0.000000000000099
   0.000000000000686
   0.000000000004924
   0.00000000036061
   0.000000000267817
   0.000000002009396
   0.00000015193230
   0.00000115575245
   0.000000883478688
   0.000006780588417
   0.000052214928893
   0.000403235494027
   0.003121681002098
   0.024219318525940
   0.188258967030616
   1.465743747535147
                   0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
C =
```

1.0e+16 \*

0.000000000000000 0.0000000000000002 0.0000000000000069 0.000000000000492 0.00000000003606 0.000000000026782 0.000000000200940 0.00000001519323 0.00000011557524 0.000000088347869 0.000000678058842 0.000005221492889 0.000040323549403 0.000312168100210 0.002421931852594 0.018825896703062 0.146574374753515 1.129491804131115 0 0 0 0 0 0 0 0 0

C =

1.0e+16 \*

0.00000001519323 0.00000011557524 0.000000088347869 0.000000678058842 0.000005221492889 0.000040323549403 0.000312168100210 0.002421931852594 0.018825896703062 0.146574374753515 1.129491804131115 8.698691609468558 0 0 0 0 0 0 0 0 0

C =

1.0e+18 \*

0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000001 0.000000000000005 0.000000000000036 0.000000000000268 0.000000000002009 0.00000000015193 0.00000000115575 0.000000000883479 0.000000006780588 0.000000052214929 0.000000403235494 0.000003121681002 0.000024219318526 0.000188258967031 0.001465743747535 0.011294918041311 0.086986916094686 1.268785879046714 0 0 0 0 0 0 0

C =

1.0e+18 \*

0.000000000000000 0.0000000000000000 0.000000000000000 0.00000000000000001 0.000000000000005 0.000000000000036 0.000000000000268 0.000000000002009 0.00000000015193 0.00000000115575 0.000000000883479 0.000000006780588 0.000000052214929 0.000000403235494 0.000003121681002 0.000024219318526 0.000188258967031 0.001465743747535 0.011294918041311 0.086986916094686 1.268785879046714 1.737938326404992 0 0 0

```
C =
```

1.0e+18 \*

0.000000000000000 0.0000000000000000 0.000000000000000 0.000000000000001 0.000000000000005 0.000000000000036 0.000000000000268 0.000000000002009 0.00000000015193 0.00000000115575 0.000000000883479 0.000000006780588 0.000000052214929 0.000000403235494 0.000003121681002 0.000024219318526 0.000188258967031 0.001465743747535 0.011294918041311 0.086986916094686 1.268785879046714 1.737938326404992 2.365785090006721 0 0 0 0 0

## C =

1.0e+19 \*

0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000004 0.000000000000027 0.00000000000000000 0.00000000001519 0.00000000011558 0.000000000088348 0.000000000678059 0.00000005221493 0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0 0 0 0 0

## C =

1.0e+19 \*

0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0.360973987430084 0 Ω 0 0

C =

1.0e+19 \*

0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000004 0.0000000000000027 0.00000000000000001 0.00000000001519 0.00000000011558 0.000000000088348 0.000000000678059 0.000000005221493 0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0.360973987430084 0.631696556867365 0 0 0

C =

1.0e+19 \*

0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000000 0.000000000000004 0.0000000000000027 0.00000000001519 0.00000000011558 0.000000000088348 0.000000000678059 0.000000005221493 0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0.360973987430084 0.631696556867365 0.826987866754702 0 0.000000000000000 0.000000000000000 0.0000000000000000 0.000000000000000 0.0000000000000000 0.000000000000004 0.0000000000000027 0.00000000001519 0.00000000011558 0.000000000088348 0.000000000678059 0.000000005221493 0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0.360973987430084 0.631696556867365 0.826987866754702 0.294629420061233

1.0e+19 \*

C =

1.0e+19 \*

0.0000000000000000 0.000000000000000 0.0000000000000000 0.000000000000000 0.000000000000000 0.000000000000004 0.0000000000000027 0.0000000000000201 0.000000000001519 0.00000000011558 0.000000000088348 0.000000000678059 0.00000005221493 0.000000040323549 0.000000312168100 0.000002421931853 0.000018825896703 0.000146574374754 0.001129491804131 0.008698691609469 0.126878587904671 0.173793832640499 0.236578509000672 1.416517298572189 0.360973987430084 0.631696556867365 0.826987866754702 0.294629420061233 3.905527425950357

C2 =

3.152946861735881

C2 =

0 0 0

C2 =

C2 =

1.0e+02 \*

0.031529468617359 0.166680067822790 0.934981926997248 5.379402073302585 

C2 =

1.0e+03 \*

C2 =

1.0e+04 \*

0.000315294686174 0.001666800678228 0.009349819269972 0.053794020733026 0.313818005809108 1.846636374810176

```
C2 =
```

1.0e+05 \*

## C2 =

1.0e+05 \*

## C2 =

1.0e+06 \*

0.000003152946862 0.000016668006782 0.000093498192700 0.000537940207330 0.003138180058091 0.018466363748102 0.109308577659040 0.649821981081621 3.875732367539766

C2 =

1.0e+07 \*

C2 =

1.0e+08 \*

0.00000031529469 0.00000166680068 0.000000934981927 0.000005379402073 0.000031381800581 0.000184663637481 0.001093085776590 0.006498219810816 0.038757323675398 0.231754968116108 1.388689985619671 

C2 =

1.0e+08 \*

0.00000031529469 0.00000166680068 0.000000934981927 0.000005379402073 0.000031381800581 0.000184663637481 0.001093085776590 0.006498219810816 0.038757323675398 0.231754968116108 1.388689985619671 8.335366008733715 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

C2 =

1.0e+09 \*

0.000000003152947 0.00000016668007 0.000000093498193 0.000000537940207 0.000003138180058 0.000018466363748 0.000109308577659 0.000649821981082 0.003875732367540 0.023175496811611 0.138868998561967 0.833536600873371 5.010346207927062 0 0 0 0 0 0 0 0

0

0

C2 =

1.0e+10 \*

0.00000000315295 0.000000001666801 0.000000009349819 0.000000053794021 0.000000313818006 0.000001846636375 0.000010930857766 0.000064982198108 0.000387573236754 0.002317549681161 0.013886899856197 0.083353660087337 0.501034620792706 3.015378958256151 0 0 0 C2 = 1.0e+11 \*

0.00000000031529 0.00000000166680

0.000000000934982 0.000000005379402 0.000000031381801 0.00000184663637 0.000001093085777

0.000006498219811 0.000038757323675 0.000231754968116 0.001388689985620

0.008335366008734 0.050103462079271 0.301537895825615 1.816662033953544

> 0 0 0

C2 = 1.0e+12 \*

> 0.00000000003153 0.00000000016668

> 0.000000000093498 0.00000000537940 0.000000003138180 0.00000018466364

> 0.000000109308578 0.000000649821981

0.000003875732368 0.000023175496812 0.000138868998562

0.000833536600873 0.005010346207927

0.030153789582562 0.181666203395354 1.095481802147560

> 0 0 0

0

0 0 0

0 0

C2 =

1.0e+12 \*

0.00000000003153 0.00000000016668 0.00000000093498

0.00000000537940

0.000000003138180 0.00000018466364 0.000000109308578 0.000000649821981 0.000003875732368 0.000023175496812 0.000138868998562 0.000833536600873 0.005010346207927 0.030153789582562 0.181666203395354 1.095481802147560 6.611224024660095 0 0 0 0 0 0 0 0 0 0

C2 =

1.0e+13 \*

0.000000000000315 0.00000000001667 0.00000000009350 0.00000000053794 0.000000000313818 0.00000001846636 0.00000010930858 0.000000064982198 0.000000387573237 0.000002317549681 0.000013886899856 0.000083353660087 0.000501034620793 0.003015378958256 0.018166620339535 0.109548180214756 0.661122402466010 3.993517661949297 0 0 0 0 0 0 0 0 0

C2 =

1.0e+14 \*

0.000000000000032 0.000000000000167 0.000000000000935 0.00000000005379 0.00000000031382 0.00000000184664 0.000000001093086 0.000000006498220 0.000000038757324 0.000000231754968 0.000001388689986 0.000008335366009 0.000050103462079 0.000301537895826 0.001816662033954 0.010954818021476 0.066112240246601 0.399351766194930 2.411735754894678 0 0

```
0
                   0
C2 =
   1.0e+15 *
  0.000000000000003
   0.000000000000017
   0.0000000000000093
  0.000000000000538
   0.000000000003138
   0.00000000018466
   0.000000000109309
   0.00000000649822
   0.000000003875732
   0.000000023175497
   0.00000138868999
   0.000000833536601
   0.000005010346208
   0.000030153789583
   0.000181666203395
   0.001095481802148
   0.006611224024660
   0.039935176619493
   0.241173575489468
   1.463594765573816
                   0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
C2 =
  1.0e+15 *
   0.000000000000003
   0.000000000000017
   0.000000000000093
   0.00000000000538
   0.000000000003138
   0.00000000018466
   0.00000000109309
   0.000000000649822
   0.00000003875732
   0.000000023175497
   0.00000138868999
   0.000000833536601
   0.000005010346208
   0.000030153789583
   0.000181666203395
   0.001095481802148
   0.006611224024660
   0.039935176619493
   0.241173575489468
   1.463594765573816
   8.540004394849523
                  0
                   0
                   0
                   0
                   0
                   0
                   0
                   0
C2 =
   1.0e+16 *
   0.000000000000000
   0.0000000000000002
   0.000000000000009
   0.00000000000054
   0.000000000000314
   0.00000000001847
   0.00000000010931
   0.00000000064982
```

0.00000000387573

0.000000002317550 0.00000013886900 0.000000083353660 0.000000501034621 0.000003015378958 0.000018166620340 0.000109548180215 0.000661122402466 0.003993517661949 0.024117357548947 0.146359476557382 0.854000439484952 5.519103546223878 0 0 0 0 0 0

C2 =

1.0e+17 \*

0.000000000000000 0.000000000000000 0.000000000000001 0.000000000000005 0.000000000000031 0.00000000000185 0.000000000001093 0.00000000006498 0.00000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 0 0 0 0 0 0

C2 =

1.0e+17 \*

0.000000000000000 0.000000000000000 0.0000000000000001 0.000000000000005 0.0000000000000031 0.000000000000185 0.00000000001093 0.000000000006498 0.000000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 2.285585552110712

1.0e+17 \*

0.0000000000000000 0.000000000000000 0.00000000000000001 0.000000000000005 0.000000000000031 0.000000000000185 0.00000000001093 0.000000000006498 0.00000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 2.285585552110712 2.033889351503177 0 0 0 0

C2 =

1.0e+17 \*

0.0000000000000000 0.000000000000000 0.0000000000000001 0.000000000000005 0.000000000000031 0.00000000000185 0.00000000001093 0.00000000006498 0.00000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 2.285585552110712 2.033889351503177 3.331690512212583 0 0 0

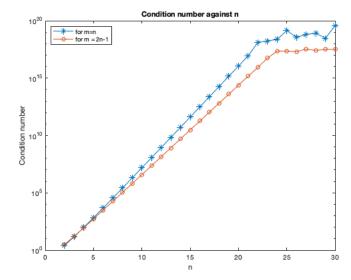
C2 =

1.0e+17 \*

2.285585552110712 2.033889351503177 3.331690512212583 2.617475526314923 Ω Ω C2 = 1.0e+17 \* 0.0000000000000000 0.000000000000000 0.000000000000001 0.000000000000005 0.000000000000031 0.00000000000185 0.000000000001093 0.000000000006498 0.00000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 2.285585552110712 2.033889351503177 3.331690512212583 2.617475526314923 3.175836547198190 C2 = 1.0e+17 \* 0.000000000000000 0.000000000000000 0.000000000000001 0.000000000000005 0.000000000000031 0.00000000000185 0.00000000001093 0.000000000006498 0.00000000038757 0.000000000231755 0.00000001388690 0.000000008335366 0.000000050103462 0.000000301537896 0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188 2.285585552110712 2.033889351503177 3.331690512212583 2.617475526314923 3.175836547198190 3.261114208147999 m=2n-1. Hence the dimension of the matrix affects the condition number.

0.000001816662034 0.000010954818021 0.000066112240247 0.000399351766195 0.002411735754895 0.014635947655738 0.085400043948495 0.551910354622388 2.264830123228188

For m = n, A is a square matrix, and gives large condtion numbers as n increases, compared to when



Published with MATLAB® R2020b