Morse Coefficient Optimization

By Terry Bondy, VA3TYB

In [1]:
```
printf(strftime ("Last updated: %A %e %B %Y", localtime (time ())))
```

```
Last updated: Sunday  8 December 2019
```

In [65]:
```
# inpAngle is a column vector, 0 <= theta <= pi, length m
# soundSilence is a row vector, 0 or 1s, length 2m + 1
function cost = costAny(inpAngle, soundSilence)
  # take first m angles, as row vector
  mAngle = inpAngle(:)';
  # Make a test vector where the back half is a mirror and congugate of
 the front half
  test = soundSilence .* [ exp(j .* mAngle), 1, exp(-j .* flip(mAngle))
];
  cost = max(abs(conv(test,flip(test))))/(soundSilence * soundSilence');
endfunction
```

In [60]:
```
function soundSilence = makeMorseSoundSilence(message)
    baseCoeff = alphaToMorse(message);
    soundSilence = horzcat(baseCoeff, [ 0 0 0 0 0 0 0 ], flip(baseCoeff
));
    sz = columns(soundSilence);
    # See if needs padding
    if (sz < 551)
        half = (551 - sz)/2;
        soundSilence = horzcat(zeros(1,half), baseCoeff, [ 0 0 0 0 0 0 0
], flip(baseCoeff), zeros(1,half));
    endif
endfunction
```

In [5]:
```
ss = makeMorseSoundSilence("QRG DE VA3TYB VA3TYB?");
```

In [6]:
```
columns(ss)
```

```
ans =  551
```

In [8]:
```
floor(columns(ss)/2)
```

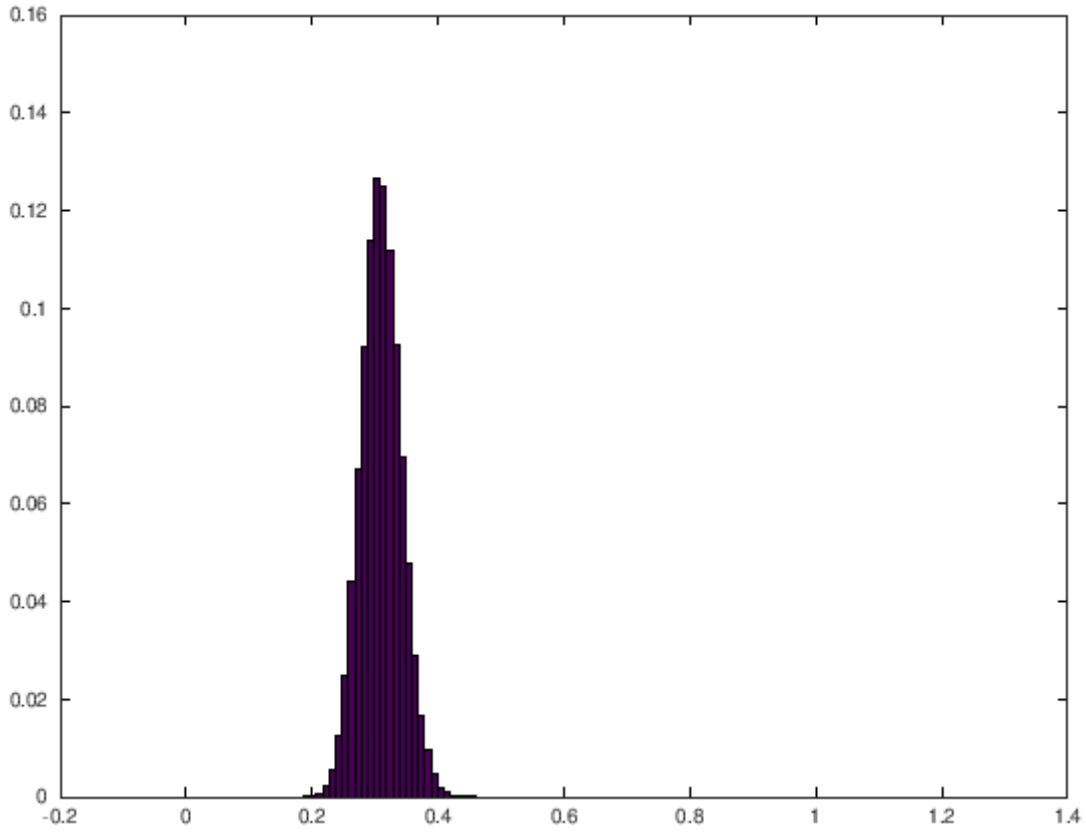
```
ans =  275
```

In [67]:
```
costAny(pi .* rand(floor(columns(ss)/2), 1), ss)
```

```
ans =  0.31560
```

In [43]:
```
h = [];
for k=1:100000
  h(end + 1) = costAny(pi .* rand(floor(columns(ss)/2), 1), ss);
end
```

In [45]:
```
hist(h, linspace(0,1,100), 1)
```



In [51]:
```
pkg load optim
```

In [68]:

```
m = floor(columns(ss)/2);
ssHalf = ss(1:m);

# t_init = .2;
# t_min = .002;
# mu_t = 1.002;
init_p = pi .* rand(m, 1) .* ssHalf';
max_rand_step = pi/100 .* ones(m, 1);
# Not varying all the parameters
fixed = not(logical(ssHalf))';
lbound = zeros(m, 1);
ubound = pi .* ones(m, 1);
[p, objf, cvg] = nonlin_min (@ (p) costAny(p, ss), init_p, optimset ("Al
gorithm", "samin",
"max_rand_step", max_rand_step,
# "T_init", t_init,
# "T_min", t_min,
"fixed", fixed,
"lbound", lbound,
"ubound", ubound,
# "mu_t", mu_t
"Display", "iter"
));
```

```
temperature no. 1: 1.000000e-01, energy 2.793685e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4776 / 6331 / 293 / 5778 / 31
temperature no. 2: 8.333333e-02, energy 3.242075e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4667 / 6403 / 330 / 5623 / 1
temperature no. 3: 6.944444e-02, energy 3.115087e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4661 / 6333 / 406 / 5648 / 4
temperature no. 4: 5.787037e-02, energy 2.728076e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4632 / 6295 / 473 / 5678 / 1
temperature no. 5: 4.822531e-02, energy 2.409991e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4454 / 6383 / 563 / 5710 / 0
temperature no. 6: 4.018776e-02, energy 2.760063e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4547 / 6171 / 682 / 5767 / 0
temperature no. 7: 3.348980e-02, energy 2.755265e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4471 / 6096 / 833 / 5624 / 2
temperature no. 8: 2.790816e-02, energy 3.359878e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4327 / 6101 / 972 / 5724 / 1
temperature no. 9: 2.325680e-02, energy 2.725171e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4326 / 5933 / 1141 / 5734 / 0
temperature no. 10: 1.938067e-02, energy 2.126222e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
4138 / 5894 / 1368 / 5680 / 4
temperature no. 11: 1.615056e-02, energy 2.381135e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3911 / 5844 / 1645 / 5577 / 3
temperature no. 12: 1.345880e-02, energy 2.774610e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3861 / 5643 / 1896 / 5722 / 0
temperature no. 13: 1.121567e-02, energy 2.291099e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3656 / 5424 / 2320 / 5683 / 2
temperature no. 14: 9.346388e-03, energy 2.269340e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3525 / 5108 / 2767 / 5593 / 0
temperature no. 15: 7.788657e-03, energy 2.252624e-01,
```

tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3270 / 5137 / 2993 / 5477 / 0
temperature no. 16: 6.490547e-03, energy 2.195340e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
3059 / 4743 / 3598 / 5393 / 8
temperature no. 17: 5.408789e-03, energy 1.952960e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2849 / 4620 / 3931 / 5211 / 0
temperature no. 18: 4.507324e-03, energy 1.364369e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2627 / 4333 / 4440 / 4995 / 15
temperature no. 19: 3.756104e-03, energy 1.223460e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2484 / 4028 / 4888 / 4570 / 1
temperature no. 20: 3.130086e-03, energy 1.323354e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2277 / 3939 / 5184 / 4064 / 13
temperature no. 21: 2.608405e-03, energy 1.006366e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2197 / 3762 / 5441 / 3534 / 9
temperature no. 22: 2.173671e-03, energy 1.001511e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
2069 / 3776 / 5555 / 3025 / 0
temperature no. 23: 1.811393e-03, energy 1.006930e-01,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1970 / 3755 / 5675 / 2620 / 9
temperature no. 24: 1.509494e-03, energy 9.472439e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1879 / 3837 / 5684 / 2314 / 5
temperature no. 25: 1.257912e-03, energy 8.527026e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1854 / 3691 / 5855 / 1823 / 11
temperature no. 26: 1.048260e-03, energy 7.851580e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1646 / 4113 / 5641 / 1674 / 2
temperature no. 27: 8.735497e-04, energy 7.304068e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1799 / 3803 / 5798 / 1267 / 1
temperature no. 28: 7.279581e-04, energy 7.038163e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1554 / 4101 / 5745 / 1369 / 6
temperature no. 29: 6.066317e-04, energy 6.616973e-02,
tries with energy less / not less but accepted / rejected: / to far / n

```
ew optimum
1554 / 4145 / 5701 / 1130 / 5
temperature no. 30: 5.055264e-04, energy 6.321285e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1438 / 4234 / 5728 / 1120 / 20
temperature no. 31: 4.212720e-04, energy 5.873838e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1467 / 4156 / 5777 / 837 / 7
temperature no. 32: 3.510600e-04, energy 5.989764e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1388 / 4255 / 5757 / 751 / 8
temperature no. 33: 2.925500e-04, energy 5.699193e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1360 / 4291 / 5749 / 838 / 8
temperature no. 34: 2.437917e-04, energy 5.504112e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1319 / 4384 / 5697 / 700 / 10
temperature no. 35: 2.031597e-04, energy 5.241477e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1193 / 4451 / 5756 / 817 / 3
temperature no. 36: 1.692998e-04, energy 4.918618e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1198 / 4545 / 5657 / 797 / 38
temperature no. 37: 1.410831e-04, energy 4.805878e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1138 / 4532 / 5730 / 771 / 10
temperature no. 38: 1.175693e-04, energy 4.807454e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1032 / 4629 / 5739 / 770 / 17
temperature no. 39: 9.797441e-05, energy 4.655872e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1199 / 4305 / 5896 / 750 / 27
temperature no. 40: 8.164534e-05, energy 4.492412e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1195 / 4536 / 5669 / 722 / 38
temperature no. 41: 6.803778e-05, energy 4.267354e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
1062 / 4652 / 5686 / 670 / 56
temperature no. 42: 5.669815e-05, energy 4.141541e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
998 / 4644 / 5758 / 663 / 27
temperature no. 43: 4.724846e-05, energy 4.017391e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
```

936 / 4756 / 5708 / 779 / 74
temperature no. 44: 3.937372e-05, energy 3.890528e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
870 / 4782 / 5748 / 827 / 41
temperature no. 45: 3.281143e-05, energy 3.791486e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
830 / 4791 / 5779 / 829 / 57
temperature no. 46: 2.734286e-05, energy 3.760460e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
889 / 4774 / 5737 / 787 / 27
temperature no. 47: 2.278572e-05, energy 3.704939e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
710 / 4876 / 5814 / 900 / 42
temperature no. 48: 1.898810e-05, energy 3.717386e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
822 / 4925 / 5653 / 826 / 1
temperature no. 49: 1.582341e-05, energy 3.683716e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
812 / 4878 / 5710 / 887 / 20
temperature no. 50: 1.318618e-05, energy 3.693952e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
887 / 4717 / 5796 / 836 / 28
temperature no. 51: 1.098848e-05, energy 3.644090e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
875 / 4756 / 5769 / 832 / 60
temperature no. 52: 9.157068e-06, energy 3.614564e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
857 / 4844 / 5699 / 902 / 40
temperature no. 53: 7.630890e-06, energy 3.612005e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
736 / 5002 / 5662 / 859 / 36
temperature no. 54: 6.359075e-06, energy 3.586896e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
873 / 4719 / 5808 / 779 / 44
temperature no. 55: 5.299229e-06, energy 3.577385e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
756 / 4952 / 5692 / 837 / 22
temperature no. 56: 4.416024e-06, energy 3.563905e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
824 / 4799 / 5777 / 830 / 44
temperature no. 57: 3.680020e-06, energy 3.556793e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
862 / 4740 / 5798 / 871 / 34

```
temperature no. 58: 3.066684e-06, energy 3.550690e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
834 / 4799 / 5767 / 840 / 33
temperature no. 59: 2.555570e-06, energy 3.544578e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
878 / 4828 / 5694 / 790 / 50
temperature no. 60: 2.129641e-06, energy 3.540002e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
741 / 4953 / 5706 / 867 / 28
temperature no. 61: 1.774701e-06, energy 3.538226e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
762 / 4855 / 5783 / 758 / 23
temperature no. 62: 1.478918e-06, energy 3.536054e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
725 / 5035 / 5640 / 771 / 16
temperature no. 63: 1.232431e-06, energy 3.534522e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
715 / 4960 / 5725 / 787 / 19
temperature no. 64: 1.027026e-06, energy 3.531014e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
743 / 4880 / 5777 / 749 / 58
temperature no. 65: 8.558551e-07, energy 3.530081e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
785 / 4964 / 5651 / 698 / 22
temperature no. 66: 7.132126e-07, energy 3.527235e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
762 / 4809 / 5829 / 777 / 75
temperature no. 67: 5.943438e-07, energy 3.525979e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
772 / 4904 / 5724 / 768 / 31
temperature no. 68: 4.952865e-07, energy 3.524008e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
667 / 4988 / 5745 / 840 / 57
temperature no. 69: 4.127388e-07, energy 3.522976e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
661 / 5027 / 5712 / 821 / 49
temperature no. 70: 3.439490e-07, energy 3.521968e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
570 / 5171 / 5659 / 800 / 64
temperature no. 71: 2.866241e-07, energy 3.520366e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
662 / 4927 / 5811 / 785 / 93
temperature no. 72: 2.388535e-07, energy 3.519681e-02,
```

tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
581 / 5020 / 5799 / 814 / 41
temperature no. 73: 1.990445e-07, energy 3.519153e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
687 / 4877 / 5836 / 775 / 47
temperature no. 74: 1.658705e-07, energy 3.518597e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
784 / 4929 / 5687 / 707 / 38
temperature no. 75: 1.382254e-07, energy 3.518413e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
761 / 4886 / 5753 / 756 / 50
temperature no. 76: 1.151878e-07, energy 3.517881e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
778 / 4795 / 5827 / 742 / 31
temperature no. 77: 9.598985e-08, energy 3.517555e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
723 / 5010 / 5667 / 779 / 58
temperature no. 78: 7.999154e-08, energy 3.517488e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
632 / 5115 / 5653 / 804 / 20
temperature no. 79: 6.665962e-08, energy 3.517081e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
569 / 4955 / 5876 / 721 / 59
temperature no. 80: 5.554968e-08, energy 3.516642e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
586 / 5094 / 5720 / 753 / 116
temperature no. 81: 4.629140e-08, energy 3.516474e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
639 / 5064 / 5697 / 787 / 59
temperature no. 82: 3.857617e-08, energy 3.516240e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
642 / 4980 / 5778 / 809 / 81
temperature no. 83: 3.214681e-08, energy 3.516156e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
747 / 4757 / 5896 / 773 / 39
temperature no. 84: 2.678900e-08, energy 3.516126e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
669 / 5116 / 5615 / 774 / 18
temperature no. 85: 2.232417e-08, energy 3.516021e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
658 / 4909 / 5833 / 697 / 71
temperature no. 86: 1.860348e-08, energy 3.515924e-02,
tries with energy less / not less but accepted / rejected: / to far / n

```
ew optimum
675 / 5006 / 5719 / 764 / 81
temperature no. 87: 1.550290e-08, energy 3.515878e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
607 / 5078 / 5715 / 792 / 54
temperature no. 88: 1.291908e-08, energy 3.515793e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
699 / 4905 / 5796 / 801 / 89
temperature no. 89: 1.076590e-08, energy 3.515762e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
757 / 4916 / 5727 / 767 / 65
temperature no. 90: 8.971583e-09, energy 3.515729e-02,
tries with energy less / not less but accepted / rejected: / to far / n
ew optimum
582 / 5113 / 5705 / 803 / 64
samin: convergence near bounds
objective function: 3.515728e-02
parameter #1, value: 3.340423e-02, search width: 3.990236e-05
parameter #2, value: 1.043568e+00, search width: 1.348225e-05
parameter #3, value: 8.172393e-01, search width: 6.650393e-06
parameter #4, value: 1.806159e-07, search width: 5.055845e-06
parameter #5, value: 1.533519e-05, search width: 3.990236e-05
parameter #6, value: 8.163681e-06, search width: 6.312678e-06
parameter #7, value: 3.087737e-06, search width: 1.995118e-05
parameter #8, value: 3.761154e-06, search width: 6.312678e-06
parameter #9, value: 4.416454e-01, search width: 1.050926e-05
parameter #10, value: 2.717346e-06, search width: 3.940974e-06
parameter #11, value: 1.630228e+00, search width: 1.182292e-05
parameter #12, value: 5.491975e-07, search width: 7.989483e-06
parameter #13, value: 1.557245e+00, search width: 1.576390e-05
parameter #14, value: 2.101207e-06, search width: 2.525071e-05
parameter #15, value: 5.240387e-01, search width: 2.022338e-05
parameter #16, value: 3.141590e+00, search width: 5.055845e-06
parameter #17, value: 1.525076e+00, search width: 1.476198e-05
parameter #18, value: 6.869711e-06, search width: 1.868314e-05
parameter #19, value: 3.340532e-06, search width: 1.968264e-05
parameter #20, value: 2.068553e-05, search width: 1.294515e-05
parameter #21, value: 1.235105e+00, search width: 3.546876e-05
parameter #22, value: 1.311327e+00, search width: 2.840705e-05
parameter #23, value: 2.572366e+00, search width: 3.152779e-05
parameter #24, value: 2.709975e-04, search width: 1.729628e-05
parameter #25, value: 1.480882e+00, search width: 2.491085e-05
parameter #26, value: 1.441665e-06, search width: 4.734509e-06
parameter #27, value: 1.742016e+00, search width: 3.595267e-05
parameter #28, value: 3.542469e-06, search width: 1.065264e-05
parameter #29, value: 4.420726e-06, search width: 6.741127e-06
parameter #30, value: 1.748837e+00, search width: 1.262536e-05
parameter #31, value: 3.141587e+00, search width: 1.597897e-05
parameter #32, value: 2.428608e-06, search width: 1.995118e-05
parameter #33, value: 1.479374e+00, search width: 1.683381e-05
parameter #34, value: 2.426683e+00, search width: 9.841322e-06
parameter #35, value: 1.401437e+00, search width: 1.182292e-05
parameter #36, value: 1.577950e+00, search width: 2.101853e-05
parameter #37, value: 1.994244e+00, search width: 2.101853e-05
```

```
parameter #38, value: 5.564533e-06, search width: 4.203705e-05
parameter #39, value: 4.556868e-06, search width: 3.499137e-05
parameter #40, value: 3.141566e+00, search width: 4.550260e-05
parameter #41, value: 1.341195e+00, search width: 3.195793e-05
parameter #42, value: 2.034056e+00, search width: 1.576390e-05
parameter #43, value: 1.911932e+00, search width: 3.990236e-05
parameter #44, value: 1.736411e+00, search width: 2.660157e-05
parameter #45, value: 1.411112e+00, search width: 5.392901e-05
parameter #46, value: 1.387270e+00, search width: 6.825391e-05
parameter #47, value: 1.415959e+00, search width: 3.366762e-05
parameter #48, value: 1.355868e+00, search width: 5.681410e-05
parameter #49, value: 1.181578e+00, search width: 2.992677e-05
parameter #50, value: 1.411718e+00, search width: 8.303616e-06
parameter #51, value: 3.141570e+00, search width: 4.489016e-05
parameter #52, value: 1.478811e+00, search width: 2.559521e-05
parameter #53, value: 3.141591e+00, search width: 4.265869e-06
parameter #54, value: 3.141558e+00, search width: 6.220688e-05
parameter #55, value: 3.141536e+00, search width: 1.010029e-04
parameter #56, value: 1.436188e+00, search width: 3.033507e-05
parameter #57, value: 1.837804e+00, search width: 1.660723e-05
parameter #58, value: 1.971794e+00, search width: 4.044676e-05
parameter #59, value: 3.141573e+00, search width: 4.044676e-05
parameter #60, value: 3.141579e+00, search width: 4.550260e-05
parameter #61, value: 1.359978e+00, search width: 1.995118e-05
parameter #62, value: 1.628855e+00, search width: 7.372667e-05
parameter #63, value: 9.800921e-01, search width: 2.992677e-05
parameter #64, value: 3.141541e+00, search width: 9.587380e-05
parameter #65, value: 1.672818e+00, search width: 3.990236e-05
parameter #66, value: 1.522556e+00, search width: 2.992677e-05
parameter #67, value: 2.121167e+00, search width: 1.893803e-05
parameter #68, value: 2.213190e+00, search width: 5.985354e-05
parameter #69, value: 2.367610e+00, search width: 1.597897e-05
parameter #70, value: 1.453846e+00, search width: 1.596094e-04
parameter #71, value: 3.141584e+00, search width: 2.696451e-05
parameter #72, value: 1.618875e+00, search width: 1.438107e-04
parameter #73, value: 1.660586e+00, search width: 5.392901e-05
parameter #74, value: 3.141585e+00, search width: 3.152779e-05
parameter #75, value: 2.416322e+00, search width: 5.392901e-05
parameter #76, value: 2.399929e+00, search width: 5.320315e-05
parameter #77, value: 3.141567e+00, search width: 3.644319e-05
parameter #78, value: 2.114093e+00, search width: 1.597897e-05
parameter #79, value: 2.420039e+00, search width: 6.220688e-05
parameter #80, value: 1.747179e+00, search width: 5.604941e-05
parameter #81, value: 2.216657e+00, search width: 3.736627e-05
parameter #82, value: 3.141539e+00, search width: 2.952397e-05
parameter #83, value: 2.163867e+00, search width: 2.840705e-05
parameter #84, value: 3.141590e+00, search width: 3.412695e-05
parameter #85, value: 3.141518e+00, search width: 3.595267e-05
parameter #86, value: 1.960138e+00, search width: 2.624353e-05
parameter #87, value: 1.904903e+00, search width: 5.050143e-05
parameter #88, value: 2.110584e+00, search width: 3.787607e-05
parameter #89, value: 3.141560e+00, search width: 2.992677e-05
parameter #90, value: 2.608124e+00, search width: 1.773438e-05
parameter #91, value: 2.401837e+00, search width: 1.065264e-05
parameter #92, value: 2.007965e+00, search width: 3.152779e-05
parameter #93, value: 2.285366e+00, search width: 2.214298e-05
parameter #94, value: 2.131383e+00, search width: 2.491085e-05
```

parameter #95, value: 2.214629e+00, search width: 2.840705e-05
parameter #96, value: 2.631736e+00, search width: 6.067014e-05
parameter #97, value: 2.266583e+00, search width: 2.130529e-05
parameter #98, value: 1.890990e+00, search width: 4.044676e-05
parameter #99, value: 2.601845e+00, search width: 3.195793e-05
parameter #100, value: 3.125535e+00, search width: 1.917476e-04
parameter #101, value: 2.894415e+00, search width: 3.366762e-05
parameter #102, value: 3.140017e+00, search width: 4.261058e-05
parameter #103, value: 2.171198e+00, search width: 3.736627e-05
parameter #104, value: 2.526971e+00, search width: 1.401235e-05
parameter #105, value: 2.506895e+00, search width: 1.995118e-05
parameter #106, value: 2.169349e+00, search width: 3.412695e-05
parameter #107, value: 2.615483e+00, search width: 5.985354e-05
parameter #108, value: 2.159469e+00, search width: 1.576390e-05
parameter #109, value: 2.298798e+00, search width: 1.893803e-05
parameter #110, value: 2.313664e+00, search width: 1.401235e-05
parameter #111, value: 2.267066e+00, search width: 2.244508e-05
parameter #112, value: 2.628586e+00, search width: 2.101853e-05
parameter #113, value: 2.107339e+00, search width: 8.531738e-06
parameter #114, value: 2.382527e+00, search width: 2.491085e-05

In [70]:
```
p
```

```
p =

   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.00000
   0.03340
   1.04357
```

0.81724
0.00000
0.00000
0.00002
0.00001
0.00000
0.00000
0.00000
0.00000
0.44165
0.00000
0.00000
0.00000
0.00000
1.63023
0.00000
0.00000
1.55725
0.00000
0.00000
0.52404
0.00000
0.00000
0.00000
3.14159
1.52508
0.00001
0.00000
0.00000
0.00002
1.23510
0.00000
1.31133
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
2.57237
0.00027
1.48088
0.00000
0.00000
0.00000
1.74202
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000

0.00000
0.00000
0.00000
1.74884
0.00000
3.14159
0.00000
0.00000
1.47937
2.42668
0.00000
0.00000
0.00000
1.40144
0.00000
1.57795
1.99424
0.00001
0.00000
0.00000
0.00000
0.00000
0.00000
3.14157
0.00000
1.34120
0.00000
2.03406
1.91193
1.73641
0.00000
1.41111
1.38727
1.41596
0.00000
0.00000
0.00000
1.35587
1.18158
1.41172
0.00000
0.00000
0.00000
3.14157
1.47881
3.14159
0.00000
3.14156
0.00000
3.14154
1.43619
1.83780
0.00000
1.97179
3.14157
3.14158
0.00000

0.00000
0.00000
1.35998
1.62885
0.98009
0.00000
3.14154
0.00000
1.67282
0.00000
1.52256
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
0.00000
2.12117
0.00000
2.21319
0.00000
2.36761
0.00000
1.45385
3.14158
1.61887
0.00000
0.00000
0.00000
1.66059
0.00000
3.14159
2.41632
2.39993
0.00000
0.00000
0.00000
3.14157
0.00000
2.11409
0.00000
2.42004
0.00000
1.74718
2.21666
3.14154
0.00000
2.16387
3.14159
3.14152
0.00000
0.00000
0.00000
1.96014
1.90490
2.11058

```
0.00000
0.00000
0.00000
3.14156
2.60812
2.40184
0.00000
2.00797
0.00000
2.28537
2.13138
2.21463
0.00000
2.63174
2.26658
1.89099
0.00000
0.00000
0.00000
2.60184
3.12553
2.89442
0.00000
3.14002
0.00000
2.17120
0.00000
2.52697
0.00000
0.00000
0.00000
2.50690
0.00000
2.16935
0.00000
2.61548
2.15947
2.29880
0.00000
2.31366
2.26707
2.62859
0.00000
2.10734
0.00000
2.38253
0.00000
0.00000
0.00000
```

In [71]:
```
cvg
```

```
cvg =  1
```

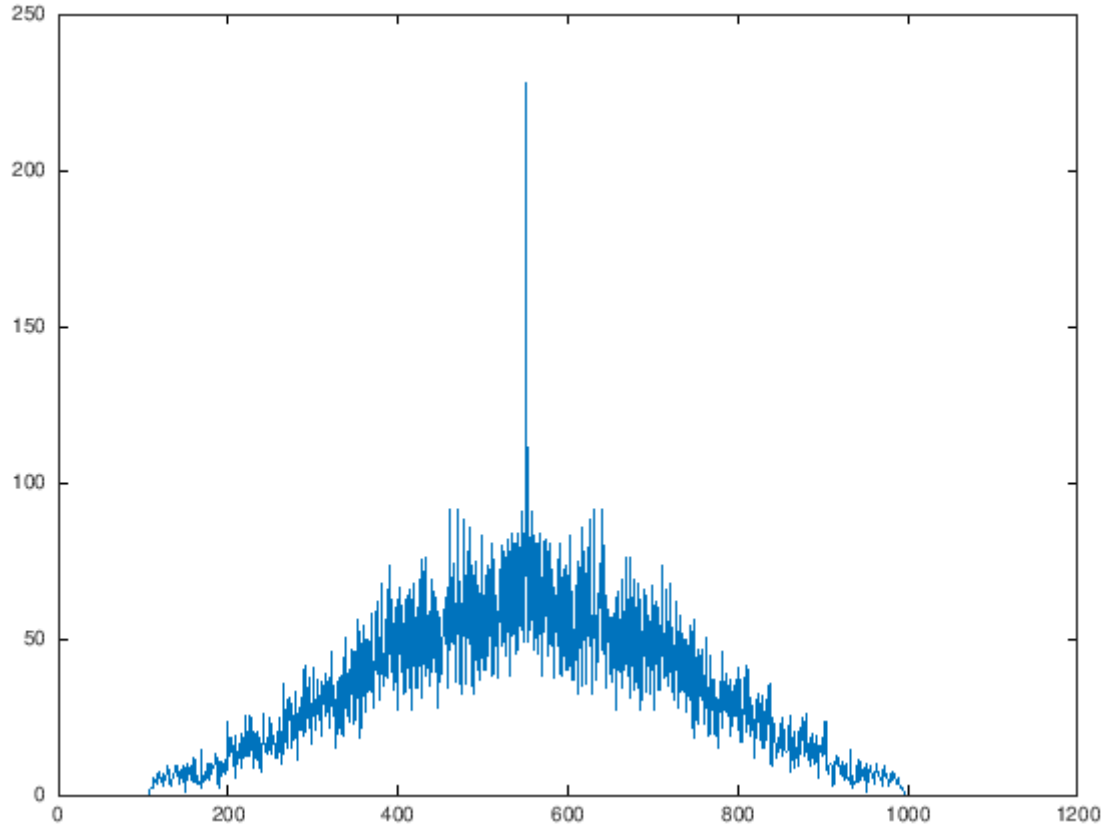
In [72]:
```
objf
```

```
objf =  0.035157
```

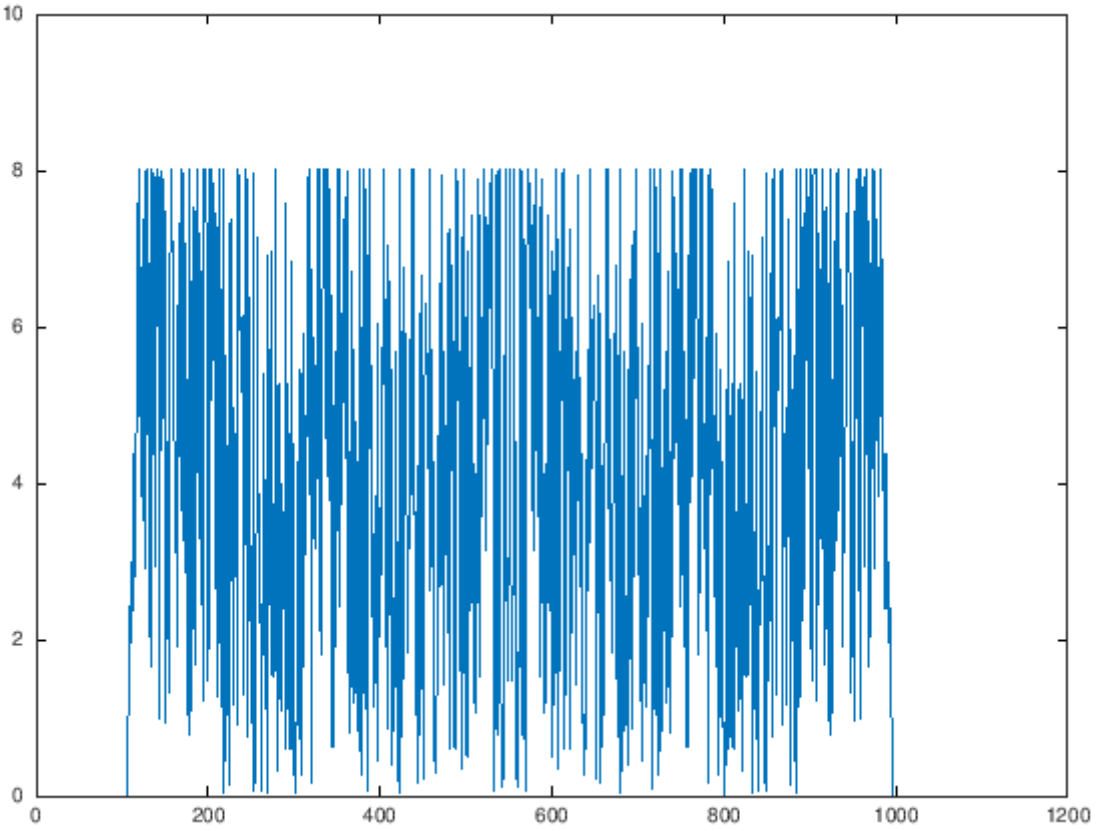
In [73]:
```
costAny(p, ss)
```

```
ans =  0.035157
```

In [74]:
```
mAngle = p(:)';
  # Make a test vector where the back half is a mirror and congugate of
 the front half
  test = ss .* [ exp(j .* mAngle), 1, exp(-j .* flip(mAngle)) ];
plot(abs(conv(test,test)))
```



In [76]:
```
plot(abs(conv(test,flip(test))))
```



In [ ]: