Temperature Prediction Check ($E_k = 0$ case)

$$Q = \begin{pmatrix} a + b(g_x^2 - 1) & bg_xg_y \\ bg_xg_y & a + b(g_y^2 - 1) \end{pmatrix}, g = [0, 1]$$

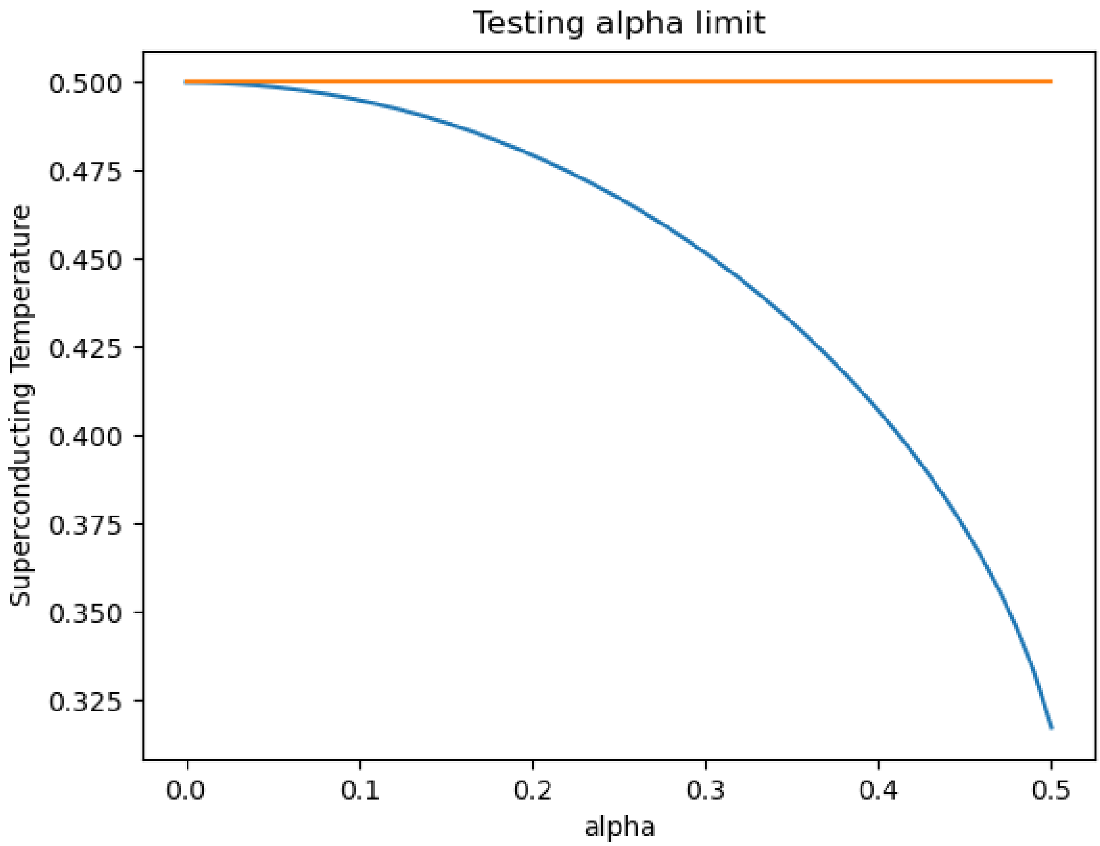
$$Q = \begin{pmatrix} a - b & 0 \\ 0 & a + b(\alpha^2 - 1) \end{pmatrix}, b = a + s$$

$$Q = \begin{pmatrix} -s & 0 \\ 0 & a\alpha^2 + s\alpha^2 - s \end{pmatrix}$$

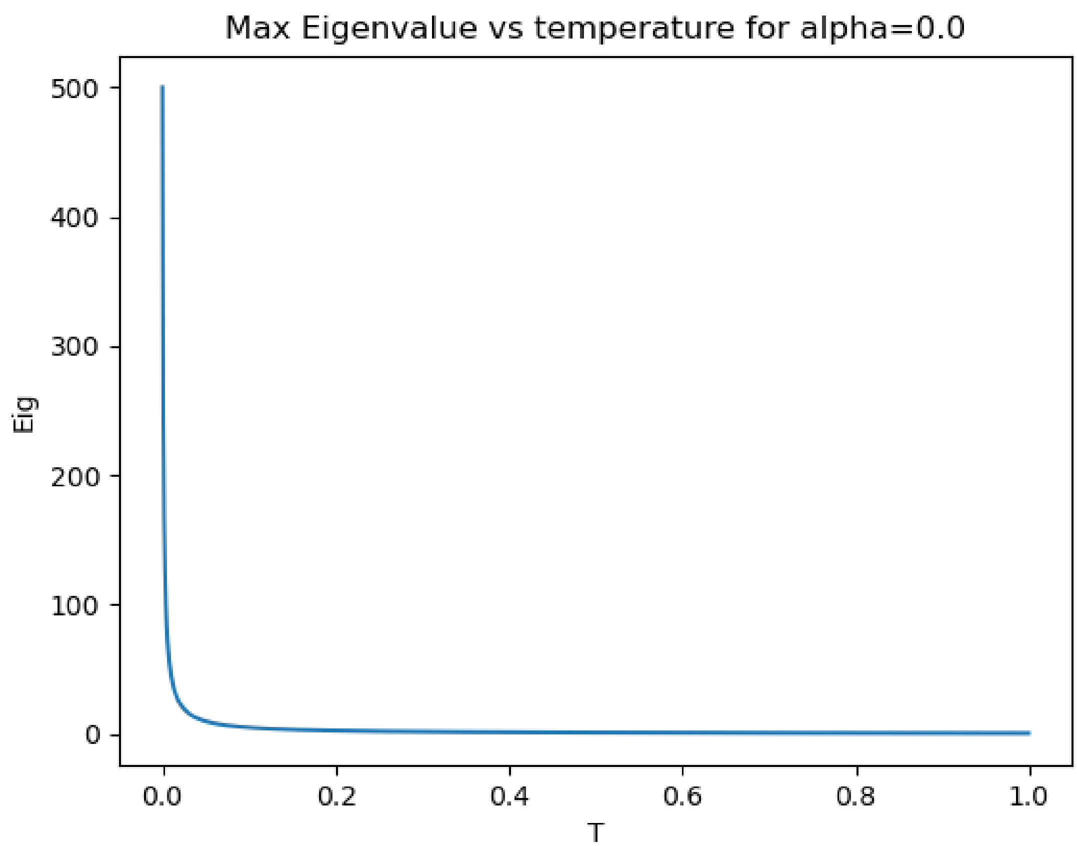
Higher eigenvalue is $max(a\alpha^2 + s\alpha^2 - s, -s)$, and as it turns out s is always greater than or equal to $-a$, since

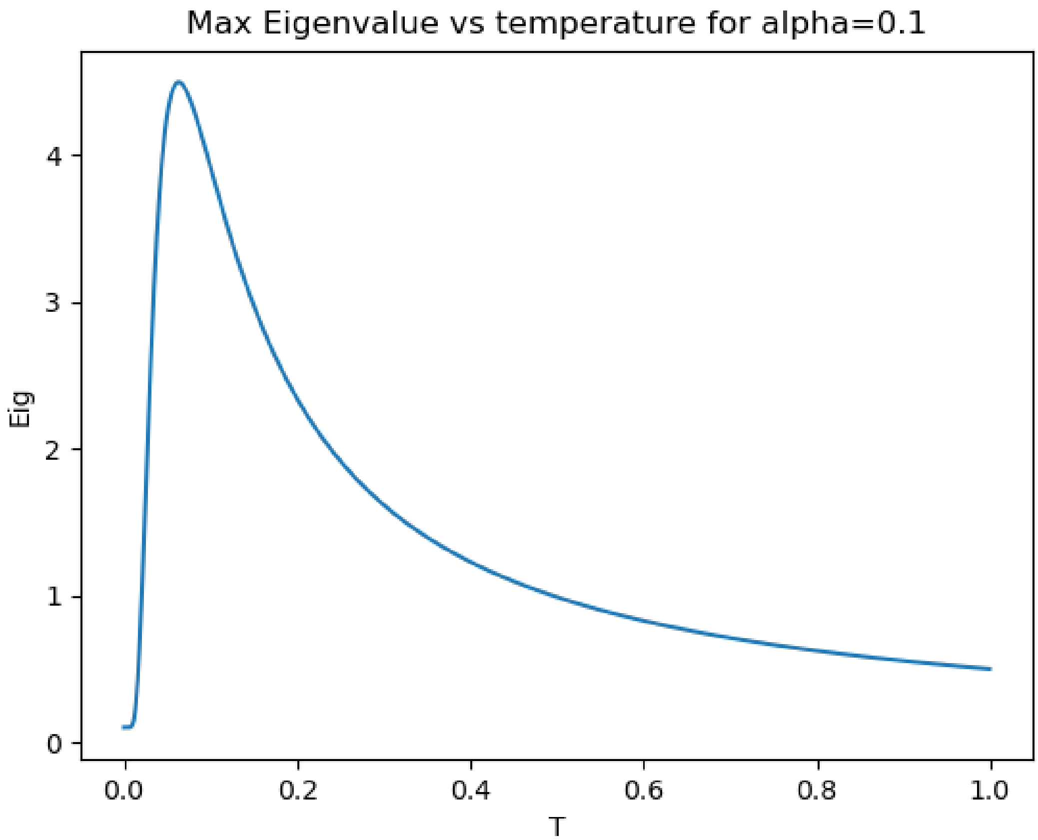
$$a = -\frac{1}{2\alpha}\tanh(\beta\alpha/2), s = \frac{\beta}{2\cosh(\beta\alpha) + 1}$$

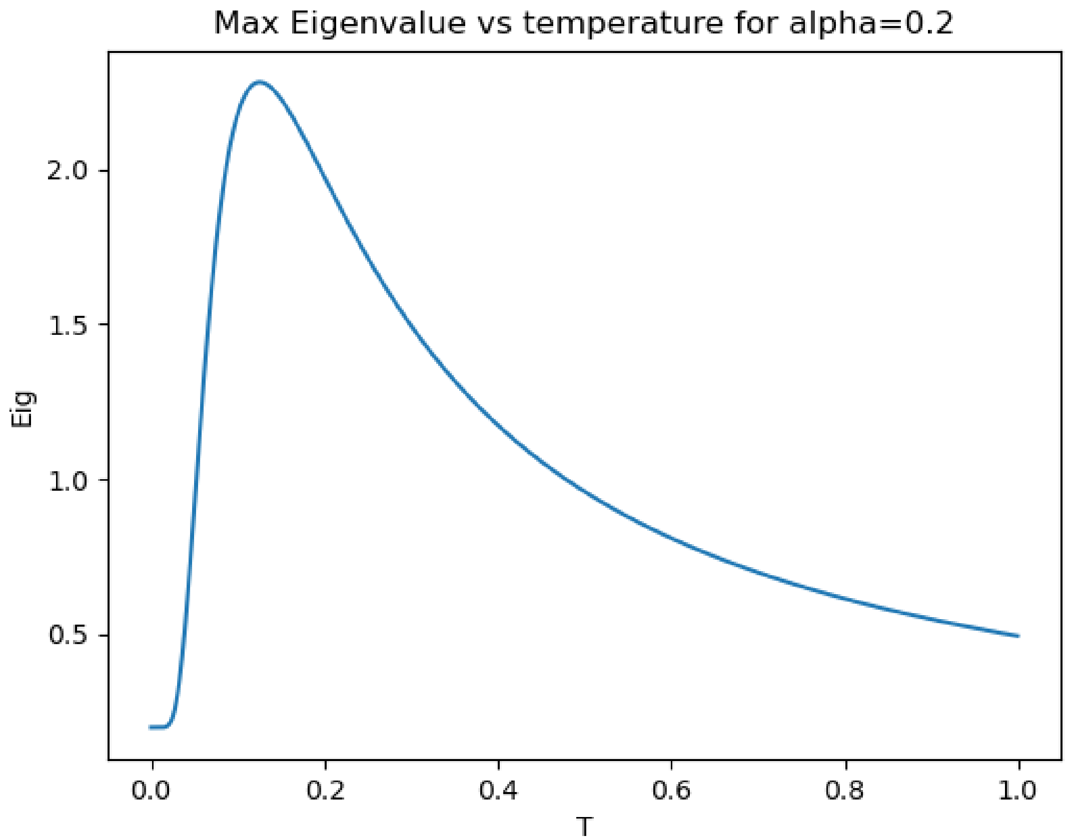
Therefore the highest eigenvalue is $a\alpha^2 + s\alpha^2 - s$, which is what is found both analytically and numerically. One interesting note is in the $E_k = 0$ limit, there is a point where a critical superconducting temperature cannot be found, around roughly the $\alpha = 0.52$ point. A graph of the temperature up until that point is shown below.



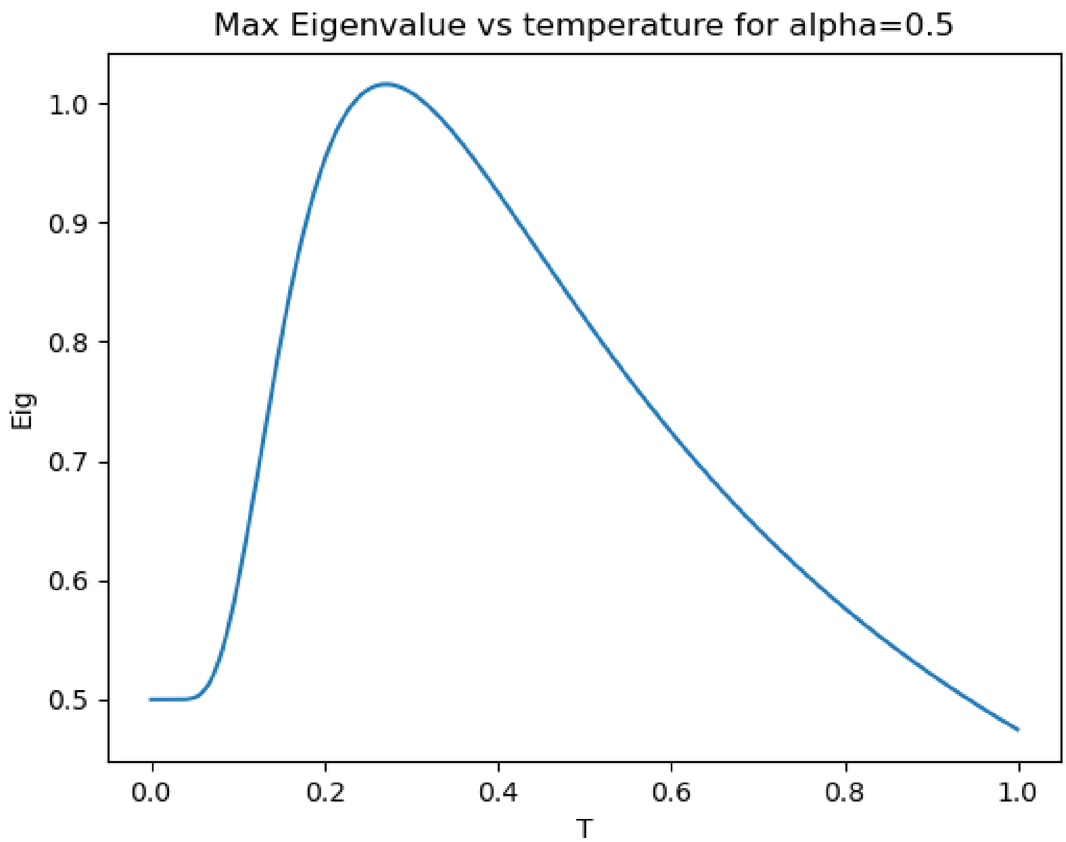
This can also be seen in some sample plots of the highest eigenvalue vs temperature, where it is clear that as alpha increases, the maximum point of 1 can no longer be reached.

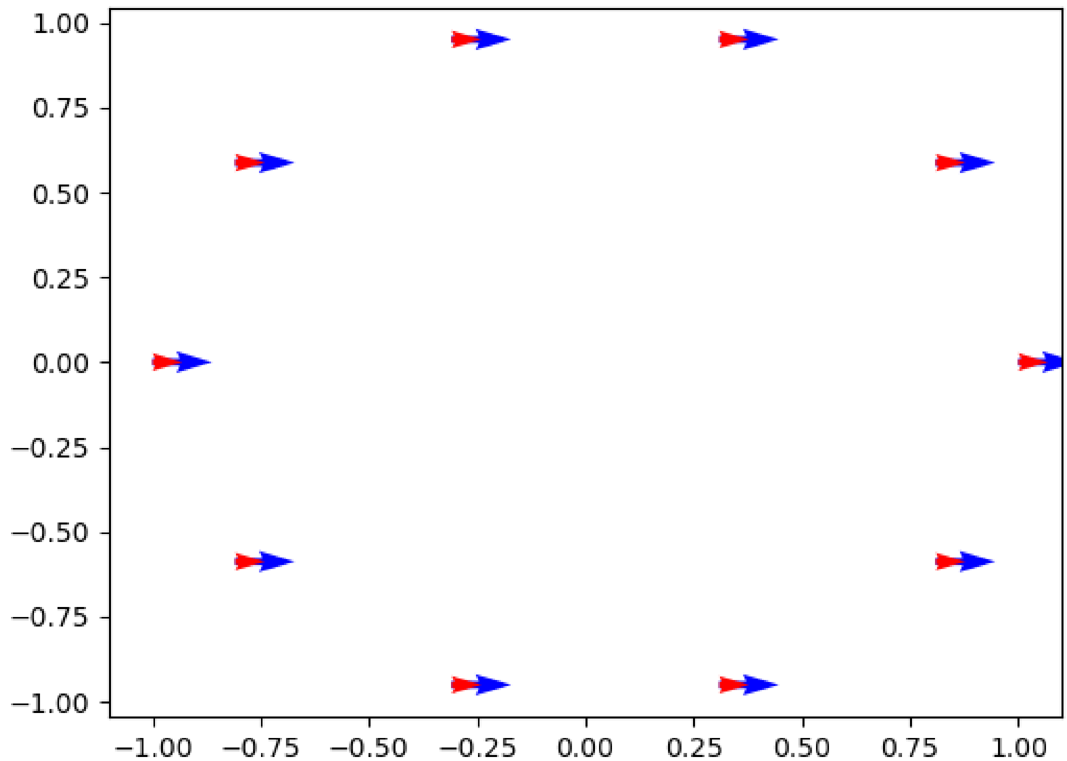

Max Eigenvalue vs temperature for alpha=0.0
Eig
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
T


Max Eigenvalue vs temperature for alpha=0.1
Eig
T
0
1
2
3
4
0.0
0.2
0.4
0.6
0.8
1.0

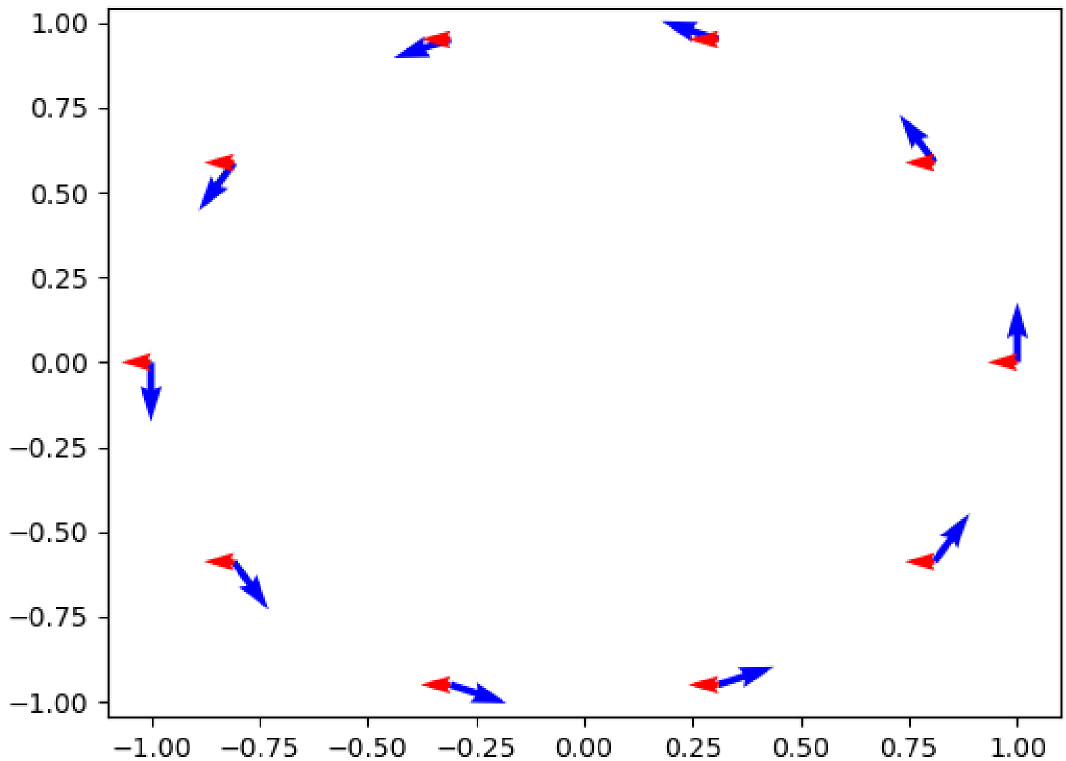


Max Eigenvalue vs temperature for alpha=0.2
Eig
T
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0


Max Eigenvalue vs temperature for alpha=0.5
Eig
T
1.0
0.9
0.8
0.7
0.6
0.5
0.0
0.2
0.4
0.6
0.8
1.0



1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00



last two plots show the d-wave direction(red) as the g-vector(blue) changes. The first plot lines up with what we expect, and the second one seems wrong. I'm still double-checking all of my physics/code to but I haven't found anything so far.