

# QUANTUM ALGORITHM GRAND CHALLENGE

Organizer: QunaSys

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Task: To calculate the ground state energy of a model (Hamiltonian) and its orbital rotations which QunaSys provided and prepared.

Date Submitted: 31<sup>st</sup> July 2023

## High Level Overview

- Load the Hamiltonian of the model and transform it to the Jordan-Wigner representation
- Define the Hartree Fock (HF) ansatz for the initial trial quantum state
- Set up the estimator for measuring the expectation value of the Hamiltonian
- Allocate shots for concurrent parameter sampling
- Implement the anti-noise VQE optimization loop
  - final cost is calculated using a technique to mitigate noise present in each iteration's output value of cost

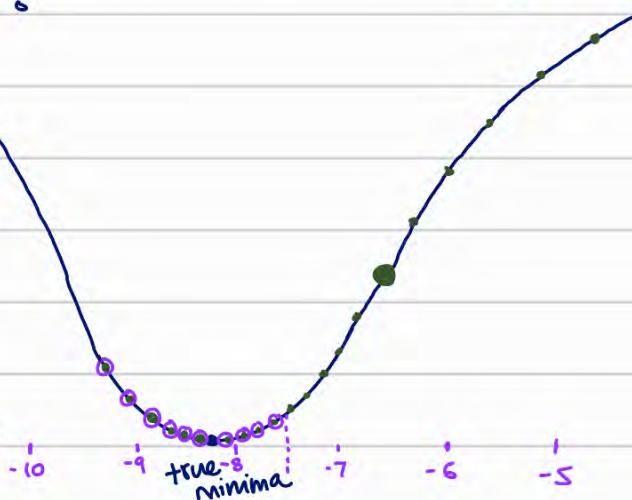
# Main Modifications

- in the HF ansatz, the parametric rotation gates ( $RX$ ,  $RY$ ,  $RZ$ ) and  $CZ$  gates are applied only in the first half of the circuit.
- the number of shots are set to approx. minimum number of shots that do not result in garbage output for the given HF ansatz in the iterations of VQE  
i.e. 100 shots for 4 qubits  
≈ 400 shots for 8 qubits

# Main Modifications (continued)

- the VQE optimization loops have been implemented using the AdaBelief optimizer
- the final cost has been calculated using the following intuition:

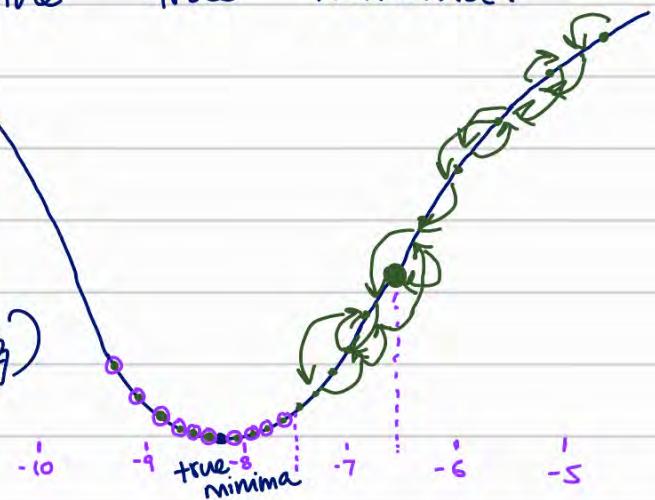
Consider the visual of the minima we're trying to find. Due to presence of noise in the quantum circuit execution, each time



# Main Modifications (continued)

VQE attempts to converge / move closer to the true minima, it ends up randomly (due to inconsistent noise) being offset to some value greater or smaller than the true minima.

Also, due to this noise, the convergence itself behaves stochastically, & (for the sake of understanding) the cost corresponding to the large green point was reached



# Main Modifications (continued)

via a stochastically behaving convergence (due to noise). But this large green point can be any green point enlarged on this blue line. So, since we're trying to approach the true minima from the right, more cost values outputted in each iteration can be assumed to be on the further right of the true value on the number line.

So, now we just have to figure out where the true value may reside and how we can determine

# Main Modifications (continued)

this value using the cost values obtained in all the iterations. For this, I have devised the following method to find the approximate final cost:

Let  $l$  be the range of the set containing all the cost values obtained per iteration.

if  $l \leq 2$ :

$$\text{final cost} = \min(\text{all cost values})$$

else:

$$\text{final cost} = \text{average}(\text{weighted cost values from the}$$

[note: this is the most simple leftmost 40% of the range of the high level presentation of the method devised] set of values)

## Some Average Scores Reported for 3 runs

<u>hamiltonian</u>	<u>trial #</u>	<u>score</u>
8-qubits-H	1	10.49675483
	2	9.92641297
8-qubits-H-1	1	1.75213983
	2	9.84010743
8-qubits-H-2	1	17.43284929
	2	26.62041316
8-qubits-H-3	1	15.69029117
	2	52.91171961
8-qubits-H-4	1	14.90099438
	2	19.6077237
8-qubits-H-5	1	2.3886265
	2	12.73810606

# Some Average Scores Reported for 3 runs

[for 8-qubits-H.data]

```
Running algorithm(1)..  
iteration 1  
-7.788757918653184  
iteration 2  
-5.945895148065876  
iteration 3  
-5.5448867947130065  
iteration 4  
-8.62812575033215  
iteration 5  
-7.1451015735887715  
iteration 6  
-6.326617579799814  
iteration 7  
-6.252771359047171  
iteration 8  
-9.525717427845759  
iteration 9  
-7.035417190300764  
iteration 10  
-7.247266037407935  
iteration 11  
-6.01390713621419  
iteration 12  
-7.627023748695448  
iteration 13  
-5.252368174798888  
iteration 14  
-5.722551441271456  
iteration 15  
-7.750879217470892  
iteration 16  
-7.827299264853831  
iteration 17  
-7.35862107447812  
iteration 18  
-6.914714622644204  
iteration 19  
-8.104554753629845  
iteration 20  
-6.441040535895034  
iteration 21  
-7.441800597115881  
iteration 22  
-6.943932900218705  
iteration 23  
-7.07403287007877  
iteration 24  
-5.255664317755679  
iteration 25  
-8.081574682157822  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858  
Calculating final cost ...  
iteration used: 25  
##### Result #####  
Resulting energy = -8.334981666600196  
Circuit time = 1000.8363999999858  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..
iteration 1
-8.916193548745884
iteration 2
-6.793958517802756
iteration 3
-5.92990231990945
iteration 4
-8.142135921092502
iteration 5
-8.099231651919188
iteration 6
-7.2197458678766235
iteration 7
-8.461240031188497
iteration 8
-7.1555379964538695
iteration 9
-8.09206234409124
iteration 10
-8.031407713978746
iteration 11
-10.047968479975838
iteration 12
-8.506902703040163
iteration 13
-7.973580059704994
iteration 14
-6.82604346194821
iteration 15
-6.875082339671743
iteration 16
-9.469593189904716
iteration 17
-7.4657298758482495
iteration 18
-7.305829943446319
iteration 19
-10.25037921615592
iteration 20
-8.7396521861563
iteration 21
-4.893747186311777
iteration 22
-8.679494568357976
iteration 23
-6.035130599294259
iteration 24
-6.948579061240149
iteration 25
-9.748961718530175
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858
Calculating final cost ...
iteration used: 25
##### Result #####
Resulting energy = -8.596996439159915
Circuit time = 1000.8363999999858
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..  
iteration 1  
-6.251428931295455  
iteration 2  
-10.0167740670988  
iteration 3  
-7.280599914447997  
iteration 4  
-7.75244031144633  
iteration 5  
-7.669426473181044  
iteration 6  
-8.000326241553319  
iteration 7  
-8.779055373353874  
iteration 8  
-7.084482188253193  
iteration 9  
-3.2157343678905486  
iteration 10  
-7.900478620095778  
iteration 11  
-9.763980801496336  
iteration 12  
-6.517248544856583  
iteration 13  
-7.624717559930174  
iteration 14  
-8.032037611728137  
iteration 15  
-6.638346792411044  
iteration 16  
-8.550066174850711  
iteration 17  
-10.350059636762175  
iteration 18  
-5.857185964791608  
iteration 19  
-6.544527329592216  
iteration 20  
-6.4594386454528046  
iteration 21  
-7.1796817410878235  
iteration 22  
-6.874296996170203  
iteration 23  
-8.865859388114874  
iteration 24  
-6.665447640518912  
iteration 25  
-5.505821723658483  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858  
Calculating final cost ...  
iteration used: 25  
##### Result #####  
Resulting energy = -8.448216745266429  
Circuit time = 1000.8363999999858  
#####  
##### Final Result #####  
Average accuracy = 0.09526753897603217  
Final point = 10.49675483  
#####  
Algorithm points: 10.496754831166411  
Energy result history: [0.08944723429785384, 0.17256753826186433, 0.02378784436837833]  
Finished
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)..  
iteration 1  
-5.99293267723336  
iteration 2  
-7.6308821921848615  
iteration 3  
-7.288993130490999  
iteration 4  
-5.986040217795635  
iteration 5  
-9.069629382197748  
iteration 6  
-4.791812185872399  
iteration 7  
-8.260737974769256  
iteration 8  
-6.291667913460346  
iteration 9  
-6.928985888017551  
iteration 10  
-6.207938107062303  
iteration 11  
-7.63279906179873  
iteration 12  
-8.475017872000324  
iteration 13  
-8.180985534798985  
iteration 14  
-8.137071979303226  
iteration 15  
-6.404314960202781  
iteration 16  
-6.774169184256311  
iteration 17  
-9.323138207583156  
iteration 18  
-9.882822745376599  
iteration 19  
-7.223894520499436  
iteration 20  
-9.353338476498866  
iteration 21  
-9.806755721897945  
iteration 22  
-7.977631711944011  
iteration 23  
-8.416992184713466  
iteration 24  
-7.206035704889582  
iteration 25  
-7.584346121142557  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858  
Calculating final cost ...  
iteration used: 25  
##### Result #####  
Resulting energy = -8.471747243229471  
Circuit time = 1000.8363999999858  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)...
iteration 1
-8.539577932904875
iteration 2
-9.47778266904811
iteration 3
-7.3279697868768485
iteration 4
-3.33459701852928
iteration 5
-7.803790347608105
iteration 6
-6.225987331554897
iteration 7
-8.180554735564433
iteration 8
-6.187741020993067
iteration 9
-9.159708184384595
iteration 10
-8.78158875907522
iteration 11
-8.294470948291215
iteration 12
-5.806704176841049
iteration 13
-9.783487332044837
iteration 14
-7.721903801820872
iteration 15
-7.269022073377858
iteration 16
-7.845591416421396
iteration 17
-7.207764313241875
iteration 18
-3.923212712189489
iteration 19
-7.103152806703172
iteration 20
-9.415112772900201
iteration 21
-8.776771855685507
iteration 22
-6.168525816824346
iteration 23
-7.697059304406423
iteration 24
-7.326272594545935
iteration 25
-6.851283069863053
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858
Calculating final cost ...
iteration used: 25
#####
Result #####
Resulting energy = -8.611583427232821
Circuit time = 1000.8363999999858
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..
iteration 1
-7.018556258278526
iteration 2
-6.701274728298964
iteration 3
-7.8148363323672445
iteration 4
-8.295486548873736
iteration 5
-8.904395084359338
iteration 6
-8.294892701357305
iteration 7
-8.766249106152864
iteration 8
-8.06183313694093
iteration 9
-6.240578149234417
iteration 10
-6.1138914298728535
iteration 11
-7.984710983821351
iteration 12
-6.582239272626974
iteration 13
-4.679897869629655
iteration 14
-9.285140720006698
iteration 15
-8.274036083339597
iteration 16
-7.399410296326883
iteration 17
-5.910989760618839
iteration 18
-6.387724976852839
iteration 19
-7.008017258260582
iteration 20
-7.486013985829617
iteration 21
-7.454497516990821
iteration 22
-5.196900030392359
iteration 23
-8.381666330416131
iteration 24
-5.893275252901916
iteration 25
-6.812348133841776
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.8363999999858
Calculating final cost ...
iteration used: 25

##### Result #####
Resulting energy = -8.492180008727846
Circuit time = 1000.8363999999858
#####

##### Final Result #####
Average accuracy = 0.10074132549866259
Final point = 9.92641297
#####
Algorithm points: 9.926412969554145
Energy result history: [0.04731834233142074, 0.18715452633477092, 0.0677511078297961]
Finished
```

# Some Average Scores Reported for 3 runs

[For 8-qubits-H-1.data]

```
Running algorithm(1)...
iteration 1
-8.744306268322834
iteration 2
-7.498980224384442
iteration 3
-8.321445275075094
iteration 4
-7.678081784642272
iteration 5
-7.842644468650577
iteration 6
-7.874959267862054
iteration 7
-8.066096738868978
iteration 8
-7.046100565155639
iteration 9
-8.869399945335449
iteration 10
-8.15295569816471
iteration 11
-7.81501957847498
iteration 12
-7.516398268641311
iteration 13
-8.813861529044866
iteration 14
-7.816327444781796
iteration 15
-7.018489217196091
iteration 16
-6.738489586053
iteration 17
-7.456407339669573
iteration 18
-7.491789604111711
iteration 19
-5.869628483642943
iteration 20
-7.950846164085625
iteration 21
-7.1210565775941665
iteration 22
-6.002788320071493
iteration 23
-5.764750743889008
iteration 24
-7.354214004588988
iteration 25
-7.453230773022624
iteration 26
-7.328154231715126
iteration 27
-6.989228517779679
iteration 28
-7.0231937539321985
iteration 29
-7.974120892967821
iteration 30
-7.183602533496501
iteration 31
-7.8939094754290435
iteration 32
-7.488719991965811
iteration 33
-8.337597256576812
iteration 34
-7.102652011214135
iteration 35
-7.656924318769503
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -7.610218340003515
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)...
iteration 1
-8.143069219062884
iteration 2
-7.054709701845986
iteration 3
-5.739140400790354
iteration 4
-7.378154898983584
iteration 5
-9.807153037042731
iteration 6
-9.509055982469143
iteration 7
-7.248856970147517
iteration 8
-8.685196499740341
iteration 9
-7.867363888797362
iteration 10
-7.417199329629695
iteration 11
-6.824794579397738
iteration 12
-7.768362855676704
iteration 13
-7.19728132964512
iteration 14
-8.849095113794519
iteration 15
-8.402139381010574
iteration 16
-7.358278676822668
iteration 17
-8.407099604700589
iteration 18
-7.637415226967008
iteration 19
-7.8806998647773705
iteration 20
-7.06939944235159
iteration 21
-8.501007538975172
iteration 22
-6.163607436035033
iteration 23
-8.580126472400247
iteration 24
-6.960305415445409
iteration 25
-9.054744218242408
iteration 26
-6.780514190045157
iteration 27
-6.196585845152339
iteration 28
-8.66524681125299
iteration 29
-7.992636348312237
iteration 30
-7.892652186013986
iteration 31
-8.105295520453316
iteration 32
-10.35238384310899
iteration 33
-7.8015737266828316
iteration 34
-8.046784981604894
iteration 35
-7.687391361211134
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.35305459478532
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-7.807629627335214
iteration 2
-8.195611488345072
iteration 3
-8.315662931063287
iteration 4
-8.764230398342853
iteration 5
-8.151220815749074
iteration 6
-8.605138659713816
iteration 7
-7.0805797721963035
iteration 8
-6.468801789215907
iteration 9
-6.897699783509174
iteration 10
-8.925954813200557
iteration 11
-8.464858039274995
iteration 12
-5.103078634742235
iteration 13
-8.171130851845593
iteration 14
-5.46114311441478
iteration 15
-8.09700329476947
iteration 16
-6.183935857540665
iteration 17
-11.122046236104717
iteration 18
-7.2192217474315505
iteration 19
-7.7209832091920525
iteration 20
-7.828883702908945
iteration 21
-7.141837248366763
iteration 22
-7.819983973982974
iteration 23
-6.795662304865358
iteration 24
-7.801372690577208
iteration 25
-7.326757725497953
iteration 26
-9.128357052359279
iteration 27
-7.488794658116135
iteration 28
-8.97664786654906
iteration 29
-8.449740272435319
iteration 30
-5.726969199439917
iteration 31
-7.1972820634104515
iteration 32
-9.373715246349176
iteration 33
-7.316877658334644
iteration 34
-8.586203254238855
iteration 35
-7.653894294818137
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -9.251036149354228
Circuit time = 1000.3151999999877
#####
#####
Final Result #####
Average accuracy = 0.5707307051544811
Final point = 1.75213983
#####
Algorithm points: 1.752139828764474
Energy result history: [0.8142105608945354, 0.07137430611273032, 0.8266072484561775]
Finished
```

Notice that these red terms are spaced far away. So we discard this final point as an outlier

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)..  
iteration 1  
-5.721161046340703  
iteration 2  
-5.807216533610041  
iteration 3  
-7.235539784614226  
iteration 4  
-7.615976429937769  
iteration 5  
-8.046411030843927  
iteration 6  
-9.086948211846583  
iteration 7  
-7.830909136719335  
iteration 8  
-6.919251376838502  
iteration 9  
-8.154056872834767  
iteration 10  
-7.704567231032572  
iteration 11  
-7.800703303395064  
iteration 12  
-7.564307516681078  
iteration 13  
-7.590321991434362  
iteration 14  
-7.377135329322411  
iteration 15  
-9.110353243183475  
iteration 16  
-8.438330152187516  
iteration 17  
-9.23055123988613  
iteration 18  
-4.610571288993999  
iteration 19  
-7.561277683114568  
iteration 20  
-7.582412516716695  
iteration 21  
-7.112215814702357  
iteration 22  
-7.59483030986797  
iteration 23  
-7.314471523259796  
iteration 24  
-6.363795860249814  
iteration 25  
-6.643656221544844  
iteration 26  
-9.076083170464184  
iteration 27  
-6.536387144712772  
iteration 28  
-6.379655320668011  
iteration 29  
-8.651691482071366  
iteration 30  
-7.856369330762818  
iteration 31  
-8.25337771716238  
iteration 32  
-7.651855200871118  
iteration 33  
-8.19048469030427  
iteration 34  
-8.805217035496135  
iteration 35  
-8.008243936282328  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877  
Calculating final cost ...  
iteration used: 35  
##### Result #####  
Resulting energy = -8.276969637431158  
Circuit time = 1000.3151999999877  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)...
iteration 1
-5.944684085333691
iteration 2
-6.440822663711033
iteration 3
-8.780032650202886
iteration 4
-9.086275473295846
iteration 5
-6.2184326535836645
iteration 6
-6.457534414437314
iteration 7
-7.172976395417668
iteration 8
-6.6863609054641815
iteration 9
-7.108921440413388
iteration 10
-8.125487752030583
iteration 11
-7.000352603921647
iteration 12
-7.803496162192104
iteration 13
-6.914992388690096
iteration 14
-8.52749203571679
iteration 15
-7.966112070140001
iteration 16
-7.165568277318475
iteration 17
-8.006099525870598
iteration 18
-7.891162122581813
iteration 19
-7.423952775033519
iteration 20
-7.607528183159967
iteration 21
-6.8783760056521634
iteration 22
-10.344916695191712
iteration 23
-7.989183867923926
iteration 24
-9.277300305565108
iteration 25
-7.713449251993745
iteration 26
-9.079519832770822
iteration 27
-7.026029005379704
iteration 28
-8.36710809216747
iteration 29
-5.863234476784
iteration 30
-7.024088811819154
iteration 31
-6.545060909577689
iteration 32
-8.443667834967894
iteration 33
-7.784888204651849
iteration 34
-8.408790709161641
iteration 35
-9.271541407725188
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.421964912806196
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..  
iteration 1  
-7.813444350662945  
iteration 2  
-8.191788850893648  
iteration 3  
-7.1900835108761925  
iteration 4  
-5.291280324060447  
iteration 5  
-6.335727927191436  
iteration 6  
-8.551092617194874  
iteration 7  
-7.608959780727961  
iteration 8  
-8.914664205666911  
iteration 9  
-8.628749750345666  
iteration 10  
-7.360760225159688  
iteration 11  
-7.52848169180179  
iteration 12  
-8.056792369454076  
iteration 13  
-8.011364608020914  
iteration 14  
-8.40333600087459  
iteration 15  
-7.923536912355476  
iteration 16  
-8.424843301030242  
iteration 17  
-7.5789369031446086  
iteration 18  
-7.677449730153059  
iteration 19  
-6.026485023212143  
iteration 20  
-7.423917923353173  
iteration 21  
-7.032886537291807  
iteration 22  
-8.15366588263295  
iteration 23  
-8.321856658151122  
iteration 24  
-8.462776056821383  
iteration 25  
-6.905522272521837  
iteration 26  
-8.186619975456889  
iteration 27  
-6.982520704467476  
iteration 28  
-9.017348052105515  
iteration 29  
-7.366938911722962  
iteration 30  
-9.056499633869953  
iteration 31  
-7.2565206570525875  
iteration 32  
-7.750768352465278  
iteration 33  
-9.252699509753354  
iteration 34  
-8.087451474689496  
iteration 35  
-7.304466651077394  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877  
Calculating final cost ...  
iteration used: 35  
##### Result #####  
Resulting energy = -8.269477432355085  
Circuit time = 1000.3151999999877  
##### Final Result #####  
Average accuracy = 0.10162490670057049  
Final point = 9.840107434946225  
Algorithm points: 9.840107434946225  
Energy result history: [0.1474592634668923, 0.002463988091854219, 0.15495146854296493]  
Finished
```

# Some Average Scores Reported for 3 runs

[For 8-qubits\_H\_2.data]

```
Running algorithm(2)..
iteration 1
-6.002354487940246
iteration 2
-7.12018423778495
iteration 3
-10.179436022547836
iteration 4
-9.603814227360958
iteration 5
-7.2693200110673155
iteration 6
-6.32125223529648
iteration 7
-7.940534050113071
iteration 8
-6.460386758658626
iteration 9
-8.014085845814076
iteration 10
-8.598297960758869
iteration 11
-6.434049052014147
iteration 12
-5.945077836922283
iteration 13
-8.17800863928704
iteration 14
-5.689744959096054
iteration 15
-7.607006638164385
iteration 16
-7.883689112084201
iteration 17
-7.639913840890668
iteration 18
-8.645461199973099
iteration 19
-8.589189208620887
iteration 20
-8.569401432261675
iteration 21
-8.571782136075202
iteration 22
-6.871770790662373
iteration 23
-10.102320017658961
iteration 24
-5.988687207460138
iteration 25
-7.0589108744656555
iteration 26
-9.179916863944491
iteration 27
-7.403656622309084
iteration 28
-9.381570796975087
iteration 29
-9.545674406929209
iteration 30
-6.2397401337101845
iteration 31
-6.910434665054227
iteration 32
-6.362865177518745
iteration 33
-8.191853137848856
iteration 34
-6.059842506127538
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.332000000037
Calculating final cost ...
iteration used: 34
#####
Result #####
Resulting energy = -8.467339472446122
Circuit time = 1000.332000000037
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..  
iteration 1  
-7.189329025453598  
iteration 2  
-7.744141705959947  
iteration 3  
-6.976989757935566  
iteration 4  
-9.007880410007148  
iteration 5  
-6.76264661176928  
iteration 6  
-7.790916611282079  
iteration 7  
-7.365374096046928  
iteration 8  
-5.354328614916909  
iteration 9  
-6.943525026044691  
iteration 10  
-7.645838267719229  
iteration 11  
-7.4980684412478  
iteration 12  
-8.584567788756706  
iteration 13  
-7.618942636246446  
iteration 14  
-6.890052746338009  
iteration 15  
-7.277506892592045  
iteration 16  
-8.144388850965345  
iteration 17  
-8.237939828527425  
iteration 18  
-8.992964500846918  
iteration 19  
-9.724341543148864  
iteration 20  
-7.182470949748724  
iteration 21  
-8.687243211585772  
iteration 22  
-7.733489312167014  
iteration 23  
-7.863463330796314  
iteration 24  
-5.539417376364923  
iteration 25  
-7.501419857429568  
iteration 26  
-7.652189102808937  
iteration 27  
-6.611081277717383  
iteration 28  
-7.76055643517334  
iteration 29  
-8.631457790763719  
iteration 30  
-8.643625758889767  
iteration 31  
-7.505080729287053  
iteration 32  
-7.686645724770485  
iteration 33  
-7.184370044304127  
iteration 34  
-8.861472497900575  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.332000000037  
Calculating final cost ...  
iteration used: 34  
  
##### Result #####  
Resulting energy = -8.370013905288587  
Circuit time = 1000.332000000037  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-7.99051621968954
iteration 2
-9.057098724691723
iteration 3
-8.28988705158979
iteration 4
-8.299458935184823
iteration 5
-8.339497123822856
iteration 6
-7.296883305746398
iteration 7
-7.91828401769407
iteration 8
-10.2179498573576
iteration 9
-6.288266056277356
iteration 10
-7.642226853736904
iteration 11
-7.475833436674208
iteration 12
-8.05217277884628
iteration 13
-7.634346746229584
iteration 14
-7.2431544107220915
iteration 15
-7.786028357557518
iteration 16
-7.876237291299801
iteration 17
-7.583259244676449
iteration 18
-6.920265311035715
iteration 19
-9.996465090115679
iteration 20
-6.864769680252451
iteration 21
-7.604105212726013
iteration 22
-8.582215990056959
iteration 23
-8.541662677801247
iteration 24
-8.108416714074343
iteration 25
-8.418202108997166
iteration 26
-5.849529555131218
iteration 27
-7.596603724124571
iteration 28
-7.970993964858905
iteration 29
-7.764016612107833
iteration 30
-6.6064989172138455
iteration 31
-6.922862095672844
iteration 32
-6.763191878583697
iteration 33
-8.681348092906955
iteration 34
-8.392568979145052
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.33200000037
Calculating final cost ...
iteration used: 34
#####
Result #####
Resulting energy = -8.314852582901489
Circuit time = 1000.33200000037
#####

#####
Final Result #####
Average accuracy = 0.05736296938407589
Final point = 17.43284929
#####
Algorithm points: 17.432849288265796
Energy result history: [0.008097594546203624, 0.054414995609462835, 0.109576317996561
2]
Finished
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)..  
iteration 1  
-8.065766890083035  
iteration 2  
-7.179605667049491  
iteration 3  
-6.800296983838073  
iteration 4  
-7.800197267959172  
iteration 5  
-7.402780223703052  
iteration 6  
-7.709501902517929  
iteration 7  
-8.445733070473569  
iteration 8  
-9.315614554479088  
iteration 9  
-8.754666786519882  
iteration 10  
-7.743826112363631  
iteration 11  
-7.65026402501899  
iteration 12  
-7.087001924787441  
iteration 13  
-7.753665556635629  
iteration 14  
-7.075779277568048  
iteration 15  
-7.549672233760933  
iteration 16  
-7.879037041679151  
iteration 17  
-6.870865711411897  
iteration 18  
-9.021502041996706  
iteration 19  
-7.893458408426664  
iteration 20  
-7.396216067745207  
iteration 21  
-8.168495820923884  
iteration 22  
-6.183256564315382  
iteration 23  
-7.834155817665851  
iteration 24  
-7.202288647676488  
iteration 25  
-7.448412693109189  
iteration 26  
-7.949141969966089  
iteration 27  
-7.060552520346768  
iteration 28  
-6.333778240488126  
iteration 29  
-7.7865976934293  
iteration 30  
-8.82555416032615  
iteration 31  
-6.540549143637791  
iteration 32  
-7.849978290643678  
iteration 33  
-6.881309826317118  
iteration 34  
-8.419777466426199  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.332000000037  
Calculating final cost ...  
iteration used: 34  
  
##### Result #####  
Resulting energy = -8.355247582530605  
Circuit time = 1000.332000000037  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..  
iteration 1  
-6.002354487940246  
iteration 2  
-7.12018423778495  
iteration 3  
-10.179436022547836  
iteration 4  
-9.603814227360958  
iteration 5  
-7.2693200110673155  
iteration 6  
-6.32125223529648  
iteration 7  
-7.940534050113071  
iteration 8  
-6.460386758658626  
iteration 9  
-8.014085845814076  
iteration 10  
-8.598297960758869  
iteration 11  
-6.434049052014147  
iteration 12  
-5.945077836922283  
iteration 13  
-8.17800863928704  
iteration 14  
-5.689744959096054  
iteration 15  
-7.607006638164385  
iteration 16  
-7.883689112084201  
iteration 17  
-7.639913840890668  
iteration 18  
-8.645461199973099  
iteration 19  
-8.589189208620887  
iteration 20  
-8.569401432261675  
iteration 21  
-8.571782136075202  
iteration 22  
-6.871770790662373  
iteration 23  
-10.102320017658961  
iteration 24  
-5.988687207460138  
iteration 25  
-7.0589108744656555  
iteration 26  
-9.179916863944491  
iteration 27  
-7.403656622309084  
iteration 28  
-9.381570796975087  
iteration 29  
-9.545674406929209  
iteration 30  
-6.2397401337101845  
iteration 31  
-6.910434665054227  
iteration 32  
-6.362865177518745  
iteration 33  
-8.191853137848856  
iteration 34  
-6.059842506127538  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.332000000037  
Calculating final cost ...  
iteration used: 34  
  
##### Result #####  
Resulting energy = -8.467339472446122  
Circuit time = 1000.332000000037  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-7.552285934281488
iteration 2
-7.490957576693074
iteration 3
-8.036188508083711
iteration 4
-6.734859383224094
iteration 5
-7.048544126000546
iteration 6
-8.395099060756113
iteration 7
-8.283243782741406
iteration 8
-7.1929642374037925
iteration 9
-8.432650741562778
iteration 10
-8.776446310096723
iteration 11
-8.825029544848435
iteration 12
-6.427137117159242
iteration 13
-7.179165189470086
iteration 14
-8.918631306005997
iteration 15
-6.3711292454352995
iteration 16
-8.924711038244654
iteration 17
-8.003580081563024
iteration 18
-8.174945352208223
iteration 19
-7.631882273228418
iteration 20
-7.000551326559599
iteration 21
-9.022461500932724
iteration 22
-9.680765906153754
iteration 23
-6.74329179356233
iteration 24
-7.721629958800501
iteration 25
-8.111001989568663
iteration 26
-6.073675654609978
iteration 27
-6.1806893864439125
iteration 28
-8.8220890447421
iteration 29
-7.3527864188738015
iteration 30
-7.609993389893313
iteration 31
-8.34316183136945
iteration 32
-7.167323345905676
iteration 33
-8.972561829371113
iteration 34
-6.978651231002175
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.332000000037
Calculating final cost ...
iteration used: 34
#####
Result #####
Resulting energy = -8.425032482018418
Circuit time = 1000.332000000037
#####

#####
Final Result #####
Average accuracy = 0.0375651570119615
Final point = 26.62041316
#####
Algorithm points: 26.62041315790534
Energy result history: [0.06918131836744479, 0.042910571548071985, 0.00060358112036773
55]
Finished
```

# Some Average Scores Reported for 3 runs

[For 8-qubits-H-3.data]

```
Running algorithm(1)..  
iteration 1  
-7.746456097212408  
iteration 2  
-5.3695051318156235  
iteration 3  
-7.373223513450254  
iteration 4  
-8.86651253628426  
iteration 5  
-6.946830431452742  
iteration 6  
-9.224068560719514  
iteration 7  
-7.318487890161324  
iteration 8  
-5.960408275577357  
iteration 9  
-8.592551963185235  
iteration 10  
-8.762274672871241  
iteration 11  
-7.358075681315529  
iteration 12  
-8.714274770343257  
iteration 13  
-8.06969117692391  
iteration 14  
-8.58368788145756  
iteration 15  
-7.123256095229925  
iteration 16  
-8.240805117488755  
iteration 17  
-8.058683917224727  
iteration 18  
-6.393466414587927  
iteration 19  
-9.050158412861373  
iteration 20  
-7.27598919280795  
iteration 21  
-9.018437388617116  
iteration 22  
-8.371354696645874  
iteration 23  
-6.557707105501544  
iteration 24  
-8.267529373312197  
iteration 25  
-7.703600175140581  
iteration 26  
-6.170477790297407  
iteration 27  
-9.072892811820141  
iteration 28  
-6.8346635497820545  
iteration 29  
-9.594433991919555  
iteration 30  
-7.598324179578135  
iteration 31  
-7.671421992450767  
iteration 32  
-7.0060122432787155  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982  
Calculating final cost ...  
iteration used: 32  
  
##### Result #####  
Resulting energy = -8.460261488325639  
Circuit time = 1000.521999999982  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..  
iteration 1  
-8.542158288103607  
iteration 2  
-7.651959039840076  
iteration 3  
-6.700395035484441  
iteration 4  
-8.724748389830927  
iteration 5  
-7.070203788156222  
iteration 6  
-8.449998394861954  
iteration 7  
-9.042033809187899  
iteration 8  
-9.441415386591066  
iteration 9  
-7.706652363085389  
iteration 10  
-8.023421123185686  
iteration 11  
-8.63387961627171  
iteration 12  
-7.103444059536001  
iteration 13  
-7.716283829859569  
iteration 14  
-7.995621121857264  
iteration 15  
-9.919192751099732  
iteration 16  
-8.344793396606994  
iteration 17  
-8.235065235920494  
iteration 18  
-9.05278488463689  
iteration 19  
-7.392483699123596  
iteration 20  
-7.905091710699254  
iteration 21  
-5.66663226284489  
iteration 22  
-7.2119122529598405  
iteration 23  
-8.93401040151987  
iteration 24  
-8.40672879479046  
iteration 25  
-9.54040910858479  
iteration 26  
-7.082372856937442  
iteration 27  
-8.340105936232495  
iteration 28  
-7.170721566651082  
iteration 29  
-7.645088535131086  
iteration 30  
-8.530655054738668  
iteration 31  
-8.412577993326593  
iteration 32  
-6.823681557494036  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982  
Calculating final cost ...  
iteration used: 32  
  
##### Result #####  
Resulting energy = -8.524276315855065  
Circuit time = 1000.521999999982  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-9.824971710109484
iteration 2
-8.044491011993351
iteration 3
-6.745629849540029
iteration 4
-8.895219009964514
iteration 5
-8.28027051268008
iteration 6
-7.238622207225038
iteration 7
-7.468862951950478
iteration 8
-6.889544626198063
iteration 9
-9.919213425634513
iteration 10
-7.2648083222538435
iteration 11
-7.550621051673381
iteration 12
-7.9314301983118085
iteration 13
-7.1951377651344375
iteration 14
-9.380587708348328
iteration 15
-8.16605075009188
iteration 16
-8.23810774372491
iteration 17
-6.659269238684347
iteration 18
-8.096723732641237
iteration 19
-8.69784181345192
iteration 20
-8.417732900781285
iteration 21
-7.664486306953271
iteration 22
-6.109714547976854
iteration 23
-8.76035664224793
iteration 24
-8.60198498430753
iteration 25
-5.524780097506622
iteration 26
-8.004299293228254
iteration 27
-6.717172662879994
iteration 28
-8.92072616905847
iteration 29
-7.313154333603854
iteration 30
-7.9305634746120655
iteration 31
-7.425531129975952
iteration 32
-8.278098190354795
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982
Calculating final cost ...
iteration used: 32
#####
Result #####
Resulting energy = -8.479949939164158
Circuit time = 1000.521999999982
#####

#####
Final Result #####
Average accuracy = 0.06373368021690358
Final point = 15.69029117
#####
Algorithm points: 15.690291170958897
Energy result history: [0.035832587427588436, 0.09984741495701499, 0.05552103826610732
5]
Finished
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)...
iteration 1
-8.034781534930955
iteration 2
-7.930961913112884
iteration 3
-8.766688857211436
iteration 4
-8.490256941417652
iteration 5
-6.902290951063342
iteration 6
-7.723717559076226
iteration 7
-6.063248118908669
iteration 8
-8.56182003095342
iteration 9
-7.953439866656867
iteration 10
-7.135191327645112
iteration 11
-8.393802365170751
iteration 12
-8.542237173272815
iteration 13
-8.680414968756942
iteration 14
-9.018243837877618
iteration 15
-7.54678980099675
iteration 16
-7.365057235946928
iteration 17
-7.0644329269546375
iteration 18
-8.684113600446153
iteration 19
-8.432074045952996
iteration 20
-8.832125528595338
iteration 21
-8.674705797619954
iteration 22
-7.783481710356302
iteration 23
-5.499217919306758
iteration 24
-8.916396981055623
iteration 25
-5.932497583942604
iteration 26
-5.992307345139626
iteration 27
-8.804653780393458
iteration 28
-6.787028521387629
iteration 29
-7.994841973402378
iteration 30
-8.077381978230493
iteration 31
-7.581014089678446
iteration 32
-8.05394699807183
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982
Calculating final cost ...
iteration used: 32
#####
Result #####
Resulting energy = -8.425053671968564
Circuit time = 1000.521999999982
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)...
iteration 1
-8.569391845186795
iteration 2
-7.704532708420892
iteration 3
-7.907583040266408
iteration 4
-6.524401997258694
iteration 5
-7.47957277192243
iteration 6
-6.805510671197492
iteration 7
-7.900610304344608
iteration 8
-7.003588672394053
iteration 9
-6.3671023484144795
iteration 10
-6.548938482711673
iteration 11
-7.2162503262910755
iteration 12
-5.985180535559463
iteration 13
-6.681460346482953
iteration 14
-9.017781070884297
iteration 15
-8.167029126022102
iteration 16
-7.391159319990066
iteration 17
-9.04997874172424
iteration 18
-5.309740669636938
iteration 19
-6.757685078007101
iteration 20
-7.343443106570594
iteration 21
-9.989167115574267
iteration 22
-7.842759001391185
iteration 23
-8.588961680002136
iteration 24
-7.908554458001075
iteration 25
-8.479178452215171
iteration 26
-8.634070183789843
iteration 27
-8.394171076449425
iteration 28
-6.836033898284
iteration 29
-7.656747073692718
iteration 30
-7.728396743122981
iteration 31
-7.5020710923601435
iteration 32
-6.549553966058506
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982
Calculating final cost ...
iteration used: 32
#####
Result #####
Resulting energy = -8.37396259935845
Circuit time = 1000.521999999982
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..  
iteration 1  
-6.922909649877147  
iteration 2  
-7.096774197356581  
iteration 3  
-6.956680625329293  
iteration 4  
-8.320028925773997  
iteration 5  
-8.75120696713611  
iteration 6  
-7.710807945781484  
iteration 7  
-7.829364277960771  
iteration 8  
-7.706744593584422  
iteration 9  
-5.845202147542311  
iteration 10  
-7.855976453871361  
iteration 11  
-6.064296885598638  
iteration 12  
-7.145803486391805  
iteration 13  
-7.002784713549727  
iteration 14  
-6.841556222164023  
iteration 15  
-7.016161211850989  
iteration 16  
-8.004749024313961  
iteration 17  
-8.012608161759966  
iteration 18  
-9.140102372494436  
iteration 19  
-9.365065836747235  
iteration 20  
-5.827448151249332  
iteration 21  
-8.25853353118114  
iteration 22  
-8.307095114497104  
iteration 23  
-7.375225560476209  
iteration 24  
-8.294346681691948  
iteration 25  
-7.496971290206212  
iteration 26  
-7.266656899327646  
iteration 27  
-7.026501548378531  
iteration 28  
-7.732765048346377  
iteration 29  
-7.297132948090041  
iteration 30  
-8.284458092067817  
iteration 31  
-6.183488702567508  
iteration 32  
-9.84929026061378  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.521999999982  
Calculating final cost ...  
iteration used: 32  
##### Result #####  
Resulting energy = -8.430036042257651  
Circuit time = 1000.521999999982  
#####  
##### Final Result #####  
Average accuracy = 0.01889940465657188  
Final point = 52.91171961  
#####  
Algorithm points: 52.911719610822274  
Energy result history: [0.000624771070514285, 0.05046630153960052, 0.00560714135960083  
1]  
Finished
```

# Some Average Scores Reported for 3 runs

[For 8-qubits-H-4.data]

```
Running algorithm(1)..
iteration 1
-7.036562849959344
iteration 2
-7.359738074480835
iteration 3
-8.146761755011466
iteration 4
-7.863506743663589
iteration 5
-6.583281525167109
iteration 6
-9.108736129311893
iteration 7
-6.703313729686525
iteration 8
-7.938828438831325
iteration 9
-7.198200111130747
iteration 10
-6.722223404378549
iteration 11
-6.221968838790587
iteration 12
-7.854384724959414
iteration 13
-8.604125135138291
iteration 14
-6.405082457282418
iteration 15
-7.3490900864407305
iteration 16
-6.855941783988135
iteration 17
-7.647165577726042
iteration 18
-10.04744717087804
iteration 19
-7.219019939521198
iteration 20
-7.503971864864447
iteration 21
-7.476386848528128
iteration 22
-7.669606037382897
iteration 23
-5.70828265862801
iteration 24
-6.098874226082374
iteration 25
-6.593852253478713
iteration 26
-10.260748934952364
iteration 27
-8.180018748372062
iteration 28
-8.970427828879476
iteration 29
-7.057790039192551
iteration 30
-7.9448978183550905
iteration 31
-7.228555083185293
iteration 32
-8.372743193821991
iteration 33
-8.46018360445979
iteration 34
-6.087037933616636
iteration 35
-8.658799202680337
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.306049990638371
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..
iteration 1
-7.345331955564372
iteration 2
-7.635516460226167
iteration 3
-7.76367980454633
iteration 4
-6.619976865247941
iteration 5
-6.31211829305456
iteration 6
-6.947285801802967
iteration 7
-8.919953948135905
iteration 8
-8.005839281124015
iteration 9
-6.897307883849553
iteration 10
-7.553050555720903
iteration 11
-7.467869685376303
iteration 12
-7.370347161541849
iteration 13
-8.2877920693307
iteration 14
-7.280249707246061
iteration 15
-9.019119621096637
iteration 16
-9.243833005773451
iteration 17
-6.488710642124152
iteration 18
-8.015587243457981
iteration 19
-8.438357321541645
iteration 20
-9.764908410943471
iteration 21
-6.966238666556624
iteration 22
-7.27565985162381
iteration 23
-9.384803014368844
iteration 24
-7.124182594356681
iteration 25
-6.515617948310556
iteration 26
-7.198091276151812
iteration 27
-6.841672781086389
iteration 28
-6.900902620229093
iteration 29
-7.495118781923793
iteration 30
-5.992549425054726
iteration 31
-6.467155261581233
iteration 32
-6.562142796127337
iteration 33
-6.547710832639574
iteration 34
-7.612007765247062
iteration 35
-8.489195920263558
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.34258511582413
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-6.722996333030956
iteration 2
-8.37081493863799
iteration 3
-7.128572364736065
iteration 4
-6.8988442530425536
iteration 5
-5.849922414898122
iteration 6
-8.526563666658696
iteration 7
-6.032644026358803
iteration 8
-6.808762228296568
iteration 9
-7.058394714672067
iteration 10
-7.485316755297804
iteration 11
-8.521829306188955
iteration 12
-7.290845779963165
iteration 13
-8.224307318298077
iteration 14
-9.162934429828093
iteration 15
-7.796298792567819
iteration 16
-8.50981324995545
iteration 17
-6.3289318017706995
iteration 18
-6.834740603111253
iteration 19
-7.963695804868855
iteration 20
-8.375511022465027
iteration 21
-8.042247649811864
iteration 22
-7.803481051553945
iteration 23
-9.249074879862375
iteration 24
-7.979932621270039
iteration 25
-8.925135941628835
iteration 26
-8.15579982037628
iteration 27
-7.309838335841217
iteration 28
-8.242566866607357
iteration 29
-7.953285758067401
iteration 30
-8.955497296148618
iteration 31
-8.440012366414333
iteration 32
-7.499220256205524
iteration 33
-7.406558778706039
iteration 34
-6.044248941600782
iteration 35
-8.549630617453825
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.423322750366088
Circuit time = 1000.3151999999877
#####

#####
Final Result #####
Average accuracy = 0.06710961528852029
Final point = 14.90099438
#####
Algorithm points: 14.90099437615252
Energy result history: [0.11837891025967906, 0.08184378507391976, 0.00110615053196205
8]
Finished
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)...
iteration 1
-8.498855314424956
iteration 2
-6.89566960823409
iteration 3
-7.062418989328724
iteration 4
-8.142579333873645
iteration 5
-8.957178587570048
iteration 6
-6.89032375477605
iteration 7
-8.184543112349312
iteration 8
-5.812027679290376
iteration 9
-6.987510278376979
iteration 10
-7.128850413130634
iteration 11
-8.46677875321911
iteration 12
-8.010244222596558
iteration 13
-6.9545984517627675
iteration 14
-8.926553883444818
iteration 15
-8.854043080284212
iteration 16
-8.962246406863297
iteration 17
-8.182579195599294
iteration 18
-8.537967563416393
iteration 19
-6.381649548675269
iteration 20
-8.519316258798952
iteration 21
-9.086915007006795
iteration 22
-7.598782072334002
iteration 23
-9.65895187097007
iteration 24
-7.538457280395302
iteration 25
-8.355120592781638
iteration 26
-7.464948605693279
iteration 27
-7.577836054786057
iteration 28
-7.043018535636688
iteration 29
-6.178935712480121
iteration 30
-8.43256943060733
iteration 31
-7.7762487089858014
iteration 32
-8.596475496836964
iteration 33
-8.05741330846163
iteration 34
-7.4494014042552426
iteration 35
-7.650463822391684
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35

##### Result #####
Resulting energy = -8.440790310072716
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..
iteration 1
-6.962805558510315
iteration 2
-8.050165792820913
iteration 3
-7.1605394726999325
iteration 4
-7.428844782502723
iteration 5
-7.546541774388355
iteration 6
-8.28948165040486
iteration 7
-6.3898195769938315
iteration 8
-8.267460490935232
iteration 9
-6.733669753775843
iteration 10
-7.806731775351221
iteration 11
-8.222972021166786
iteration 12
-7.31403222912588
iteration 13
-6.045799014425859
iteration 14
-8.856609571137472
iteration 15
-7.440646711737405
iteration 16
-9.159285590821039
iteration 17
-6.904969640687433
iteration 18
-7.119126645093743
iteration 19
-6.63481987946633
iteration 20
-8.386866264676792
iteration 21
-6.851972826972268
iteration 22
-6.7110768579212445
iteration 23
-7.026011650508611
iteration 24
-5.750717808027624
iteration 25
-6.637312971276625
iteration 26
-9.154941962056467
iteration 27
-8.542553299995305
iteration 28
-9.476952669541546
iteration 29
-5.30676145999021
iteration 30
-7.6734451413482585
iteration 31
-7.668045886406007
iteration 32
-8.314942535162674
iteration 33
-8.288272129582051
iteration 34
-7.964512528587523
iteration 35
-9.093365104526043
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.358188878947423
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)...
iteration 1
-8.834382340483
iteration 2
-7.8980197840446245
iteration 3
-8.607534520152683
iteration 4
-8.12310377492552
iteration 5
-8.095290312153665
iteration 6
-7.243076869313103
iteration 7
-6.629848927979075
iteration 8
-6.174039893341291
iteration 9
-6.141656525037196
iteration 10
-8.76157149368646
iteration 11
-8.74060522861465
iteration 12
-7.8395691159292635
iteration 13
-7.356820591291712
iteration 14
-5.936112219999785
iteration 15
-7.909797701302094
iteration 16
-7.769390831629421
iteration 17
-6.846900126832267
iteration 18
-9.348959471041319
iteration 19
-8.273716977264236
iteration 20
-7.7888870639008045
iteration 21
-8.155414388103718
iteration 22
-7.078188062264174
iteration 23
-6.734055903986641
iteration 24
-8.270060906027972
iteration 25
-7.96640801013065
iteration 26
-8.606399575035907
iteration 27
-6.88282775466096
iteration 28
-6.5231335631070895
iteration 29
-7.167187797009614
iteration 30
-7.452116882460101
iteration 31
-7.379197376940255
iteration 32
-8.348899467837281
iteration 33
-6.472961129844339
iteration 34
-6.086953849884461
iteration 35
-6.90021722839395
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.354029400025787
Circuit time = 1000.3151999999877
#####
#####
Final Result #####
Average accuracy = 0.05100031066585172
Final point = 19.6077237
#####
Algorithm points: 19.607723697055242
Energy result history: [0.016361409174665553, 0.06624002195062673, 0.0703995008722628
8]
Finished
```

# Some Average Scores Reported for 3 runs

[For 8-qubits-H-S-data]

```
Running algorithm(1)...
iteration 1
-7.324204109547568
iteration 2
-7.302888976158413
iteration 3
-8.855350560631376
iteration 4
-7.826177127981295
iteration 5
-6.292998634475958
iteration 6
-5.500252395617554
iteration 7
-8.679173989228737
iteration 8
-7.14473995203126
iteration 9
-7.970507510179492
iteration 10
-6.708804280979283
iteration 11
-6.378405152998523
iteration 12
-8.991029541756408
iteration 13
-6.611733039522516
iteration 14
-8.02907395654495
iteration 15
-9.674023329263614
iteration 16
-7.5215834416298195
iteration 17
-8.89054542676213
iteration 18
-5.880742572362148
iteration 19
-8.17942067243801
iteration 20
-6.495121353350809
iteration 21
-8.7244121503552
iteration 22
-7.833835993036664
iteration 23
-8.10390566974194
iteration 24
-8.80197936896173
iteration 25
-7.7843200769308005
iteration 26
-9.226307571335429
iteration 27
-6.442082819304458
iteration 28
-7.455718754947519
iteration 29
-8.281690879770483
iteration 30
-8.25524434750012
iteration 31
-7.697040748067095
iteration 32
-6.969202112737277
iteration 33
-8.756802133764152
iteration 34
-8.098985443539595
iteration 35
-5.353083718908651
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.482920479125138
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)..  
iteration 1  
-5.869149210646225  
iteration 2  
-7.2214786854097905  
iteration 3  
-7.116436129903887  
iteration 4  
-6.578635071680962  
iteration 5  
-7.010511892414329  
iteration 6  
-6.669955533356144  
iteration 7  
-7.583547242500791  
iteration 8  
-6.36565925724137  
iteration 9  
-7.017161388153933  
iteration 10  
-8.424224713839415  
iteration 11  
-7.393391451754658  
iteration 12  
-7.709781725287384  
iteration 13  
-7.746745841675306  
iteration 14  
-8.322084430846564  
iteration 15  
-8.000648518448987  
iteration 16  
-8.236007587819225  
iteration 17  
-7.452693545256547  
iteration 18  
-7.0634098471207665  
iteration 19  
-8.32815491593131  
iteration 20  
-8.837196142755989  
iteration 21  
-7.7647746444936265  
iteration 22  
-6.6029802458549  
iteration 23  
-7.204018906546153  
iteration 24  
-6.34689501344376  
iteration 25  
-7.544544837988889  
iteration 26  
-8.17045008602667  
iteration 27  
-6.752099241618727  
iteration 28  
-6.445236456863394  
iteration 29  
-7.604966230410501  
iteration 30  
-8.255941746212008  
iteration 31  
-7.2356106666627324  
iteration 32  
-6.662910969309078  
iteration 33  
-7.096803234567354  
iteration 34  
-7.796081684082485  
iteration 35  
-6.8665680145335966  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877  
Calculating final cost ...  
iteration used: 35  
##### Result #####  
Resulting energy = -7.3936848191887306  
Circuit time = 1000.3151999999877  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..  
iteration 1  
-6.945667778316453  
iteration 2  
-7.010138270947824  
iteration 3  
-8.268041729585242  
iteration 4  
-7.59443754494838  
iteration 5  
-7.587599437349462  
iteration 6  
-7.745416038327312  
iteration 7  
-8.832367050048756  
iteration 8  
-8.752562886181405  
iteration 9  
-7.7765860372791735  
iteration 10  
-7.585384971938317  
iteration 11  
-9.351212728845477  
iteration 12  
-8.785587452624595  
iteration 13  
-8.84137157916392  
iteration 14  
-5.983530824177094  
iteration 15  
-6.360268806240073  
iteration 16  
-7.84455430805502  
iteration 17  
-7.259611665599392  
iteration 18  
-8.192475057700669  
iteration 19  
-6.742377928489579  
iteration 20  
-8.021276384852357  
iteration 21  
-8.406304503594344  
iteration 22  
-6.074290224063639  
iteration 23  
-8.216491689630866  
iteration 24  
-7.579592366954494  
iteration 25  
-7.550005739622932  
iteration 26  
-7.5798962864027315  
iteration 27  
-7.133014347308546  
iteration 28  
-8.307471190268597  
iteration 29  
-9.277604963421949  
iteration 30  
-7.24421796285016  
iteration 31  
-7.859275650614822  
iteration 32  
-7.57192218832131  
iteration 33  
-7.538383205846317  
iteration 34  
-7.912085194033177  
iteration 35  
-7.907727521786036  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877  
Calculating final cost ...  
iteration used: 35  
##### Result #####  
Resulting energy = -8.257712655032865  
Circuit time = 1000.3151999999877  
#####  
##### Final Result #####  
Average accuracy = 0.4186506352671975  
Final point = 2.3886265  
#####  
Algorithm points: 2.3886264960801147  
Energy result history: [0.058491578227087615, 1.0307440817093196, 0.1667162458651852]  
Finished
```

Note that 1 of these 3 purple terms is spaced far away from the other 2. So, we discard this final point as an outlier

# Some Average Scores Reported for 3 runs

```
Running algorithm(1)..  
iteration 1  
-8.155824231477085  
iteration 2  
-9.64014050919483  
iteration 3  
-7.675571105532807  
iteration 4  
-7.700621922457639  
iteration 5  
-7.601879146039632  
iteration 6  
-8.186902437067047  
iteration 7  
-6.702099210238327  
iteration 8  
-8.515349276741988  
iteration 9  
-6.904668398266774  
iteration 10  
-7.423311769395711  
iteration 11  
-7.565628039272682  
iteration 12  
-7.918001599891353  
iteration 13  
-7.170335551937819  
iteration 14  
-8.369268515283764  
iteration 15  
-7.733307101504012  
iteration 16  
-5.98154520081705  
iteration 17  
-8.89943809817793  
iteration 18  
-6.860953770269667  
iteration 19  
-9.468984002156493  
iteration 20  
-8.03238710928461  
iteration 21  
-7.764523257446992  
iteration 22  
-8.245605547404345  
iteration 23  
-7.754375013552678  
iteration 24  
-7.191390390171737  
iteration 25  
-9.24703673418173  
iteration 26  
-7.653261438361919  
iteration 27  
-7.133902704764493  
iteration 28  
-6.643321181272703  
iteration 29  
-6.7501541598282815  
iteration 30  
-8.813954284512633  
iteration 31  
-8.56012074624738  
iteration 32  
-6.559327534715156  
iteration 33  
-8.684568770882635  
iteration 34  
-9.12467879672284  
iteration 35  
-7.520444689959058  
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877  
Calculating final cost ...  
iteration used: 35  
##### Result #####  
Resulting energy = -8.3596308472733  
Circuit time = 1000.3151999999877  
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(2)...
iteration 1
-8.202757721317298
iteration 2
-7.628575377411388
iteration 3
-5.450347272179329
iteration 4
-7.542327794662086
iteration 5
-6.698441324881374
iteration 6
-9.259029598269715
iteration 7
-9.176308595603015
iteration 8
-8.186280566376972
iteration 9
-8.822360960041573
iteration 10
-6.2807359291358695
iteration 11
-8.629925607387186
iteration 12
-7.204313080390719
iteration 13
-6.383805595617136
iteration 14
-8.141362558773883
iteration 15
-6.33444368309729
iteration 16
-7.1039870989969325
iteration 17
-8.14630751978951
iteration 18
-6.602785099684047
iteration 19
-6.966601575098992
iteration 20
-7.12495537587172
iteration 21
-7.256590089130361
iteration 22
-8.247987742993411
iteration 23
-8.129038654210046
iteration 24
-8.886689549498461
iteration 25
-5.48134480318705
iteration 26
-7.953406154725208
iteration 27
-8.198680305223233
iteration 28
-7.493385527040339
iteration 29
-9.030762076201485
iteration 30
-7.247748337102252
iteration 31
-6.718280459891741
iteration 32
-7.939467900186424
iteration 33
-7.082595960820667
iteration 34
-8.372364219651958
iteration 35
-7.563799397202414
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.386529433644052
Circuit time = 1000.3151999999877
#####
```

# Some Average Scores Reported for 3 runs

```
Running algorithm(3)..
iteration 1
-6.985503571772749
iteration 2
-7.068351614636209
iteration 3
-6.100350457579344
iteration 4
-7.354878438256383
iteration 5
-7.606813373627042
iteration 6
-6.477046805843966
iteration 7
-7.025028652028923
iteration 8
-8.409968980802846
iteration 9
-7.100240352118005
iteration 10
-8.516543560772533
iteration 11
-5.994022924341128
iteration 12
-7.848709327165617
iteration 13
-6.786240557517227
iteration 14
-7.687073542197643
iteration 15
-7.838130013545467
iteration 16
-8.399407205536017
iteration 17
-7.072722500926949
iteration 18
-8.251378937490282
iteration 19
-7.778154001626317
iteration 20
-7.986235332174299
iteration 21
-7.867781324898623
iteration 22
-6.994889838981245
iteration 23
-7.320574941951323
iteration 24
-8.019458816698357
iteration 25
-6.59069350170271
iteration 26
-8.050791351225449
iteration 27
-8.30213498718091
iteration 28
-7.693653693095497
iteration 29
-7.416452499306935
iteration 30
-7.565650493988294
iteration 31
-8.958654513941466
iteration 32
-7.872201433141456
iteration 33
-9.810978738233818
iteration 34
-6.896439089338417
iteration 35
-7.125003842398057
Reached maximum quantum circuit time 1000. Quantum circuit time 1000.3151999999877
Calculating final cost ...
iteration used: 35
#####
Result #####
Resulting energy = -8.2916126032377
Circuit time = 1000.3151999999877
#####
#####
Final Result #####
Average accuracy = 0.07850460617969961
Final point = 12.73810606
#####
Algorithm points: 12.738106063623418
Energy result history: [0.06479805362475055, 0.03789946725399851, 0.13281629766034975]
Finished
```