

Our aim in this code is to plot the contour of the error function and see where it intersects with the constraint region as this is the region where the constraint is satisfied, and the error function has the minimum value.

$$\text{minimise } E(w) = \frac{1}{2} \sum_{n=1}^N (y_n - t_n)^2 \text{ subject to } |w_1|^q + |w_2|^q \leq \eta$$

Eq1

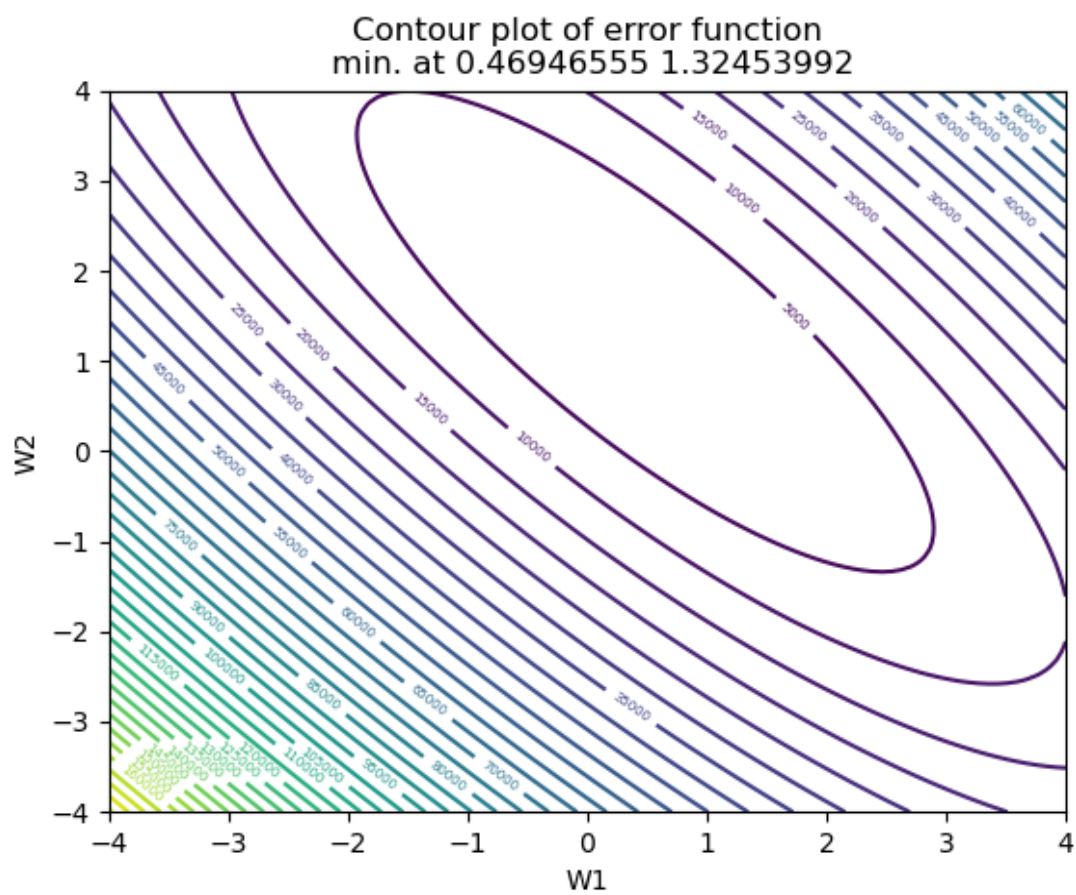
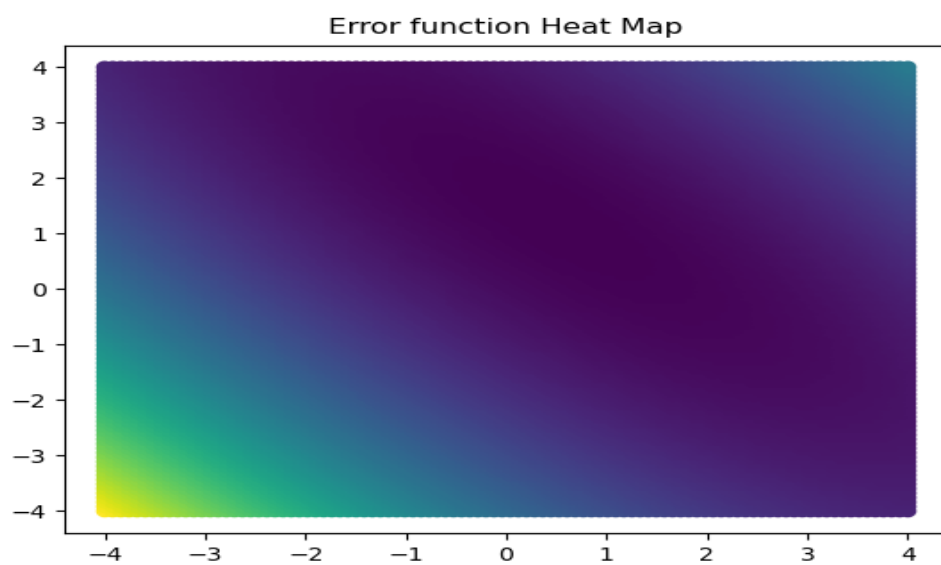
$$\frac{1}{2} \sum_{n=1}^N \{t_n - \mathbf{w}^T \phi(\mathbf{x}_n)\}^2 + \frac{\lambda}{2} \sum_{j=1}^M |w_j|^q$$

Eq2

Both the above equations are equivalent, and the solution of one problem gives the corresponding solution for the other equation. The Lambda of the second equation gives us the eta of the first equation. After finding the lambda of the second equation, we can Lagrange multipliers to arrive at the eta of the first equation.

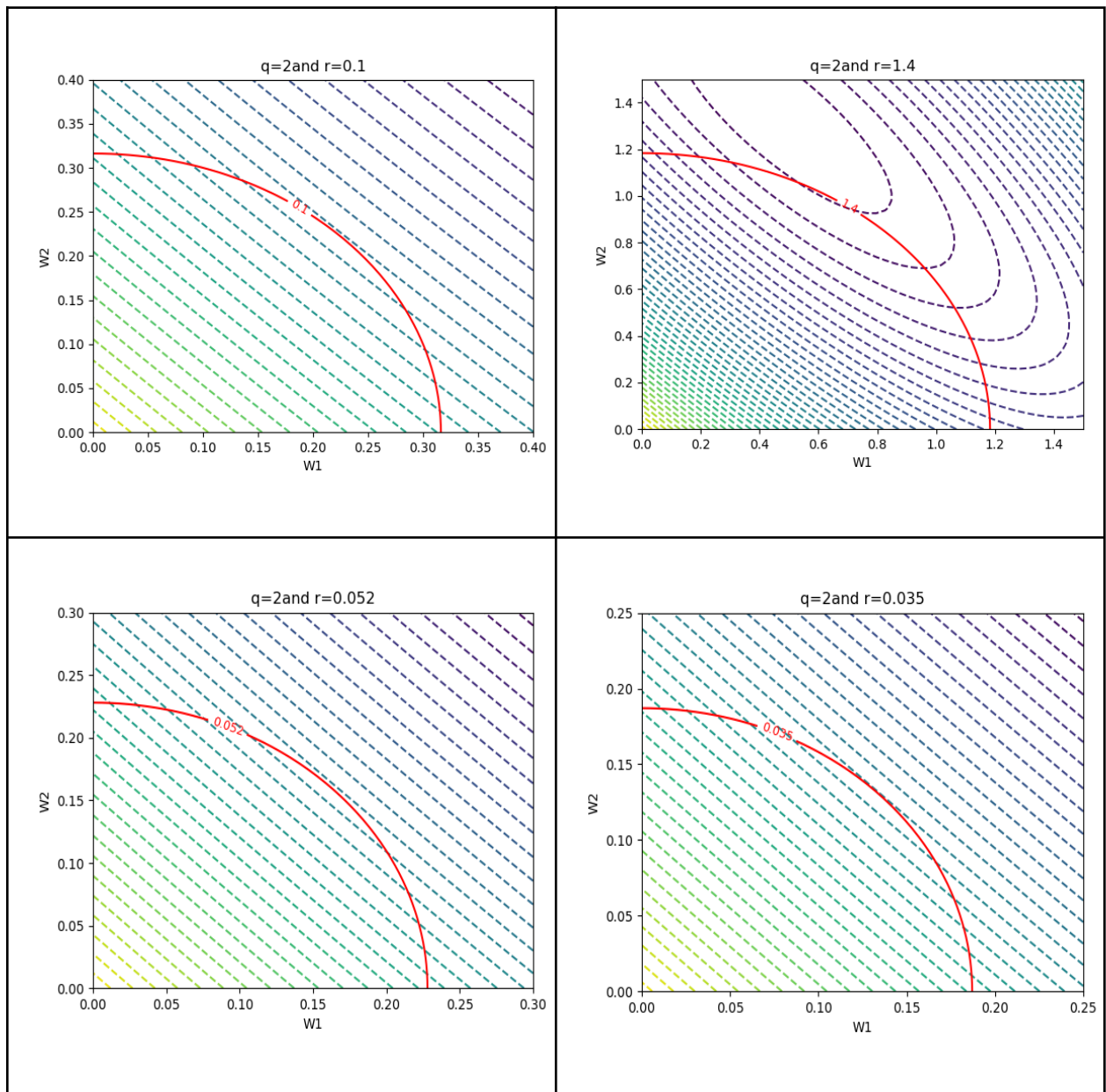
In our code, by using matplotlib we have plotted the contour of the error function, and our observation is that

- it forms ellipses centered around **(0.47,1.32)**.
- It is a convex function with a single global minimum.

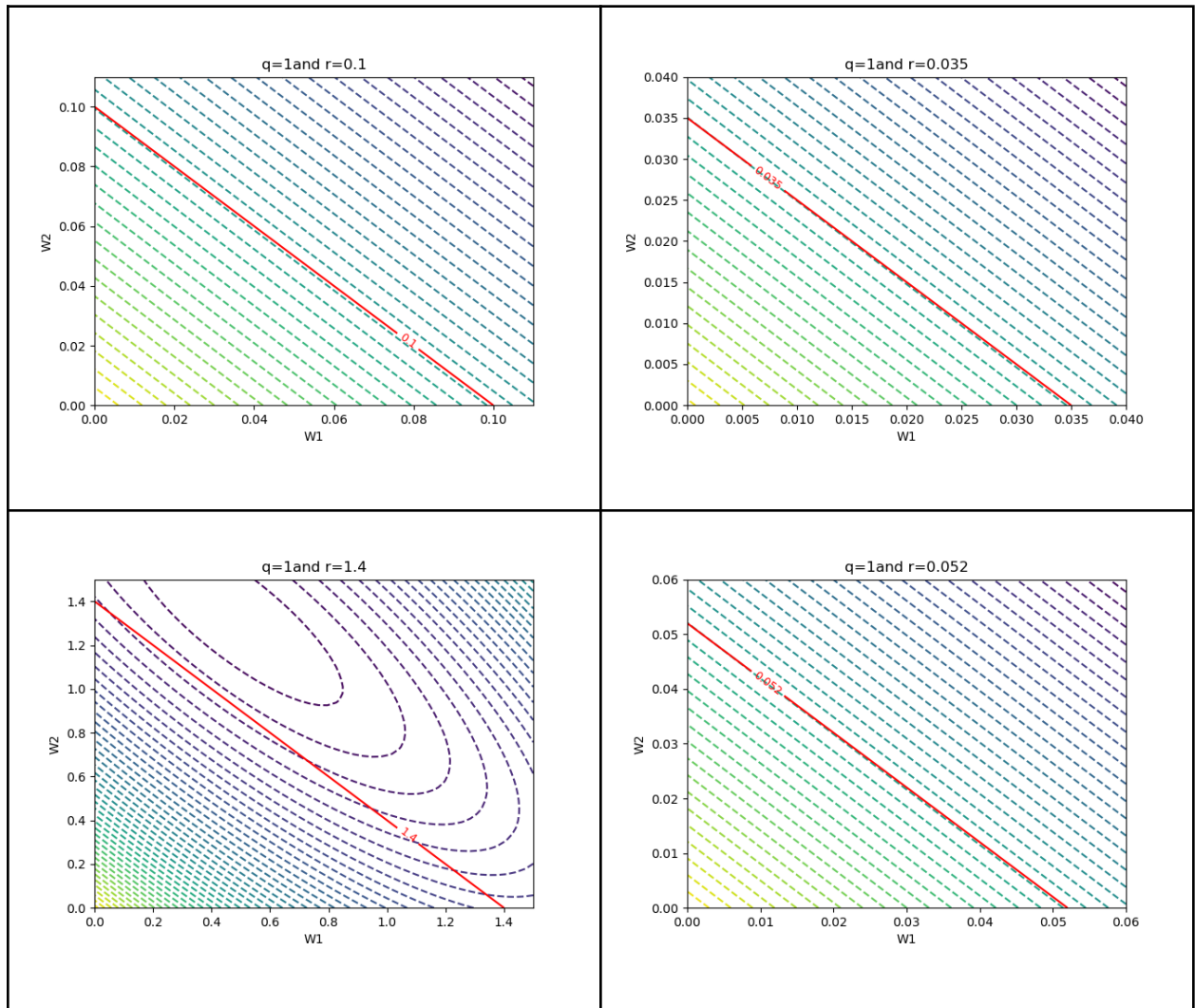


Next, we plotted the contour of the regions. These contours cut our constraint region at various points, but the first point of intersection is the point at which the error function is minimum, and the constraint is also satisfied.

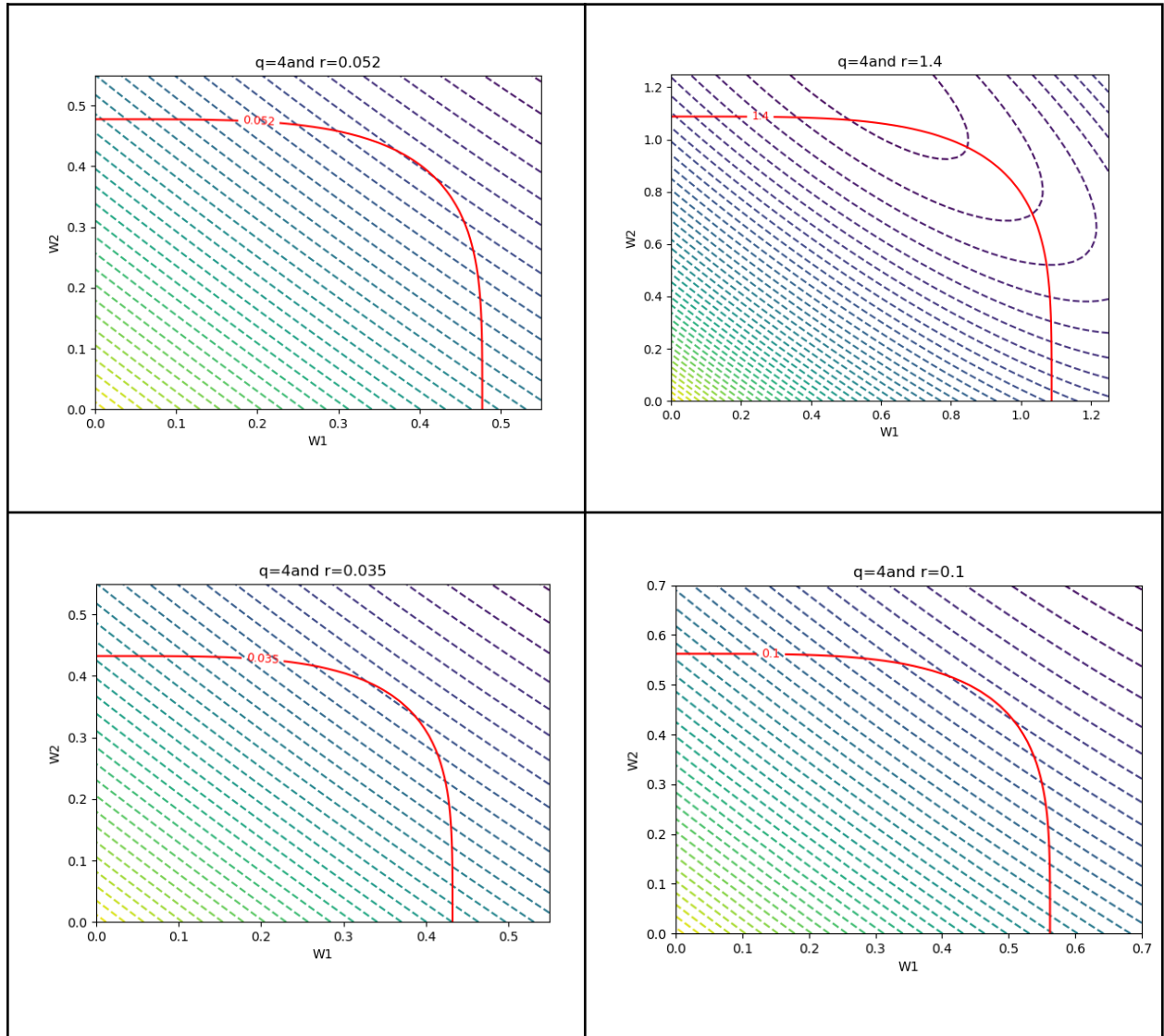
**Q=2**



**Q = 1**

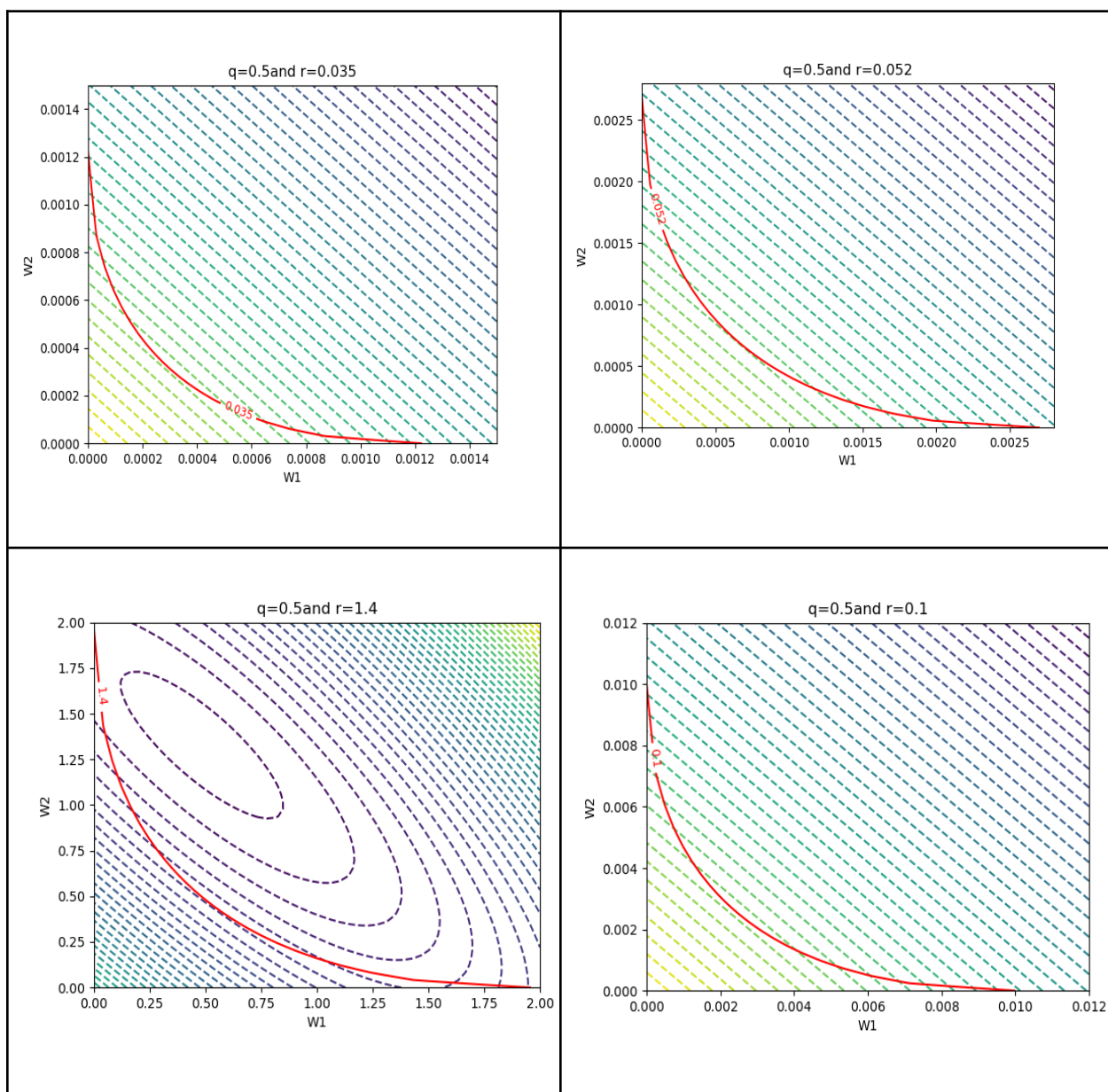


**Q = 4**





**Q = 0.5**



**Q = 0.5**

<b>lamba</b>	<b>RMS training error</b>	<b>RMS testing error</b>
1.4	0.13845590756307553222	0.13358655076532628741
0.1	0.13782805347033946886	0.13086366476270246978
0.035	0.13782484000329772917	0.13075568710428230106
0.052	0.1378254688361844262	0.13078371629263154611

**Q = 1**

<b>lamba</b>	<b>RMS training error</b>	<b>RMS testing error</b>
1.4	0.13872875818540012515	0.13440482907445875022
0.1	0.13783540459185287528	0.13096831666941221068
0.035	0.13782837900581003885	0.13082386219374417205
0.052	0.13782986896219660284	0.13086138457427500412

**Q = 2**

<b>lamba</b>	<b>RMS training error</b>	<b>RMS testing error</b>
1.4	0.13863101584455587423	0.13389986766197437722
0.1	0.13783891008772992651	0.13096587599316882672
0.035	0.13782942932481611809	0.13082339196009078511
0.052	0.13783150458007837087	0.1308605407493211276

**Q = 4**

<b>lamba</b>	<b>RMS training error</b>	<b>RMS testing error</b>
1.4	0.13820221079910438203	0.13241866746871744045
0.1	0.13783578358321646703	0.13089007419633427043
0.035	0.13782881535002523516	0.13079768298470047614
0.052	0.13783040849345483438	0.1308220204817352949