Question 2a Recall the optimal value of θ should minimize our loss function. One way we've approached solving for θ is by taking the derivative of our loss function with respect to θ, like we did in HW5.

Write/derive the expressions for following values and write them with LaTeX in the space below.

- $R(\mathbf{x}, \mathbf{y}, \theta_1, \theta_2)$: our loss function, the empirical risk/mean squared error
- $\frac{\partial R}{\partial \theta_1}$: the partial derivative of R with respect to θ_1
- $\frac{\partial R}{\partial \theta_2}$: the partial derivative of R with respect to θ_2

Recall that $R(\mathbf{x}, \mathbf{y}, \theta_1, \theta_2) = \frac{1}{n} \sum_{i=1}^{n} (\mathbf{y}_i - \hat{\mathbf{y}}_i)^2$

$R(\mathbf{x}, \mathbf{y}, \theta_1, \theta_2) = \frac{1}{n} \sum_{i=1}^{n} (\mathbf{y}_i - \hat{\mathbf{y}}_i)^2$

$\frac{\partial R}{\partial \theta_1} = \frac{1}{n} \sum_{i=1}^{n} 2(\theta_1 x_i + \sin(\theta_2 x_i) - y_i) * x_i$

$\frac{\partial R}{\partial \theta_2} = \frac{1}{n} \sum_{i=1}^{n} 2(\theta_1 x_i + \sin(\theta_2 x_i) - y_i) * \cos(\theta_2 x_i) * x_i$

In 1-2 sentences, describe what you notice about the path that theta takes with a static learning rate vs. a decaying learning rate. In your answer, refer to either pair of plots above (the 3d plot or the contour plot).

The static learning path rate is mor jagged and each successive gradient jumps around in various directions. The decaying learning rate is more direcr and that decends generally in one direction, down.

0.0.1 Question 4b

Is this model reasonable? Why or why not?

the prob is confined to thw range 0.5 - 0.8 which means that no matter what points the teams score the probility is still high. Therefore this model is not reasonable as it is problematic to classify.

0.0.2 Question 4c

Try playing around with other theta values. You should observe that the models are all pretty bad, no matter what θ you pick. Explain why below.

This is a binary response variable (0 or 1) which means that the underlying relationship is not linear and would be better suited in another model. This is problemmatic because there is a chance that the output is beyond the range of 0 and 1 which would not fit the model and very sensitve to outliers.

0.0.3 Question 5b

Using the plot above, try adjusting θ_2 (only). Describe how changing θ_2 affects the prediction curve. Provide your description in the cell below.

when θ_2 is more negative (changed from -5 to -15) the s curve lose its shape until it becomes more linear on the winning probability 0 where it predicts 0 for all points. If θ_2 becomes more positive then the curve becomes closer to a linear model where the winning probillity predicts 1 for all points.

0.0.4 Question 7c

Look at the coefficients in `theta_19_hat` and identify which of the parameters have the biggest effect on the prediction. For this, you might find `useful_numeric_fields.columns` useful. Which attributes have the biggest positive effect on a team's success? The biggest negative effects? Do the results surprise you?

FGM, FG3_PCT, FT_PCT have the biggest positive effects. FG_PCT and PTS have the biggest negative effects. I had to look up some rules about basketball as my knowledge is limited but the the biggest positive effects FGM-Field Goal, FG3_PCT-3 point field goal, FT_PCT-free throw percentage have the highest scores thus higher prediction values. FG_PCT has the biggest negative effect at -2.1902e+01. This is the ratio of field goals made to field goals attempted which makes sense in the negative effects aka attempted field goals.

To double-check your work, the cell below will rerun all of the autograder tests.

In [1]:
```
grader.check_all()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)

<ipython-input-1-0885c929a0c9> in <module>
----> 1 grader.check_all()


NameError: name 'grader' is not defined
```

0.1 Submission

Make sure you have run all cells in your notebook in order before running the cell below, so that all images/graphs appear in the output. The cell below will generate a zip file for you to submit. **Please save before exporting!**

In [ ]:
```
# Save your notebook first, then run this cell to export your submission.
grader.export("hw7.ipynb")
```