**IMSE 982 Final Project**

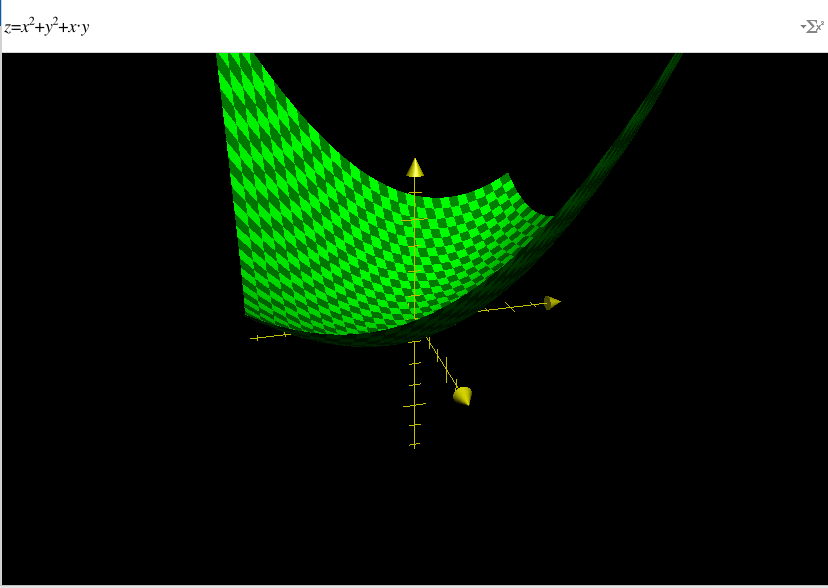
**Blake Conrad**

* Python
* Numpy
* Pandas
* Conjugate Gradient Fletcher Reeves Method
* Golden Search
* Convex Convergence
* Multiple KKT point dispersion
* Penalty method feasibility

Problem 1: Quasi-convex function: Hyper-Bowl Function;

* Hessian is clearly Positive Definite, so our function is convex.
* We should expect given any random starting point we will converge to the same optimal solution via our algorithm of choice.

*Illustration 1:* Image to articulate a 4-dimensional surface with a single dimension (z) held constant (E.g., z=0).



*Table 1:* 10 Samples of Conjugate Gradient Fletcher Reeves Method converging to the same point with different starting points.

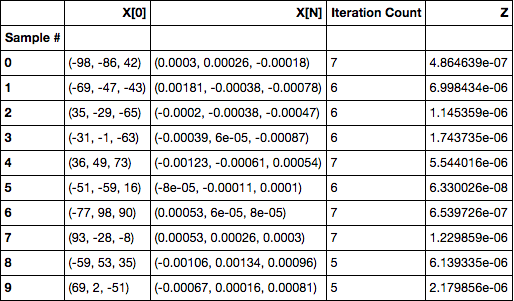
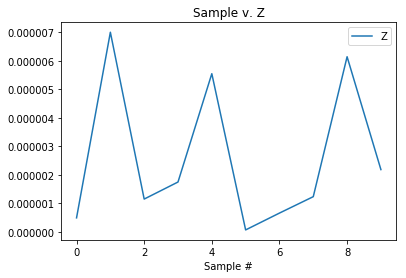


Illustration 2: Display of each sample converging to a point within a billionth of a decimal place to each other.

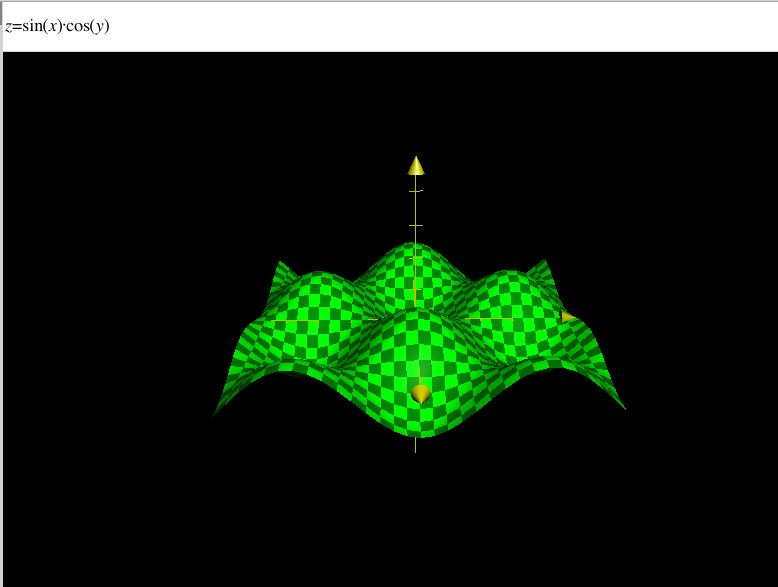


Problem 2: Non Convex Function (Multiple KKT Points): Periodic Wave Function;

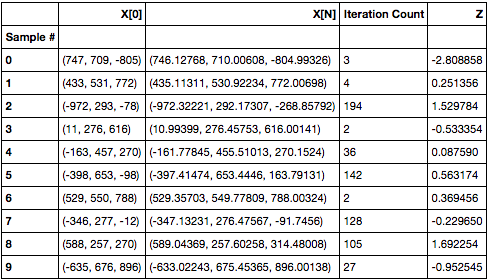
* Only convex when

  + ||

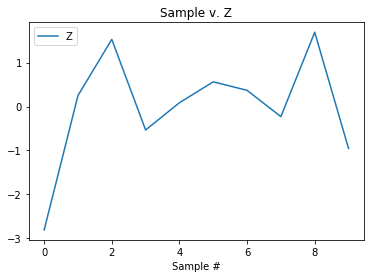
*Illustration 3:* Image to articulate a 4-dimensional surface with a single dimension (z) held constant (E.g., z=1).



*Table 2*: Samples of Conjugate Gradient Fletcher Reeves Method converging to different points with different starting points.



*Illustration 4:* Display of each sample distant from one another with varying final points.



Problem 3: Constrained Quasi-convex function: Hyper-Bowl Function;

subject to:

🡪 **-**

The Penalty Function will be defined as

* Paraboloid
* Inside of Hyper-sphere.
* Upper Half-space of Hyper-plane.
* We expect only 1 KKT point for a convex function as illustrated in problem 1.
* After running GRG, we expect our solution at . Therefore, we expect under fletcher reeves conjugate gradient, .