1. (30 points) An optimization problem: A broken, object-oriented program for the quarter car model in the MVC patern has been provided. This simulation imagines that the car is traveling at fixed speed (specified by the user in the GUI) along a horizontal plane and encounters a linear ramp up to a new level of y=6 inches, where the ramp angle is specified by the user in the GUI. We model the behavior of the car using only a single wheel (i.e., the quarter car model) and treat the tire as a spring between the road and the hub of the wheel and the suspension as a spring and dashpot in parallel between the wheel hub and the car body.

To estimate the spring constants, we guess that a static compression of the spring of the suspension should be between say 3” to 6” and for the tire between 1.5” to 0.75”. Given a car with a mass of 0.25mcar=450kg, use minimize from scipy.optimize to calculate the best combination of k1, c1 and k2 for our car model to minimize the sum of squared errors between the vertical position of the car and the contour of the road.

Diagram

Description automatically generated

Necessary steps:

1. Calculate the minimum and maximum values for k1 and k2 based on the static compression values.
2. Calculate the sum of squared errors SSE as Σ(ycar(t)-yroad(t))2 with penalties if k1 or k2 violate the limits from 1.
3. Use minimize(SSE, x0, method=’Nelder-Mead’)
4. You will want to update the values for k1, c1, and k2 on your GUI to show the optimized values and update the plot.
5. Plot the acceleration experienced by the car passengers and limit the acceleration to something reasonable (say ~2.0g) in your suspension optimization.

**Bonus points credit:**  You will notice that a crude schematic using QTViewFramework has been started. Complete the schematic by creating spring and dashpot custom items and add them to the scene. This bonus credit if for up to **10pts added to your total exam score.** \*\*You probably want to check the update github repository for the Week 11 lecture which has the 4-bar linkage.

You may work with up to two other team members and only one person needs to submit the github repository, but list all team members in your CANVAS comments.