# Homework 1

Due 11:59PM October 5, 2016. **READ ALL DIRECTIONS VERY CAREFULLY!**
**Only PDF** will be accepted. **No scans** of handwritten work will be accepted. You **MUST**
put each problem on a separate page with 1a on the first page, for example 1a will be on
page 1 and 1b will be on page 2. You **MUST** put your name and student ID in the upper
right hand corner of the first page.

1) For this problem you will consider a database schema for automobiles consisting
   of four relations:

   Product(maker, model, year)
   Car(model, city, highway, style, passengers, trunk, msrp)
   Pickup(model, city, highway, passengers, cargo, towing, msrp)
   EV(model, range, battery, passengers, msrp)

   Assume model names are not reused between makers. The city and highway
   values are the EPA fuel economy ratings in miles per gallon. Passengers is the
   number of passengers the vehicle can carry. Trunk and cargo are the volume of
   the trunk and pickup bed respectively. Towing is the towing capacity of the
   pickup in lbs. Range is the EV range in miles and battery is the energy capacity of
   the battery pack in kWh. The msrp is the manufacturers suggested retail price.
   The year in Product refers to the year the model was introduced. Write
   expressions in relational algebra to answer the following queries:

   a) What Car models have a city fuel economy less than 50MPG?
   b) Find all of the Pickup models that have a towing capacity of at least
      12,500lbs and a highway fuel economy less than 20MPG.
   c) Find all automakers that sell at least one vehicle that costs less than
      $25,000 and at least one vehicle that costs greater than $60,000.
   d) Find the prices that exist for two or more vehicles.
   e) Find the automaker(s) of the highest combined fuel economy (55% city,
      45% highway) of conventional vehicles (cars and pickups).
   f) Find the vehicle model with the highest miles per gallon gasoline
      equivalent (MPGGE). For this problem assume combined fuel economy
      formula from above, and that a gallon of gasoline is equivalent to
      33.1kWh.
   g) Find automaker(s) that sell a car with a city fuel economy of less than
      15MPG and also sell an EV.
   h) Find automaker(s) that sell conventional vehicles (cars and pickups) with
      at least three different trunk/cargo volumes.

2) Using the database schema from problem 1 write constraints that express the following:

    a) A pickup with a towing capacity less than 12,000lbs cannot cost more than $25,000.

    b) All EVs must have a range of at least 105 miles.

    c) A car with a city fuel economy of 50MPG or greater must have a highway fuel economy of at least 40MPG or cost less than $20,000.

    d) No pickup manufacturers may also make EVs.

    e) A manufacturer may not release more than one model in a single year.

    f) A manufacturer of a pickup must also make a car with a higher highway fuel economy.

    g) If a pickup has a higher city fuel economy than a car, then it must have a price at least 75% higher than the car.

3) Part of this problem is from Exercise 3.1.2 from the book: Consider a relation representing the present position of molecules in a closed container. The attributes are the ID for the molecule, the X, Y, and Z coordinates of the molecule, and its velocity in the X, Y, and Z dimensions. Refer to the X, Y, and Z coordinates as $P_X$, $P_Y$, and $P_Z$ respectively, and the X, Y, and Z velocities as $V_X$, $V_Y$, and $V_Z$ respectively.

$$ID \rightarrow Px,Py,Pz,Vx,Vy,Vz$$

    a) What functional dependencies do you expect to hold?    Px,Py,Pz->ID,Vx,Vy,Vz

    b) What are the keys?   {Px,Py,Pz}, {ID}

    c) Other than the keys list three superkeys. {Px,Py,Pz,Vx}, {ID,Px}, {ID,Vx}

    d) Other than the keys how many superkeys are there?

$$6C1 + 6C2+6C3+6C4+6C5+6C6+3C1+3C2+3C3$$
$$= 6+15+20+15+6+1+3+3+1 = 70$$