Homework #2a: Polynomial Models

Math 4334: Mathematical Modeling
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Problem #1. Braking Distance. The data sets `braking-distance-1.xlsx` and `braking-distance-2.xlsx` contain two sets of measurements on the braking distance of a car as a function of speed. The experimental setup consists of a driver on a closed course. At a random, unexpected time, an experimenter simultaneously records the car's position, and causes the sound of a bell to be played inside the car. At that point, the driver must apply the brakes and bring the car to a stop as soon as possible, and the distance traveled from the moment the bell rings is recorded. The experiment is conducted for two sets of conditions:

	Run 1	Run 2
Car	Toyota Prius	Tesla Model 3
Driver	Math Professor	Professional Driver
Other Occupants	Two Children	none

For each data set,

- find a polynomial model that fits each data set reasonably well
- justify the order of, and terms in, the polynomial you chose
- record the polynomial coefficients you obtained (for future use)
- Use your model to predict the braking distance for each case if the speed were 100 mph.
- Discuss whether your prediction seems reasonable, and any limitations that should be considered.

Problem #2. Algorithm Runtime. One fundamental way of analyzing computer algorithms is to determine their ***characteristic run time*** as a function of their input size N. For example, you might ask "how long does it take to sort a list of N strings?" Frequently-encountered runtimes include things like:

Notation	**Description**	**Example**	**Comments**
$\mathcal{O}(\log(N))$	logarithmic time	phone book lookup	best case
$\mathcal{O}(N)$	linear time	vector-vector product	typical case
$\mathcal{O}(N^2)$	quadratic time	matrix-vector product	typical case
$\mathcal{O}(N^p)$	polynomial time	matrix-matrix product	typical case
$\mathcal{O}(N!)$	factorial time	traveling salesman	worst case

The data sets `algorithm-runtime-1.xlsx` and `algorithm-runtime-2.xlsx` contain measurements of the runtime of two different algorithms for various input sizes. For each data set:

- find a polynomial model that fits the data reasonably well
- justify the order of, and terms in, the polynomial you chose
- record the polynomial coefficients you obtained (for future use)
- If you had to decide which algorithm to use to perform calculations on an input of size 10,000, how would you approach this decision?