# MA372 Submission Problems

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1. In a fantasy video game, I am playing as a wizard who is fighting a dragon. My character uses spells which require "mana points" in order to be cast, and my character has a total of 1400 mana points. My character has access to two spells. The first, "Fireball," takes four seconds to cast, and requires 100 mana points. The second, "Lightning Bolt," takes two seconds to cast, and requires 200 mana points. The game rules prohibit me from casting Lightning Bolt more than five times in one battle. Casting Fireball will score 1000 damage points against the dragon, and casting Lightning Bolt will score 3000 damage points against the dragon. The fight against the dragon lasts 32 seconds, and I want to score as many damage points as possible in this time. Model this problem as a linear program.

1. **Decision Variables**: Since we are interested in the number of times each spell is cast in the battle with the dragon, I let $x_1$ be the number of times Fireball is cast and $x_2$ be the number of times Lightning Bolt is cast.

   **Objective Function**: We wish to maximize the damage dealt from the cast spells. Each Fireball scores 1000 damage points and each Lightning Bolt scores 3000 damage points.

   We thus wish to maximize

   $$z = 1000x_1 + 3000x_2$$

   **Contraints**: We are constrained to using no more than 1400 mana points. Fireball costs 100 mana points, and Lightning Bolt costs 200 mana points.

   $$100x_1 + 200x_2 \leq 1400$$

   Lightning Bolt cannot be cast more than 5 times per battle.

   $$x_2 \leq 5$$

No more than 32 seconds can be spent casting spells. Fireball takes 4 seconds to cast, and Lightning Bolt takes 2 seconds.

$$4x_1 + 2x_2 \leq 32$$

In addition to the structure constraints, we also have the nonnegativity constraints since it does not make sense to cast a spell a negative number of times.

$$x_1 \geq 0, x_2 \geq 0$$