Simplex and the science of making a better burger

Mathematical Investigation Task

Setting the Scene

While traditional hamburgers have an all-beef patty, 'veggie burgers' are becoming increasingly popular, as some consumers seek to decrease or eliminate meat from their diets for environmental, ethical and/or personal health reasons. One way of having 'the best of both worlds' is to blend beef and plant-based ingredients like textured soy protein to make a lower fat, higher protein, more economical, burger patty.

Exploratory Questions

Given the following

- Your recipe for the 100 gram burger patty requires
  - Protein - a minimum of …
  - Fat - a minimum of …
- Beef mince contains 20% protein and 15% fat
- TSP contains 30% protein and 0.2% fat

Can you use all beef mince to make your patty? What about all TSP? Can you use 55 grams of beef and 40 grams of TSP? Answer these questions in sentences incorporating relevant calculations

Mathematical Modelling

- Define variables to represent the amount of beef mince and the amount of TSP in your patty.
- Express your recipe's minimum requirements as inequalities in terms of these variables.
- Write down an inequality that ensures that your patty is 100 grams in total, including beef mince, TSP and other ingredients.
- Graph these inequalities on a cartesian plan.

The overlap of these three half-planes is called the feasible region. It contains all feasible of values (x,y)

- Is the point (55, 40) within the feasible region? How does this relate to the answer to the exploratory questions?
- For a selection of points within the feasible region, calculate the cost of the burger patty, if beef mince costs $XX per kg and TSP costs $YY per kg.
- Make a conjecture about where in the feasible region the cost of patty might be greater or lesser?
- Calculate the vertices of the feasible region, using both algebraic and graphical methods.
- Decide upon the optimal recipe for your burger patty, being the combination of ingredients that satisfies the recipe requirements while minimising cost.

What if …

- The price of TSP is subject to change. What effect would a decrease in the cost of TSP have on cost of the burger patty? At what point would it effect the optimal recipe?
- The fast food chain using your optimal recipe wants to produce a premium patty. If they are prepared to spend an extra 20% on ingredients, how much extra beef mince can they include?

Task completion

Complete these tasks and present your work as a free-standing piece of mathematics. Link together your work to create a purposeful whole. You work should be readable without reference to this task sheet.

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Can you use all beef mince to make your patty? What about all TSP? Can you use 55 grams of beef and 40 grams of TSP? Answer these questions in sentences incorporating relevant calculations.

Mathematical Modelling

The 100 g patty contain some amount of beef mince, let's call it x grams, and let's call the amount of TSP y grams. Thinking about the two ingredients contributing to the amount of protein required, we know:

20% of x plus 30% of y must be greater than or equal to $(\dots)$

This can be written as the inequality

$$0.2x + 0.3y \geq (\dots)$$

This inequality can be converted to 'slope-intercept form' as follows

$$0.3y \geq -0.2x + (\dots)$$

$$y \geq -\frac{0.2}{0.3}x + \frac{(\dots)}{0.3}$$

$$y \geq -\frac{2}{3}x + \dots$$

Write down a second inequality involving x and y based on the two ingredients contributing to the amount of protein required.

Convert it to 'gradient-intercept' form. Graph these inequalities on a Cartesian Plane.

Add the inequality $x + y \leq 100$ to your graph. Explain why it is needed.

Shade the region on your graph that satisfies all three of these inequalities.

The overlap of these three half-planes is called the feasible region. It contains all feasible of values (x, y)

Is the point (55, 40) within the feasible region? How does this relate to the answer to the exploratory questions?

For a selection of points within the feasible region, calculate the cost of the burger patty, if beef mince costs $XX per kg and TSP costs $YY per kg.

Make a conjecture about where in the feasible region the cost of patty might be minimised.

Calculate the vertices of the feasible region, using both algebraic and graphical methods.

Decide upon the optimal recipe for your burger patty, being the combination of ingredients that satisfies the recipe requirements while minimising cost.

What if …

The price of TSP is subject to change. What effect would a decrease in the cost of TSP have on cost of the burger patty? At what point would it effect the optimal recipe?

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