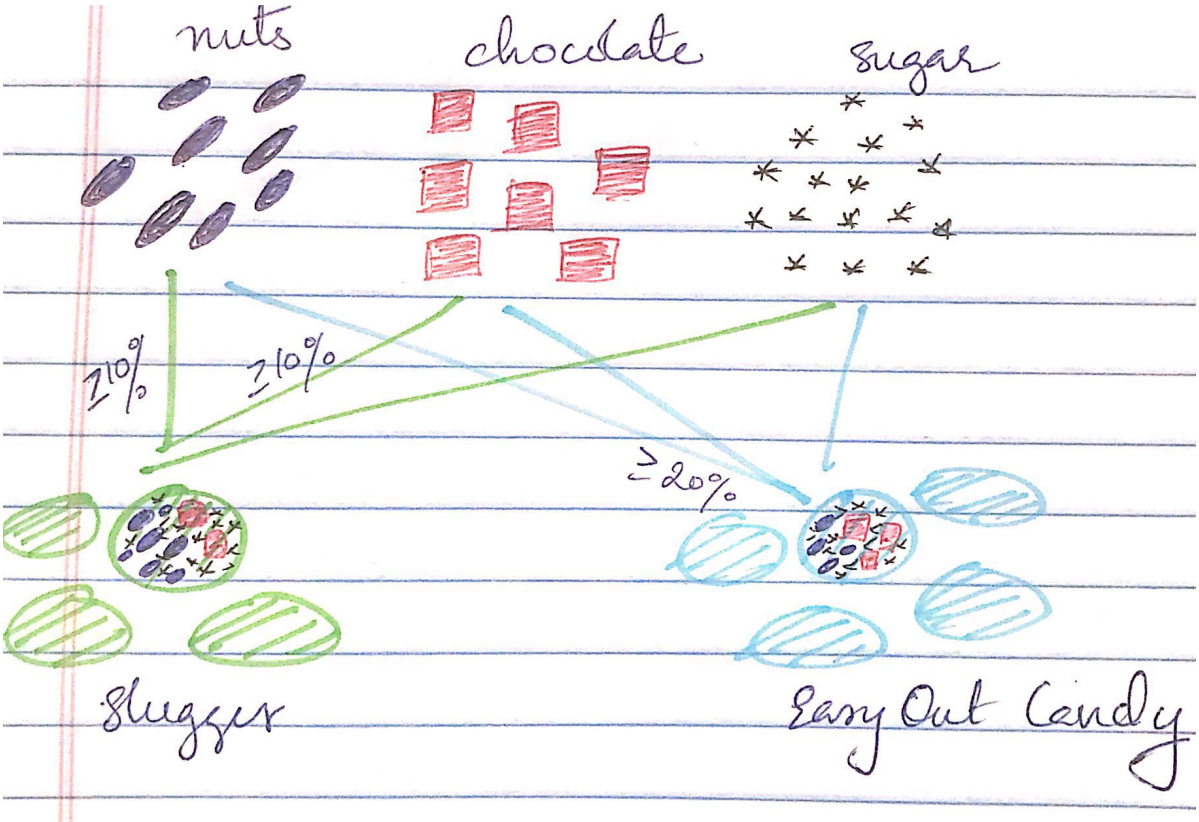
Blending. You have decided to enter the candy business. You are considering producing two types of candies: Slugger candy and Easy Out candy, both of which consist solely of sugar, nuts, and chocolate. At present, you have in stock 10,000 ounces of sugar, 2000 ounces of nuts, and 3000 ounces of chocolate. The mixture used to make Easy Out candy must contain at least 20% nuts. The mixture used to make Slugger candy must contain at least 10% nuts and 10% chocolate. Each ounce of Easy Out candy can be sold for $1.40, and each ounce of Slugger candy for $1.20.
Determine how you can maximize your revenue from candy sales.

Discussion.

This is an example of a blending problem where a particular product is a mix of two or more materials. Here, there are 2 types of candy, each made from a mixture of sugar, chocolate and nuts. We have the requirement that at least a certain fraction of each candy of each type must be composed of a specific material. Since we have the available ounces of each material, the decision variable must be how many ounces of each material must be allocated to produce a candy type. The sum of materials for each candy type can be assumed to be the number of units of each candy type sold. This derived number of units of candy sold can be used to find that total revenue, which must be minimized according to the objective. The constraints are clear that the total material allocated for both candy types must be within the available ounces of that material and the minimum fraction of a particular material needed in a candy type must be satisfied while allocating materials.



Model.

Parameters:

S_C : *Selling Price of candy type* c, *where* $c \in (Easy\ out,\ Slugger)$

F_{ic}: *Minimum fraction of material* i *to be present in candy type* c, *where* $i \in (sugar, nuts, chocolates),\ c \in (Easy\ out,\ Slugger)$

A_i : *Availability of material* i, *where* $i \in (sugar, nuts, chocolates)$

Decisions:

x_{ic}: *Ounces of material* i *to to be allocated to candy type* c, *where* $i \in (sugar, nuts, chocolates),\ c \in (Easy\ out,\ Slugger)$

Objective: *Maximize Revenue*

$max \sum_{i \in (Easy\ out,\ Slugger)} x_{ic} * S_C$

Constraints:

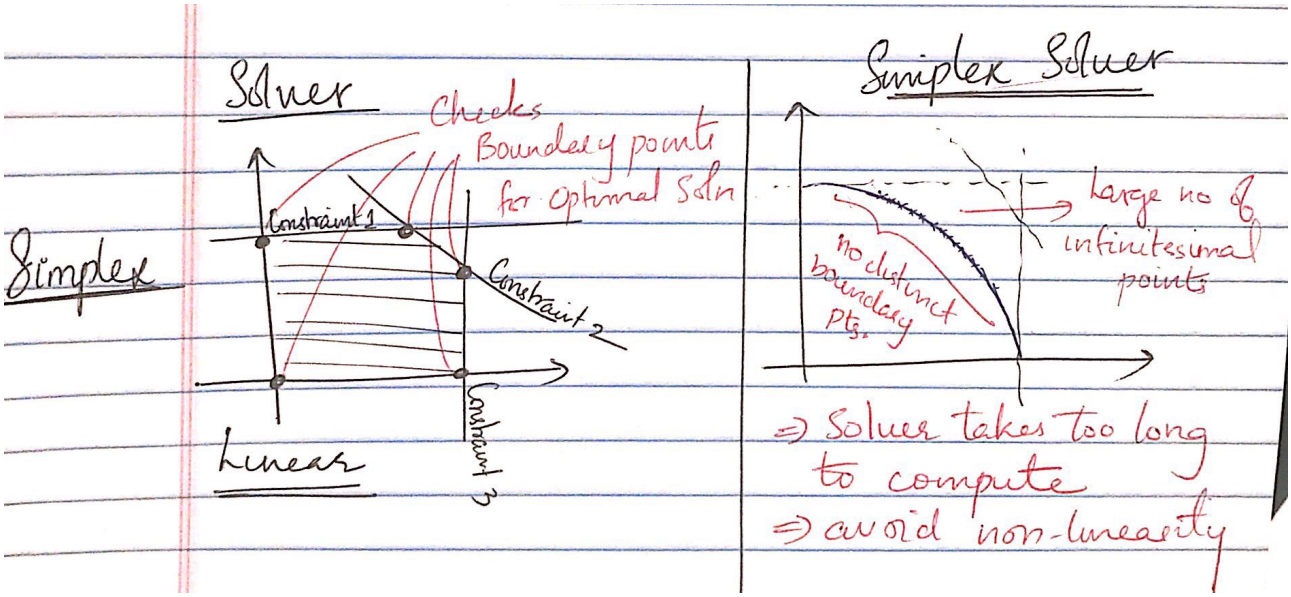
$x_{ic} \geq 0$ (1) Non- negative allocation

$x_{ic} \geq F_{ic} * \sum_i x_{ic}$ (2) Satisfy minimum percentage of each material units of in each candy type

$\sum_c x_{ic} \leq A_i$ (3) Maximum availability of materials.

Notes:

1) Constraint (2) ensures that units of each candy type has the required percentage of materials mentioned. It is important to denote this equation in a linear format, i.e., a decision variable cannot be present in a denominator of the fraction. It is natural to write this constraint as $x_{ic} / \sum_i x_{ic} \geq F_{ic}$,which is a non-linear representation, since a decision variable is present in the denominator. To convert this to the linear format, simply move this denominator to the right-hand side of the equation to get constraint (2). Below the implications of a linear and non-linear representations when using simplex solver is illustrated. It is important to note that the simplex solver computes the optimal solution by checking only the boundary points of the feasible region.



2) Constraint (3) ensures the total of each materials among the 2 candy types stays within the availability if that corresponding material

Optimal Solution. The following is the solution obtained from Excel Solver.

17(AP).xlsx

A maximum revenue of $19000 can be attained by allocating each of the materials to each of the candy types as follows.

Decision				
materials to be allocated to each candy	Sugar	Nuts	Chocolate	Total Candy
Easy out candy	2000	1000	2000	5000
Slugger candy	8000	1000	1000	10000

Inputs				
	Sugar	Nuts	Chocolate	
Available onces of material	10000	2000	3000	
Sellind Price				
Easy out candy	1.4			
Slugger candy	1.2			
Minimum fraction of material needed	Sugar	Nuts	Chocolate	
Easy out candy	0	0.2	0	
Slugger candy	0	0.1	0.1	
Min material needed				
Easy out candy	0	1000	0	>constraint
Slugger candy	0	1000	1000	>constraint
Decision				
materials to be allocated to each candy	Sugar	Nuts	Chocolate	Total Candy
Easy out candy	2000	1000	2000	5000
Slugger candy	8000	1000	1000	10000
Total Material	10000	2000	3000	>constraint
Objective	19000			