# SFWR ENG 4O03

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## Contents



## Linear

**Linear Program**: an optimization problem in which the objective function is linear and each constraint is a linear inequality or equality
**Decision variables**: describe our choices that are under our control
**Objective function**: describes a criterion that we wish to max/minimize; doesn't have an in/equality
e.g. max 40x + 30y

**Constraints**: describe the limitations that restrict our choices for our decision variables, always *inequalities*.

**Basic variable**: the variables corresponding to the identity matrix, usually have to be set to 0
**Non-basic variable**: …not basic variables

### Converting constraints to equalities

**Slack variable**: basic variable greater than constraint, added to turn inequalities into equalities
**Surplus variable**: equation variable less than constraint, subtracted

**Hyperplane**: a hyperplane in $R^x$ is a shape in $R^{x-1}$, e.g. line in $R^2$

**Optimal Solution**: either a maximum or minimum of the objective function based on constraints
**Basic Solution**: a solution which has as many slack variables as basic variables
**Basic Feasible Solution**: all variables are non-negative

- Unique

- obtained by setting the non-basic variables to 0

**Standard form**: when you take inequalities and use slack variables to turn them into equalities.

- Note: all variables need to be ≥ 0.
- All remaining constraints are expressed as equality constraints.

e.g.)

$2x_1 + 4x_2 – x_3 – x_4 \geq 1$

$2x_1 + 4x_2 – x_3 – x_4 + s = 1$

## Graphical Method

1. Sketch the region corresponding to the system of constraints. The points inside or on the boundary of the region are the *feasible solutions*.
2. Find the vertices of the region.
3. Test the objective function at each of the vertices and select the values of the variables that optimize the objective function. For a bounded region, both a minimum and maximum value will exist. For an unbounded region, if an optimal solution exists, then it will occur at a vertex.

## Simplex Method: Maximization

**Simplex Method**: useful for solving linear optimization problems cheaply

- Cannot be done with **strict inequalities**, i.e. when there is no possibility of being equal
- Can only work if your objective function is in *standard form*

**Simplex Tableau**: visual representation of stuff

1. The *basic variables* can be identified if they have a column with one row of 1 and the rest of the rows are 0's. The value of the variable is at the row with the 1.
2. The bottom row is going to identify the constants for the new equation. You should see 0's in the columns that are non-basic

1. Find the column with the "lowest z value". That column is called the **pivot column**.
2. **Minimum test**: find the row with the smallest RHS/$x_{pivot}$. That row is called the **pivot row**.
3. The intersection of the pivot row & column is called the **pivot point**.
4. If your pivot point ≠ 1, divide your row out by the value of your point

## Simplex: Minimization

ti

## Phase Simplex

When the origin is not part of your basic solution

### Phase I

Hi

### Phase II

Oh no!

## Bland's Rule

**Bland's Rule**: a way of guaranteeing that you don't repeat going over the same variables (a cycle) by picking the negative number with the largest index