1. Graph. ① Find 2 points for each constraint $\Rightarrow$ lines
② Using one point to check which side is we want.
③ Don't forget sign restriction.

optimal solution — 2-variable ① draw isoprofit line
② Find the direction of $\uparrow z$ $\downarrow z$
③ parallel moving to get the optimal solution

multi-variable : Using Simplex Algorithm

Feasible point : the points in feasible region
(or) satisfy all constraints & sign restrictions.

Basic solution (def §4.2) $A \in \mathbb{R}^{m \times n}$ $(n \geq m)$
Set n-m variables equal to 0 $\Rightarrow$ one basic solution
(Intersection of any two constraints lines including sign restrictions).

Basic feasible solution
For a basic solution, if it is feasible, then it is a BFS
(call the extreme points of feasible region)

2. Standard Form
1. All constraints are = RHS
2. All variables are ≥ 0
3. All RHS values are ≥ 0.

→ used to : Simplex Algorithm.

3. dual

	min	max	
costraints	$\geq$ RHS	≥ 0	Variables
	$\leq$ RHS	≤ 0	
	= RHS	urs	
variables	≥ 0	$\leq$ RHS	constraints
	≤ 0	$\geq$ RHS	
	urs	= RHS	

4. How to decide the type of LP based on Simplex tableau?

- RHS of all rows (except row 0) must be non-negative ($b_i \geq 0$)

why? $\because$ BU = RHS and All variables ≥ 0
NBU = 0

- unbounded
- infeasible
- Multiple solutions
- unique solution

1). unbounded

Can get an entering variables, but all the entries of this column are ≤ 0.

e.g.

	z	x_1	x_2	x_3	RHS
row 0 (max)	1	0	0	-3	7
		1	0	-4	3
		0	1	0	2

2). Multiple solutions.

The coefficient of a non-basic variable is 0, and after pivoting by using this non-basic as entering variable, we can get the different solution b_2
b_1

(The RHS of row 0 will not change).

All optimal solutions = $c \cdot b_1 + (1-c) b_2$ $c \in [0, 1]$

3> Unique. Solution.

There is no coefficient of non-basic variable is ≥ 0 for min. / ≤ 0 for max

4>. Infeasible LP $\Leftrightarrow$ feasible region $= \phi$

- Big M

1> If we can't continue (all coefficient of non-basic variable are ≥ 0 for max / ≤ 0 for min), and all artificial variables are 0, then we get the optimal solution.

2> If we can't continue with at least one artificial variable > 0 in the optimal solution, then LP is infeasible.

- Two phase.

1>. After doing phase I, if optimal value of $w > 0$, then LP is infeasible

2> $w = 0$, then LP has feasible solutions.

5. • Big-M

1) Remember to change Row 0 first !

Make sure all coefficients of Basic variables are 0 in row 0.

2) Max / Min

3) RHS of all constraints are ≥ 0.

• Two Phase

1) min $w = \sum_{\forall i} a_i$

Remember to chang row 0 first

2) Phase II. max/min !

3) Follow the 3 cases of 2-phase.

6/7. Don't forget 1) information

2) sign restriction

8. BV: the variables, entries of its column are 0 except a 1. value = RHS.

NBV: the rest variables. value = 0.

Entering variable: coefficient of this nonbasic variable ≥ 0 for min, ≤ 0 for max