

# Linear Programming

# Definitions

**Variables** -- the goal is to find values for these

**Objective Function** -- a linear equation over the variables which will be maximized or minimized

**Constraints** -- linear inequalities that define what values of the variables are valid

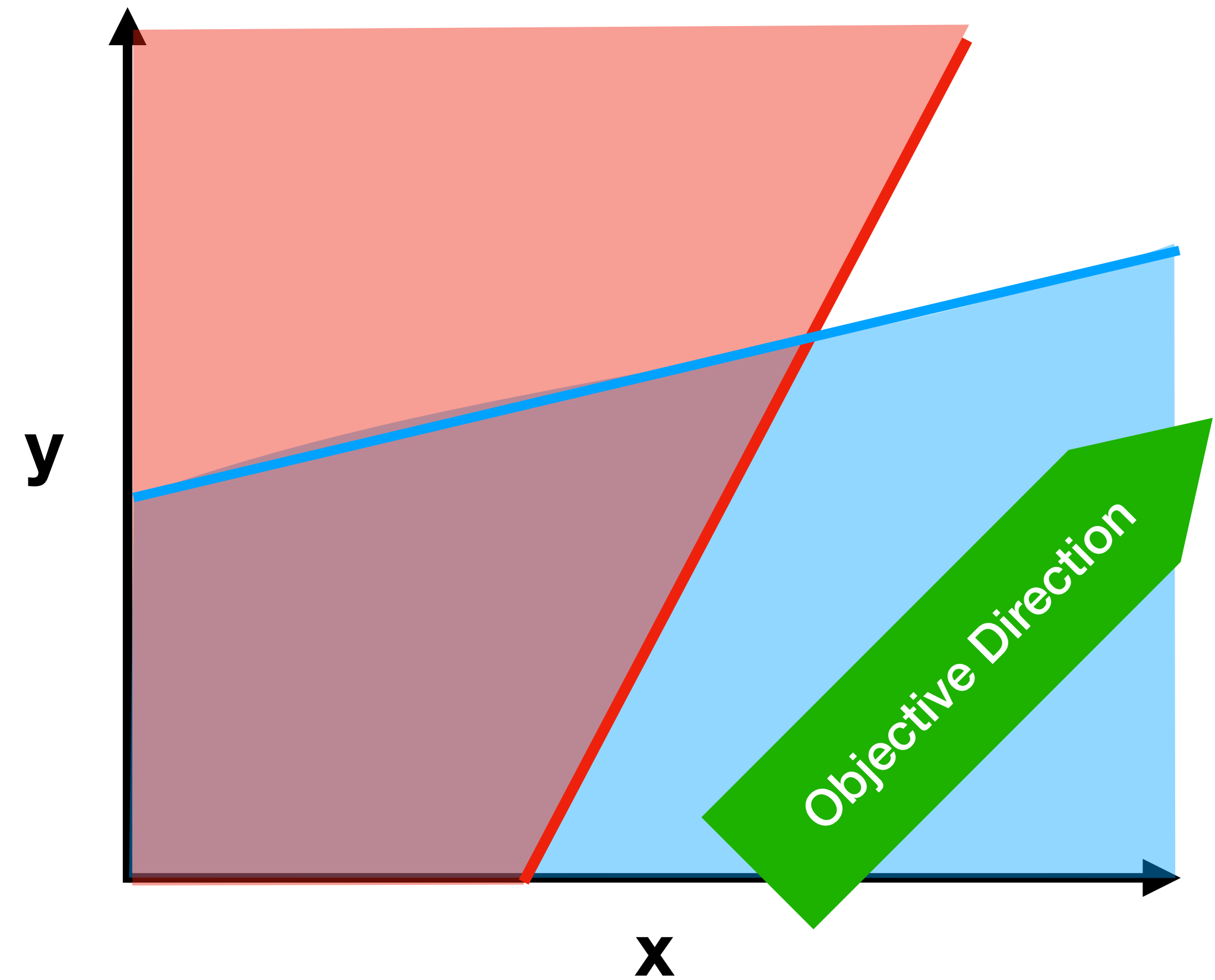
# Example

maximize  $x+y$

subject to:

$$y - 3x > -4$$

$$3y - x < 6$$



# Example

maximize  $x+y$

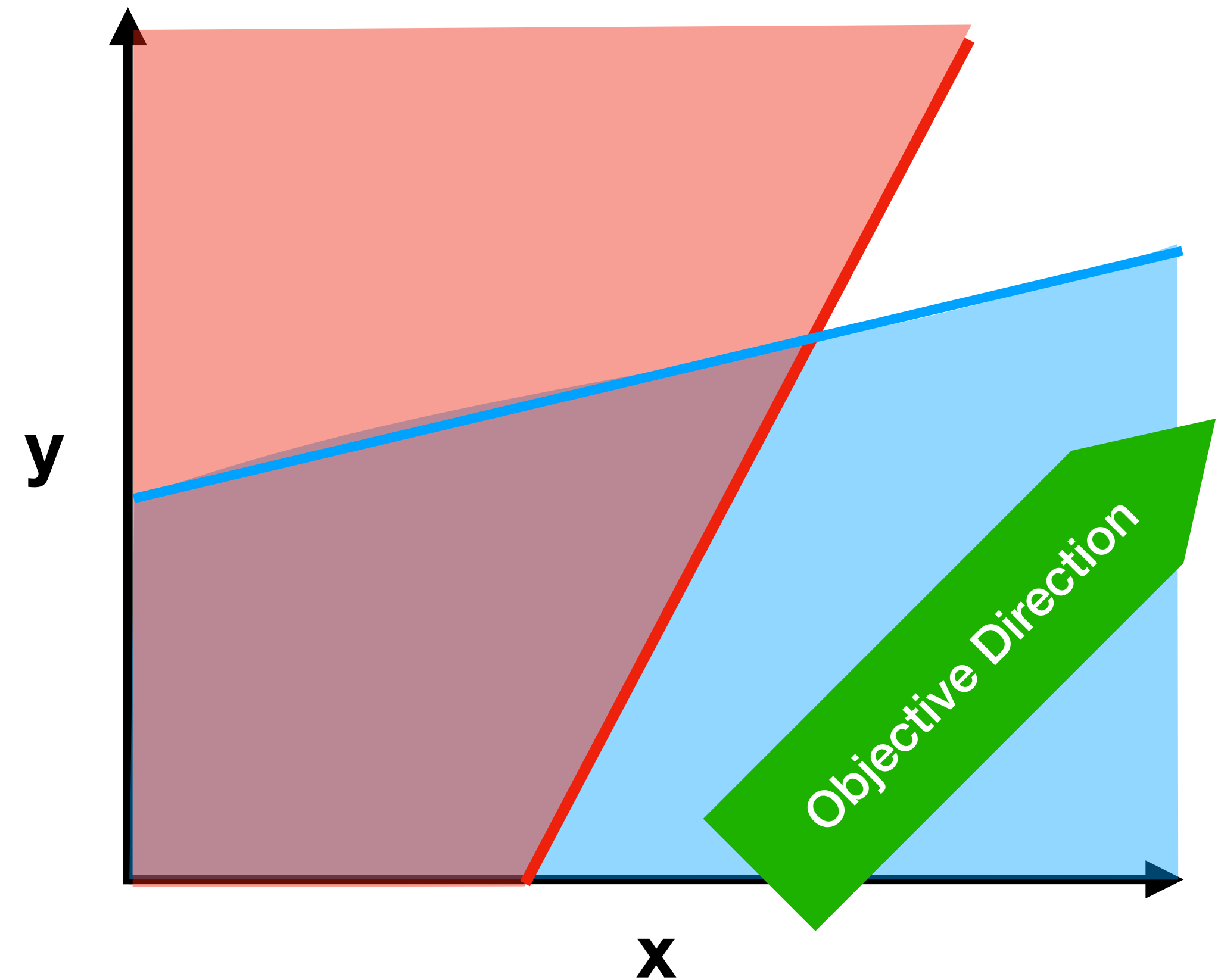
subject to:

$$y - 3x > -4$$

$$3y - x < 6$$

$$x = 9/4 = 2.25$$

$$y = 11/4 = 2.75$$



# Example

maximize  $x+y$

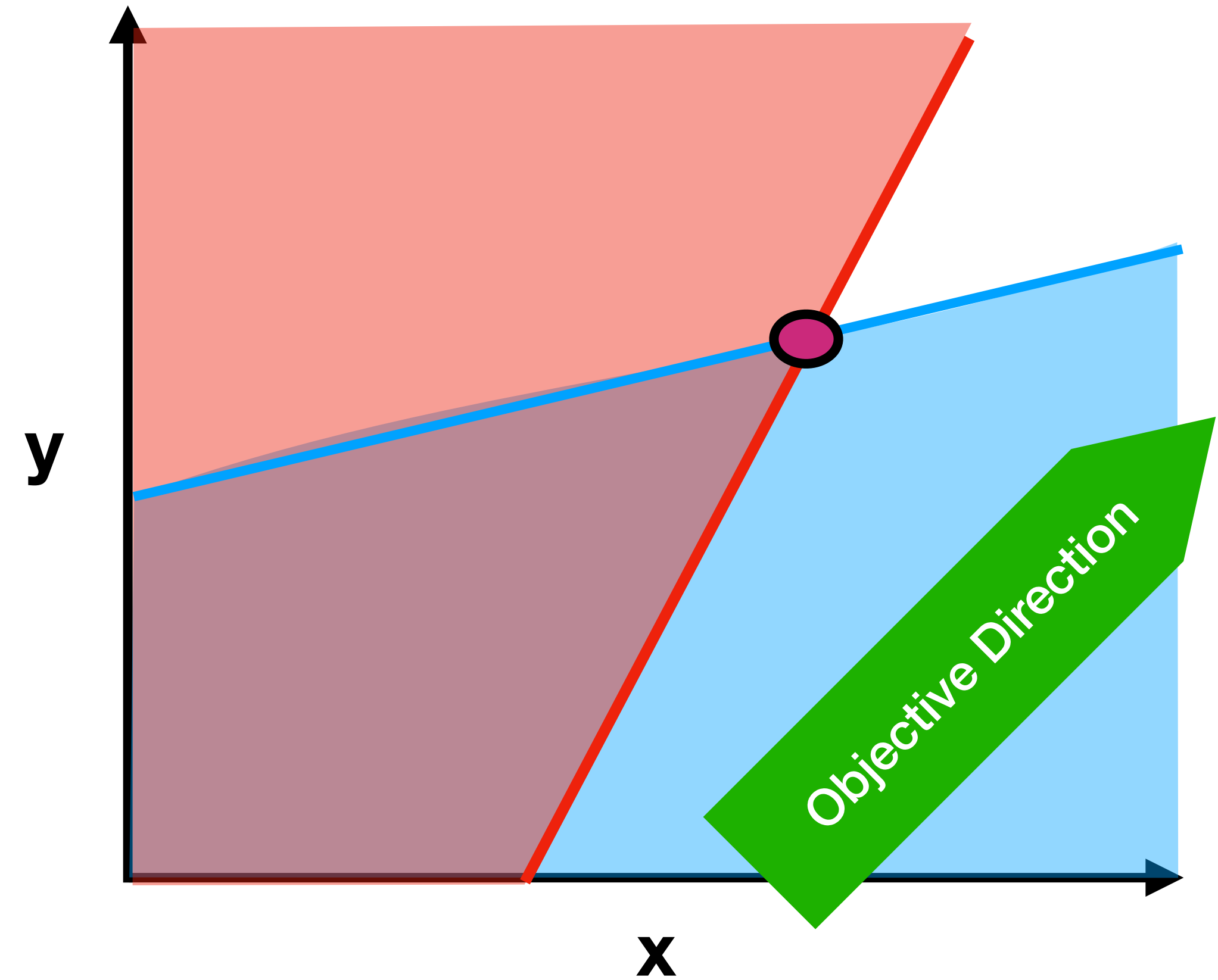
subject to:

$$y - 3x > -4$$

$$3y - x < 6$$

$$x = 9/4 = 2.25$$

$$y = 11/4 = 2.75$$



# Integers

Same idea, but the variables have to be integer values.

maximize  $x+y$

subject to:

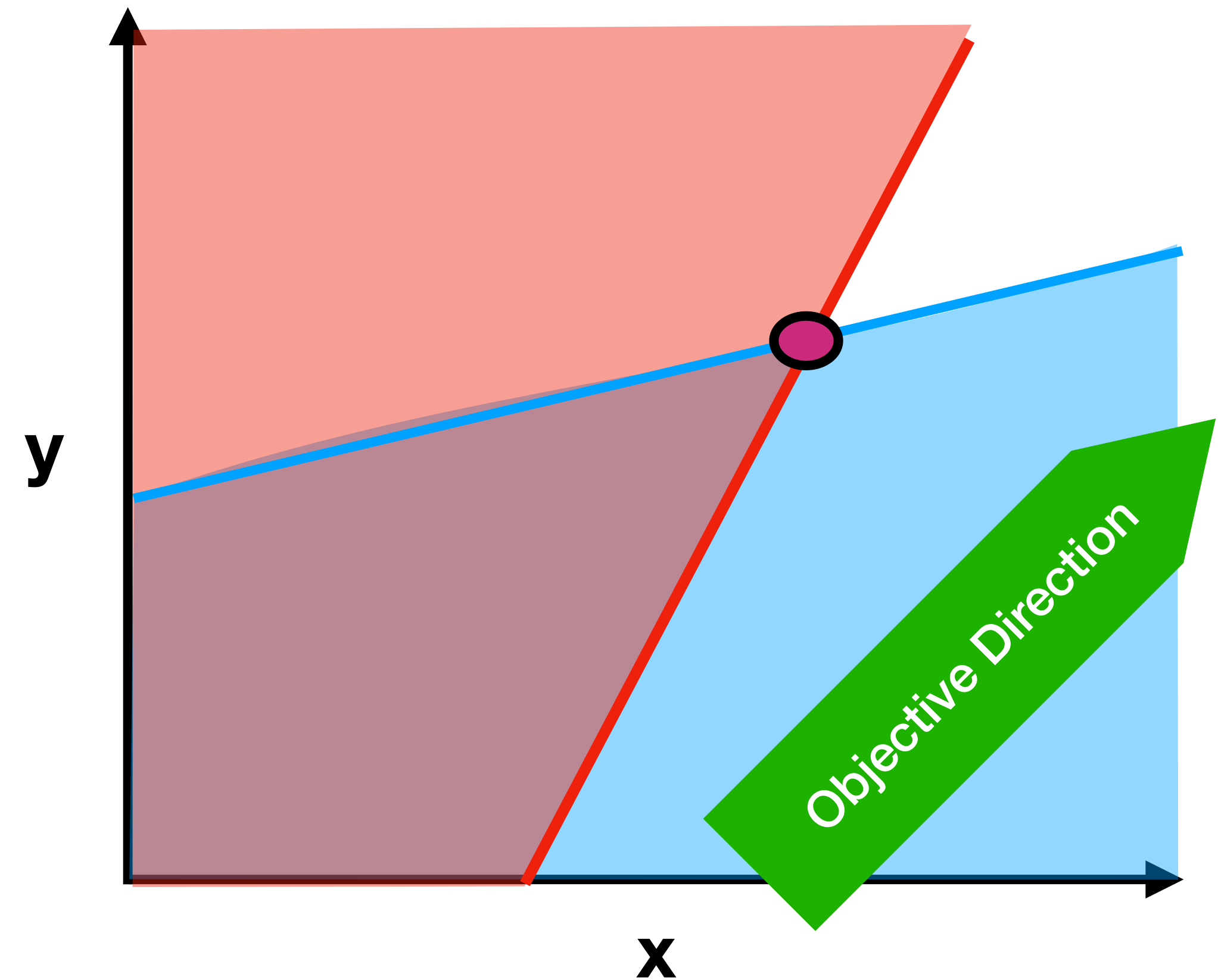
$$y - 3x > -4$$

$$3y - x < 6$$

$$x, y \in \mathbb{Z}$$

$$x = 9/4 = 2.25$$

$$y = 11/4 = 2.75$$



# Integers

Same idea, but the variables have to be integer values.

maximize  $x+y$   
subject to:

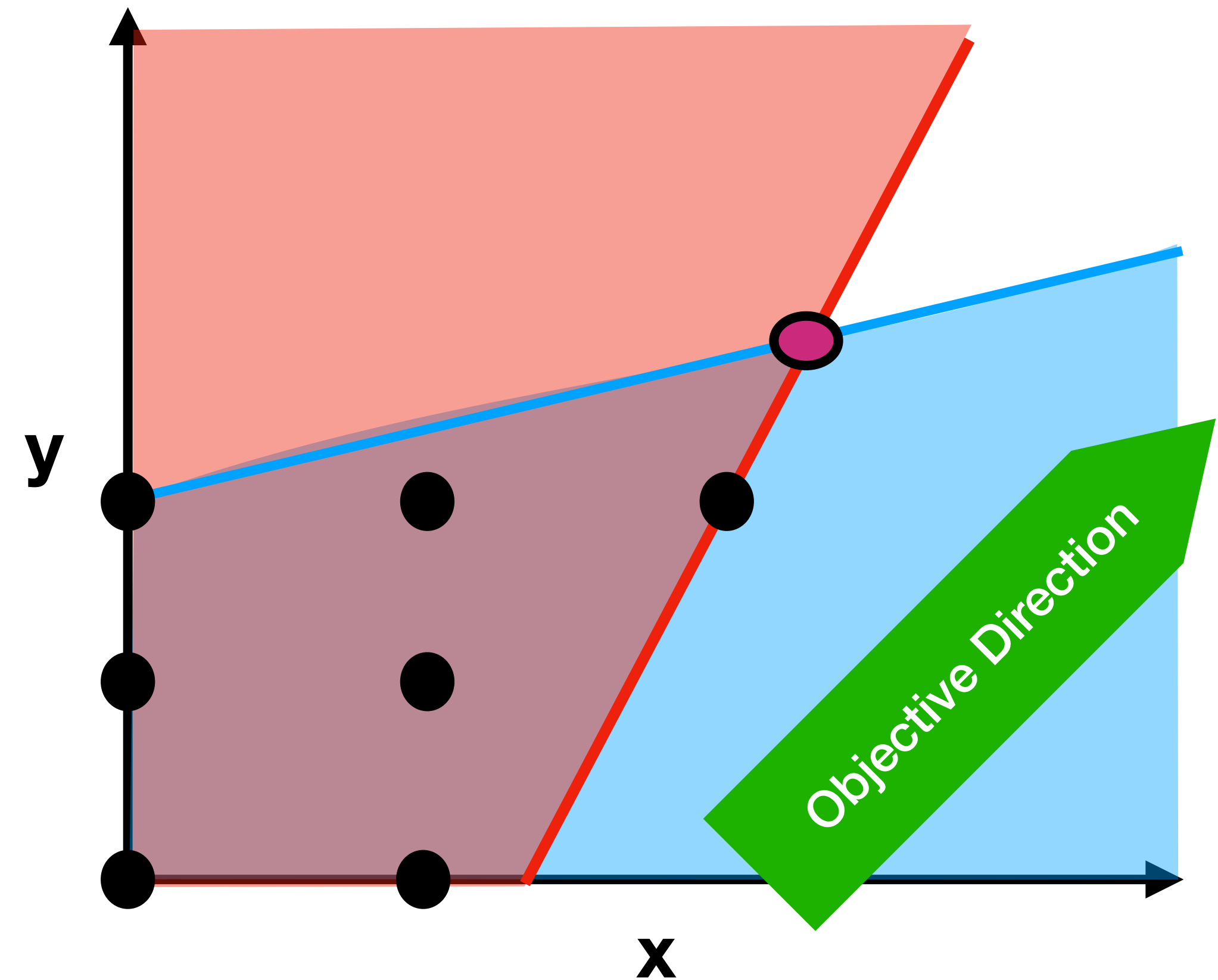
$$y - 3x > -4$$

$$3y - x < 6$$

$$x, y \in \mathbb{Z}$$

$$x = 9/4 = 2.25$$

$$y = 11/4 = 2.75$$



# Integers

Same idea, but the variables have to be integer values.

maximize  $x+y$

subject to:

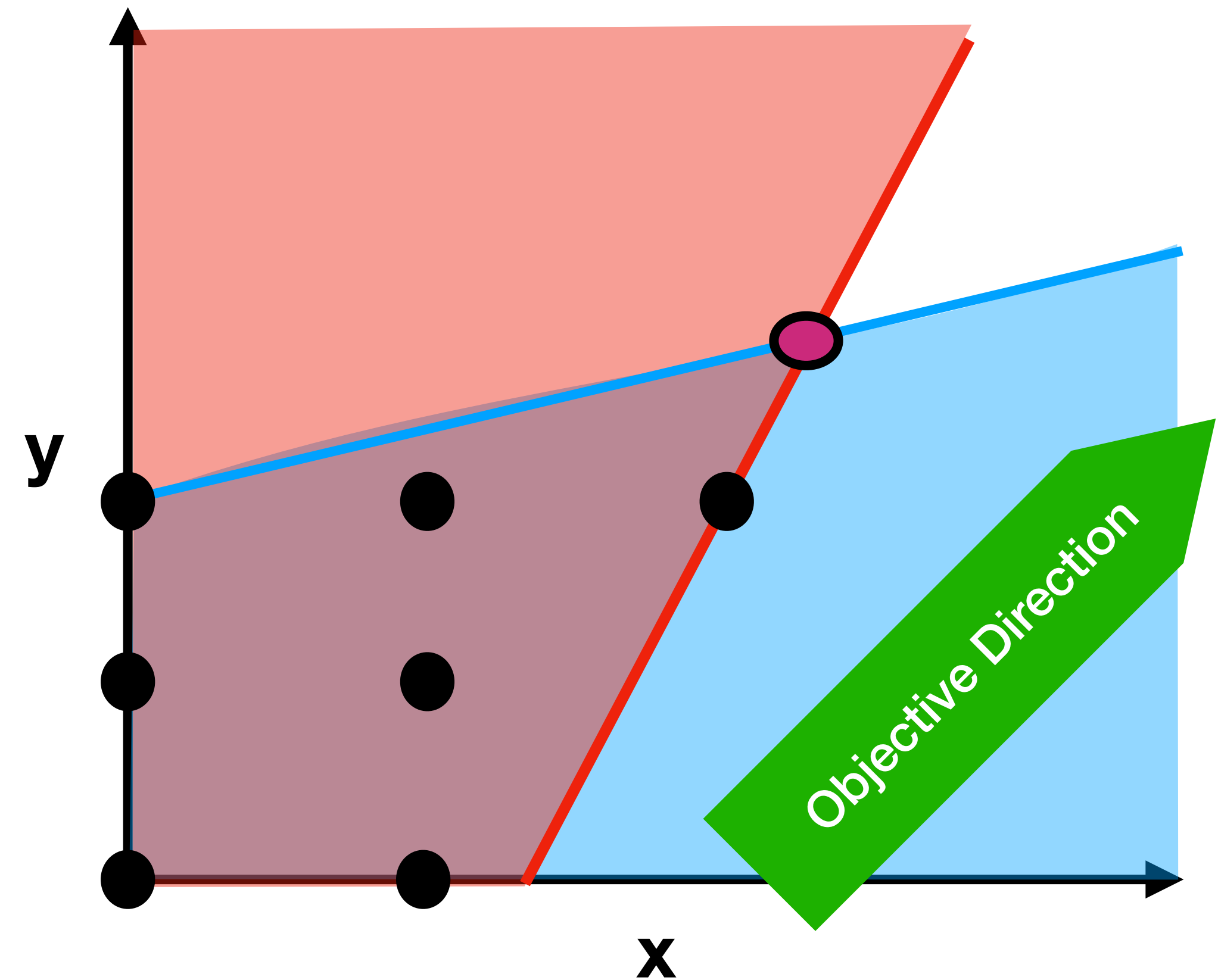
$$y - 3x > -4$$

$$3y - x < 6$$

$$x, y \in \mathbb{Z}$$

$$x=9/4 = 2.25$$

$$y=11/4 = 2.75$$





# Solving (Integer) Linear Programs

TL;DR there are programs available to do this efficiently the details aren't important.

Solving an LP is actually polynomial time solvable

- ILPs is NP-Hard

Major solvers will solve both problems

- CPLEX (by IBM, closed source)
- GUROBI (closed source)
- COIN-OR (open source)

# Where is LP used?

- Transcript Assembly
- Parameter Advising (don't know why I think this is important)
- Phylogeny
- Computational Auctions
- Business Workflow Optimization
- ....