1. Consider the following functions.

$$f(x,y) = x, \qquad g(x,y) = y, \qquad h(x,y) = x^2 + y^2$$

   (a) Find the critical points of each of the functions f, g, h.

   (b) Do these functions have any local maximum, local minimum, or saddle points?

   (c) Do these functions have any global maximum or minimum points in their unrestricted domain?

   (d) Now consider each of the following constraints. Find the global maximum and global minimum values of f, g, h on each of these constrains, and specify the points at which these values are attained (if they exist). **Do these problems geometrically, without doing unnecessary calculations!** For example, the function f is maximized by the point in the constrain farthest to the right (why?).

      i. $\{(x,y) \in \mathbb{R}^2 | y = x^2\}$
      ii. $\{(x,y) \in \mathbb{R}^2 | x = y^2\}$
      iii. $\{(x, y \in RR^2 | y = 2x\}$
      iv. $\{(x, y \in RR^2 | x^2 + y^2 \leq 1\}$
      v. $\{(x, y \in RR^2 | x^2 + y^2 < 1\}$
      vi. $\{(x, y \in RR^2 | x^2 + y^2 = 1\}$
      vii. $\{(x, y \in RR^2 | (x-1)^2 + y^2 = 1$

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2. For each function, find the global maximum and minimum on the given domain.

   (a) $f(x,y) = 5x - 3y$ on $x^2 + y^2 = 1$

   (b) $f(x,y) = 4x^2 + 10y^2$ on $x^2 + y^2 \leq 4$.

   (c) $f(x,y) = x^2 + 4y^2 - 2x^2y + 4$ on $\{(x,y) \in \mathbb{R}^2 | -1 \leq x \leq 1, -1 \leq y \leq 1\}$.

   (d) $f(x,y) = x^4 - y^2(1 + x^2)$ on $x^2 + y^2 \leq 16$.