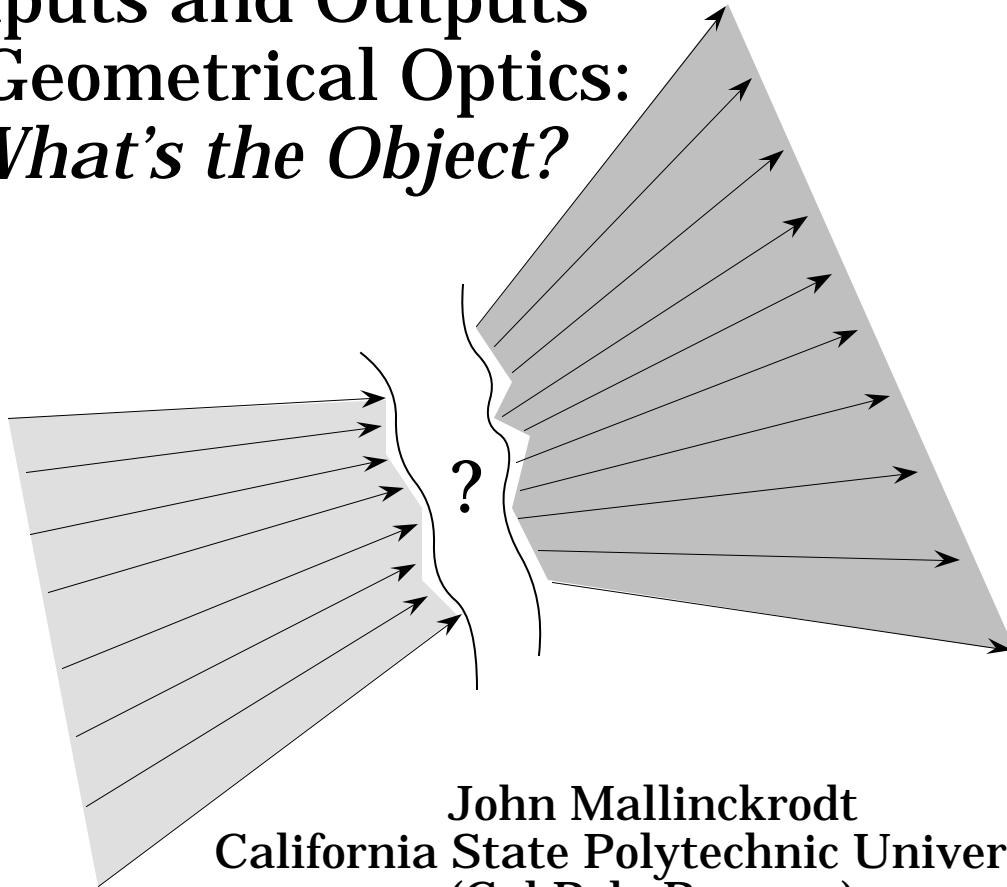
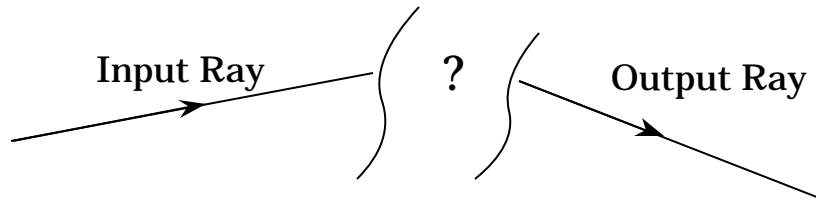


Inputs and Outputs in Geometrical Optics: *What's the Object?*

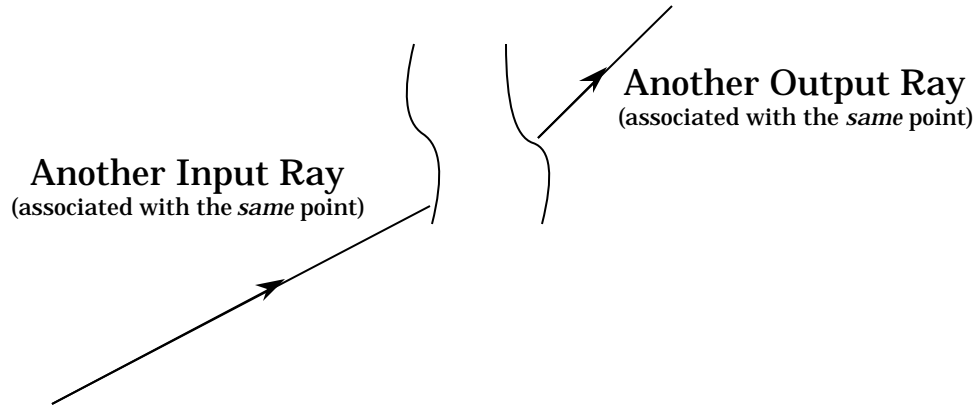


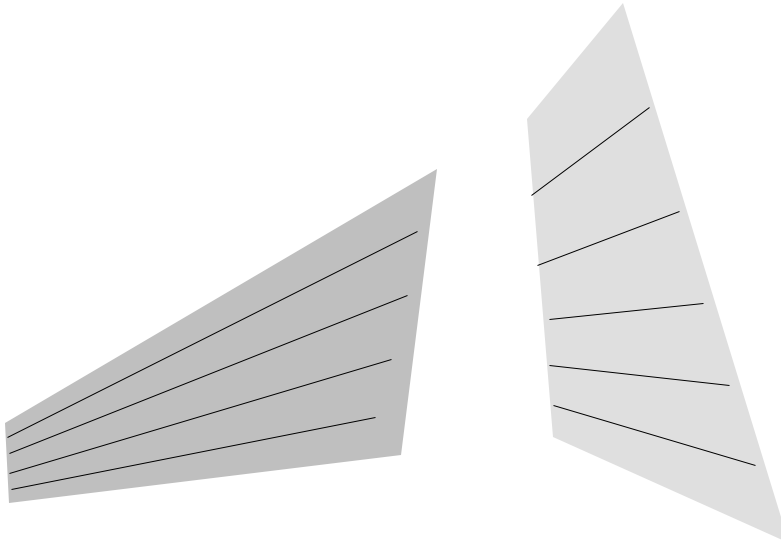
John Mallinckrodt
California State Polytechnic University
(Cal Poly Pomona)

What kind of Lens? What kind of Object? What kind of Image?

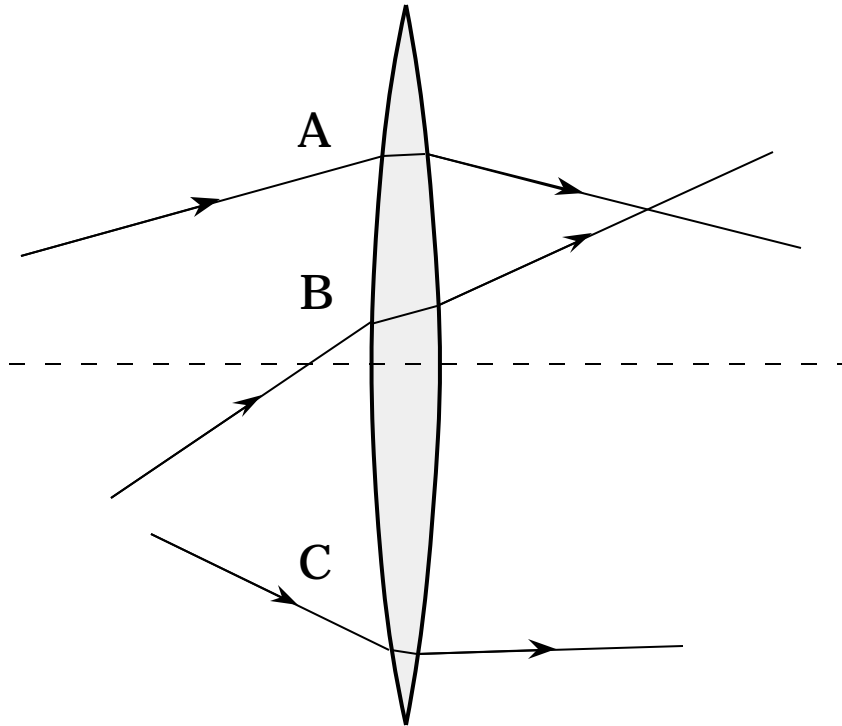


Optic Axis

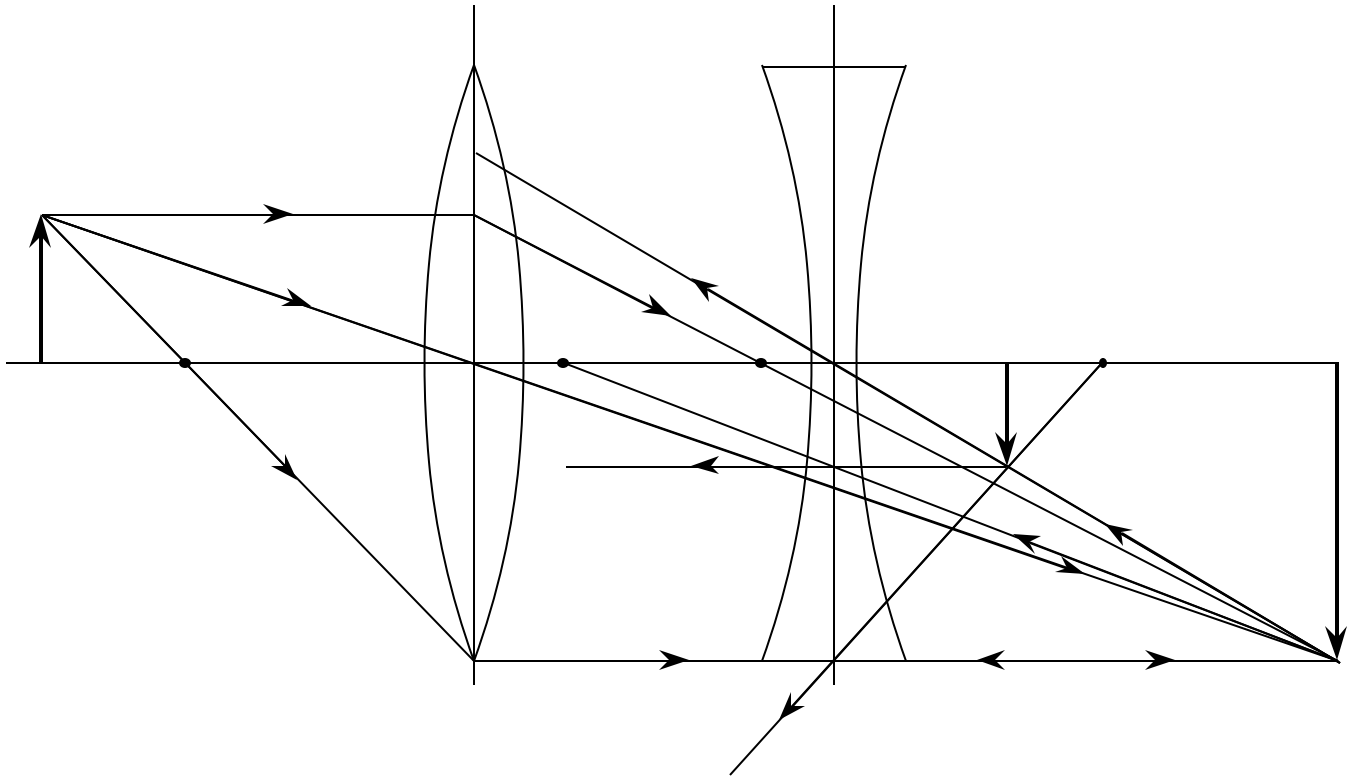




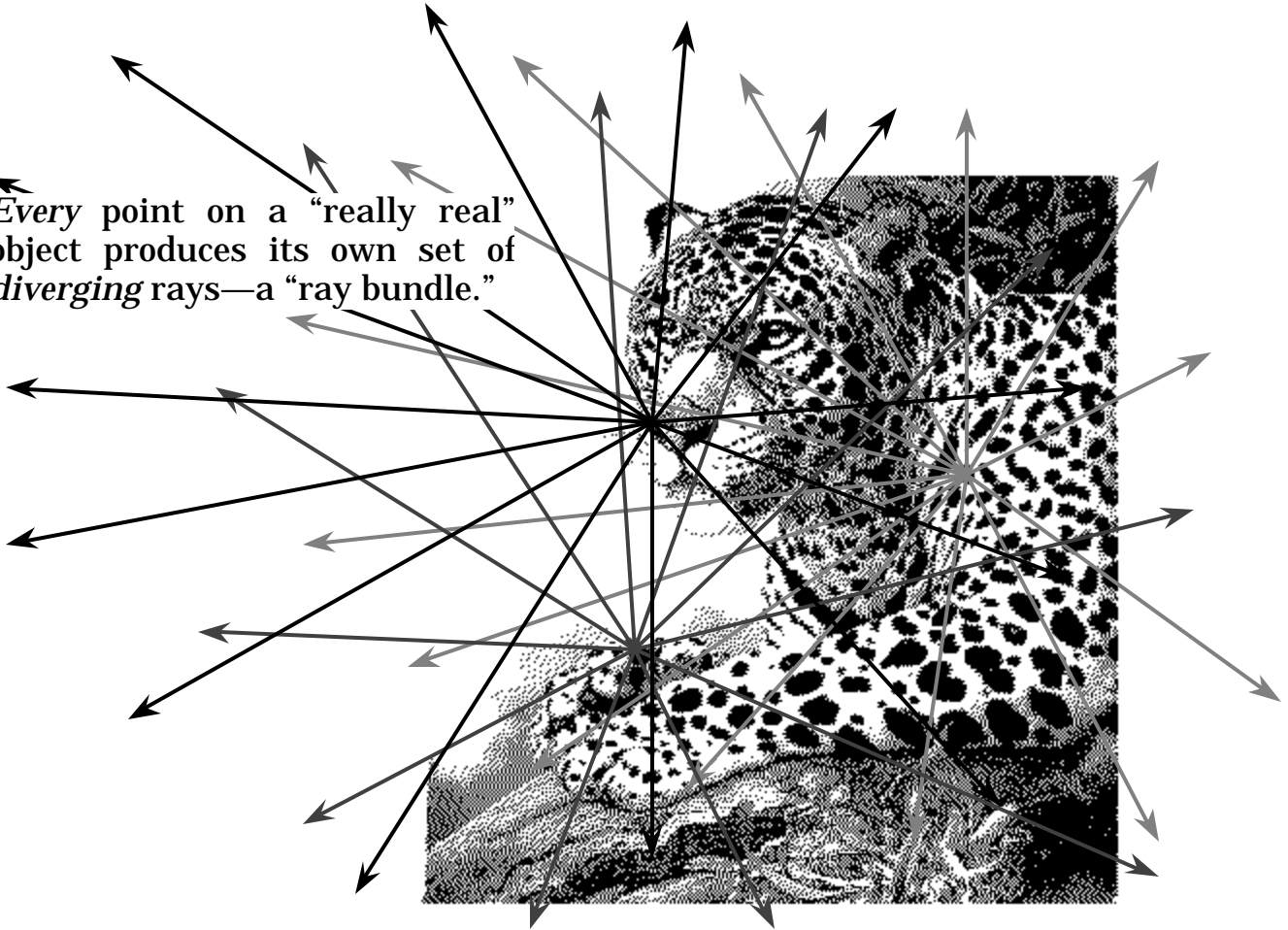
Three Rays?



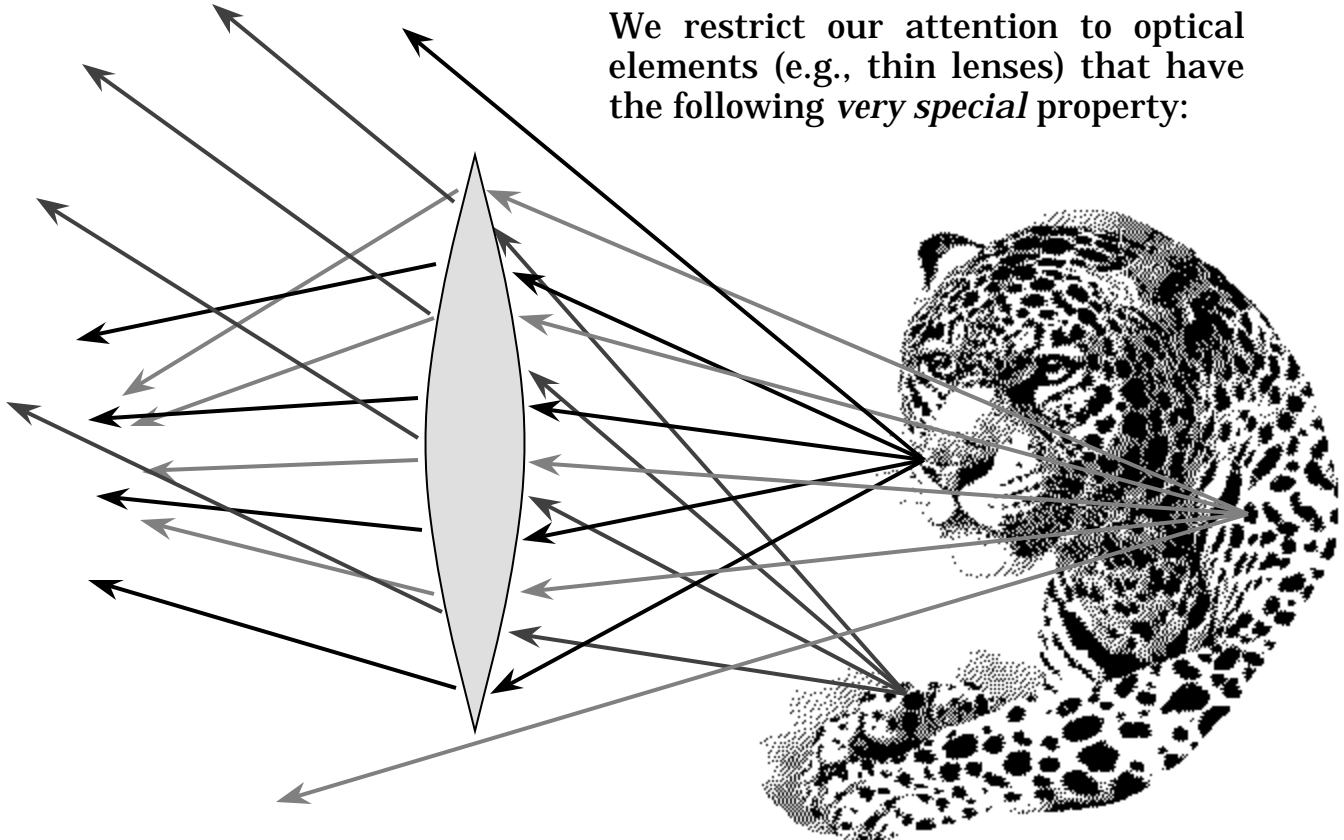
A typical student error in geometrical optics



*Every point on a “really real”
object produces its own set of
diverging rays—a “ray bundle.”*

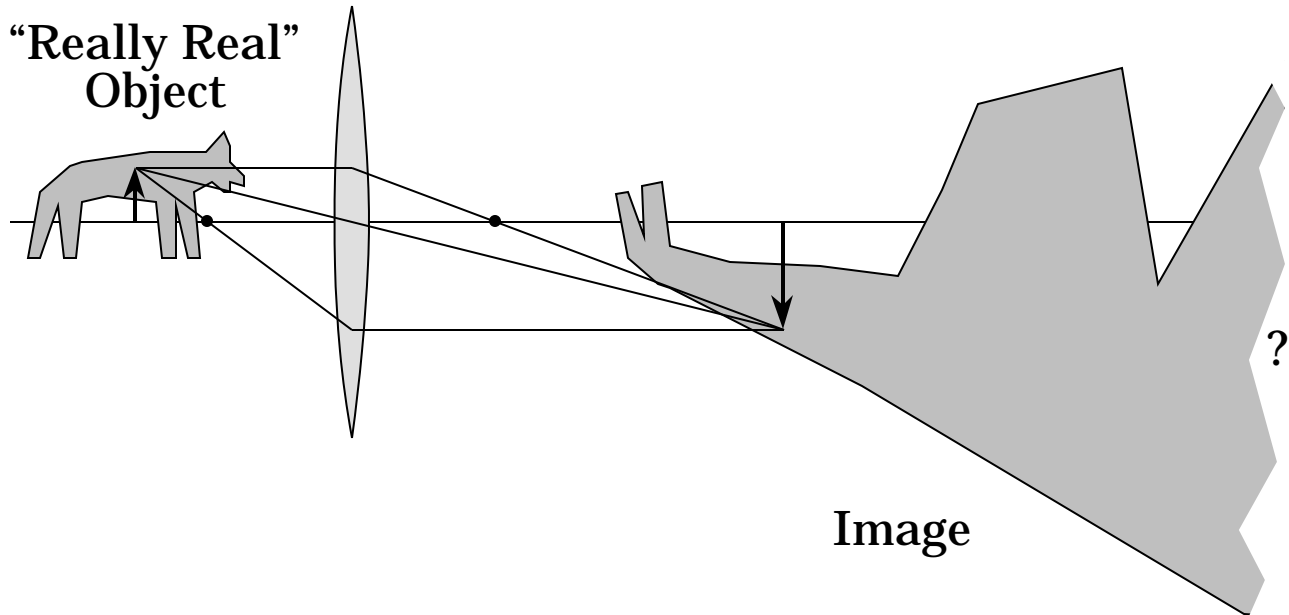


We restrict our attention to optical elements (e.g., thin lenses) that have the following *very special* property:

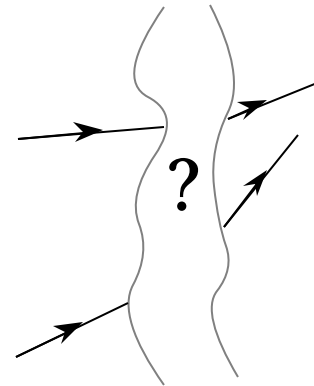
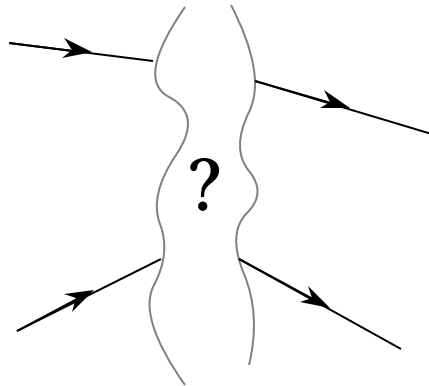
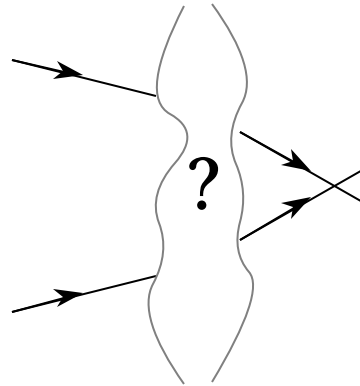
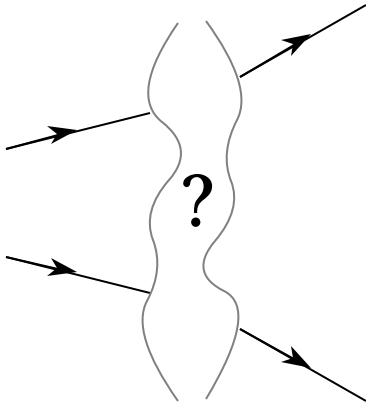


For *every* ray bundle, the element diverts *each* incident ray *in* the bundle in such a way that they *all* remain “associated with” (i.e., intersect at) a single point.

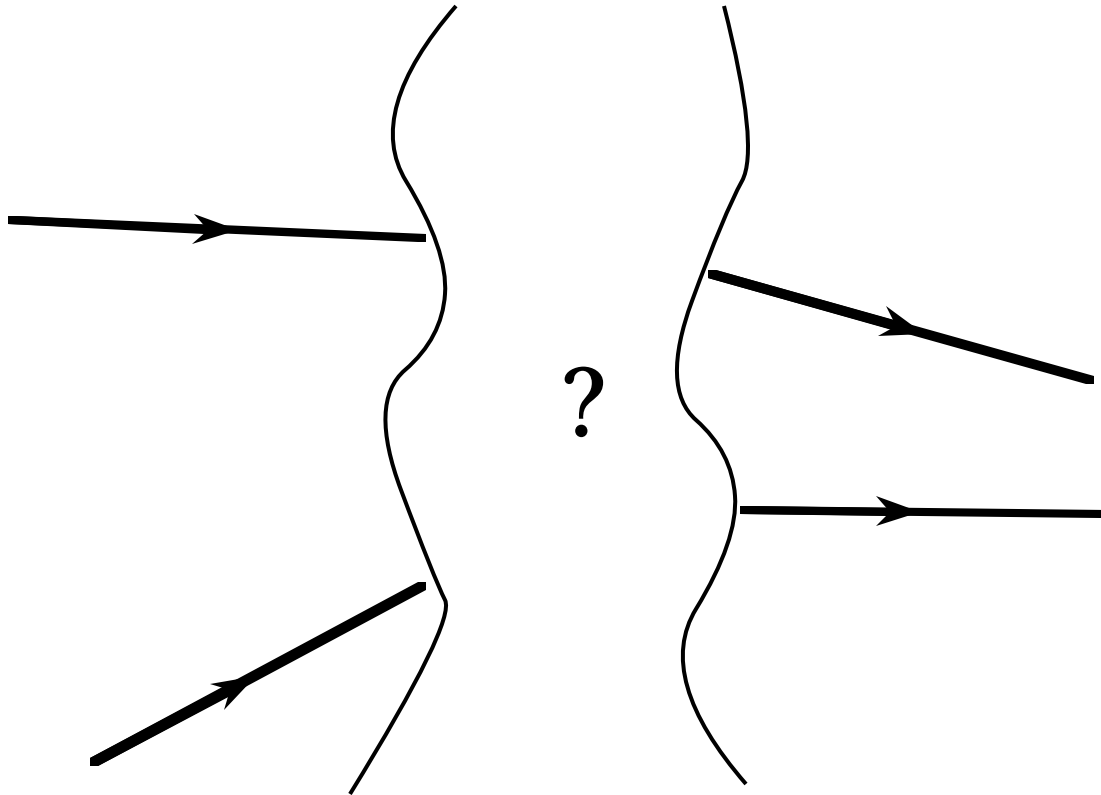
Are “things” *either* real or virtual?

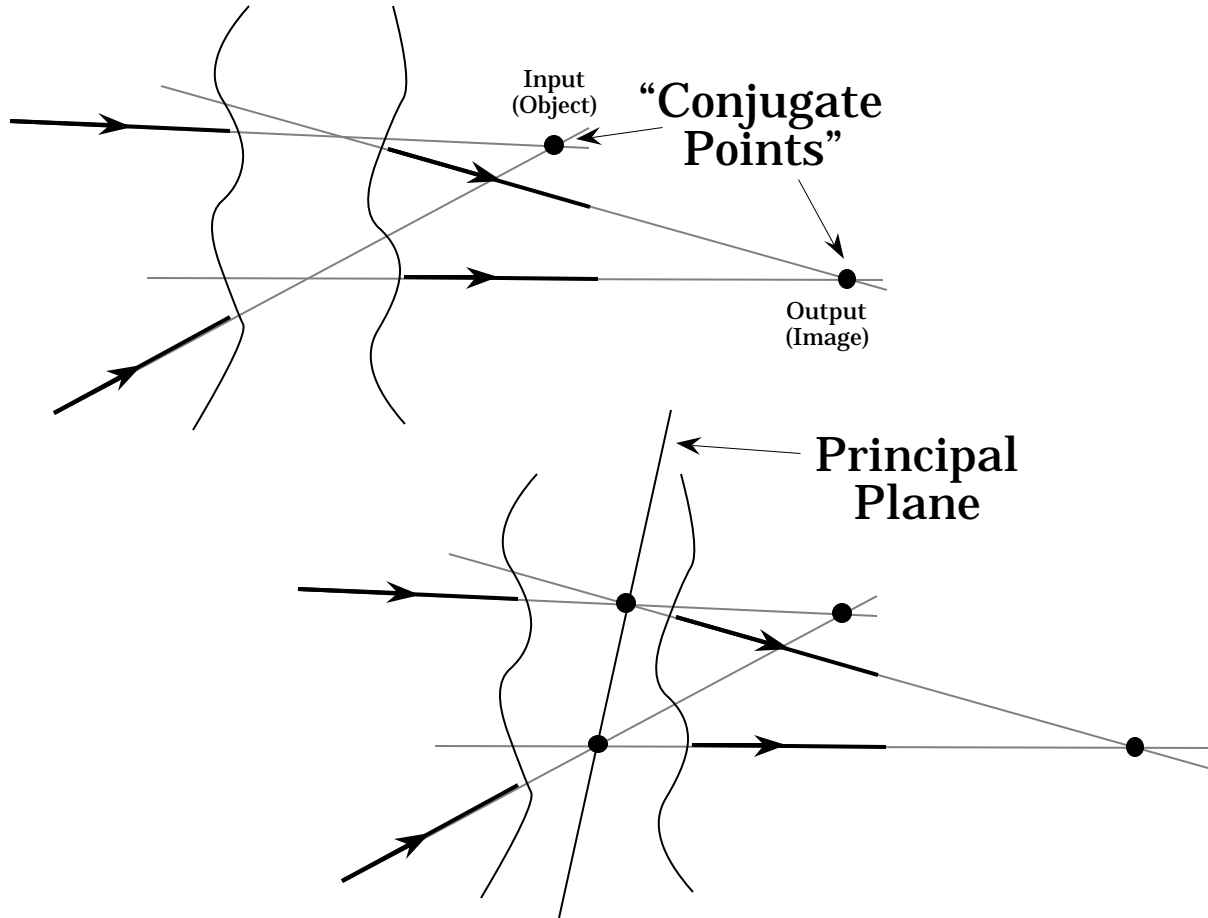


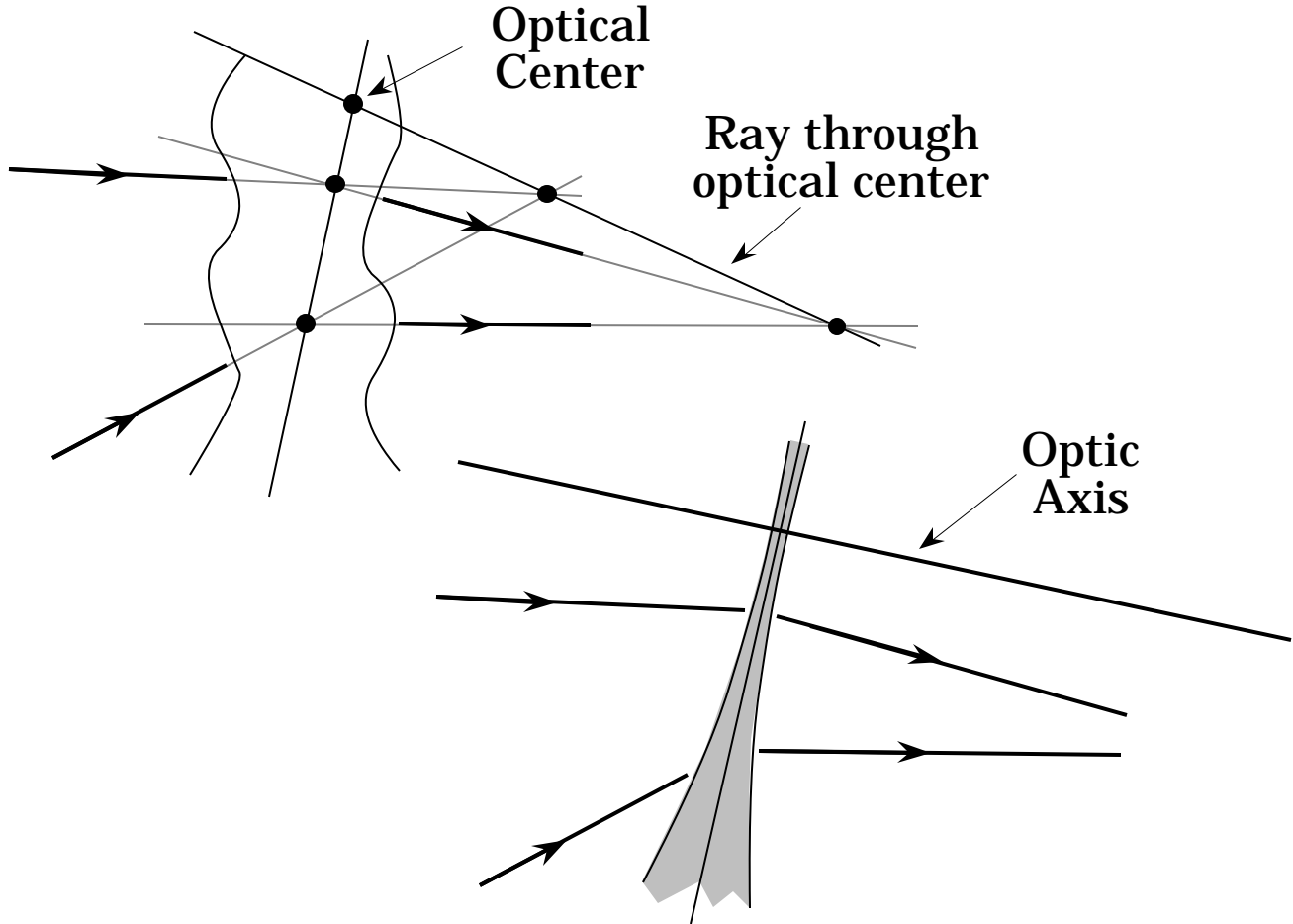
What kinds of Lenses, Objects, & Images?

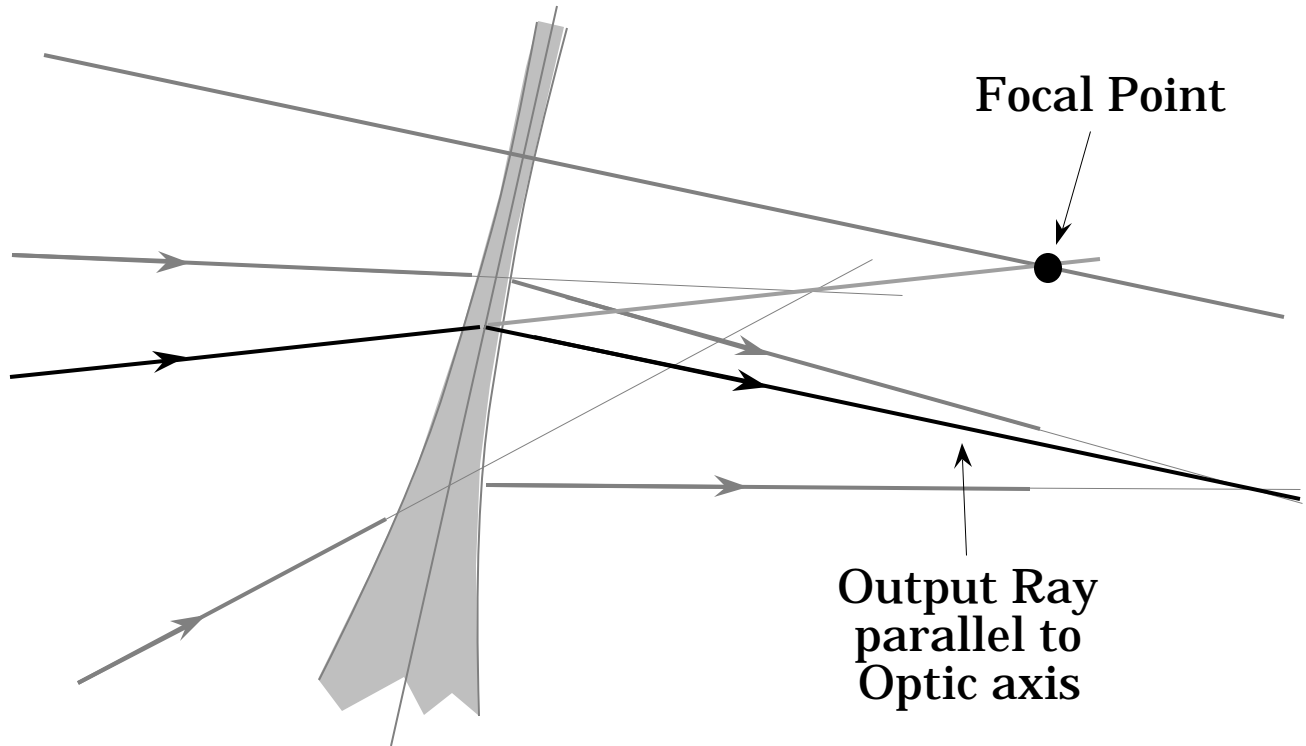


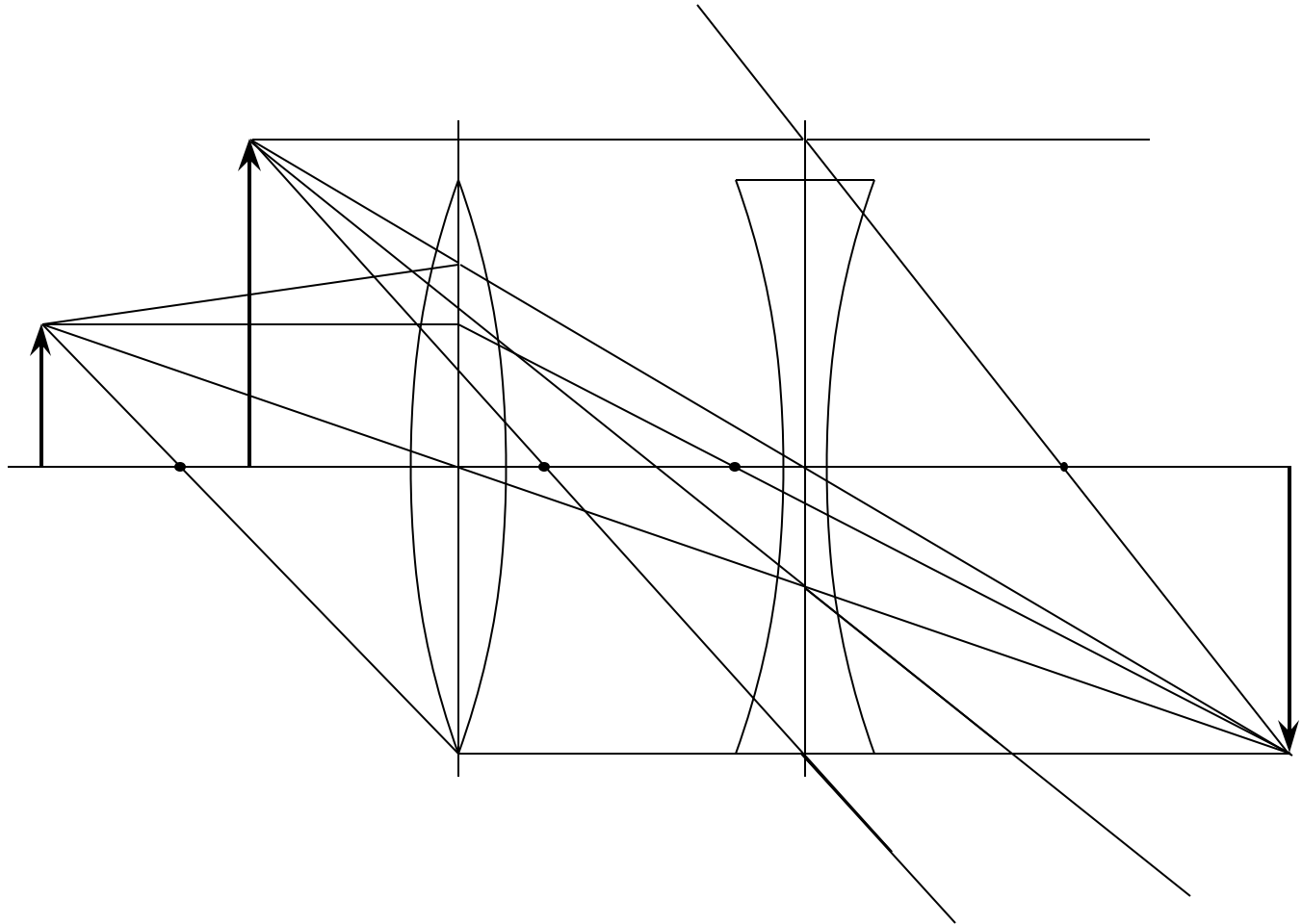
A more detailed look

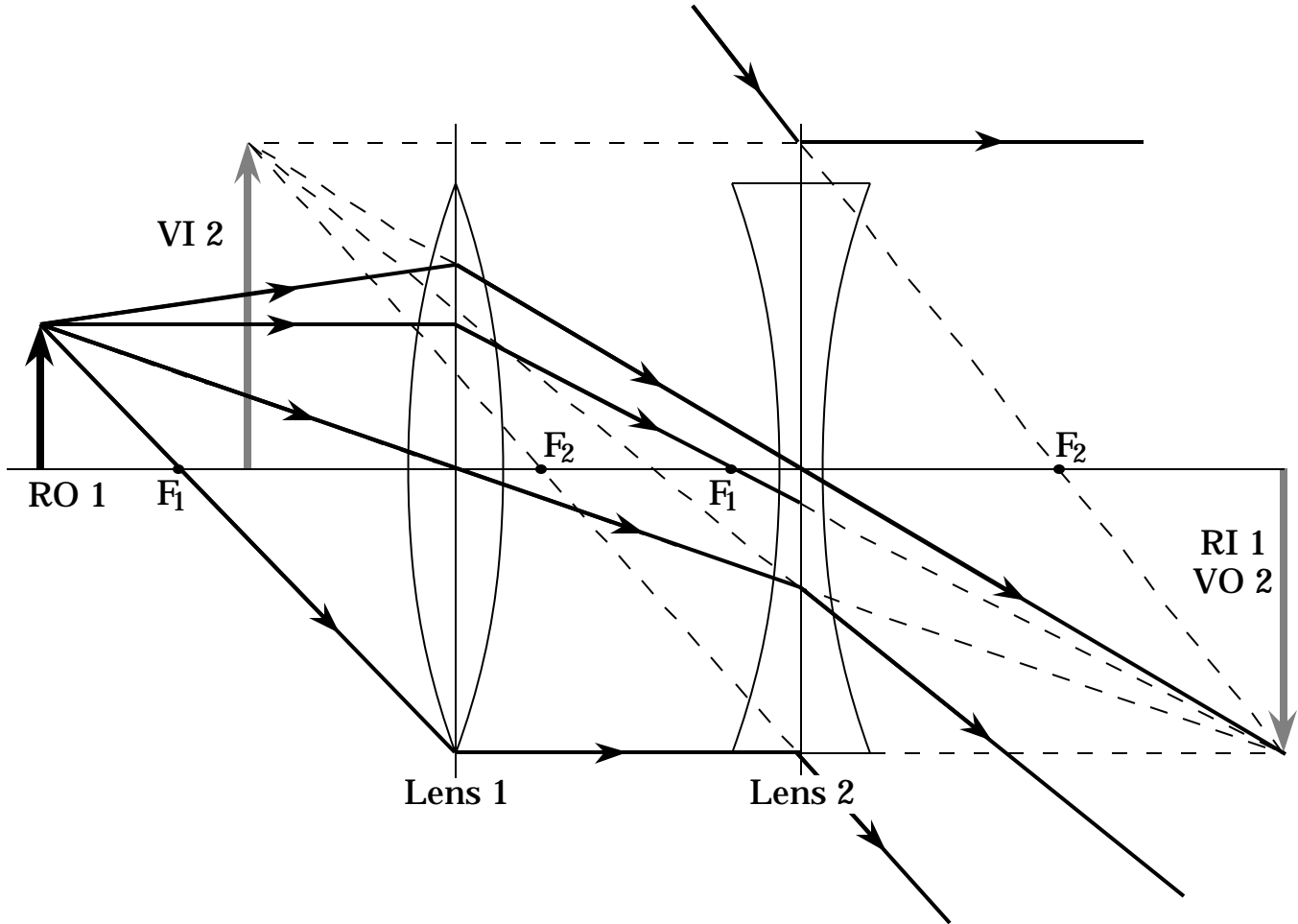








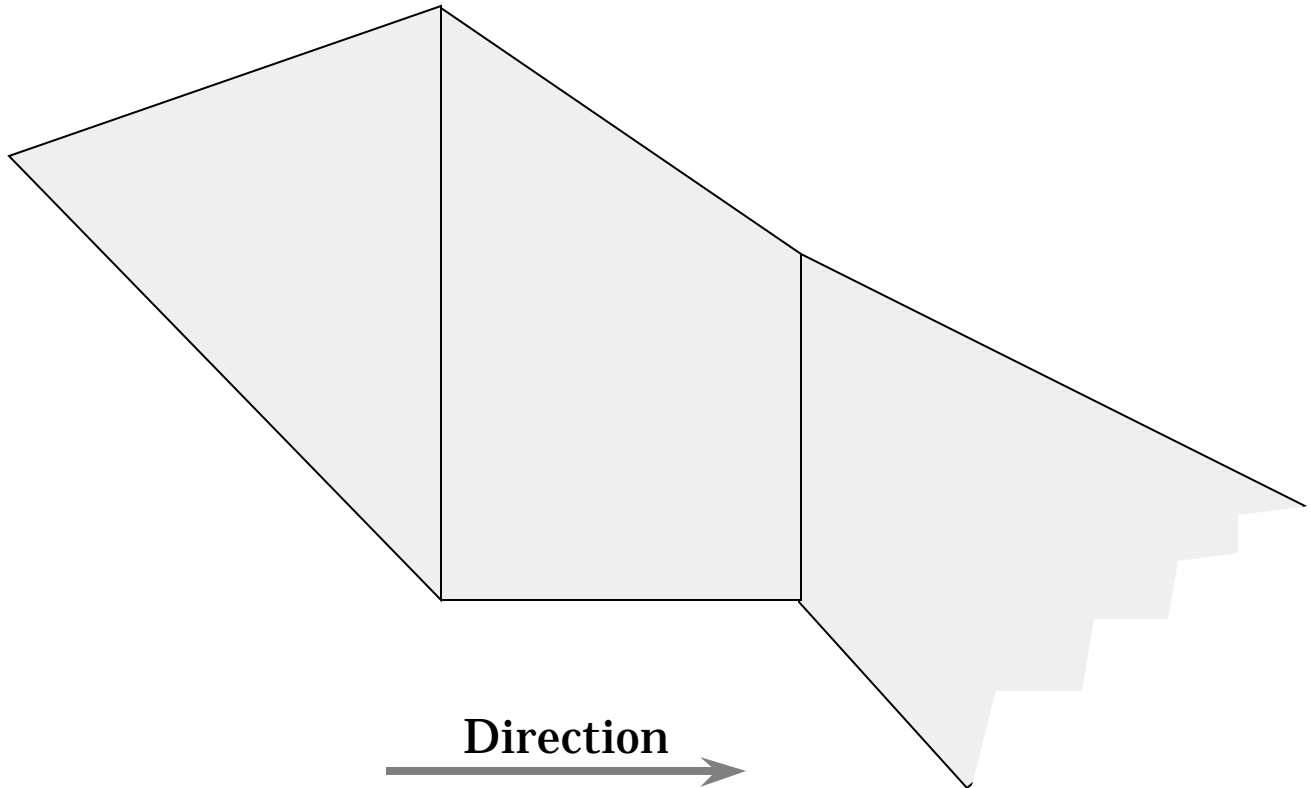




Diverging

Converging

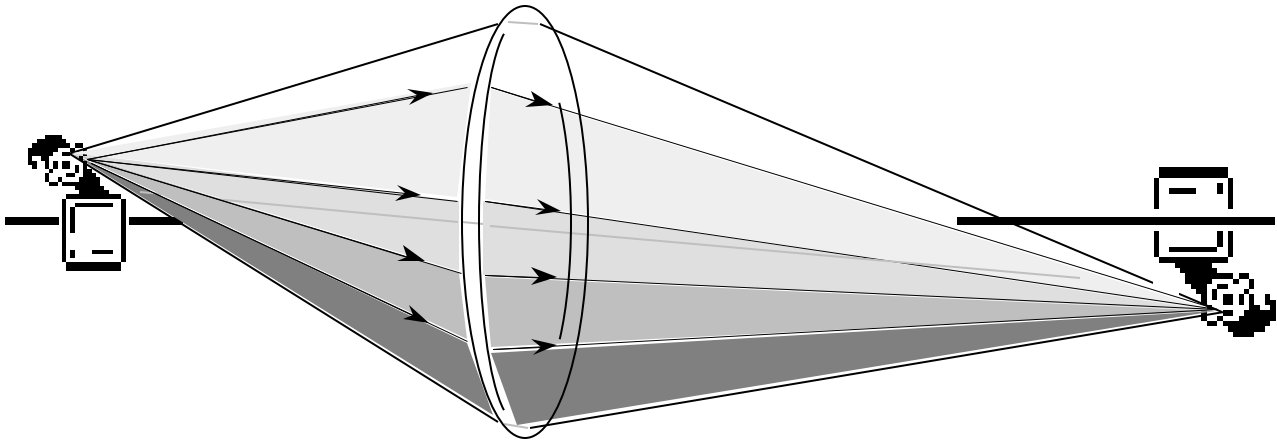
Diverging



Conclusion

A relatively subtle shift of attention toward the vergence properties of *input* and *output* ray bundles may help counter a number of common student difficulties, especially with multiple element systems, and make better connection with the physical mechanism of image formation.

The physical process of *real* image formation from *real* objects



All we *need* to know to determine the nature of the object and image (points)...

