We’re continuing to investigate azimuthal map projections centered on the north pole, which take lines of latitude to concentric circles and lines of longitude to radial lines.

The azimuthal equidistant projection is not obtained by shining a light; instead, the distance from the center of the map is proportional to the actual distance to the north pole, so there is no stretching of north-south miles. So the parallel at a latitude $\beta$ is mapped to a circle of what radius? How much is an east-west mile stretched? Plug in some numbers as always.

The defining property of the Lambert azimuthal projection is that it preserves areas. Suppose that the circle of latitude $\beta$ is mapped to a circle of radius $r(\beta)$. Write an equation involving $r(\beta)$ and $r'(\beta)$ that says that the east-west stretching times the north-south stretching equals 1. Can you find a function $r(\beta)$ that satisfies this equation? (It might be helpful to notice that $r(\beta)r'(\beta)$ is the derivative of $\frac{1}{2}r(\beta)^2$.)

If you have time to spare, analyze the orthographic projection, which just takes every point in the northern hemisphere straight up to a plane, as if we were taking a picture from space a million miles above the north pole.

If you have more time to spare, search online for conical map projections and analyze some of them.