Shortest Paths

1. **Single Source** - given \( v \), compute \( d(v,u) \) for all \( u \) vertices.
2. **All pairs** - for all \( u, v \), compute \( \omega d(v,u) \)
3. **Fixed Endpoint** - simplest algorithm!
   - given \( v, u \) find \( d(v,u) \)

**Single Source**

Suppose you want to run algorithm from \( u \) to every vertex.

\[
\text{BF}(u) = d(v,u)
\]

**Bellman-Ford Algorithm**

\[
\text{BF}(u) = \min \left\{ d(u), d(r) + \omega(r,u) \mid (r,u) \in E \right\}
\]

\[
\text{BF}(u) = d(u) \cap \min\left\{ d(r) + \omega(r,u) \right\}
\]

\[
d(u) = d(r_i) + 1
\]

\[
d(u) = \min \left\{ d(u), d(r_i) - 1 \right\}
\]

This improves the estimate!