What to do when negative weights are allowed on $G = (V, E)$?

If there is a negative weight cycle reachable from $s$, shortest path weights are not well defined.

**Bellman-Ford Algorithm**

- Solves SSSP when negative edge weights are allowed
- Indicates if there is a negative weight cycle from source $s$:
  - no solution
  - else, produces shortest paths
- Uses relaxation: decreases $d[v]$ for each $v \in V$, until $d[v] = \delta(s, v)$

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Bellman-Ford $(G, w, s)$

1. Initialize - Single-Source $(G, s)$
2. for $i = 1$ to $|V| - 1$ do
   1. for each edge $(u,v) \in E$ do
      1. Relax $(u,v,w)$
   2. for each edge $(u,v) \in E$ do
      1. if $d[v] > d[u] + w(u,v)$ then return FALSE
3. return TRUE

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Bellman-Ford time: $O(VE)$

- Correctness given by path relaxation property.
Order of edges:

$s, r, t, y, r, x, x, y, r, y, y, r, s$