

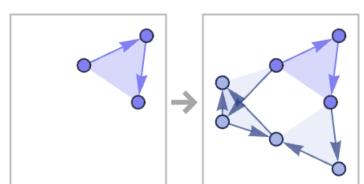
Hypergraph metamodel evolution rule

Evolution step 1

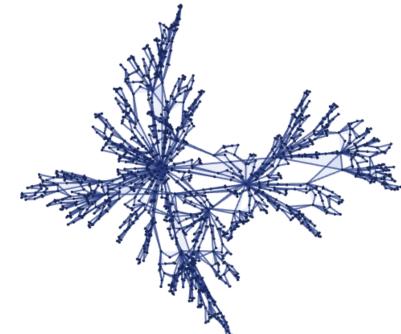
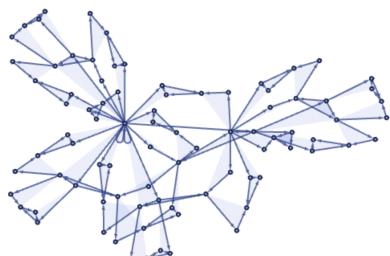
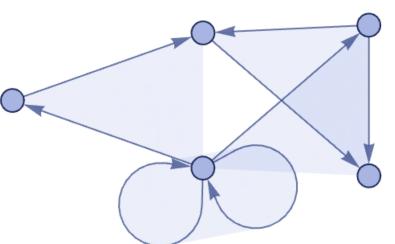
Evolution step 3

Evolution step 5

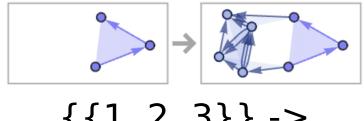
Resources input:
Fishing,
wind energy,
wave energy
harvesting and
collecting



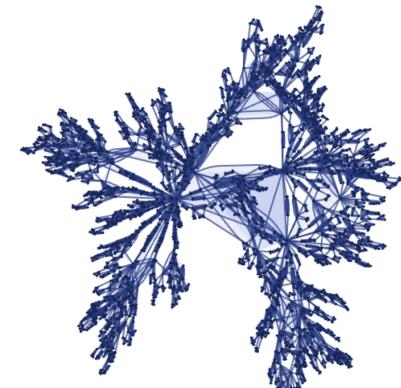
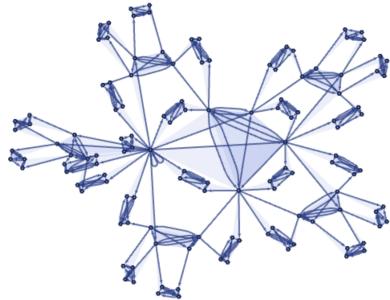
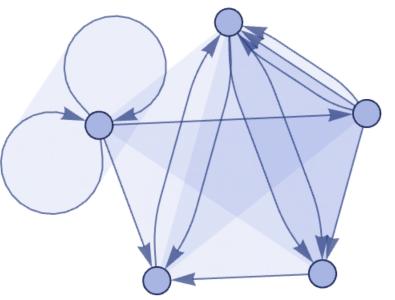
$\{\{1, 2, 3\}\} \rightarrow \{\{1, 2, 3\}, \{4, 5, 6\}, \{1, 4, 6\}, \{3, 7, 5\}\}$



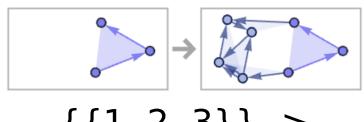
Appropriation and circulation:
Port operations,
shipbuilding,
freight shipping



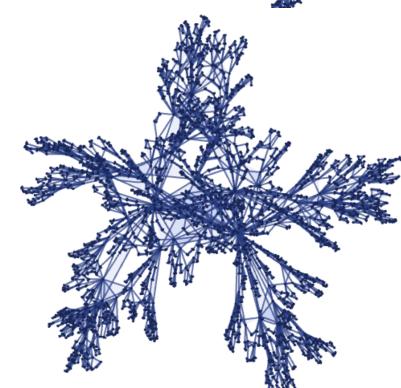
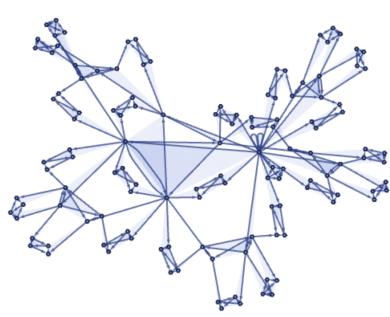
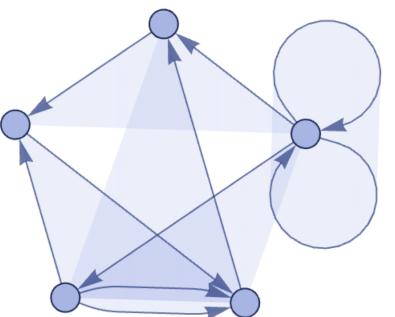
$\{\{1, 2, 3\}\} \rightarrow \{\{1, 2, 3\}, \{4, 5, 7\}, \{4, 5, 6\}, \{4, 5, 6, 7\}, \{1, 4, 6\}, \{3, 7, 5\}\}$



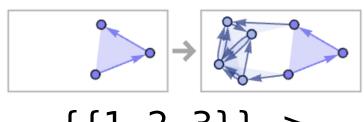
Transformation and conservation:
Marine protected areas, coastal infrastructure, aquaculture, desalination



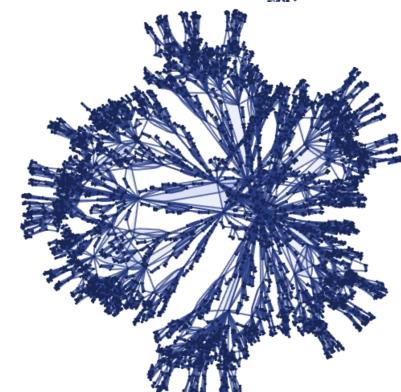
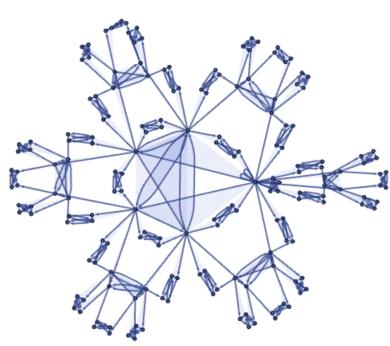
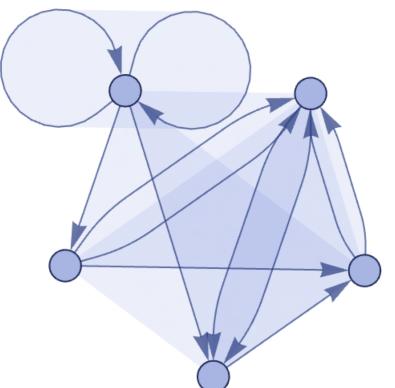
$\{\{1, 2, 3\}\} \rightarrow \{\{1, 2, 3\}, \{4, 6, 7\}, \{4, 5, 6\}, \{1, 4, 6\}, \{3, 7, 5\}\}, \{\{0, 0, 0\}\}$



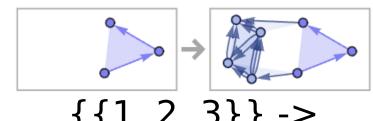
Consumption and excretion:
Ship emissions, hydrocarbon extraction, land reclamation



$\{\{1, 2, 3\}\} \rightarrow \{\{1, 2, 3\}, \{5, 6, 7\}, \{4, 5, 6\}, \{4, 6, 7\}, \{1, 4, 6\}, \{3, 7, 5\}\}$



Wastes output:
Carbon sequestration, land-based effluent, wastewater treatment



$\{\{1, 2, 3\}\} \rightarrow \{\{1, 2, 3\}, \{4, 6, 7\}, \{4, 5, 7\}, \{4, 5, 6\}, \{4, 5, 6, 7\}, \{1, 4, 6\}, \{3, 7, 5\}\}$
 $\{4, 5, 6, 7\}, \{1, 4, 6\}, \{3, 7, 5\}$

