

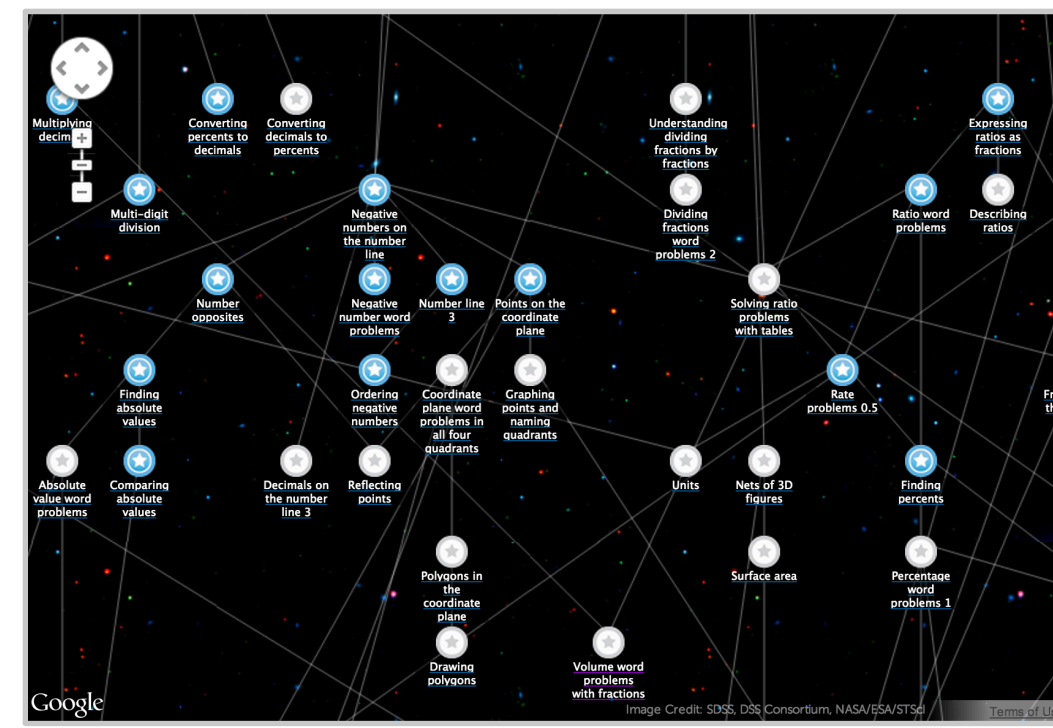
# Creating, Visualizing, and Exploring Knowledge Maps



Colorado Reed  
UC Berkeley – CS294-10 Visualization – Fall 2013

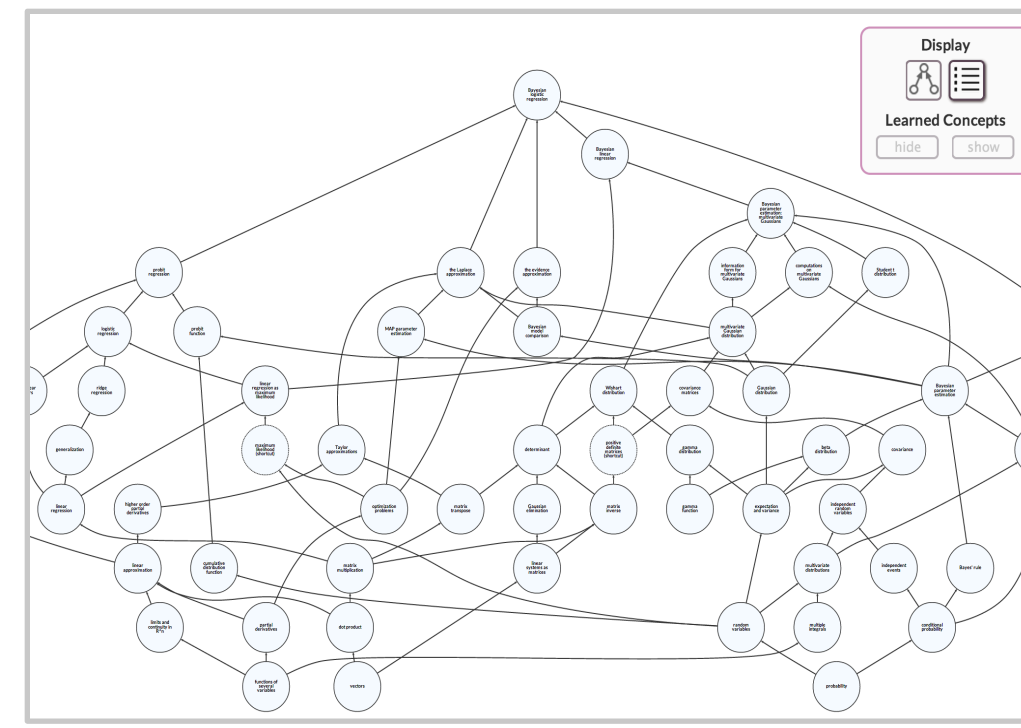


## Knowledge Maps



This is a section of a Khan Academy knowledge map for math concepts.

- nodes represent concepts
- edges specify prerequisite relationships
- associated content with each node/edge



This is a Metacademy knowledge map for "Bayesian logistic regression."

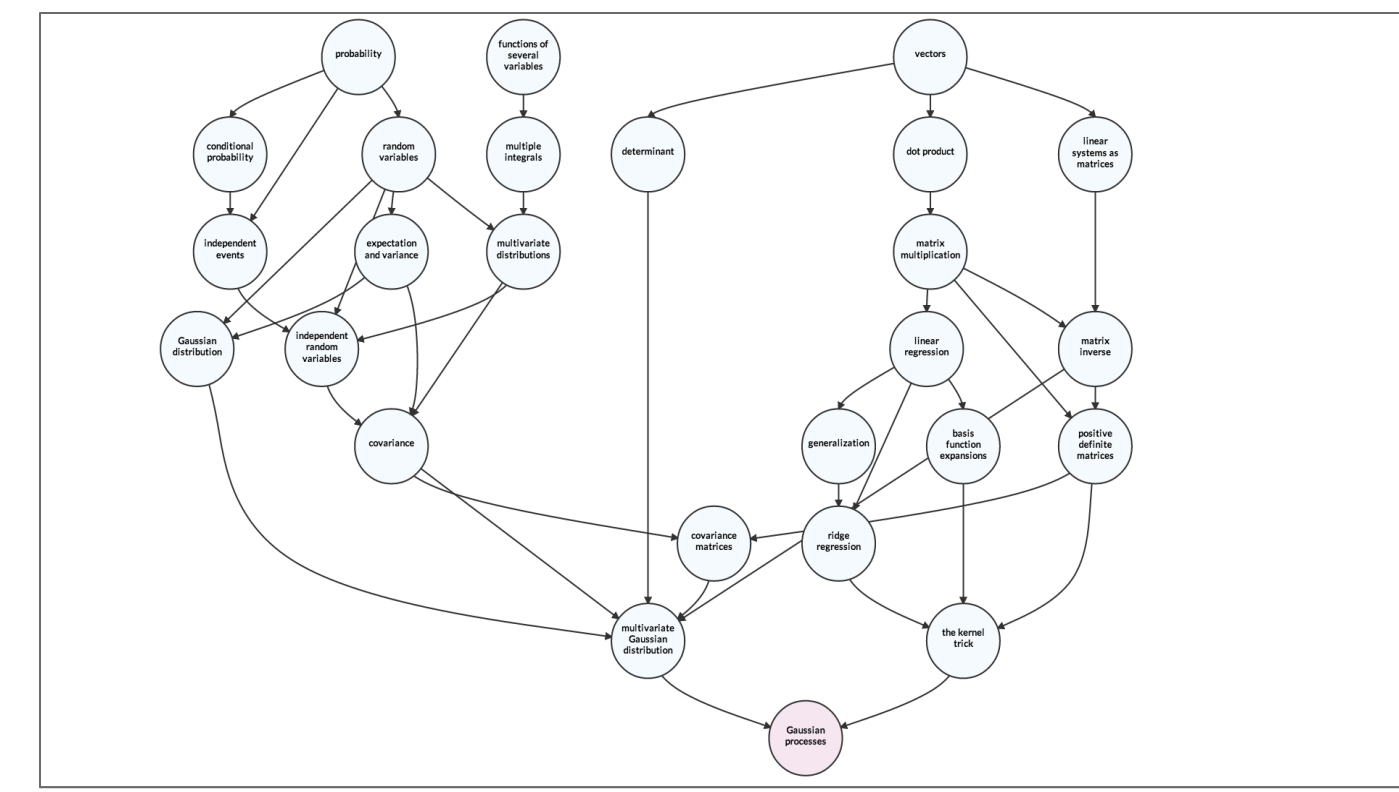
- large number of nodes and edges
- difficult to visualize relationships
- difficult to follow paths

“ [The knowledge map] became a core piece of the Khan Academy software platform. In stressing the connections among subjects and giving learners a visual picture of where they've been and where they're going, we hope to encourage students to follow their own path – to move actively up, down, and sideways, wherever their imaginations lead.

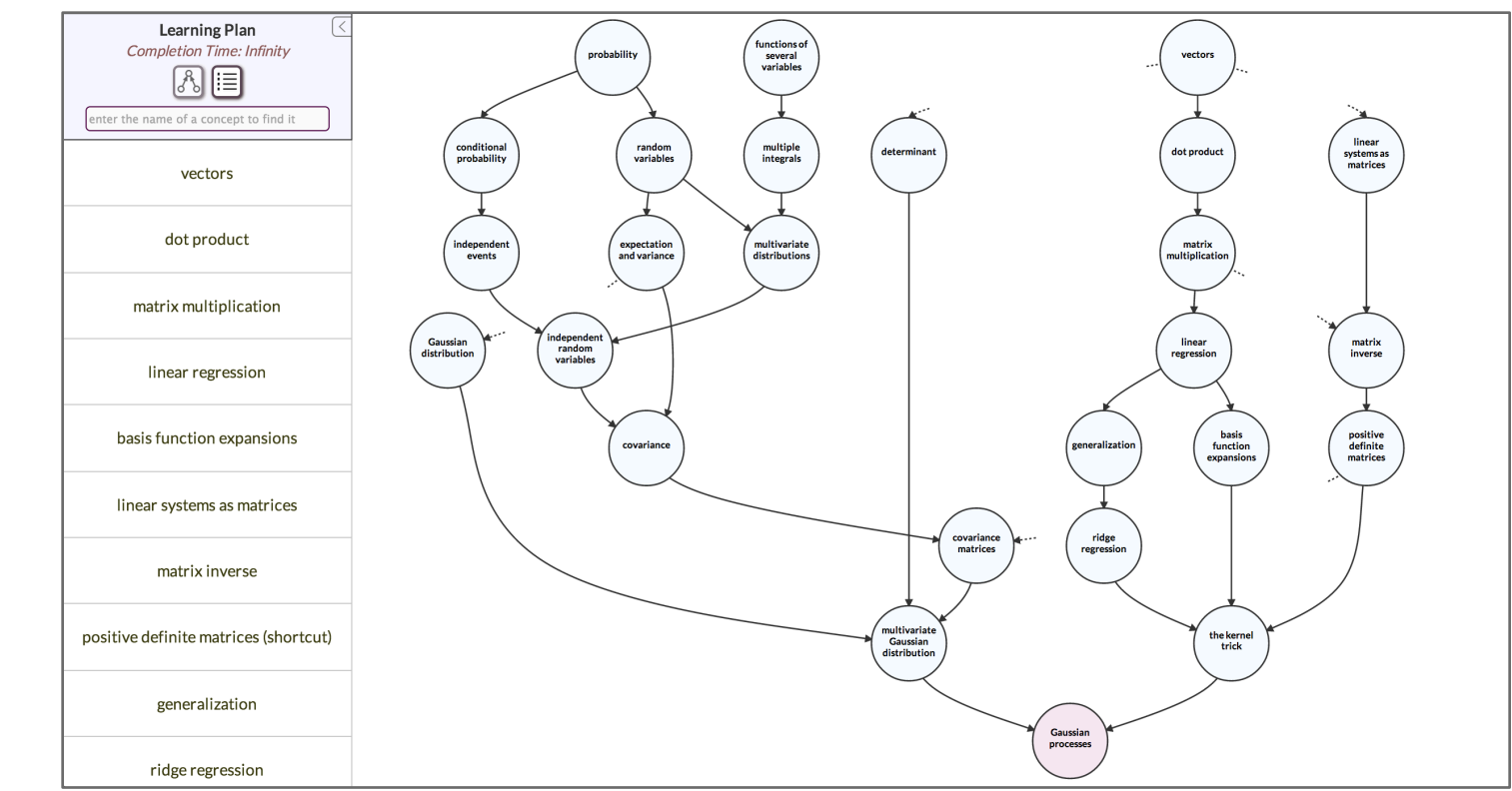


Sal Khan - Khan Academy  
(6M unique monthly visitors)

## Visualization and Exploration



This is the original knowledge map rendering using a layered (Sugiyama) graph placement (Metacademy's system). [41 edges]

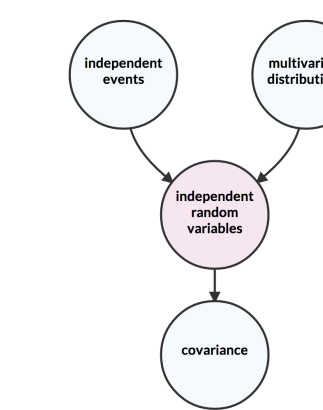


This is the same knowledge map as shown on the left but after removing transitive and non-structural edges and incorporating a number of interactive components. [33 edges]

Goal: clean, interactive, mental-map-preserving knowledge maps

### Placement

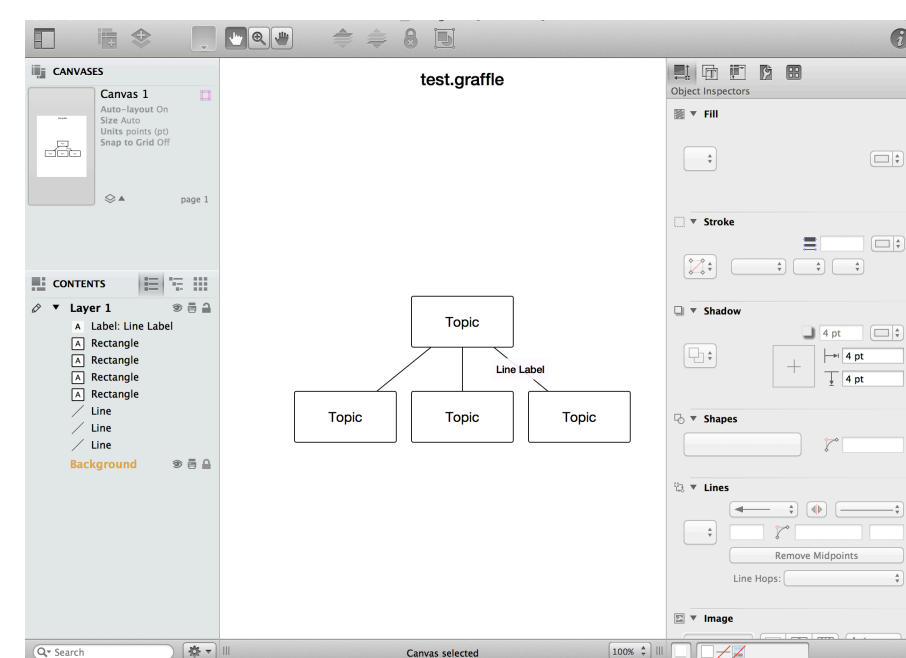
- + Remove transitive edges (transitive reduction) (e.g. remove edge  $C \rightarrow A$  if  $C \rightarrow B, B \rightarrow A$  exists)
- + only show short edges and structure edges (make sure every node has at least one outlink)
- + draw "wisp" edges to indicate absent edges (small edge segments protruding from nodes)



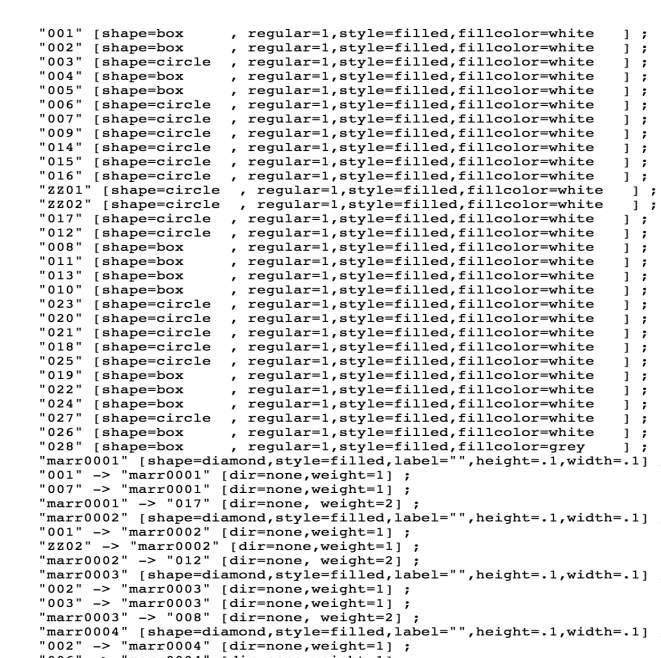
### Interaction

- + hovering over a node highlights all dependencies, outlinks, and shows all related edges
- + clicking an edge shows associated content on graph
- + clicking a node transitions to showing only the dependencies and outlinks of that node (see left)
- + search/filter concepts using the sidebar
- + directly show associated concept information on node

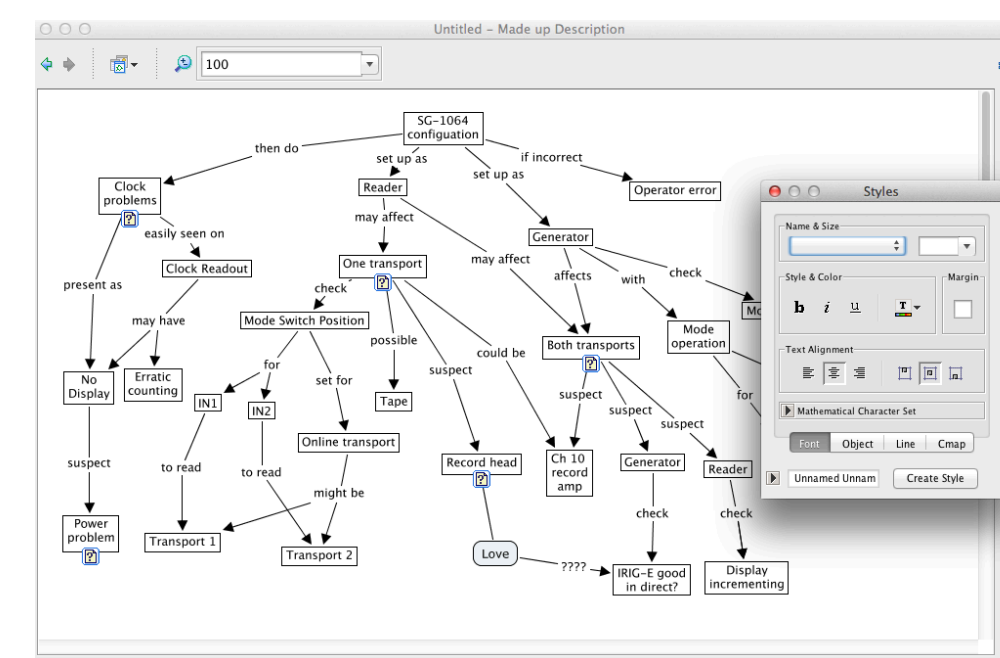
## Tools for Creating Knowledge Maps



OmniGraffle diagramming software



Graphviz graph placement and visualization software



Cmap Tools concept mapping software

Goal: Create a visual, specific-purpose knowledge map editor

Knowledge map creation tools tend to fall into four broad categories:

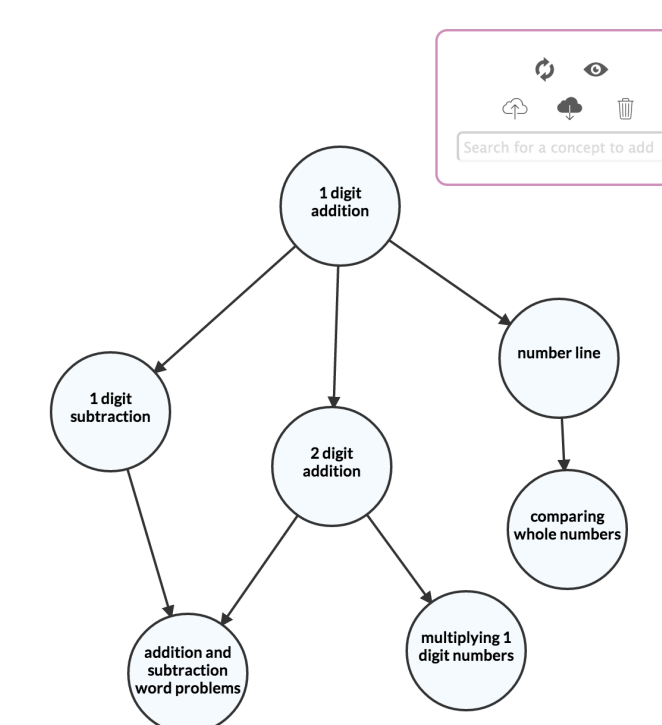
- (1) general purpose diagramming software
- (2) general purpose graph placement and visualization software
- (3) specific purpose diagramming software
- (4) research software

Knowledge map creation objectives:

- balance human and algorithmic placement
- allow quick editing of large graphs
- allow sharing/collaborating/version control
- export/import graphs to/from common formats
- Incorporate meta information (e.g. discussion)

Both Khan Academy and Metacademy use text-based (e.g. xml) to create/edit the maps and then use graphviz to generate the placement

## Knowledge Map Creation

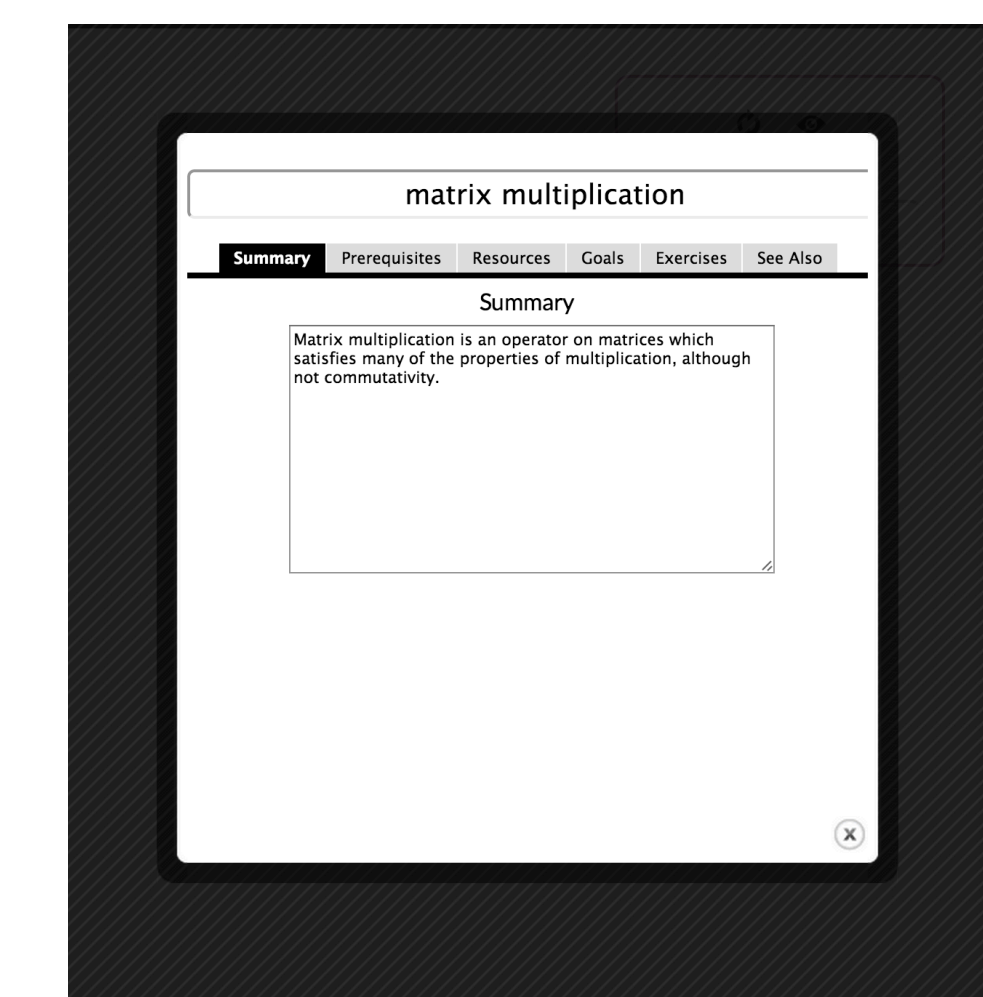
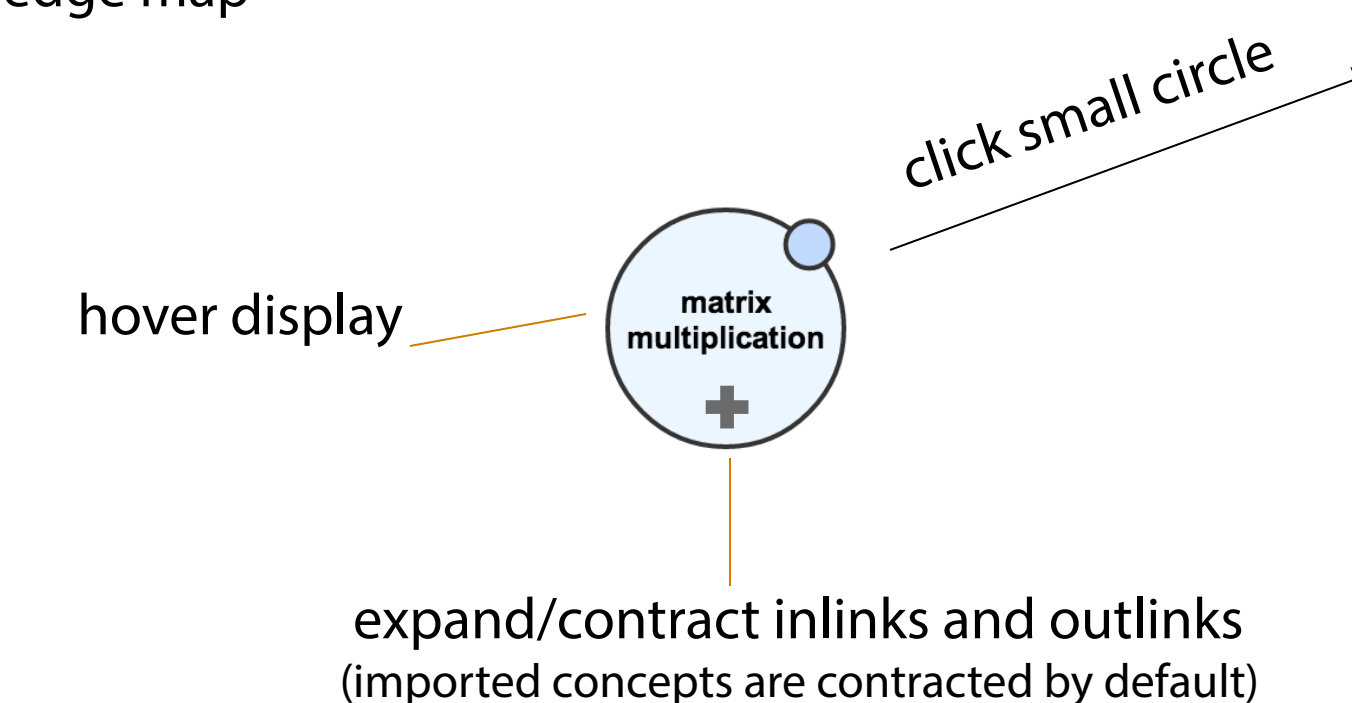


### Graph Creation Toolbox

- optimize graph placement
- upload/download graph (json format)
- search for a concept to add
- add existing concepts
- clear graph
- preview final graph

only included features that benefitted the following operations

- add/remove concept
- add/remove relationship between concepts
- add/remove associated content
- preview the knowledge map



This is the associated concept editor that overlays the displayed graph.