

# The Paths Inquiry

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## Summary

Explore connections between the Eulerian path problem (the foundation of graph theory) and a traditional “stab” bookbinding technique originating in Asia. We will use a digital app to create a stitch pattern and use mathematical inquiry to solve the puzzle of ordering the stitches. Then we will explore how to use these digital patterns to make physical projects, from quicker drawing templates to more elaborate physical books. This workshop provides an example of how to embed math content in new forms of making across the digital and physical.



## NGSS Science & Engineering Practices

- Using Mathematics and Computational Thinking (Graph Theory, Algorithms)
- Asking Questions
- Planning and Carrying out Investigations
- Constructing Explanations and Designing Solutions

## Materials

Simpler version for younger students:

- Yarn or string and yarn needles
- Single hole punch
- Plain printer paper cut into ~5.5 x 8.5 pieces (letter paper cut in half). 6 of these half-sheets per book/student.
- Decorative paper, construction paper, cardstock, or colored paper for the covers, cut to same size as printer paper. 2 per book.

More traditional bookbinding materials for older students:

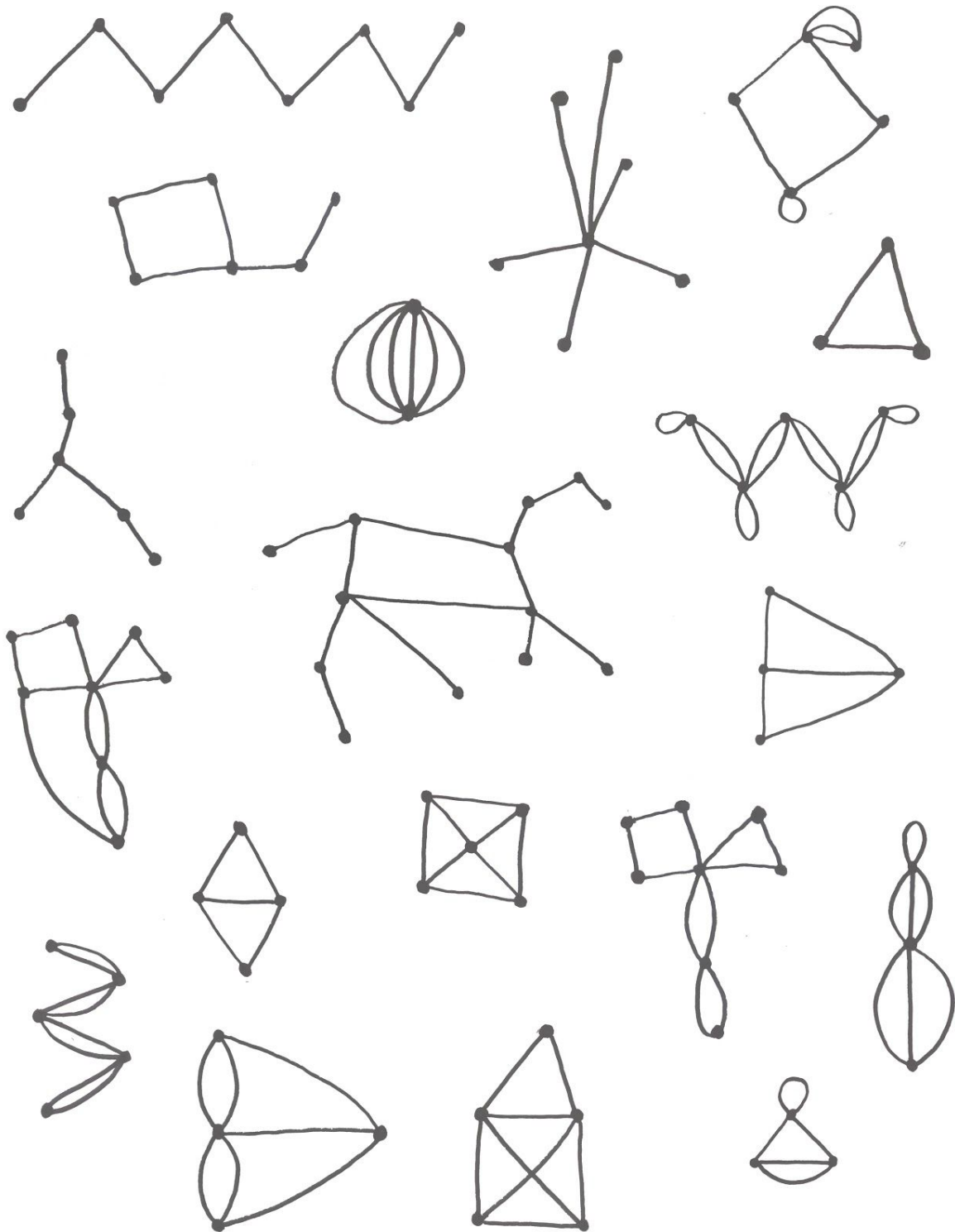
- Embroidery thread or waxed bookbinding thread
- Wax (one tea light candle works great)
- Upholstery or bookbinding needles (or any needle with large eye)
- Hand drill with 1/16" to 1/8" drill bit for drilling holes in book
- Paper and cover paper, as described above. Use more sheets per book, 10-16.



### Activity Instructions

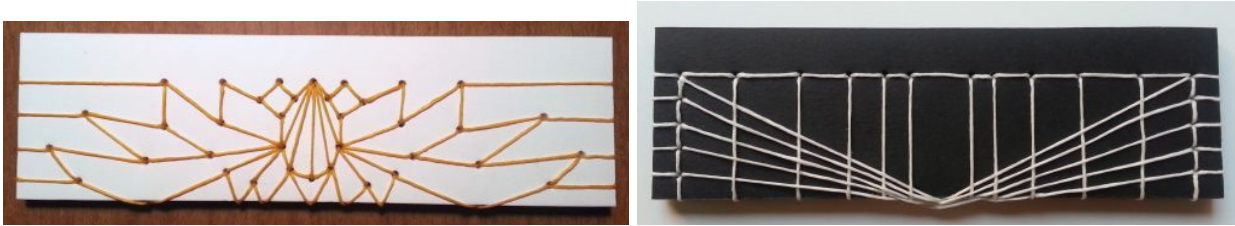
Warm-up, practicing with graphs:

Try to draw these patterns without lifting your pen and without tracing over a line more than once. Mark the ones where you come back to your starting place with the word CYCLE, those where you finish in a different spot PATH, and the ones you can't trace in one go with NONE.



## **About Stab Binding (History)**

Stab binding developed in Asia between the 7th and 14th centuries. Paper, a system of writing, printing and simple book-binding techniques were developed in China. Stab binding was developed later, first in China, and then in Japan. It was an iteration of an accordion style book, an alternative to the popular scroll of the time. The Japanese further developed it as an art form and it has become widely known as *Japanese stab binding*.



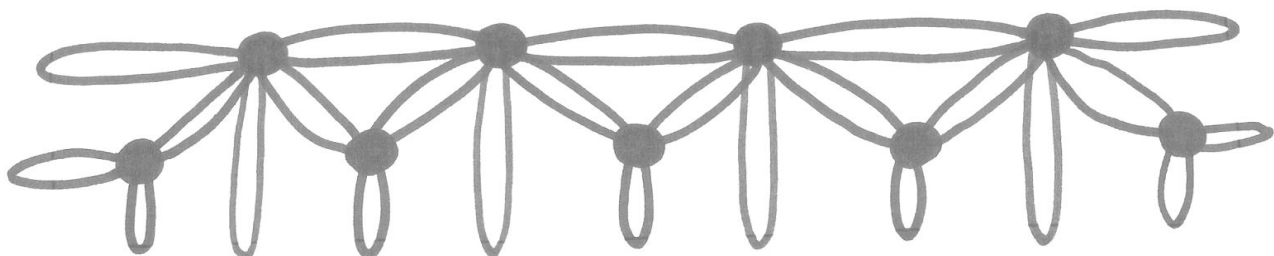
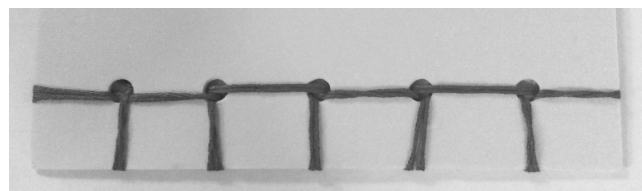
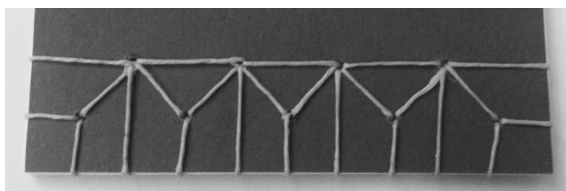
examples by Becca Hirsbrunner (beccamakingfaces.com)

## **Assembling the book**

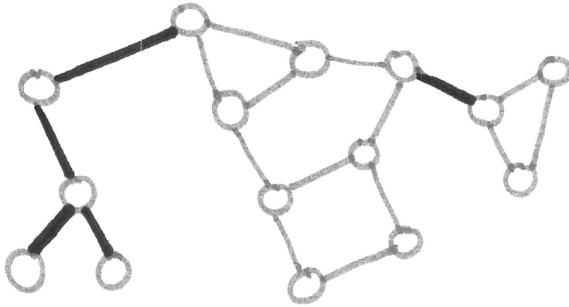
1. Get two covers and your sheets of plain paper. Stack the paper with covers on the top and bottom and tap the stack against a surface to align the edges.
2. Cut out the hole template. [Link to a template made for a ½ letter size paper book.](#)
3. Line up the template with the edge of your book and use a hammer and nail, a drill, or a hole punch to make the holes. When you've made the holes, remove the template.

## **Stitching the book**

1. Cut about \_\_\_\_\_ of thread or yarn.
2. If using thread, run wax over the length of the thread by sliding the candle against it a few times.
3. Thread a bookbinding, upholstery, or yarn needle. You can double the thread and tie the ends in a knot, or just loop over a few inches and be careful not to let it slip out of the needle as you stitch.
4. Start at any hole. Stitch from hole to hole until you have created the pattern (below). If you skip a connection (edge), go back and try to figure out how this happened. You can use the graph representation below to plan out your route.
5. When you're done and have reached where you started on the same side (don't go through the last time!), tie a double knot and cut the ends.



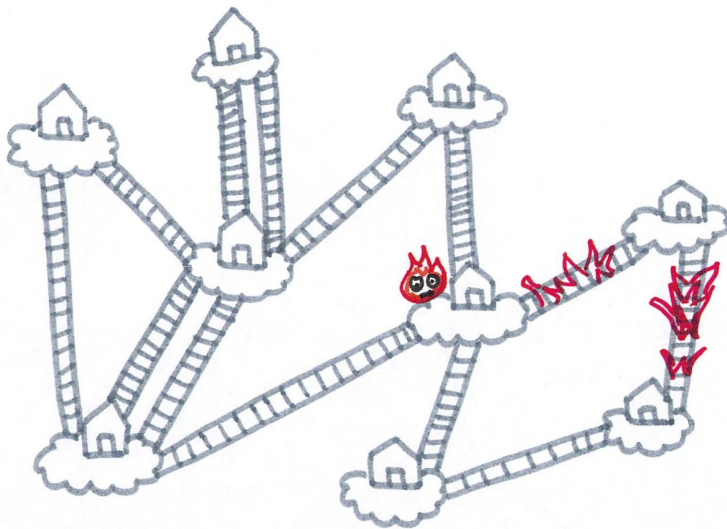
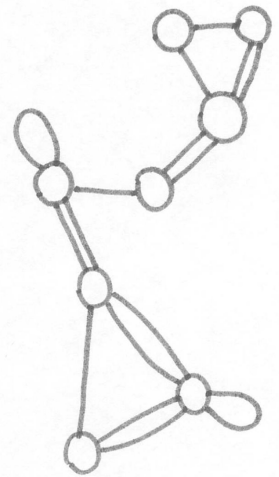
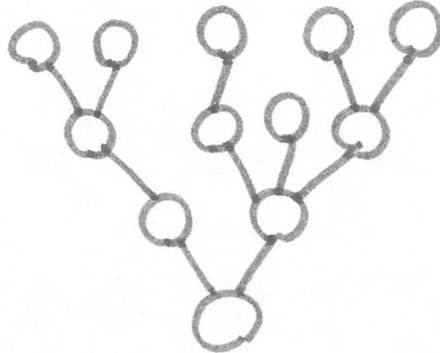
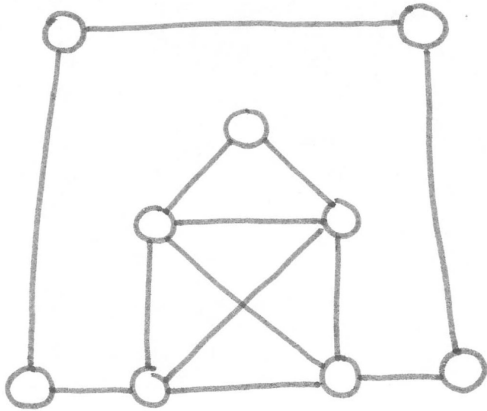
“Don’t burn bridges”: developing an algorithm to find a circuit through a graph



What is special about the bolded edges in this graph?

Come up with a name to describe these special edges:

Mark all the edges in the three graphs below that have the same property as the special edges you named:

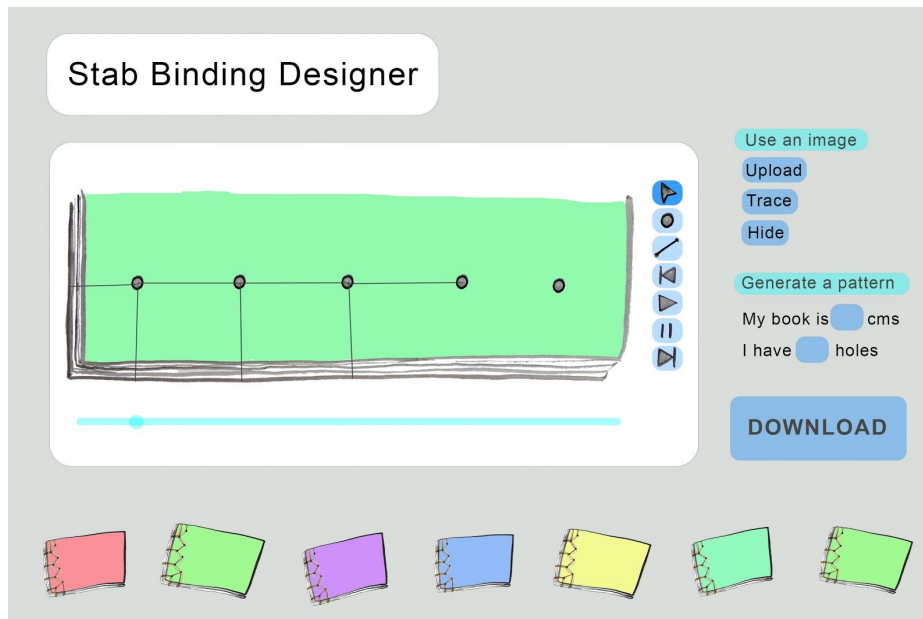


Calcifer the fire demon must burn all the ladders in Sky City to stop the spread of a terrible plague! From here, which ladder should he take, and why?

Can he save the city?

## The App

<http://tinyurl.com/stabbooks>



### **What's Going On?**

[We made a book to explain!](#) You can print and stab bind it. :)

### **Recommended Websites**

[Graph Theory Terms Video](#)

[Euler Paths, Circuits, Multigraphs](#)

[Stab Binding Tutorials](#)

[Graph Theory Lesson Plan](#)

[Stab Bound Sandwich](#)

["Math for 7-Year Olds \(Graphs\)"](#) and [for 8-Year Olds](#) Lesson Plan and Booklet

[Edgy: Block Programming Graphs \(like Snap or Scratch\)](#)