

Origami Designing - Part 2: Module

Unit 1.4.1: Validity of a Tree Diagram

Objective

At the end of this unit, you should be able to identify the validity of a tree diagram.

Prerequisite Skills

This unit does not require any prerequisite units from within this course. However, in order to complete this module, you should be able to:

- Articulate and compare the relative and proportional lengths of line segments without the use of any external tools
- Identify the number of line segments stemming from a vertex
- Assess if a set of line segments form a closed loop

Materials

As for this particular unit, no external materials or tools are required. However, within the module, there is a need for a writing utensil for a physically printed module or a computer with a document editing software capable of editing PDF files for the virtual module to assist with recording practice and self-check answers. The only relevant material is a method of viewing and navigating this module, either by a physical copy printed on a standard sheet of A4 paper or through an electronic device capable of both viewing documents at the scale of a sheet of A4 paper) and navigating all pages individually.

Previously Learned

In previous units, you learned the multiple conditions required to assess localized flat-foldability and how to verify each condition. In the more initial, large modules, you learned to describe types of origami and related art and how to follow instructional diagrams.

Future Steps

This module will introduce the concept of tree diagrams and allow you to identify the validity of them. This will allow you to build on this knowledge in later units when constructing a tree diagram from a list of specifications (unit 1.4.2) and the creation of a list of specifications based off a description of a model (unit 1.4.3). In later units (units 1.5 and 1.6), you will be able to use this skill in conjunction with additional design skills to design a model from a description to a tree diagram, and a tree diagram to a final crease pattern.

Purpose

As designing origami is a complex, multistaged process, there needs to be ways to conceptualize the model and its description in order to apply designing concepts to it. With the help of a tree diagram, the core features of a model can be distilled into a structure that can be created through traditional origami designing techniques. This includes identifying the main components of a model that can be turned into a flap of paper, which are represented by a singular line segment in a crease pattern. As described and iterated on in the provided source, [The Tree Method of Origami Design](#) and [Mathematical Methods in Origami Design](#), the tree diagram has been traditionally used to provide guidance for the subsequent step in the design process.

Without the essential skill of being able to conceptualize a model, any subsequent design techniques will likely not be able to be practically used. Being able to transfer a description of a model into a list of specifications (unit 1.4.3) and then to a tree structure (unit 1.4) will provide a method for you to have the freedom to design and create models of your choice, not just models of other's specifications.

Structure

This unit will consist of the definitions regarding the validity of a tree diagram, a set of curated and guided examples which demonstrate versions of each validity criteria, a set of practice problems with appropriate feedback, and a self-check assessment in the format of the practice problems.

Definitions

There are two different states for a tree diagram's validity: valid and invalid.

A valid tree diagram will have:

- A single set of connected line segments that does not form any closed loops
- Each line segment must be labeled with its corresponding, physical length as a unit-less whole number
- Each line segment labeled length must be directly proportional to each other line segment
- Each vertex must have 3 or more attached line segments

- Each line segment must only have connections on their end-points and must not overlap any other line segment

An invalid tree diagram would fail any condition of a valid tree diagram. These include:

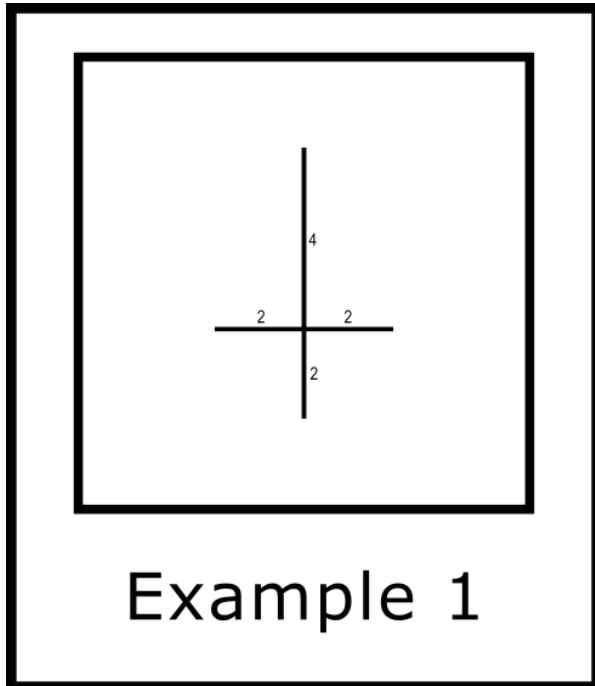
- A non-connected set of line segments or a set of line segments that form a closed loop
- At least one segment is not labeled, is labeled with a non-whole number, a number with a unit, or a number that does not correspond to its accurate length
- At least one line segment's length and corresponding labels are not directly proportional to any other line segment
- At least one vertex has the exactly 2 connected line segments
- At least one line segment has connections not on their end-points or overlaps

Examples

There are four separate sets of examples: simple valid tree diagrams, simple invalid tree diagrams, detailed invalid tree diagrams, and realistic valid tree diagrams. They are intended on being viewed in order.

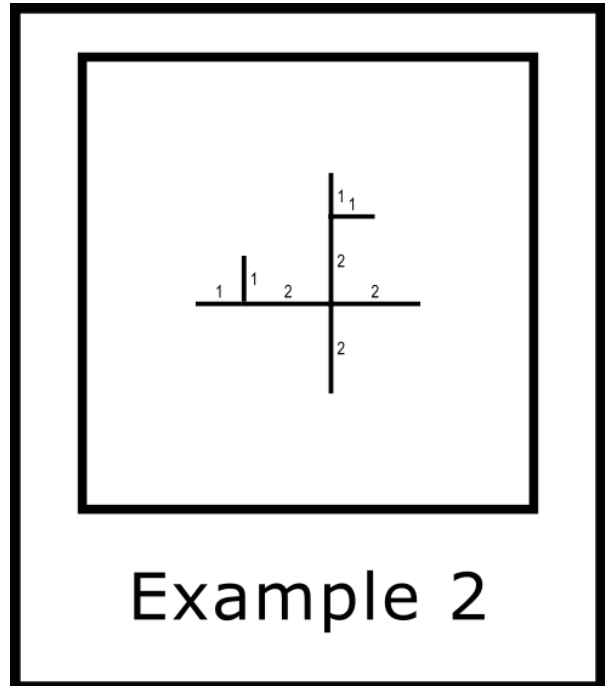
Simple Valid Tree Diagrams

There are multiple different focal points when identifying whether a tree diagram is valid or invalid. Before you get into the intricacies of invalid tree diagrams, let's examine some valid ones. Take note of specifically the connections between line segments and the associated labels for each line segment.



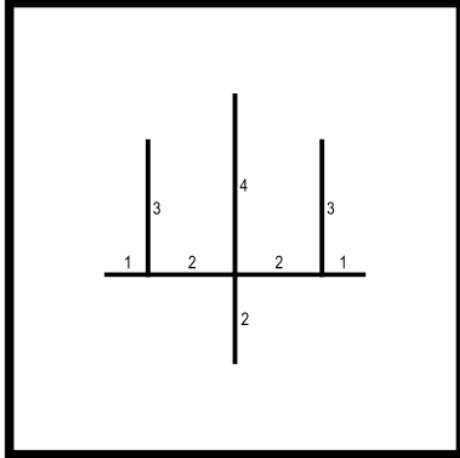
Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Valid

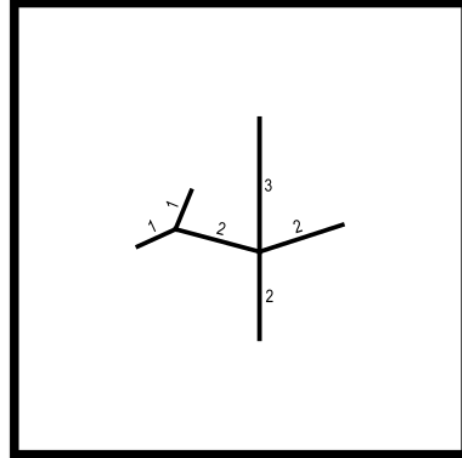
- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Example 3

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Example 4

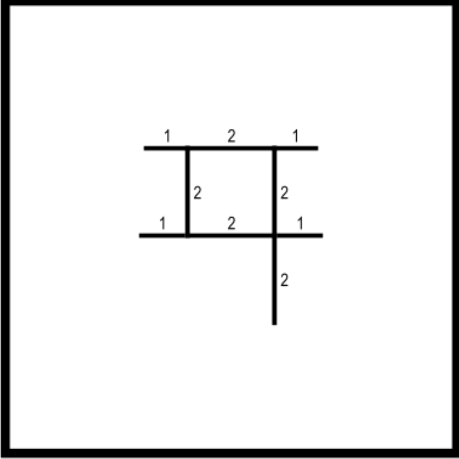
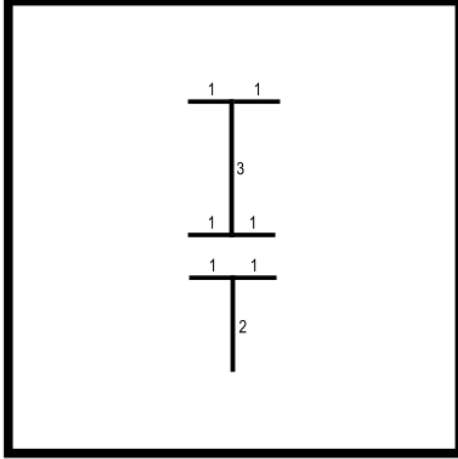
Valid

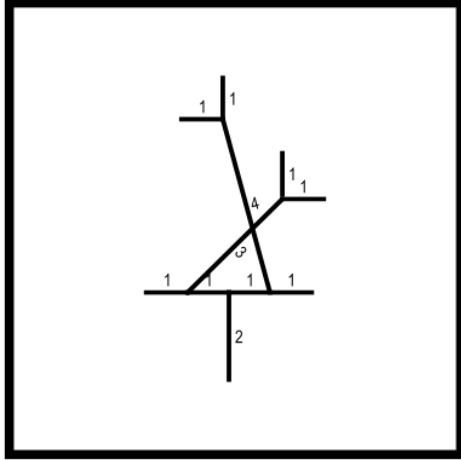
Note that line segments can be placed at any angle as long as they do not overlap or intersect any other line segment.

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed

Simple Invalid Tree Diagrams

Not that we have seen a couple valid examples, let's take a quick look at some example which are more easily identifiable as invalid. This way, it's more efficient to make sure the major aspects of the tree diagram are correct before take a closer look at more specific details. These easier-identifiable examples primarily includes the placement and organization of line segments.

 <p data-bbox="326 1041 683 1104">Example 5</p>	 <p data-bbox="943 1041 1300 1104">Example 6</p>
<p data-bbox="440 1230 561 1266">Invalid</p> <ul data-bbox="253 1329 776 1444" style="list-style-type: none">• The line segments forms a closed loop with in the center of the tree diagram	<p data-bbox="1060 1230 1182 1266">Invalid</p> <p data-bbox="824 1329 1409 1444">Note that each set of tree diagrams are individually valid, but they become invalid when combined.</p> <ul data-bbox="873 1497 1369 1612" style="list-style-type: none">• There are two separate, non-continuous sets of line segments in the of tree diagram

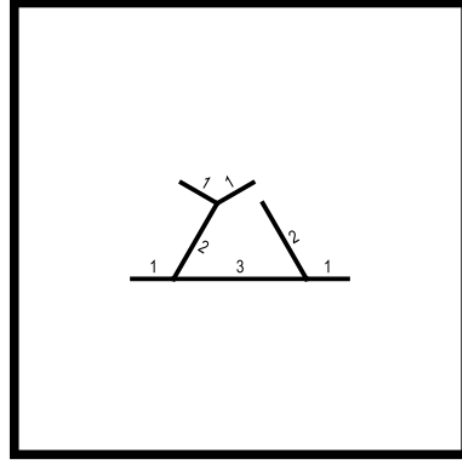


Example 7

Invalid

Note that this would be valid if line segments of length 3 and 4 were not visually crossing.

- Line segments can not be overlapped or intersected

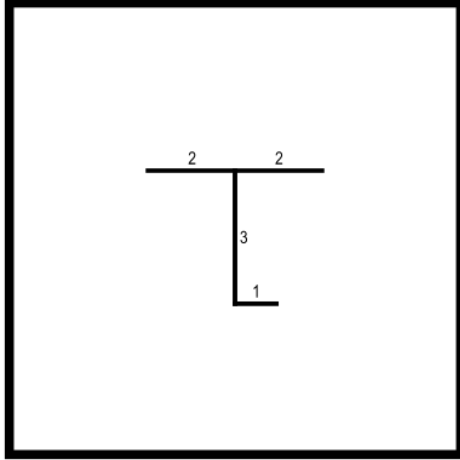


Example 8

Valid

Note that line segments can be placed at any angle as long as they do not overlap or intersect any other line segment.

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed

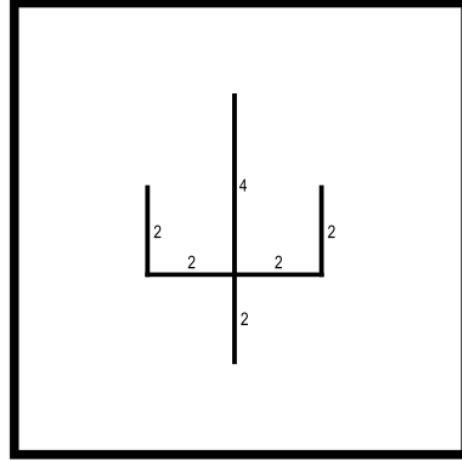


Example 9

Invalid

Note that this is only inaccurate because it can be simplified.

- All vertices must have 3 or greater line segments attached to them. This is because the 3 and 1-length line segments can be simplified in to one 4-length line segment.



Example 10

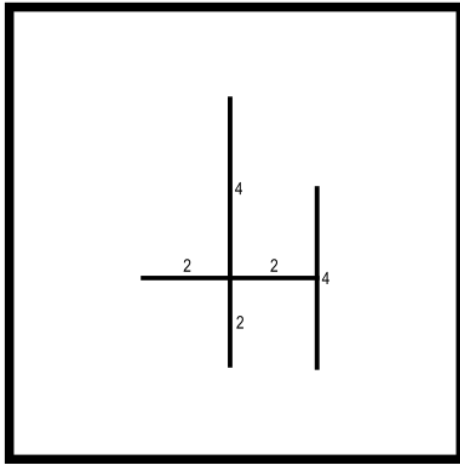
Invalid

Note that this is only inaccurate because it can be simplified.

- All vertices must have 3 or greater line segments attached to them. This is because the two 2-length line segments can be simplified in to one 4-length line segment.

Detailed Invalid Tree Diagrams

Now that you are aware of the easily identifiable ways to spot an invalid tree diagram, you can now take a look at the more detailed invalid tree diagrams that may appear correct at a first glance. These will primarily include the labels of the line segments.

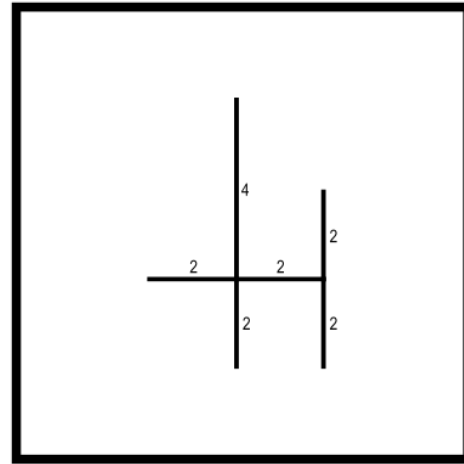


Example 11

Invalid

Note that this would be valid if the line segment of length 4 on the right extended from the endpoint of the length 2 line segment on the right.

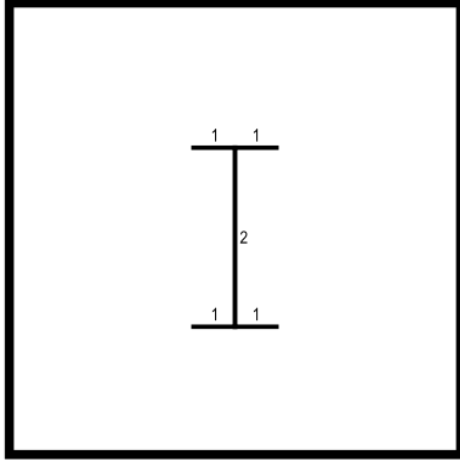
- Line segments can not be connected or intersected at any point. They can only connect to the endpoints of another line segment. In this case, the 4-length line segment is connected in the middle by the 2-length line segment.



Example 12

Valid

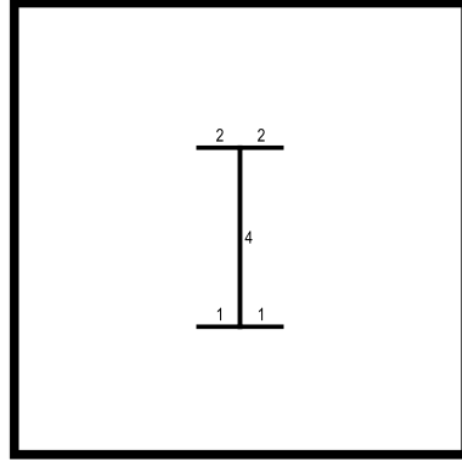
- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Example 13

Invalid

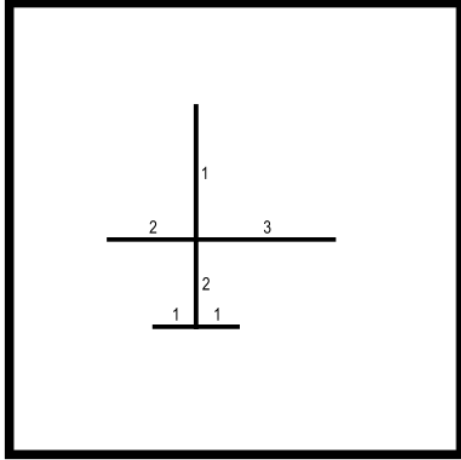
- Line segments lengths are not labeled proportionally correctly as the vertical, center line segment is significantly larger than double the length of the rest of the line segments labeled 1



Example 14

Invalid

- Line segments of the same length are not labeled the same. This introduces a contradiction and lack of clarity of the indented length of all line segments in the diagram.
- Line segments lengths are not labeled proportionally correct

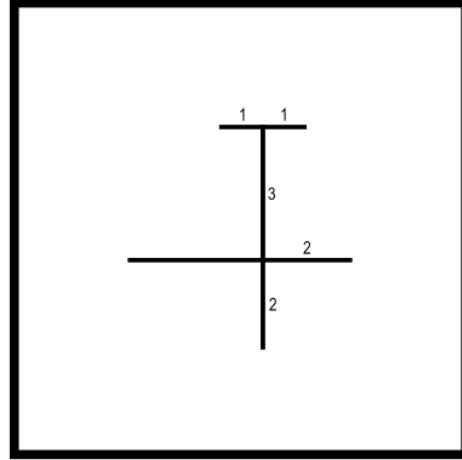


Example 15

Invalid

Note that the tree diagram is structured properly, but is not labeled properly.

- The proportions of the line segments are not all labeled properly, as the longest line segment is labeled the shortest length

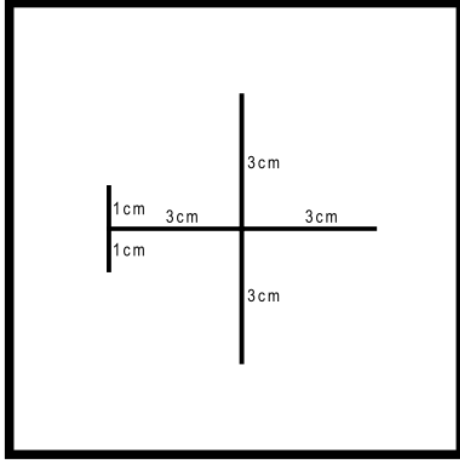


Example 16

Invalid

Note that the line segments are all placed appropriately, however they are not labeled correctly.

- Not all line segments are labeled. If their length is not specifically defined, it can not be specifically or accurately determined just by looking at the diagram.

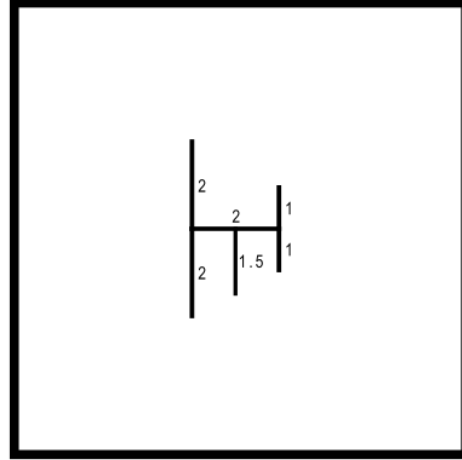


Example 17

Invalid

Note that the tree diagram is structured properly, but is not labeled properly.

- Each line segment is labeled with a measurement unit. As the tree diagram represents ratio lengths, concrete measurements would constrict the ability to utilize this and is therefore not valid.



Example 18

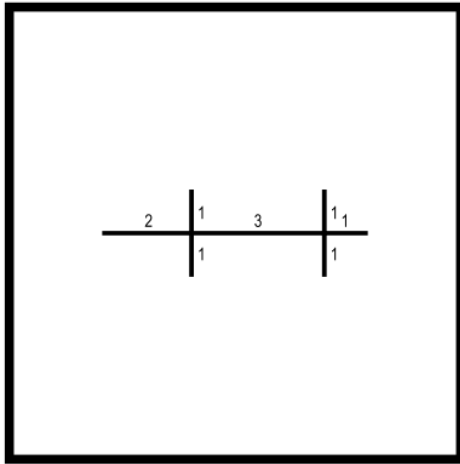
Invalid

Note that this would be valid if all label values are doubled (making the 1.5 a 3, which is a whole number). This is due to the numbers representing ratios instead of direct measurements.

- The length of all line segments must be labeled specifically by a whole number. In this example, 1.5 is not a whole number, and does not represent the ratio between whole numbers that a tree diagram is intended to represent.

Realistic Valid Tree Diagrams

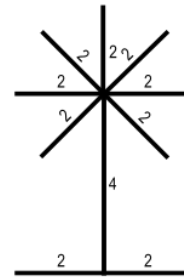
Now that you have examined examples of valid, invalid but simple or easily identifiable, and invalid but detailed, you can take a look at more realistic valid tree diagrams to see how these are used more in practice rather than just in theory.



Example 19

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed

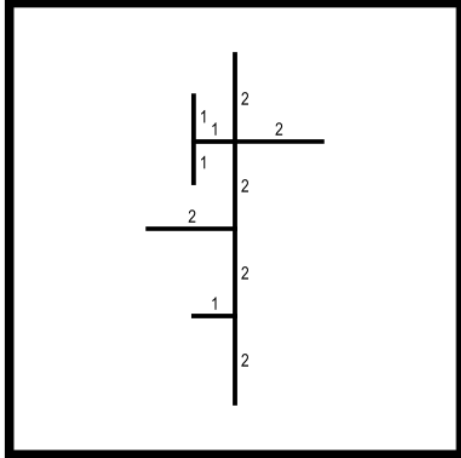


Example 20

Valid

Note that there is no maximum for the number of line segments stemming from a single vertex.

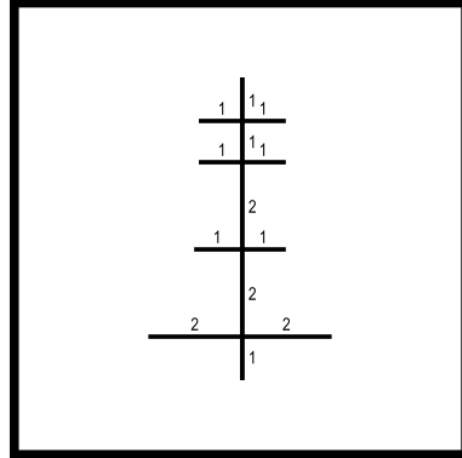
- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Example 21

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



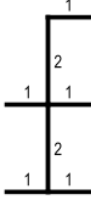
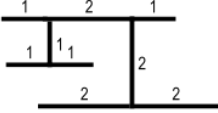
Example 22

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed

Practice

Here are a few practice problems that are based on invalid and more realistic, valid tree diagrams. They will involve tree diagrams that fall under the previous categories in examples of simple and invalid, detailed and invalid, and realistic and valid. Answers with feedback will be provided on the page after each practice problem.

<div data-bbox="277 541 732 999"></div> <p data-bbox="337 1052 669 1115">Practice 1</p>	<div data-bbox="898 541 1352 999"></div> <p data-bbox="954 1052 1286 1115">Practice 2</p>
<p data-bbox="418 1255 578 1297">___ Valid</p> <p data-bbox="407 1346 591 1388">___ Invalid</p>	<p data-bbox="1040 1255 1200 1297">___ Valid</p> <p data-bbox="1029 1346 1213 1388">___ Invalid</p>

Practice 1 is

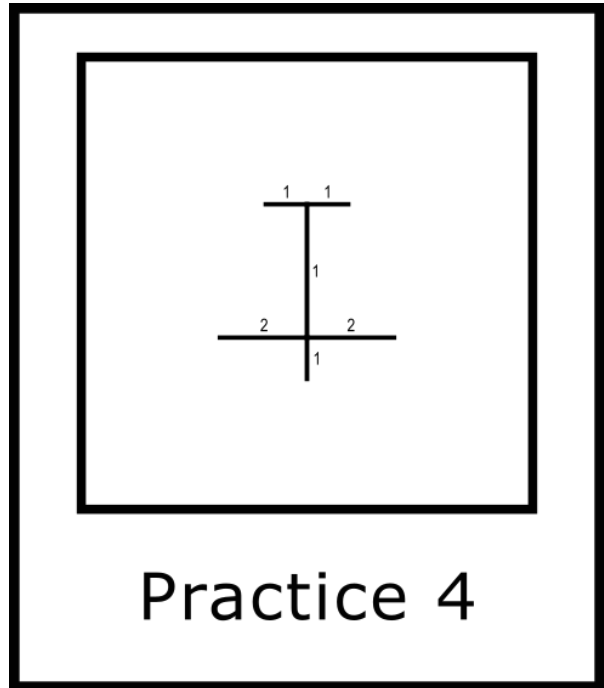
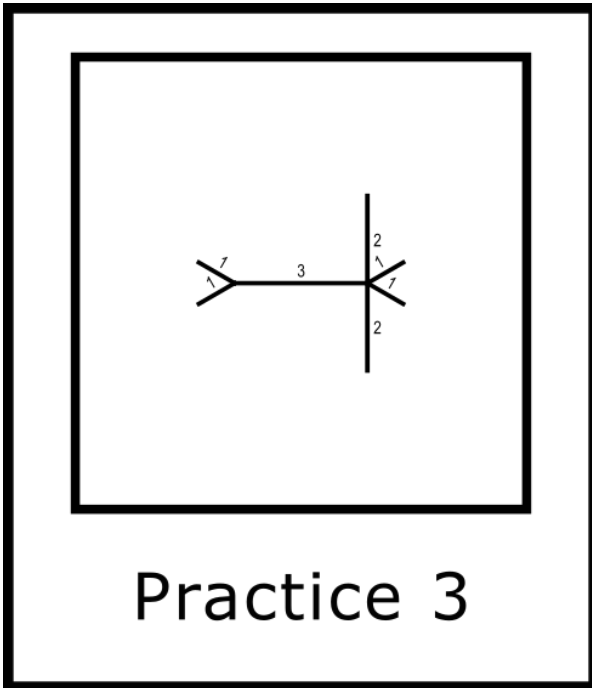
Invalid

- All vertices must have 3 or greater line segments attached to them. This is because the 2 and 1-length line segments at the top can be simplified in to one 3-length line segment.

Practice 2 is

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



___ Valid

___ Invalid

___ Valid

___ Invalid

Practice 3 is

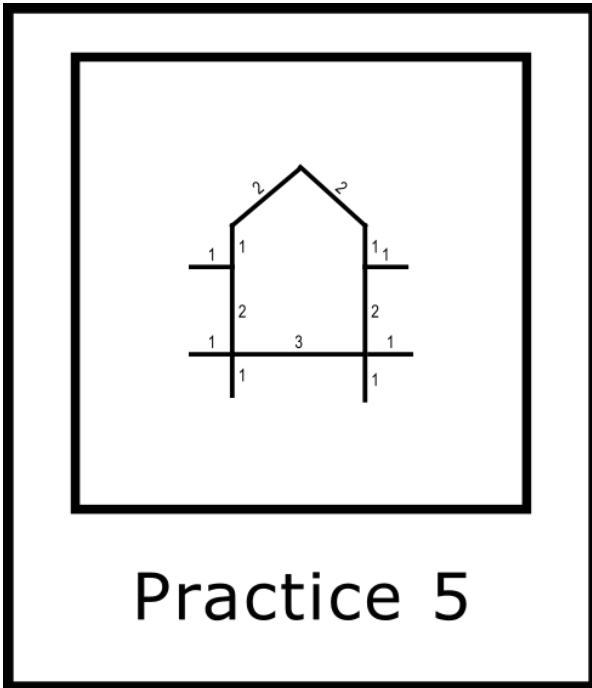
Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed

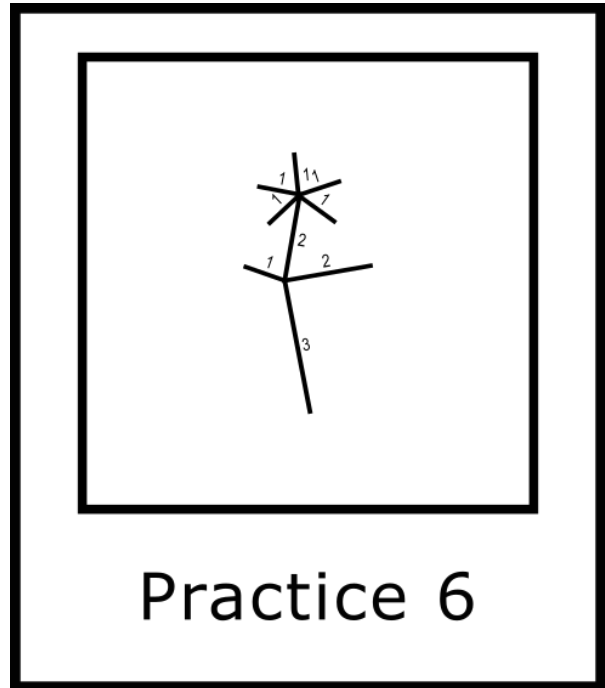
Practice 4 is

Invalid

- Line segments lengths are not labeled proportionally correctly as the vertical, center line segment is significantly larger than the length of the rest of the line segments labeled 1 or 2, yet it is labeled 1.



Practice 5



Practice 6

___ Valid

___ Invalid

___ Valid

___ Invalid

Practice 5 is

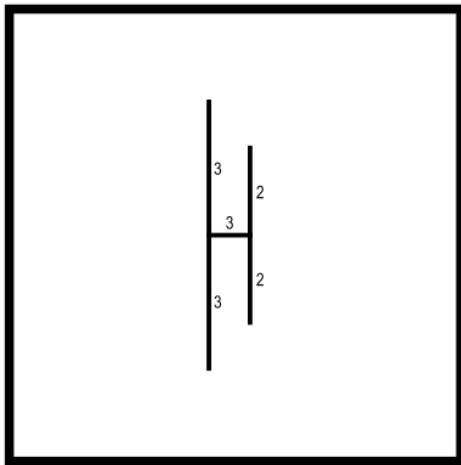
Invalid

- Line segments can not form a closed loop, be intersected or overlapped. The center line segments form a closed loop.

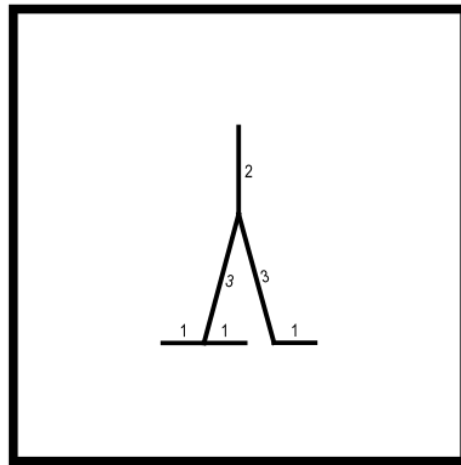
Practice 6 is

Valid

- All line segments are connected and do not form a closed loop
- Each line segment is appropriately labeled
- Each line segment is sized and labeled correctly
- Each vertex contains 3 or more connected line segments
- Each line segment is correctly placed



Practice 7



Practice 8

___ Valid

___ Invalid

___ Valid

___ Invalid

Practice 7 is

Invalid

- Line segments lengths are not labeled proportionally correctly as the vertical, center line segment is significantly smaller than the other line segments labeled as a length of 3


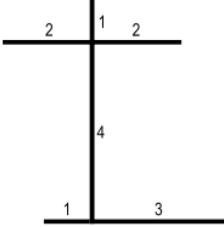
Practice 8 is

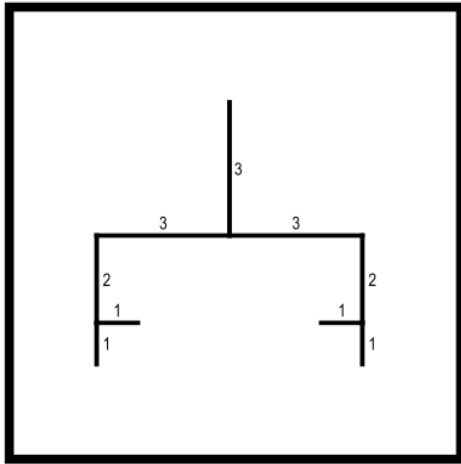
Invalid

- All vertices must have 3 or greater line segments attached to them. This is because the 3 and 1-length line segments at the bottom right can be simplified in to one 4-length line segment.

Self-Check Assessment

If you feel like you are ready for a self-check assessment, there will be 8 separate tree diagrams that fall under every category in the example and practice tree diagrams. You will pass the assessment if you correctly label at least 7 out of the 8 tree diagrams as either valid or invalid.

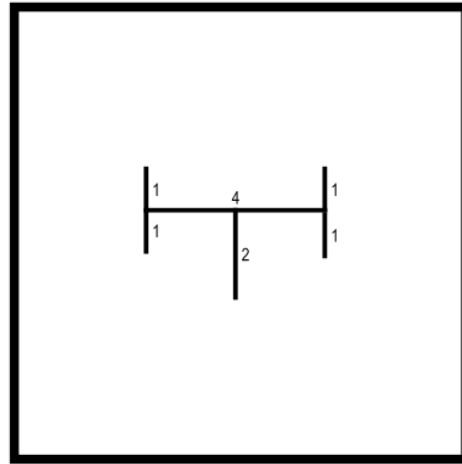
<div data-bbox="277 541 732 999"></div> <p data-bbox="289 1052 716 1115">Self-check 1</p>	<div data-bbox="894 541 1349 999"></div> <p data-bbox="911 1052 1338 1115">Self-check 2</p>
<p data-bbox="418 1255 578 1297">___ Valid</p> <p data-bbox="407 1339 591 1381">___ Invalid</p>	<p data-bbox="1040 1255 1200 1297">___ Valid</p> <p data-bbox="1029 1339 1213 1381">___ Invalid</p>



Self-check 3

Valid

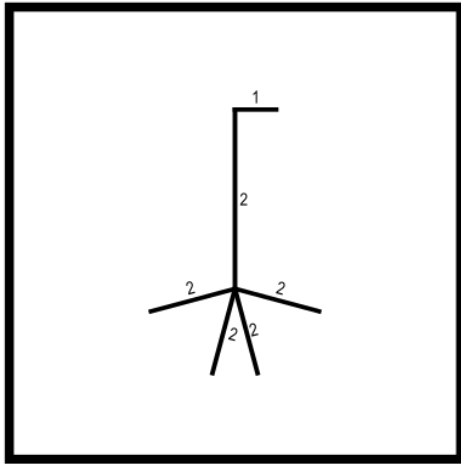
Invalid



Self-check 4

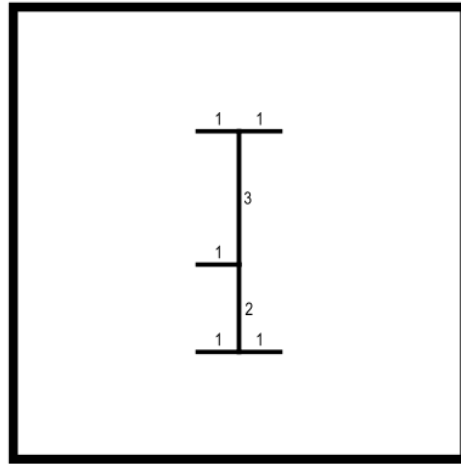
Valid

Invalid



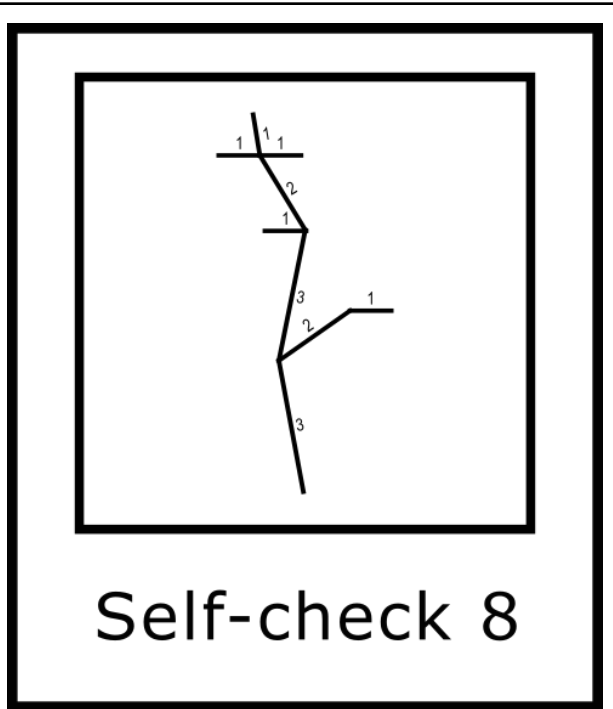
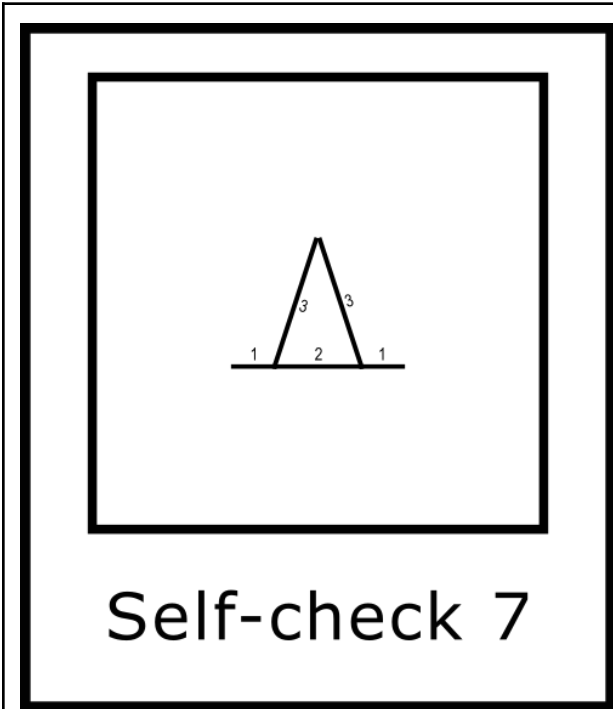
Self-check 5

Valid
 Invalid



Self-check 6

Valid
 Invalid



Valid
 Invalid

Valid
 Invalid

The answers to the self-check assessment will be on the next page

Answers to Self-Check Assessment

1. Valid
2. Valid
3. Invalid
4. Invalid
5. Invalid
6. Valid
7. Invalid
8. Invalid

This concludes module 1.4.1