# Blocks Languages for Creating Tangible Artifacts

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Visual Languages and Human-Centric Computing Symposium

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# TinkerBlocks Team



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# What We Did

Graphical microworlds

Laser cutter and vinyl cuter

1

2

Blocks programming

Improvements to typing and naming

Graphical
microworlds

Laser cutter and
vinyl cuter

1

2

Blocks
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Improvements
to typing
and naming

# Wellesley & Engineering Connections

MIT

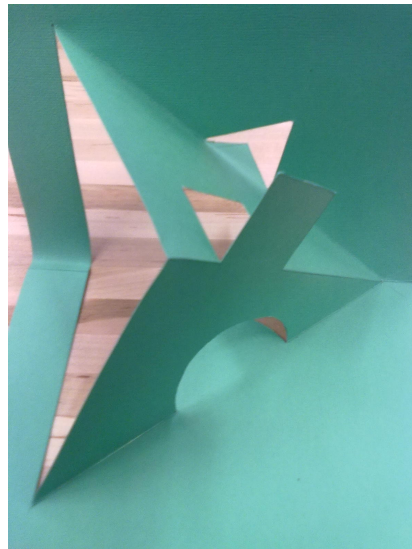Wellesley College

Olin College

# Rapid prototyping @ Wellesley

Laser cutter

3D Printer

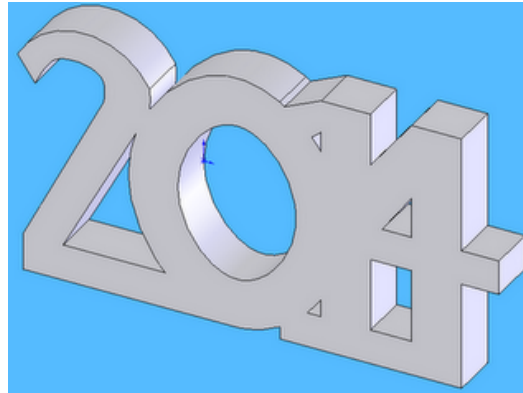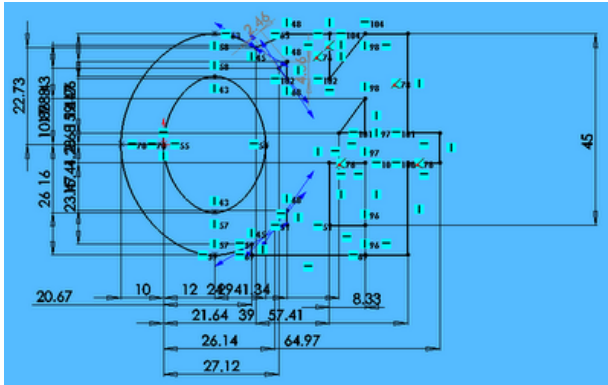

Desktop vinyl cutter

# Intro to Engineering: Bottle Openers

# Personal fabrication

Silhouette vinyl cutter: $250

MakerBot Replicator 3D printer: $2000
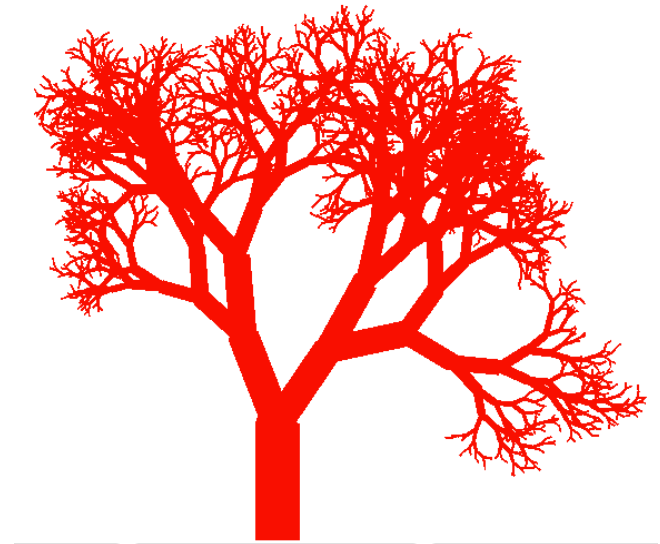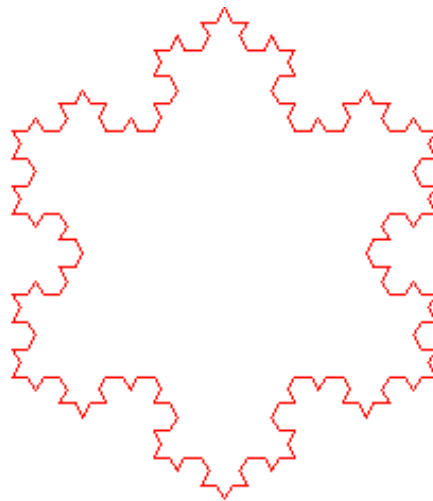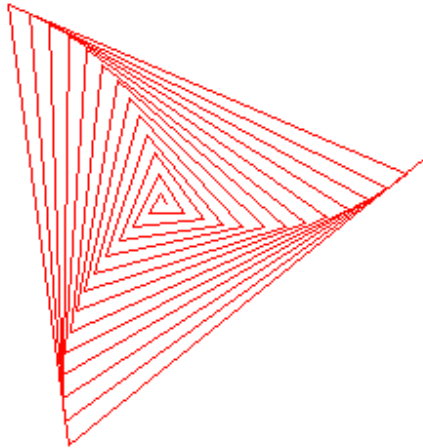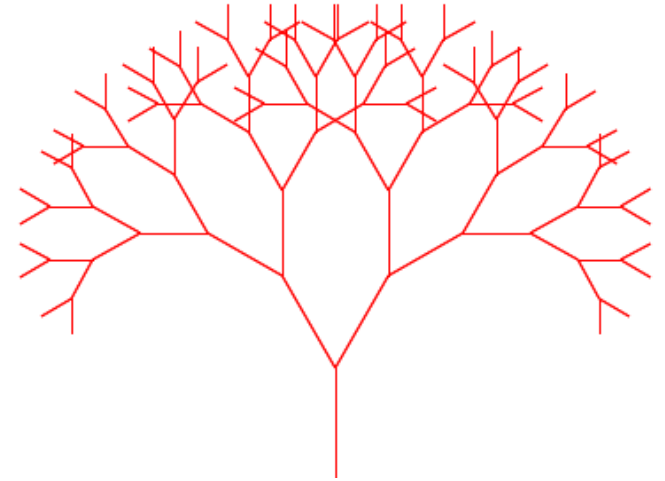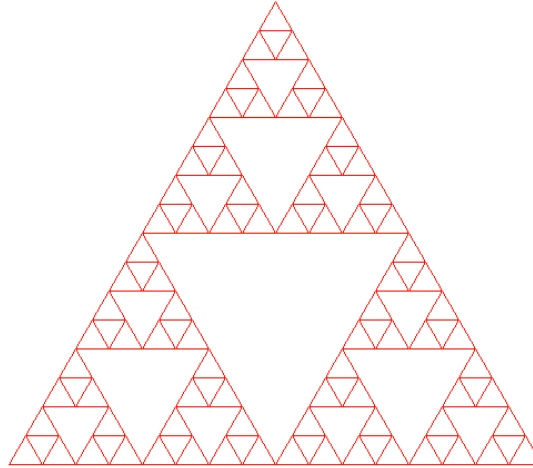
Graphical
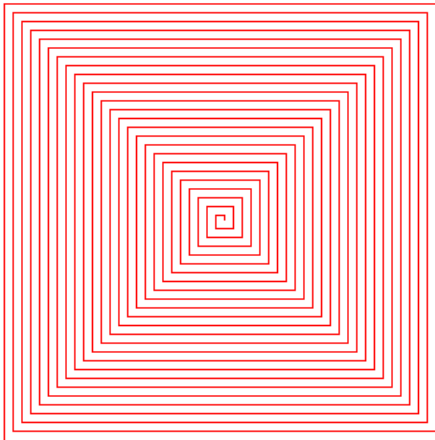microworlds

Laser cutter and
vinyl cutter
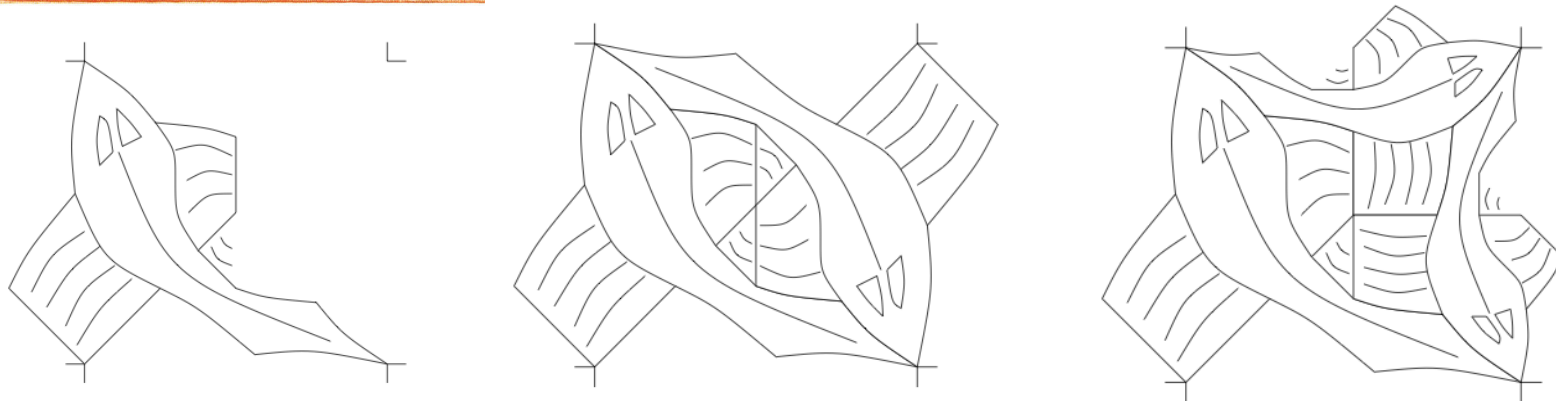
1

2

Blocks
programming
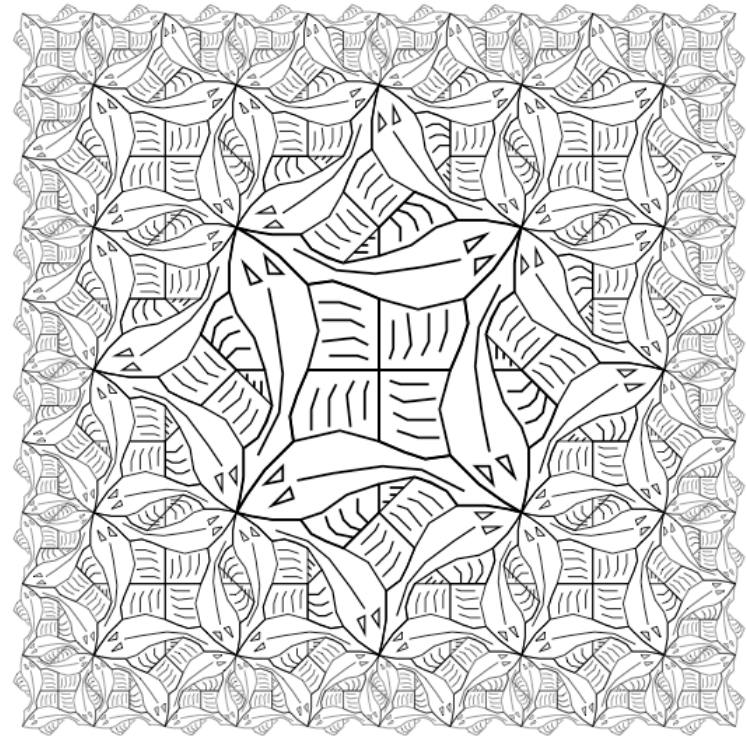
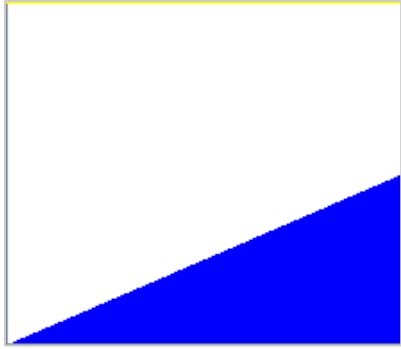Improvements
to typing
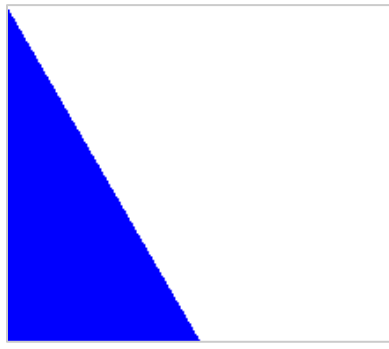and naming

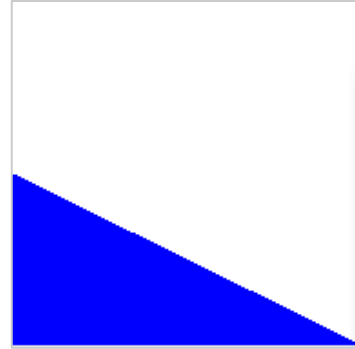# Wellesley CS111 TurtleWorld
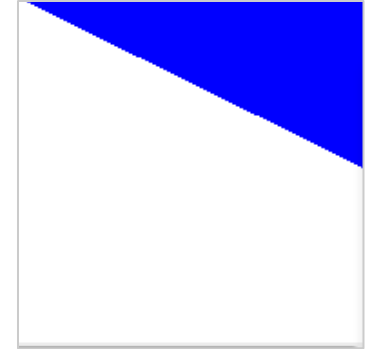
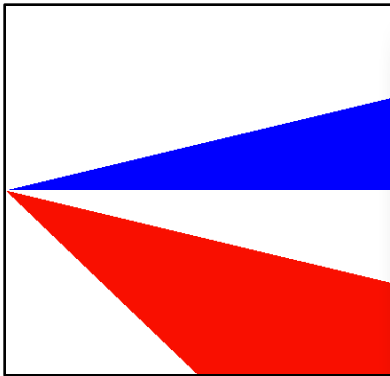# Peter Henderson's Picture Language
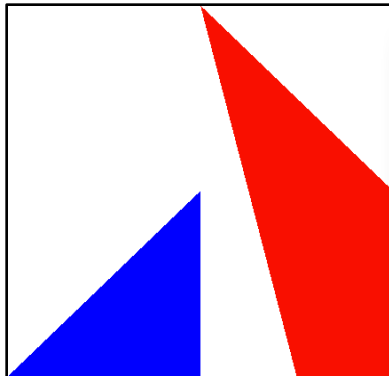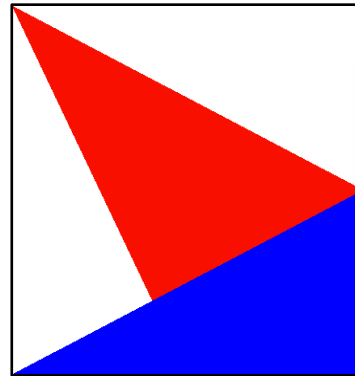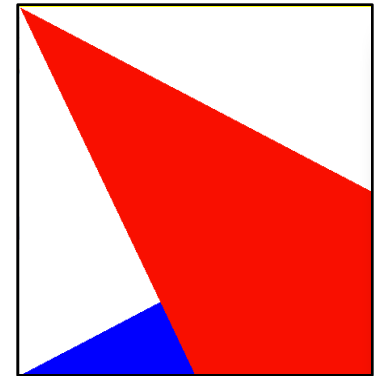
# Picture Combinators



bw

clockwise90(bw)

flipHorizontally(bw)

flipVertically(bw)

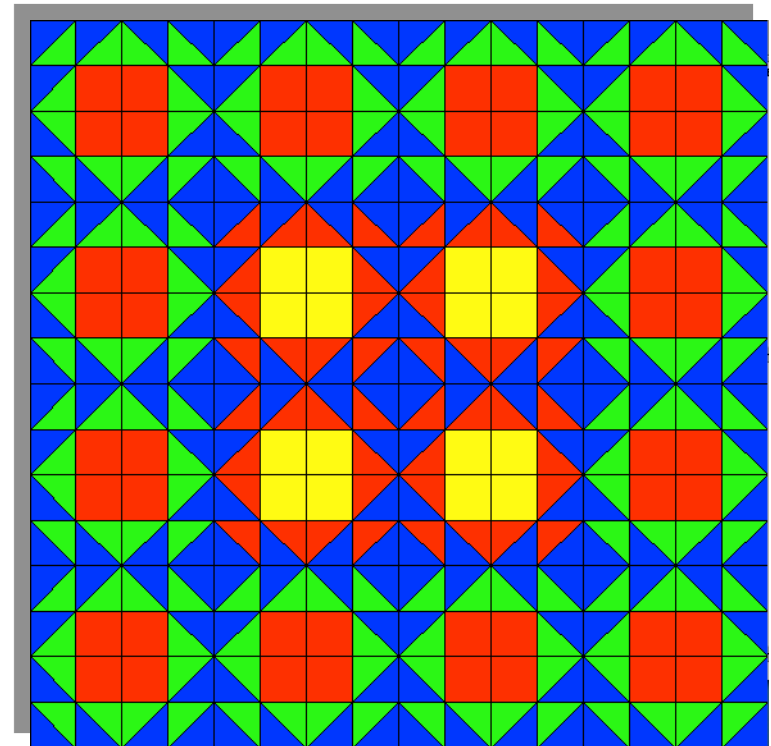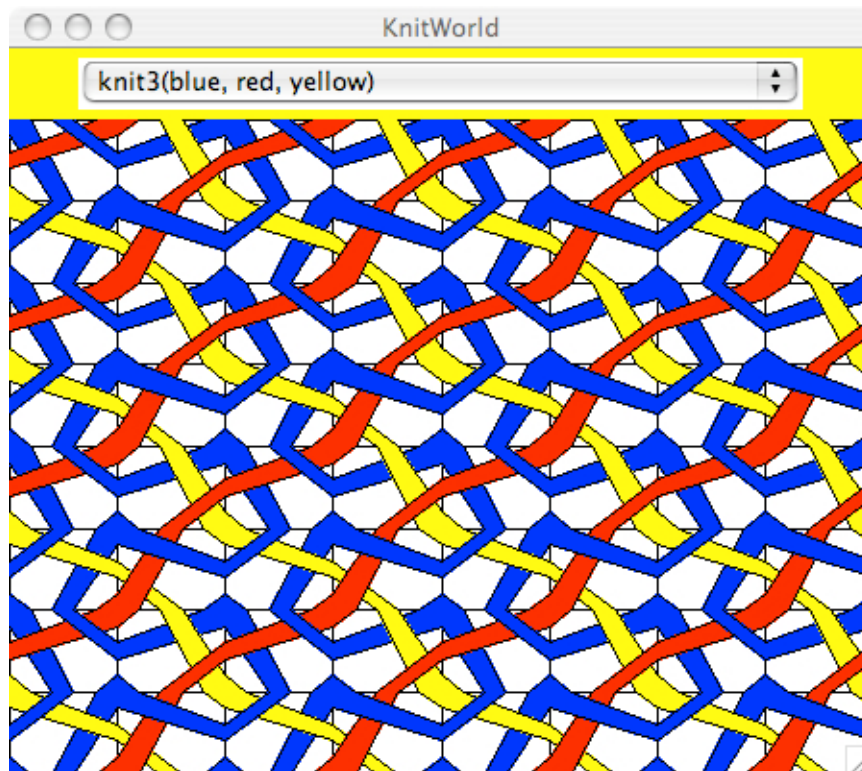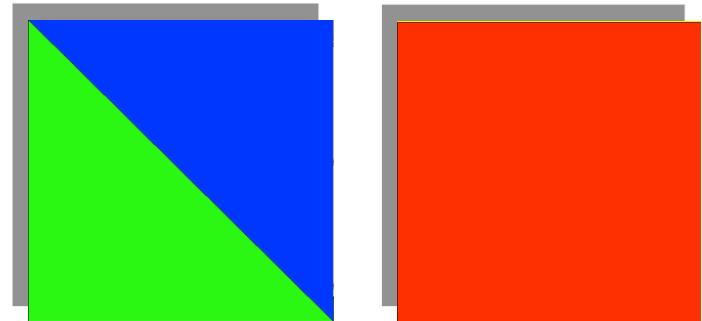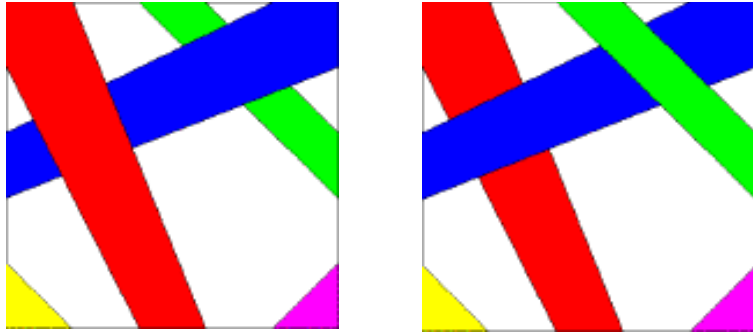above(bw,rk)

beside(bw, rk)

overlay(bw, rk)

overlay(rk, bw)

# Wellesley CS111 PictureWorld

Graphical
microworlds

Laser cutter and
vinyl cutter
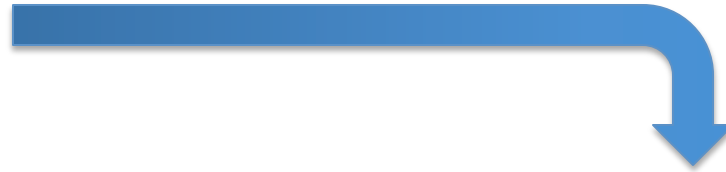
1

2

Blocks
programming

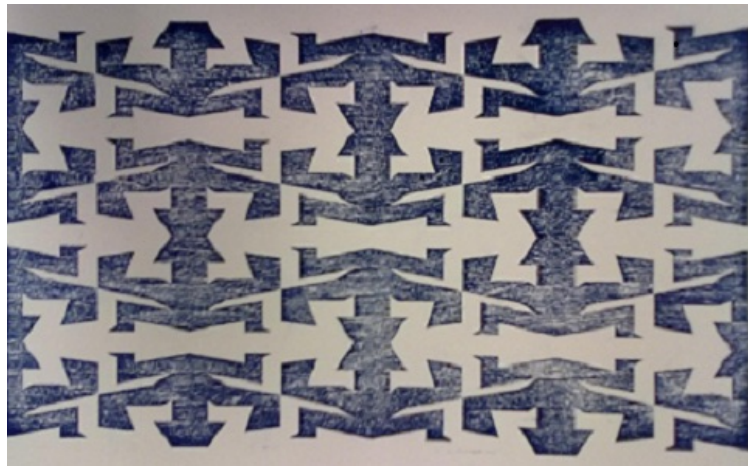Improvements
to typing
and naming

# Engraving is Easy

design
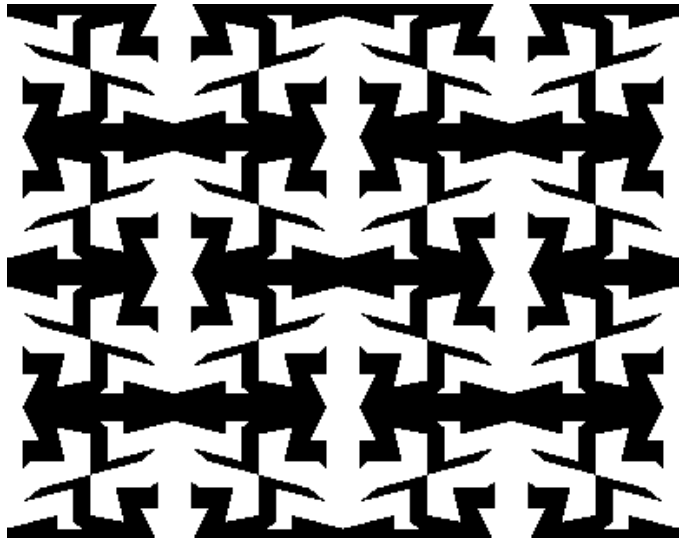


wood engraving

print from engraving

# Problem: How to Specify Cut Lines?
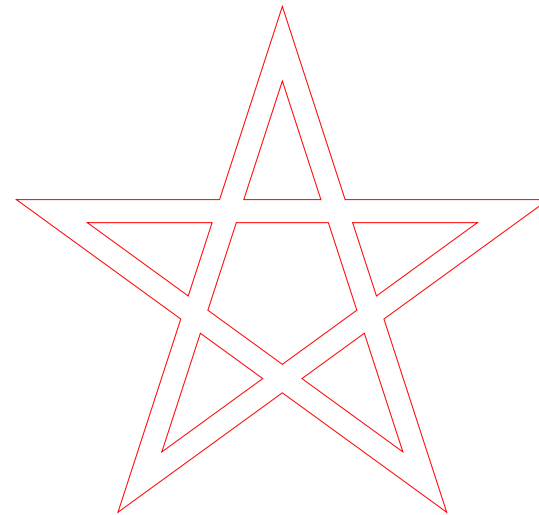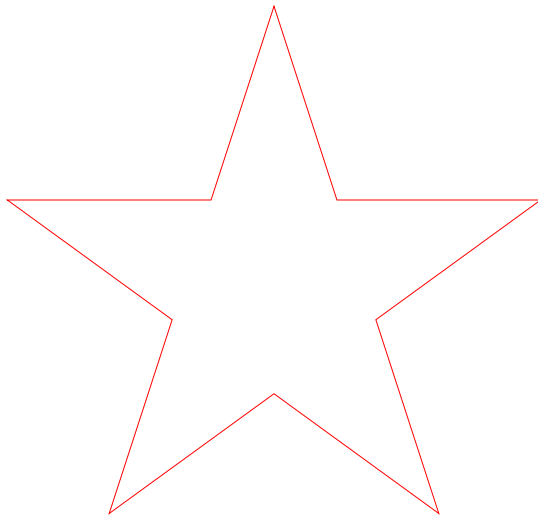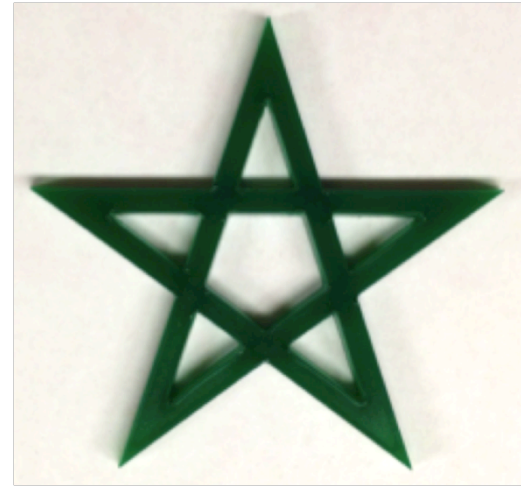
# Turtle Operations and Boundaries



fill

thick pen

boundary

boundary
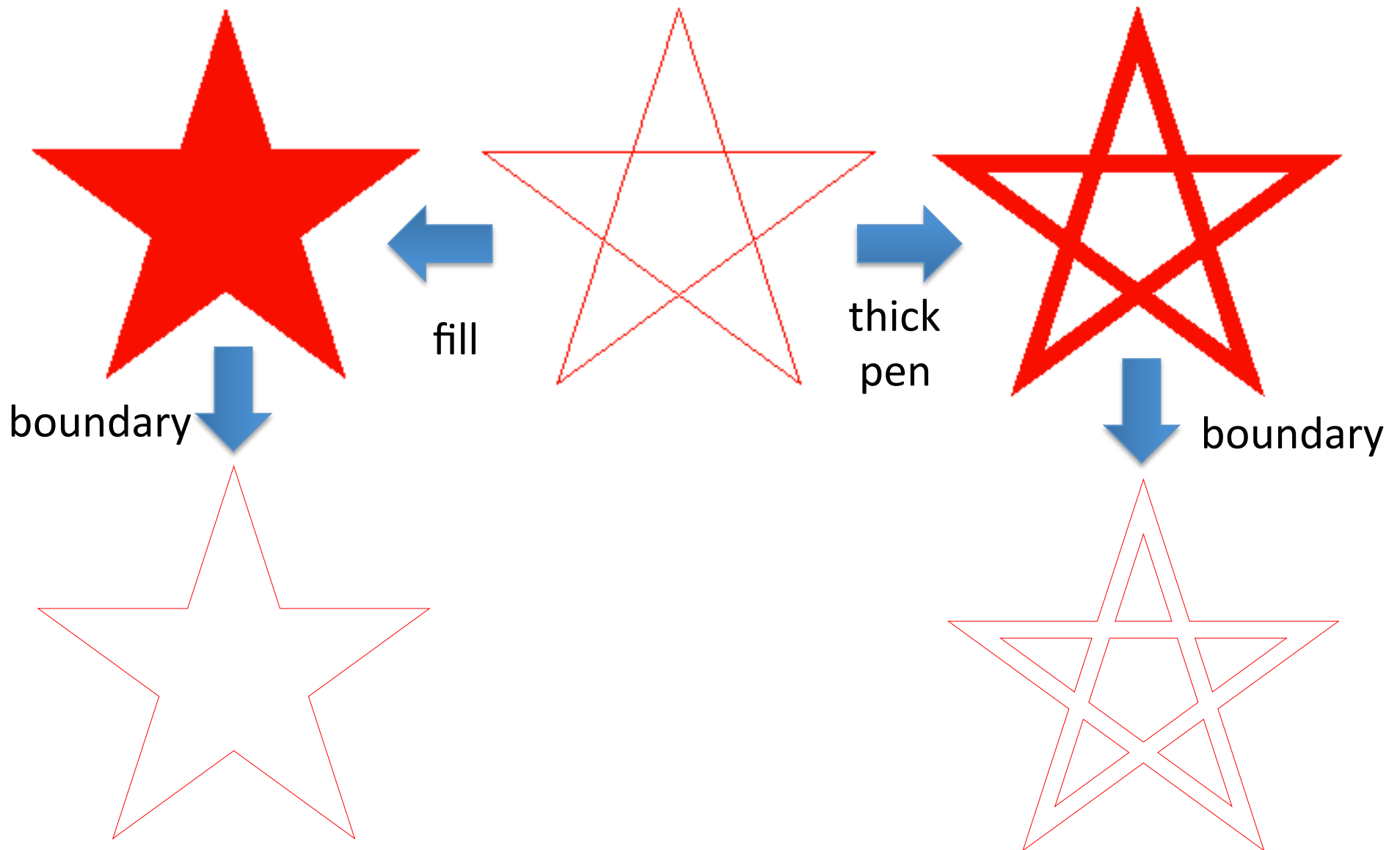
# Constructive Area Geometry
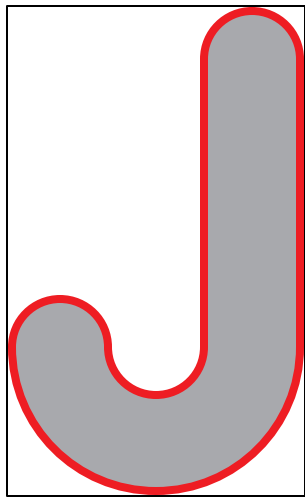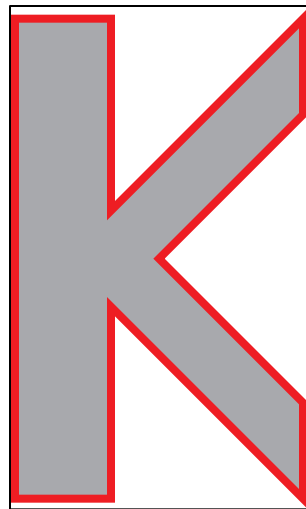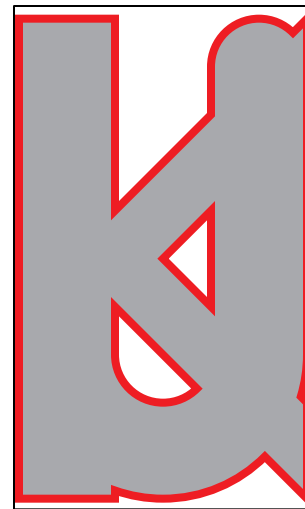


J                    K                    union(J,K)        difference(J,K)

These operations are provided in Java!

# Combining Cutting and Etching
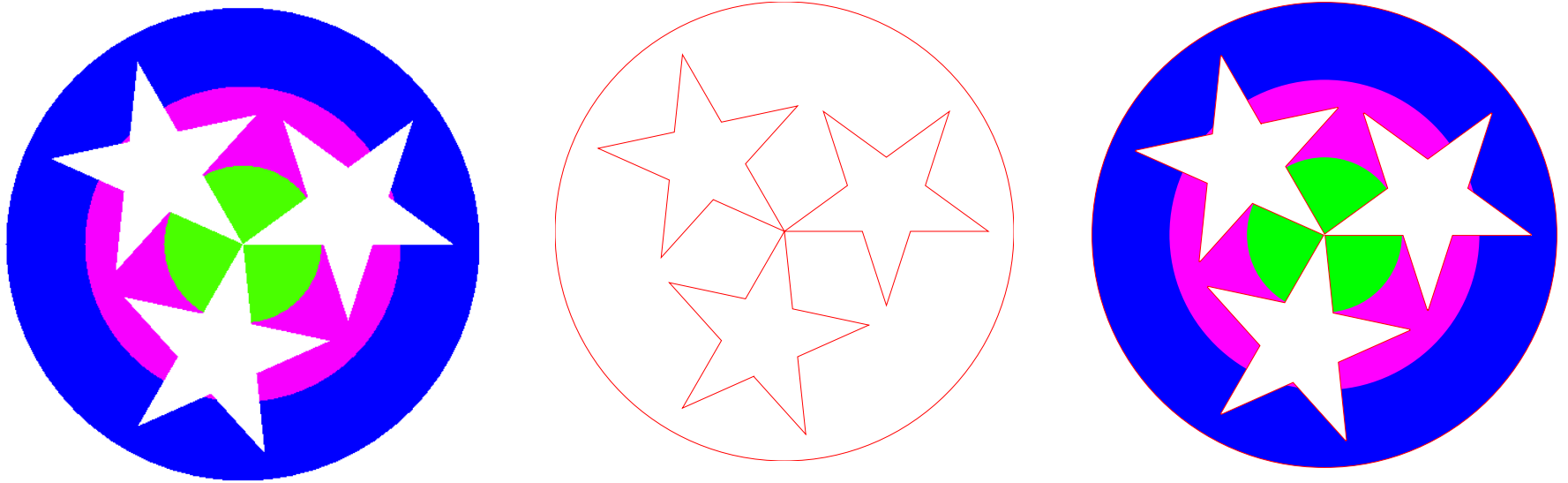
Graphical
microworlds

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vinyl cutter

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# Text vs. Blocks Turtle Programs
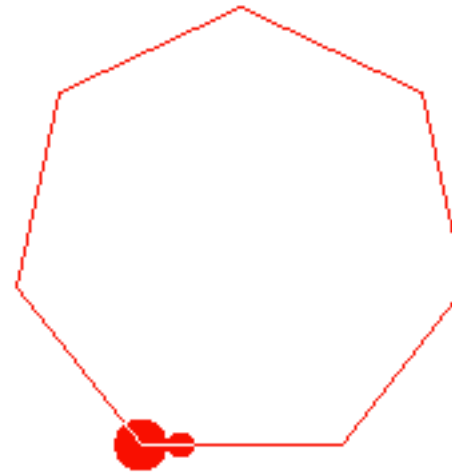


**TurtleBlocks**

# Blocks Languages: Growing in Popularity

**Scratch:** multi-media programs, animations, and games

**MIT App Inventor:** apps for Android smartphones

**StarLogo TNG**: simulations

**Blockly**: Being developed as User PL for Google products
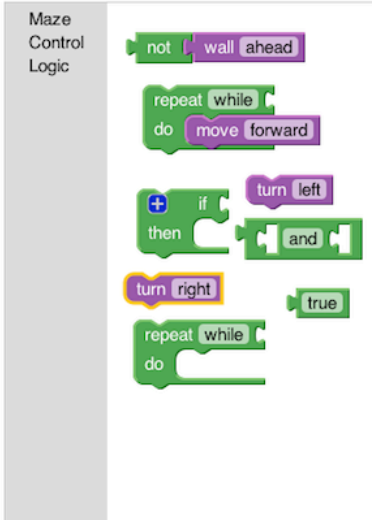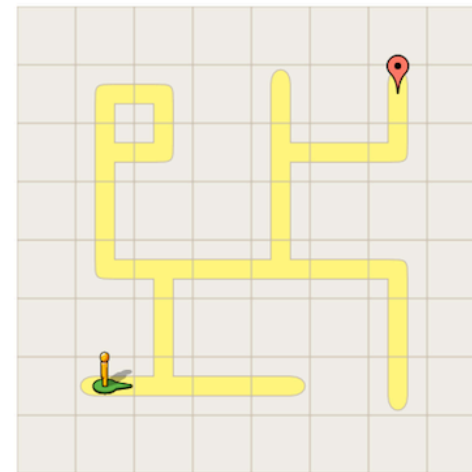
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# TurtleBlocks

TurtleBlocks program

turtle drawing



set corner type — SHARP

set thickness — 15

run once

repeat — times 5
do
forward distance 200
left degs 144
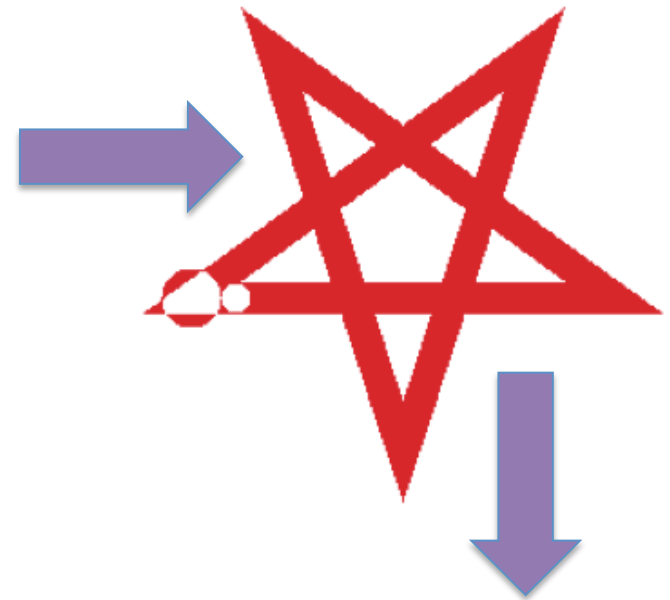
cardstock

acrylic
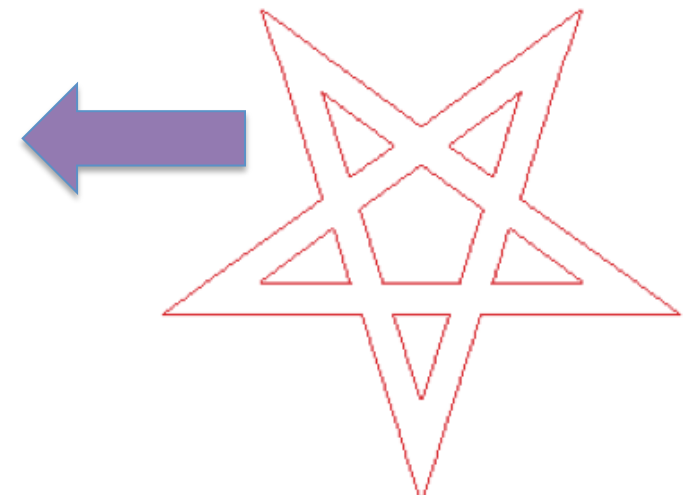
drawing boundary

# TurtleBlocks Artifacts
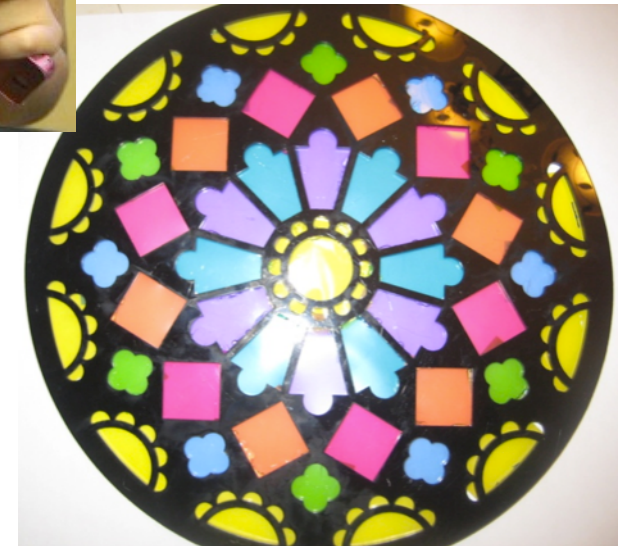
# PictureBlocks: Cutting

PictureBlocks program



wood artifact

picture boundary

resulting picture

# Sketcher: an easier way to create designs

# PictureBlocks: Sketching & Engraving

user sketch

PictureBlocks program

resulting picture



print from engraving

wood engraving

# PictureBlocks: Engraving + Cutting
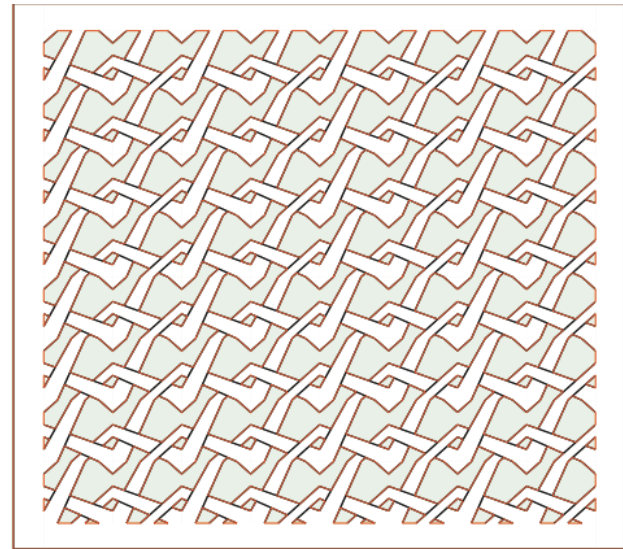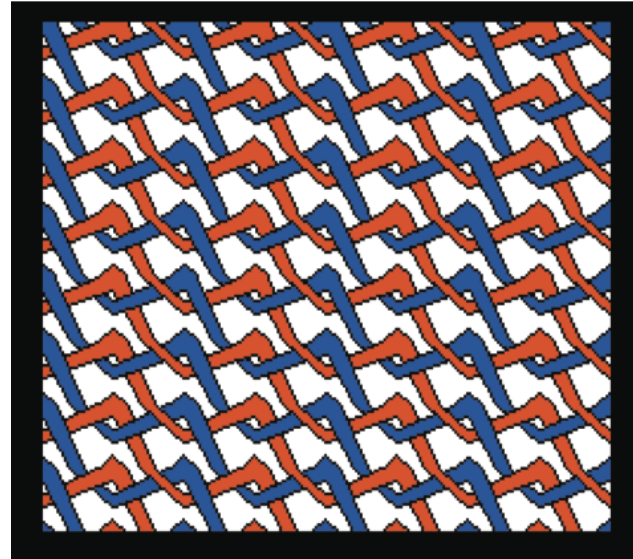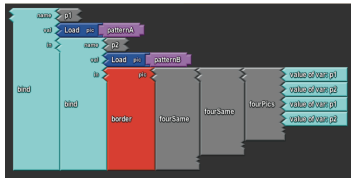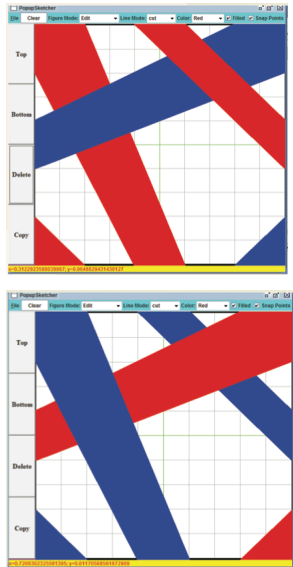
# PictureBlocks Artifacts
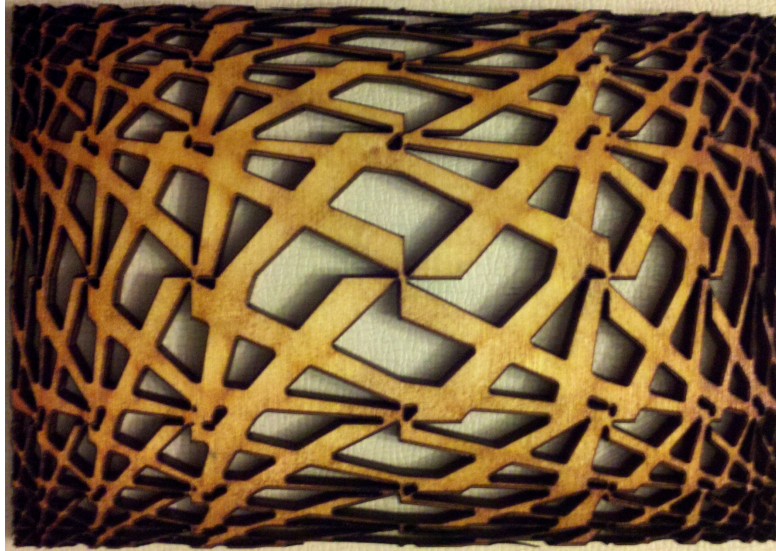
# Workshops

o   Four 70-minute TurtleBlocks workshops with 85 total CS111 students.
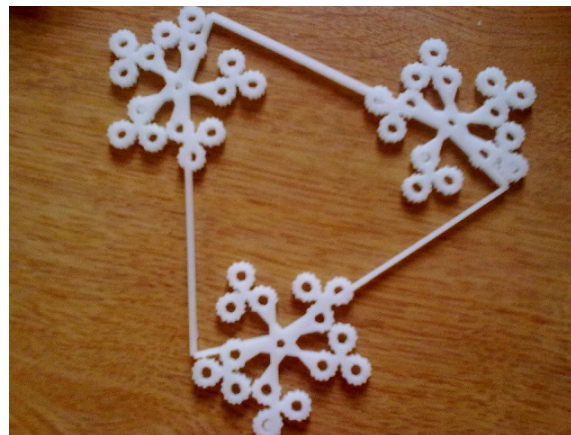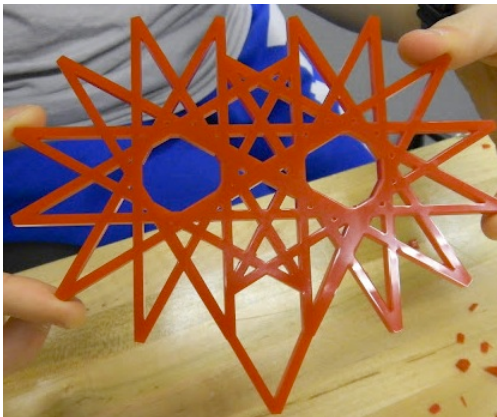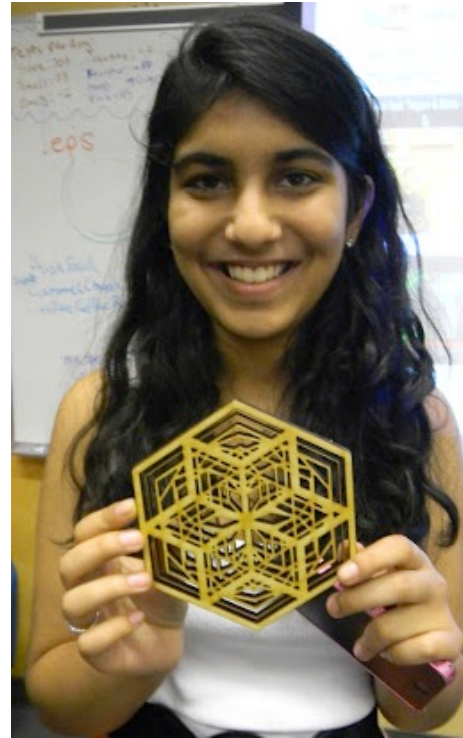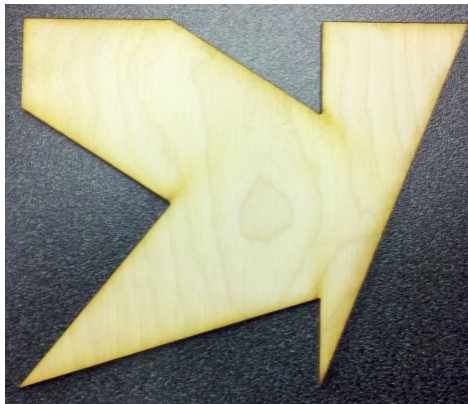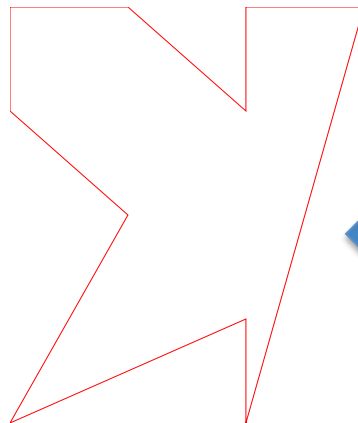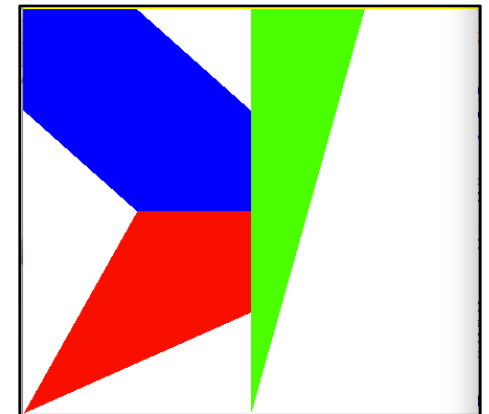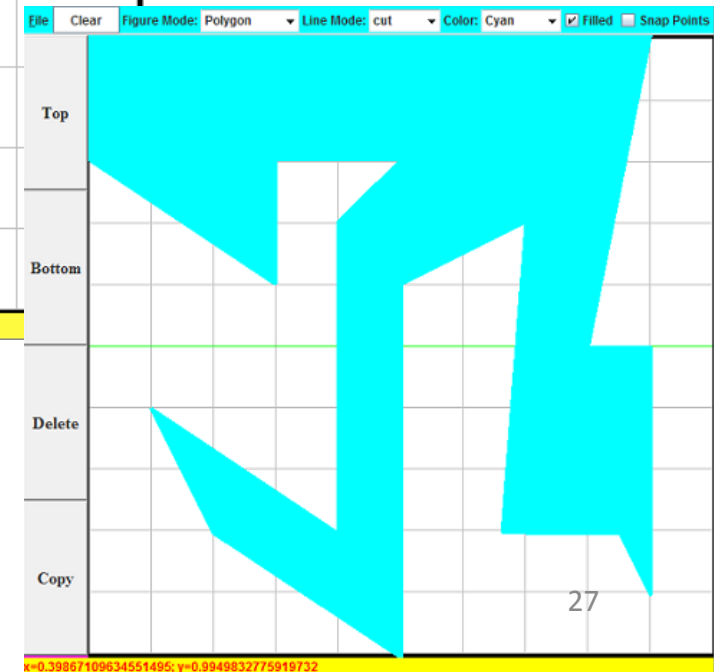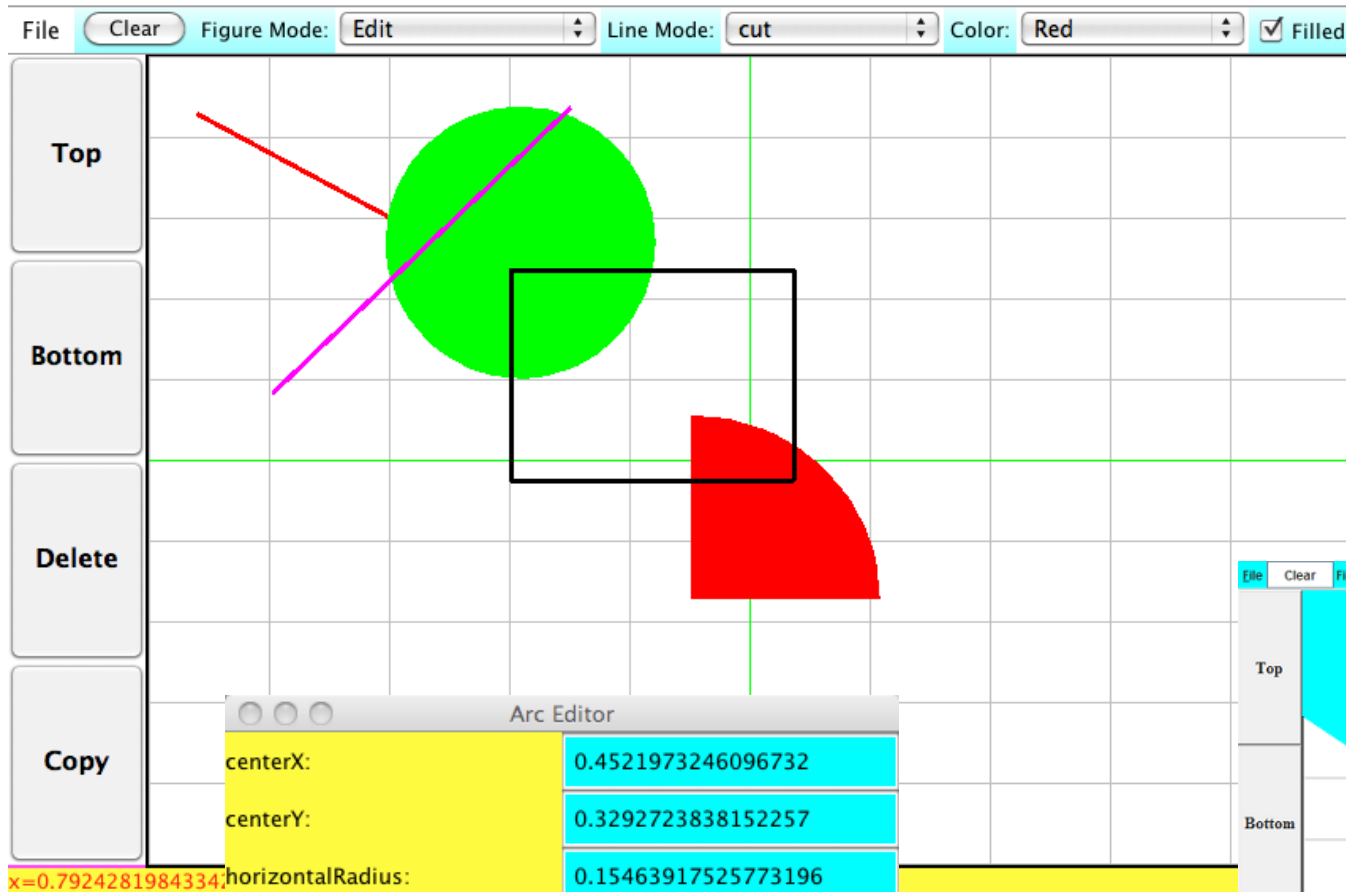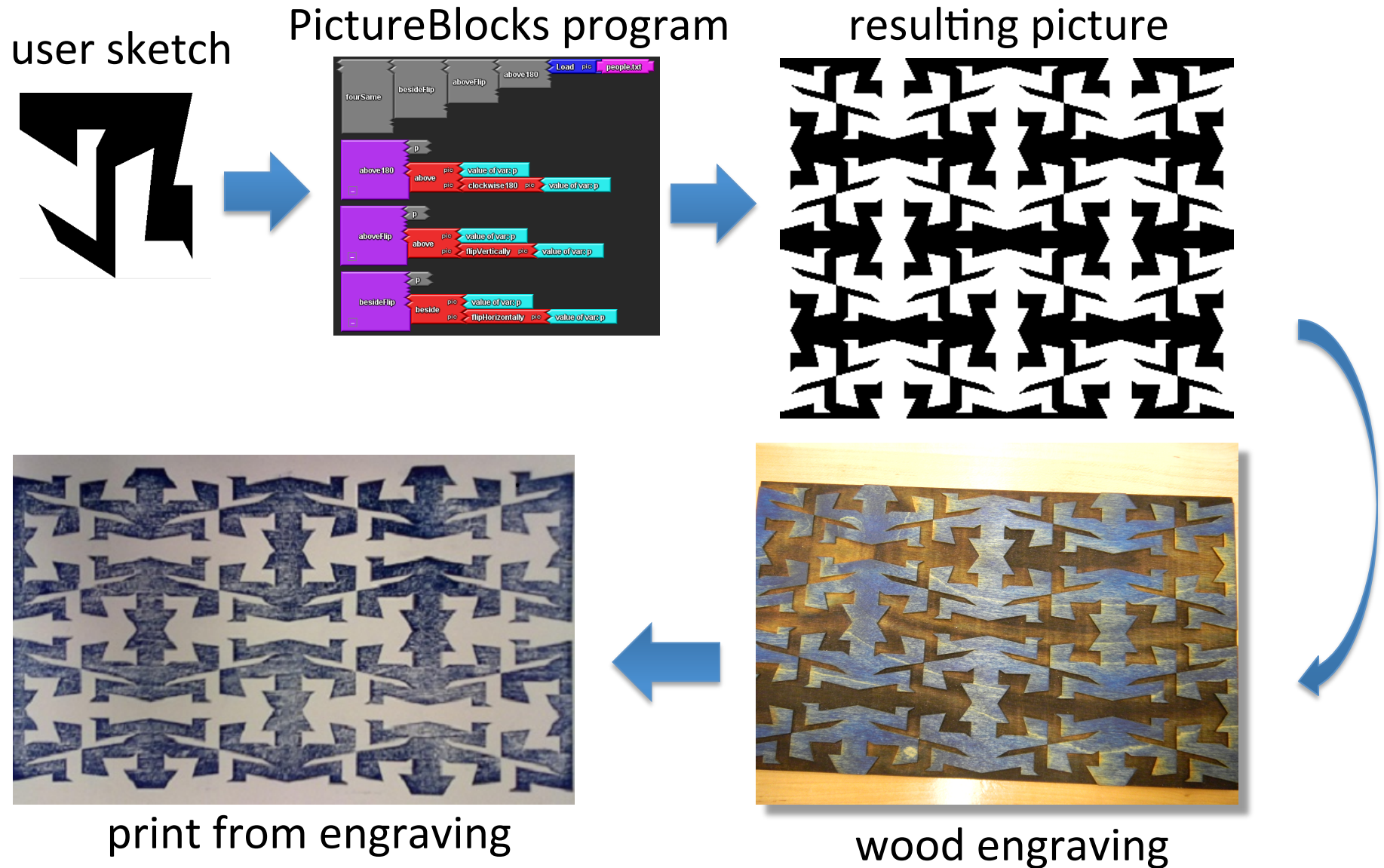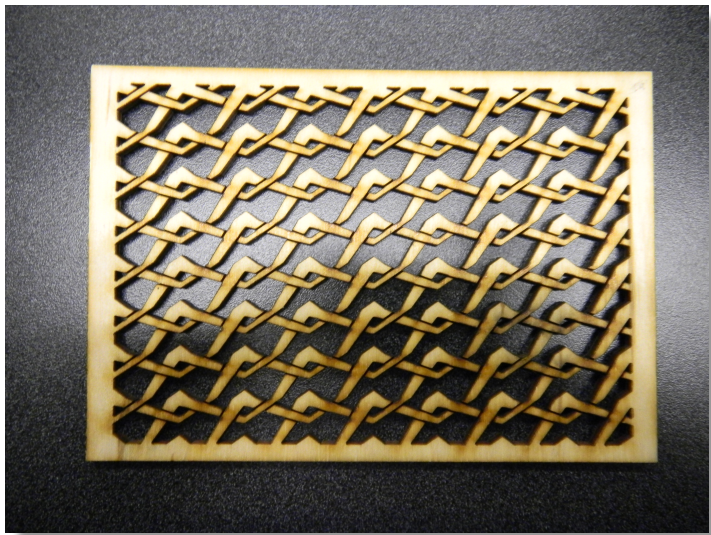
o   Two 70-minute PictureBlocks workshops with 40 total different CS111 students

o   One 2-hour TurtleBlocks workshop with 8 non-CS Wellesley students (6 with no prior programming experience).

o   One 3-hour TurtleBlocks/PictureBlocks workshop with 6 high school students and 2 non-CS Wellesley students (none with previous programming experience).  These results not in paper.

o   Workshops emphasized designing tangible artifacts, not blocks programming features.

o   Students asked to complete online survey about experience:

  •   29/125 CS111 students completed survey

  •   15/16 non-CS111 students completed survey

# Tangible Output is Motivational

41/44 respondents found tangible output more compelling than designs on screen/paper:

o   "creating the physical artifact was definitely the highlight of my week and I immediately texted a picture of it to my parents and showed my owl to everyone I knew for the next couple of days."

o   "The ability to actually hold what you created was a lot more motivating than just making a picture on a computer screen."

o   "I feel that these designs are definitely more compelling than on screen or on paper because once the designs are cut, they are physical and permanent representations of a design. They become real, instead of just ideas on paper."

o   "I found it to be more interactive as well as more intellectually compelling. I thought that the idea of printing the design out in wood inspired me to want to construct better, more creative images."

o   "The combination of man's artistic nature with innovative technology is simultaneously appealing and nostalgic."

# Other Feedback

o Desire to sketch is important for many designs

o Many CS111 students found blocks too tedious

o Easier to make designs in TurtleBlocks than PictureBlocks.

o Designing robust structures is challenging

Graphical
microworlds
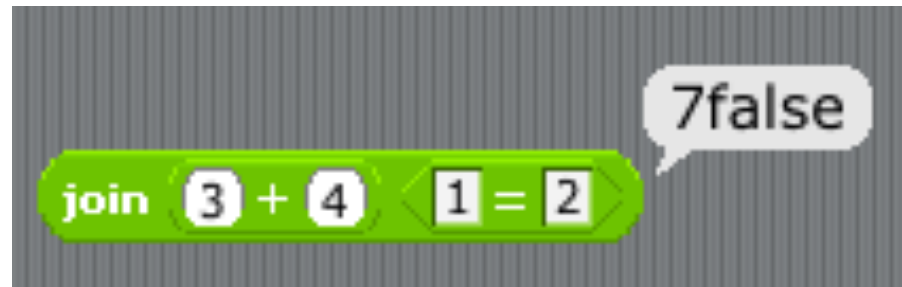
Laser cutter and
vinyl cutter

1

Blocks
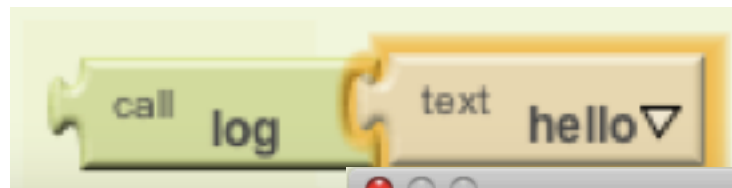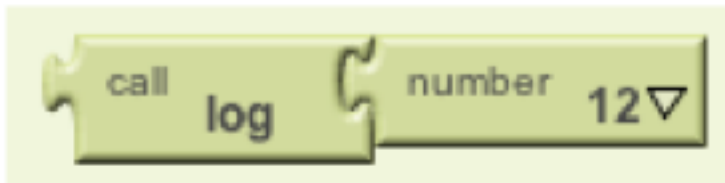programming

2
Improvements
to typing
and naming

# Turtle/PictureBlocks Implementation

| TurtleBlocks & PictureBlocks | |
|---|---|
| StarLogo TNG | App Inventor |
| OpenBlocks Java Framework (Roque MIT Masters, 2007) | |

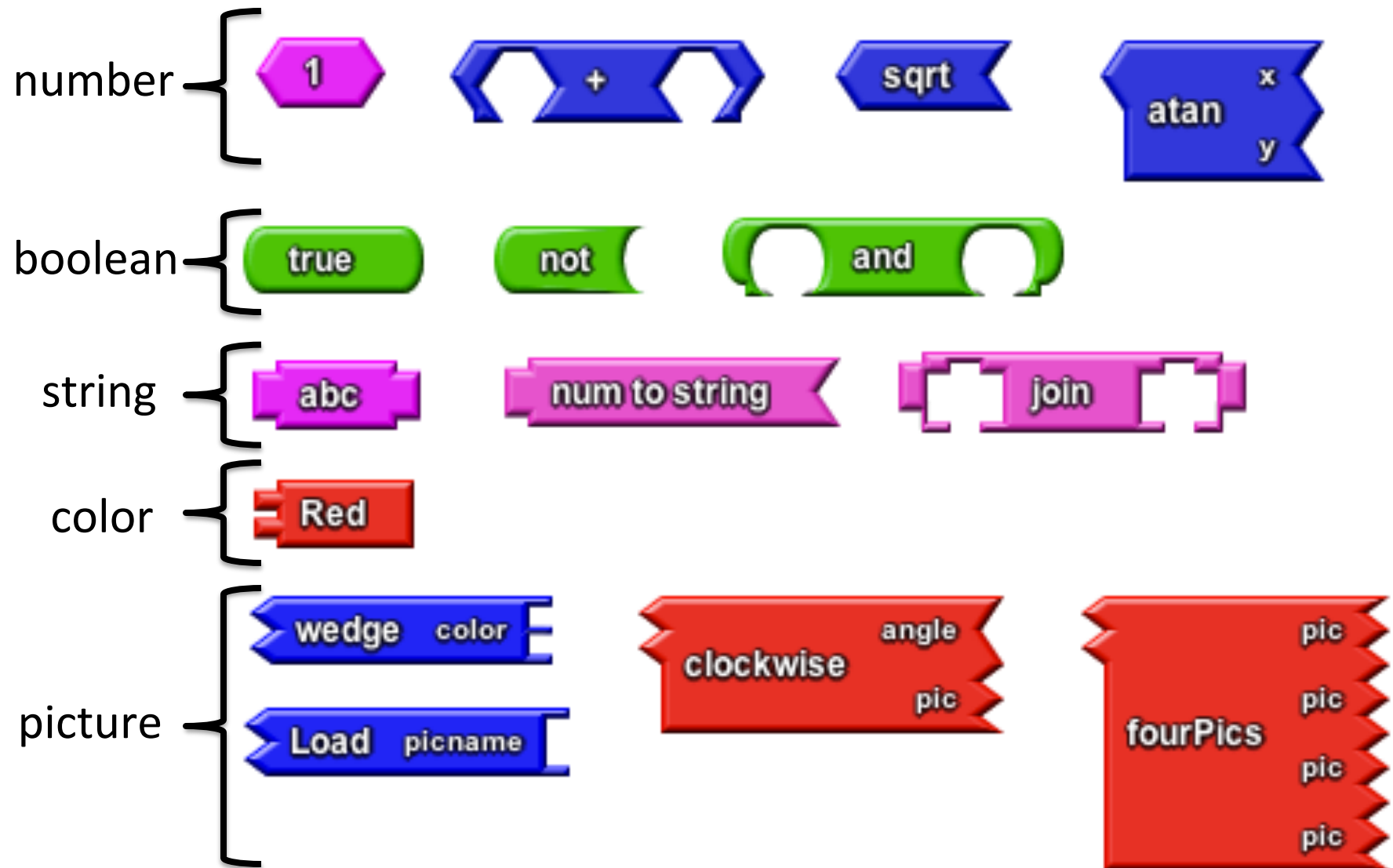# Types in Scratch

# Types in App Inventor
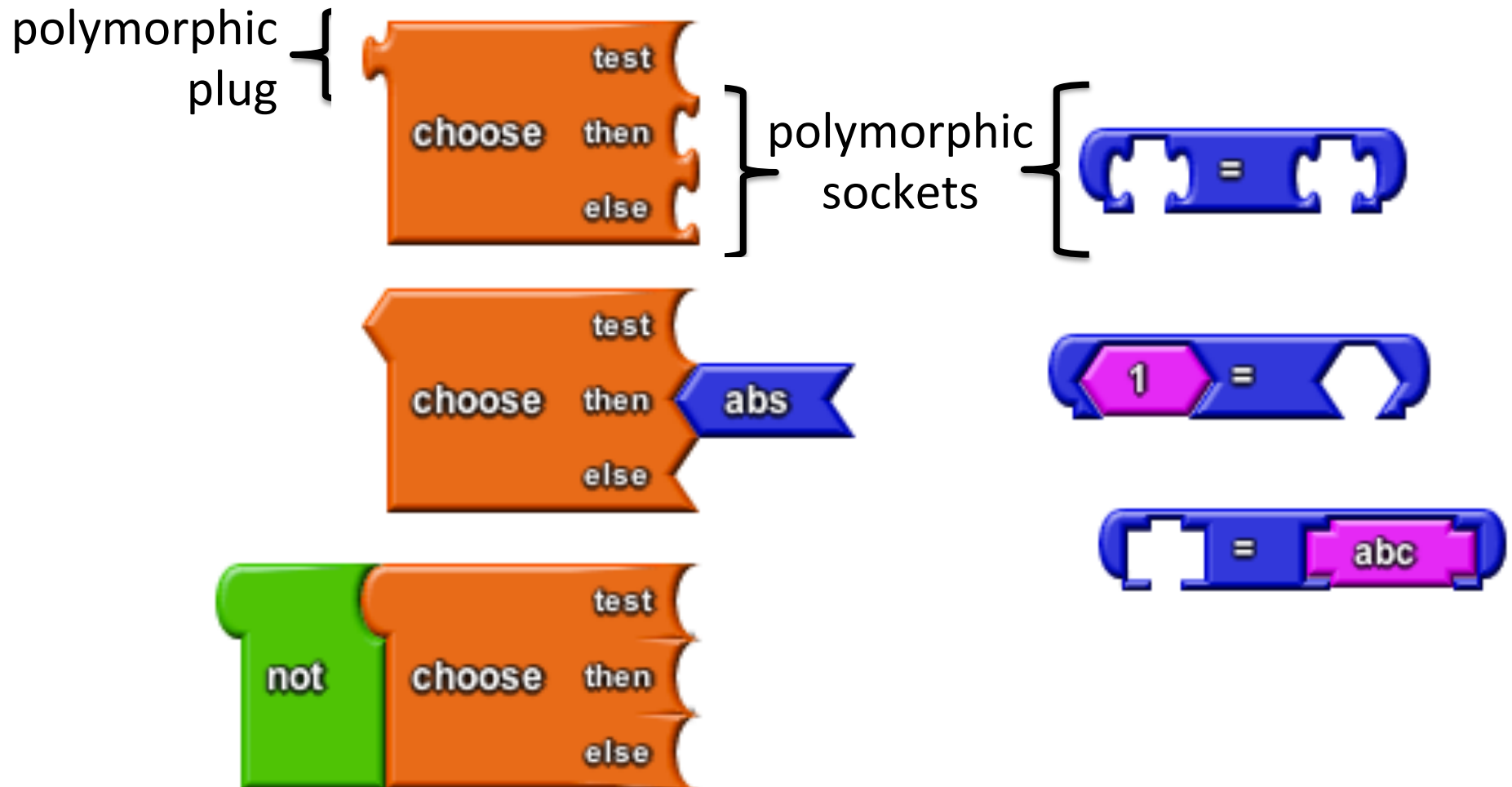


programming time error!

runtime error!
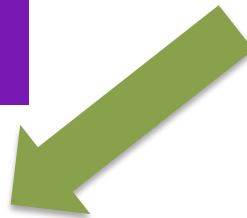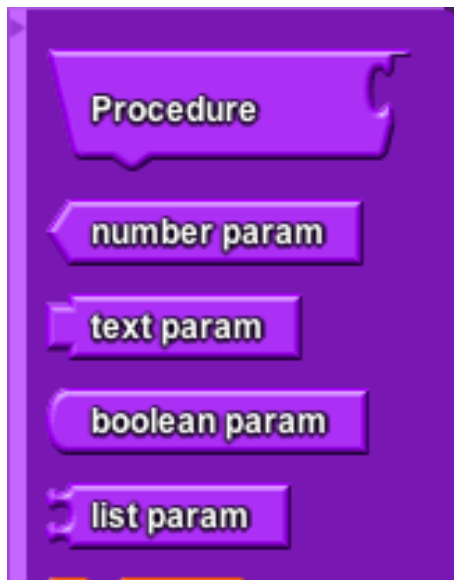
# Connector Shapes in PictureBlocks
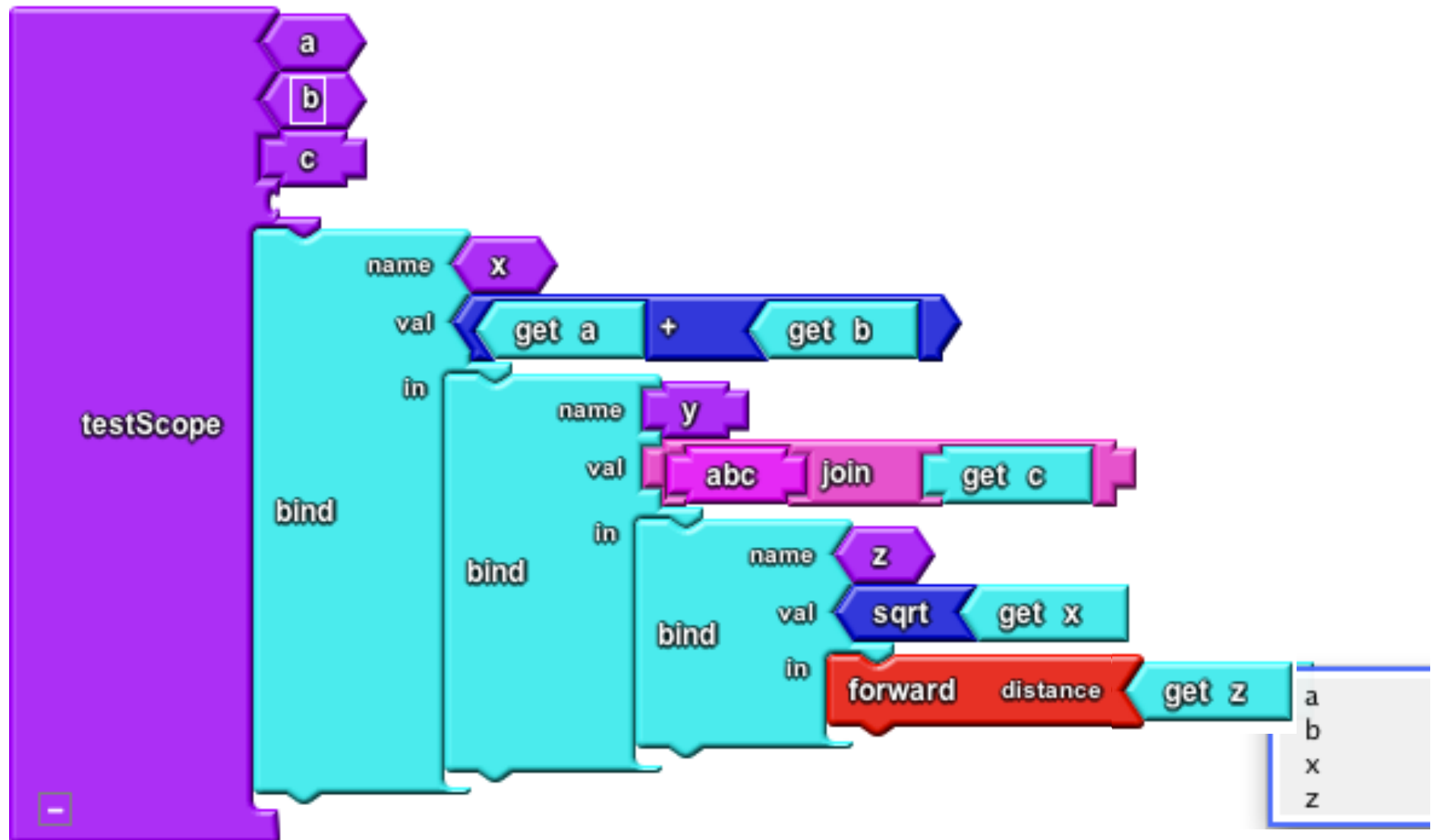
# Polymorphism in Turtle/PictureBlocks
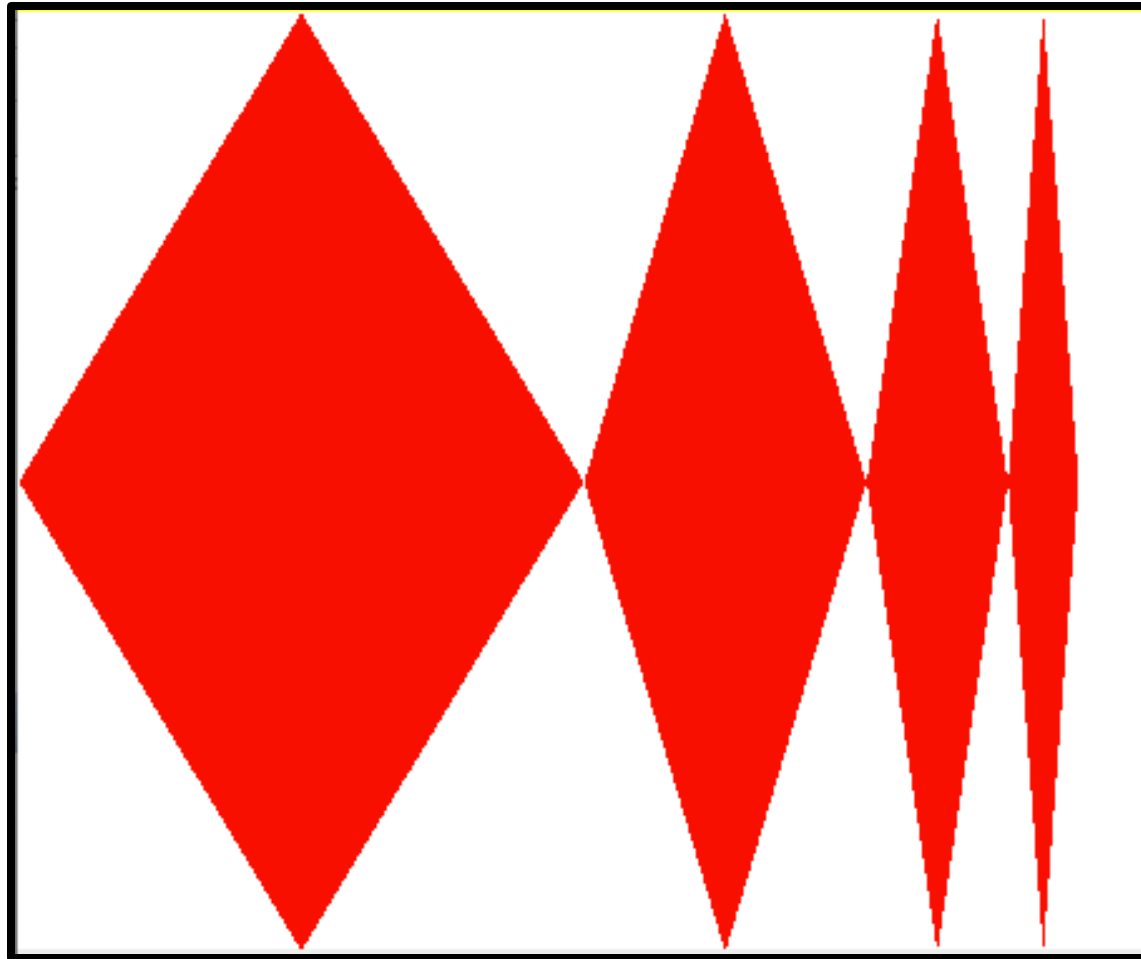
# Broken Procedure Parameter References

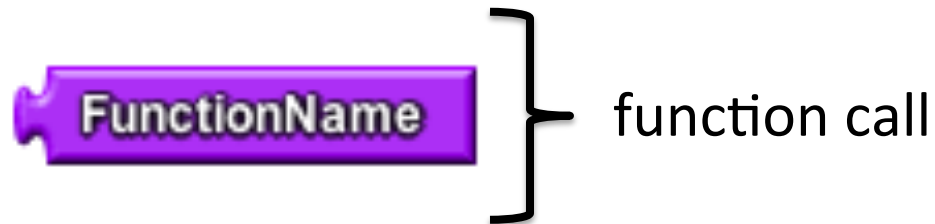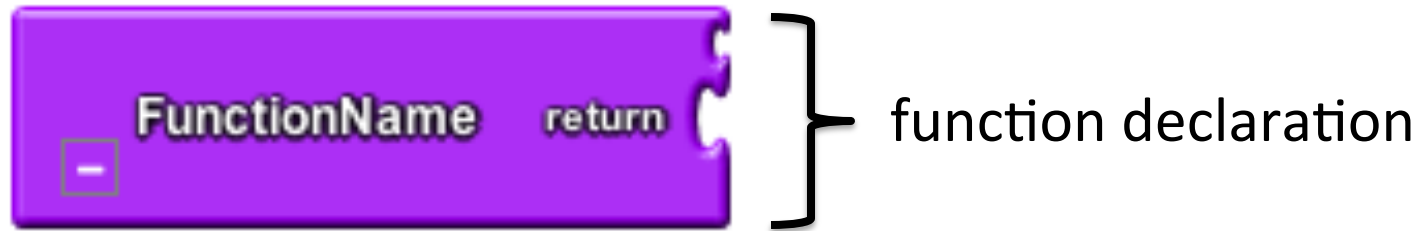Example: Procedure Parameters in StarLogo TNG (similar in AppInventor)
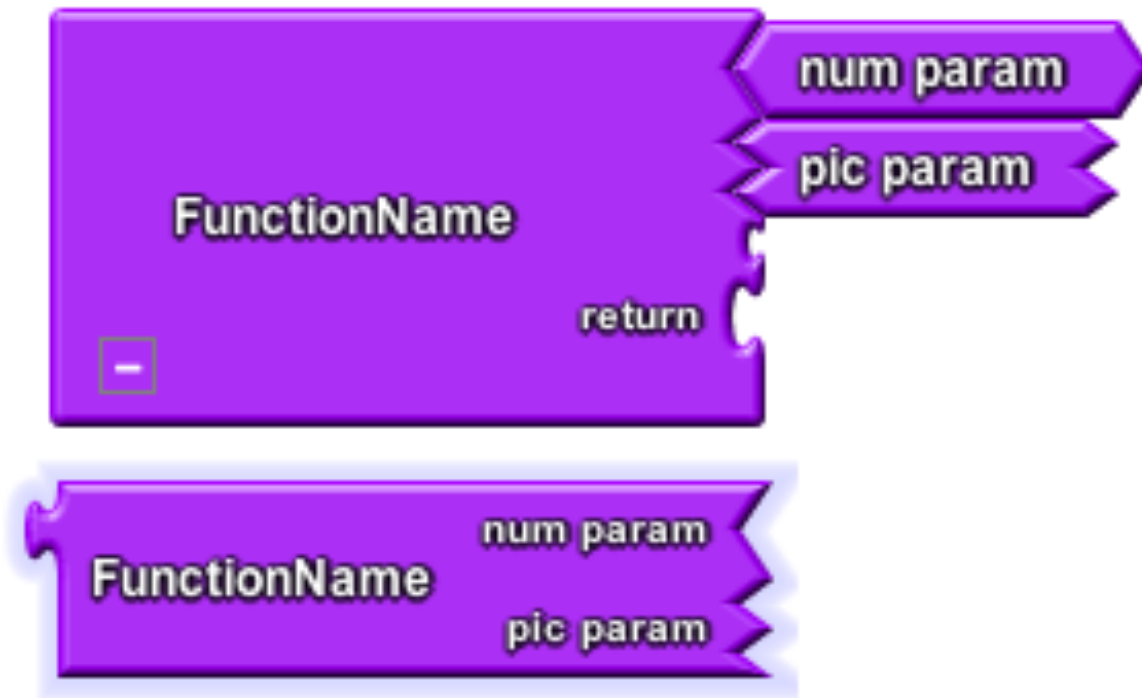
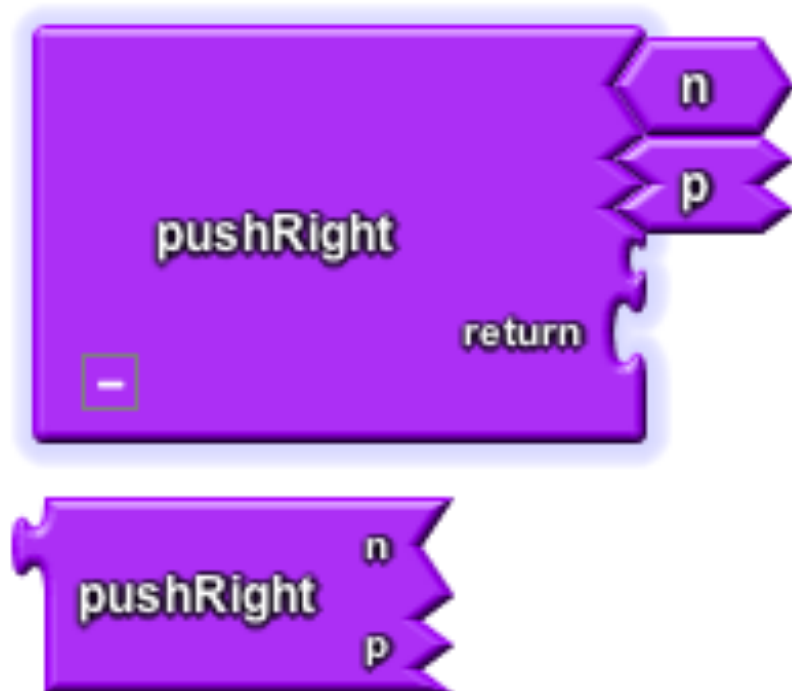# Variable Scope in Turtle/PictureBlocks

# How to Define pushRight?

# pushRight: Create Declaration and Call



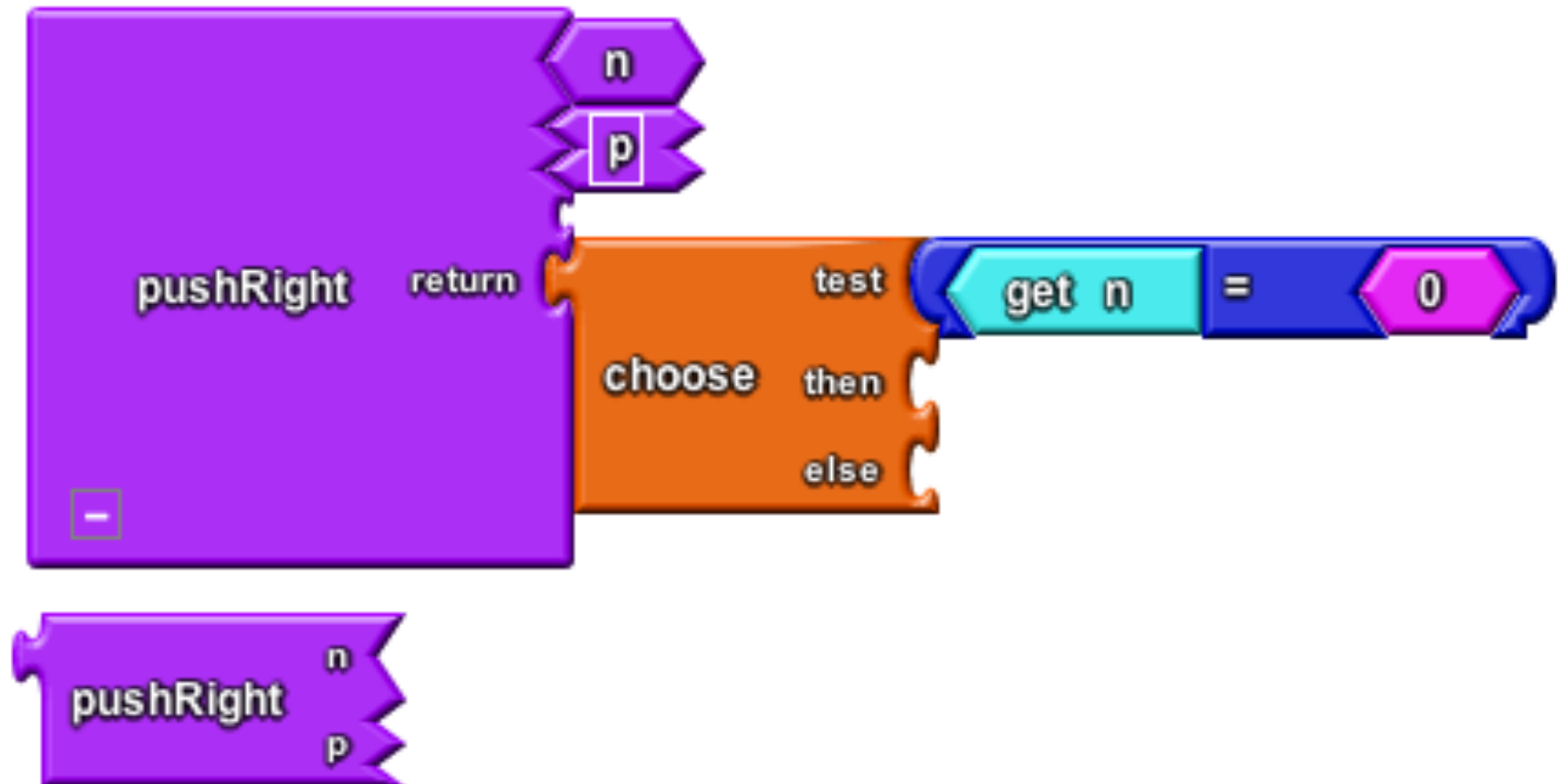function declaration

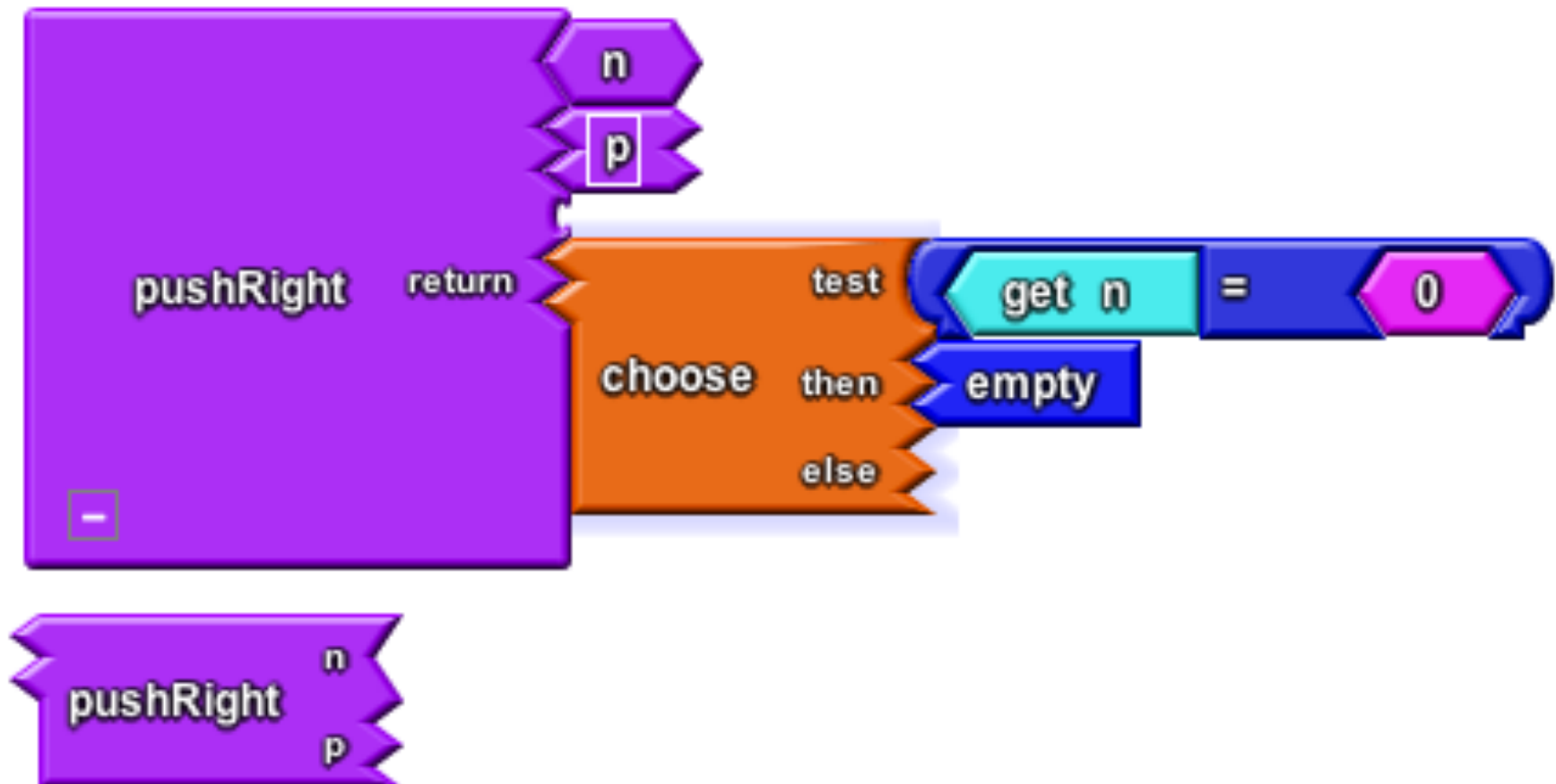function call

# pushRight: Add Parameters

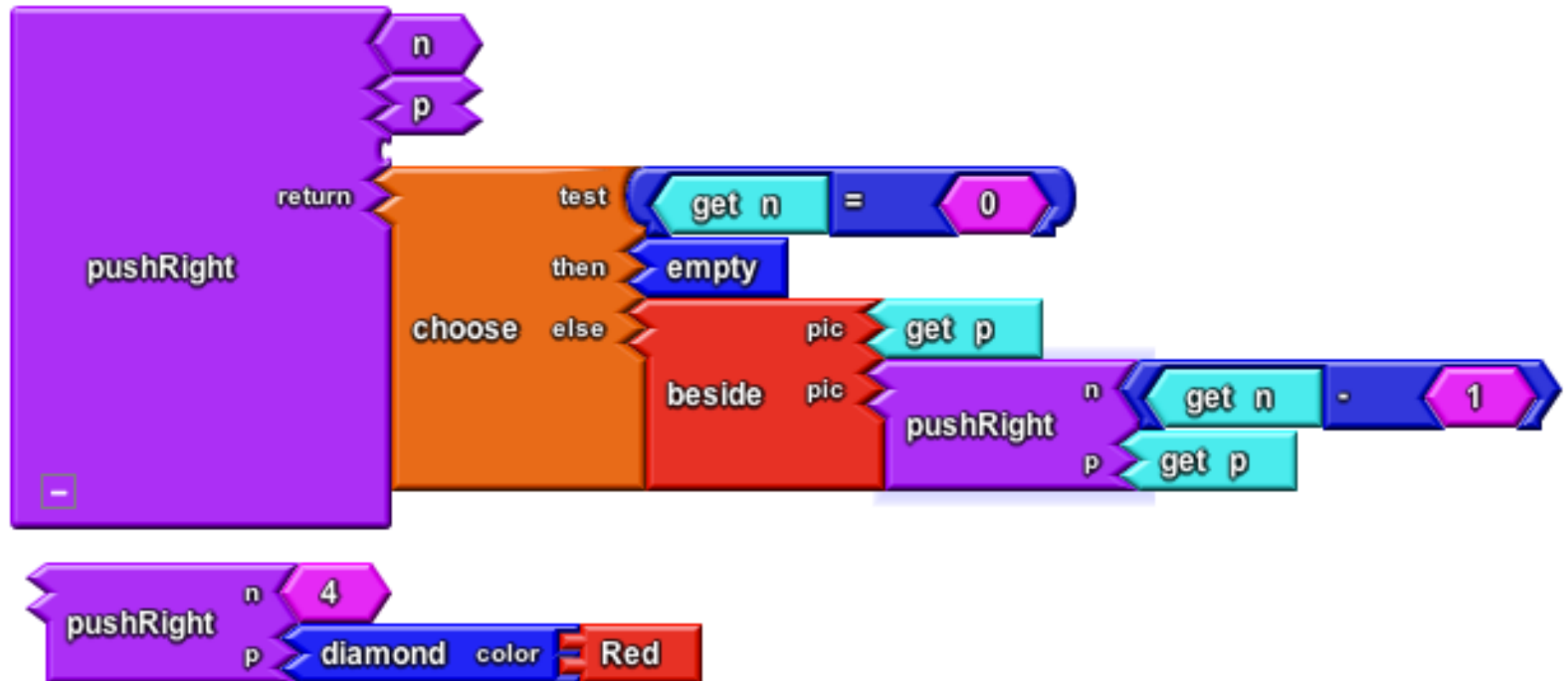# pushRight: Rename Function & Params

# pushRight: Start Function Body
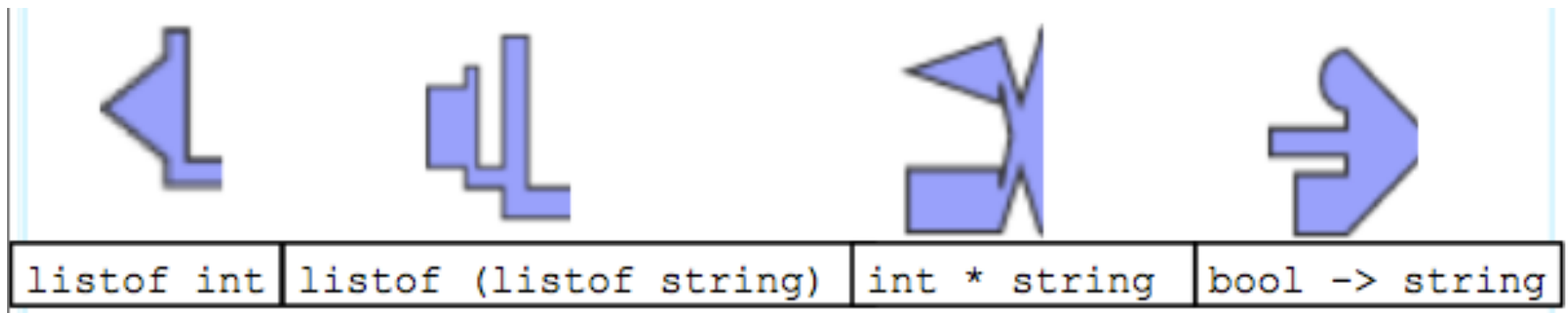
# pushRight: Specify Base Case

# pushRight: Complete Declaration and Call

# Future Work

o   Evaluate new blocks features

o   Improve App Inventor blocks language & environment

o   Explore blocks typing in blocks-based functional language; Marie Vasek has already made progress on this with her TypeBlocks work:

| listof int | listof (listof string) | int * string | bool -> string |
|---|---|---|---|

o   Environments for 3D artifacts and popups

o   Support for debugging and visualization of dynamic program execution in blocks languages.

o   Blocks language generators

# More Info: www.tinkerblocks.org