Blocks Languages for Creating Tangible Artifacts

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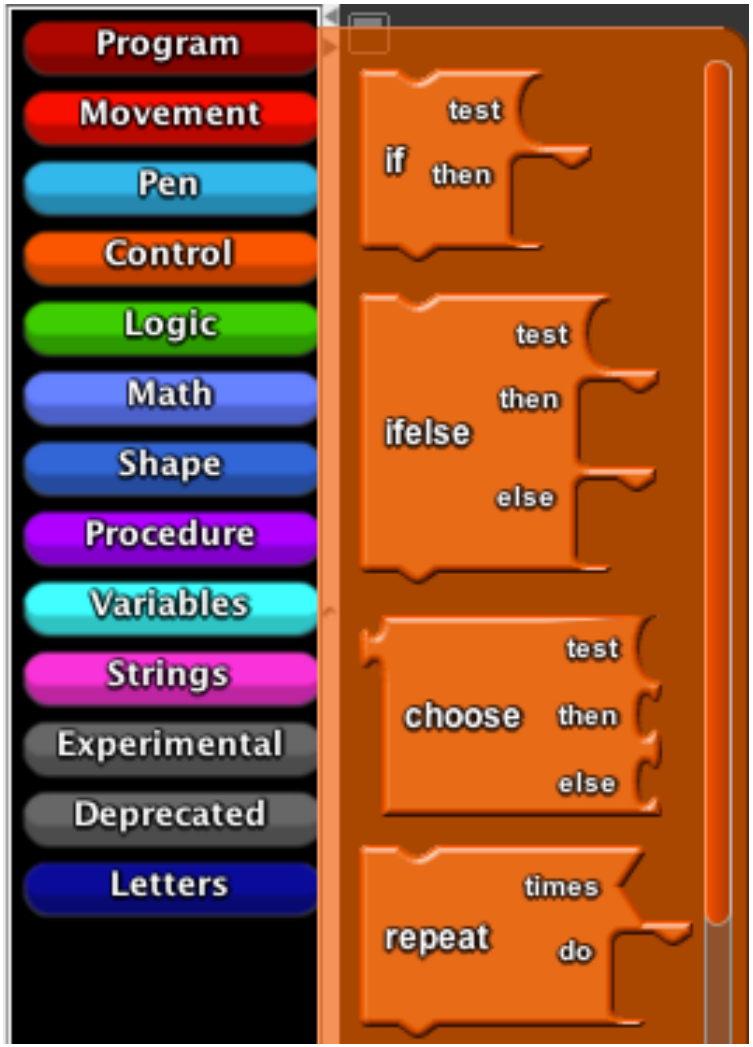
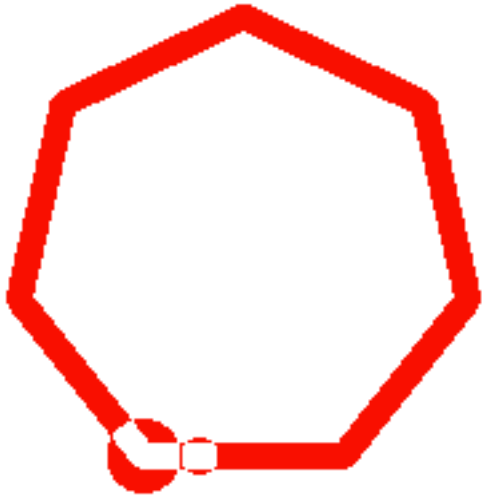
Overview

- The big picture:
  - What are blocks programming languages?
  - Who/what are they good for?
  - Why should you care about them?

- What we've done:
  - TurtleBlocks: Logo turtles
  - PictureBlocks: Henderson's picture language
  - Better handling of names in blocks languages
  - Enable creating tangible artifacts with these environments

What Are Blocks Languages?

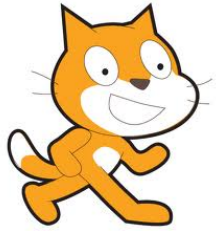




Who/What Are They Good For?

- Novices learning programming
- Occasional programmers
- Understanding programming language features
  - Statements vs. expressions
  - Procedures and invocations
  - Naming
  - Typing (Marie Vasek's talk)
- Democratizing programming in interesting domains
  - Animations/games (Scratch)
  - Smartphone apps (App Inventor)
  - Multi-agent simulations (StarLogo TNG)
  - Robotics (PicoBlocks)
  - Microprocessor programs (ModKit)
  - Tangible artifacts (TurtleBlocks & Picture Blocks)
- Personal programs

Why Care: Popularity



Scratch: 5 million downloads, 2.6 million projects shared, 330,000 sharing users

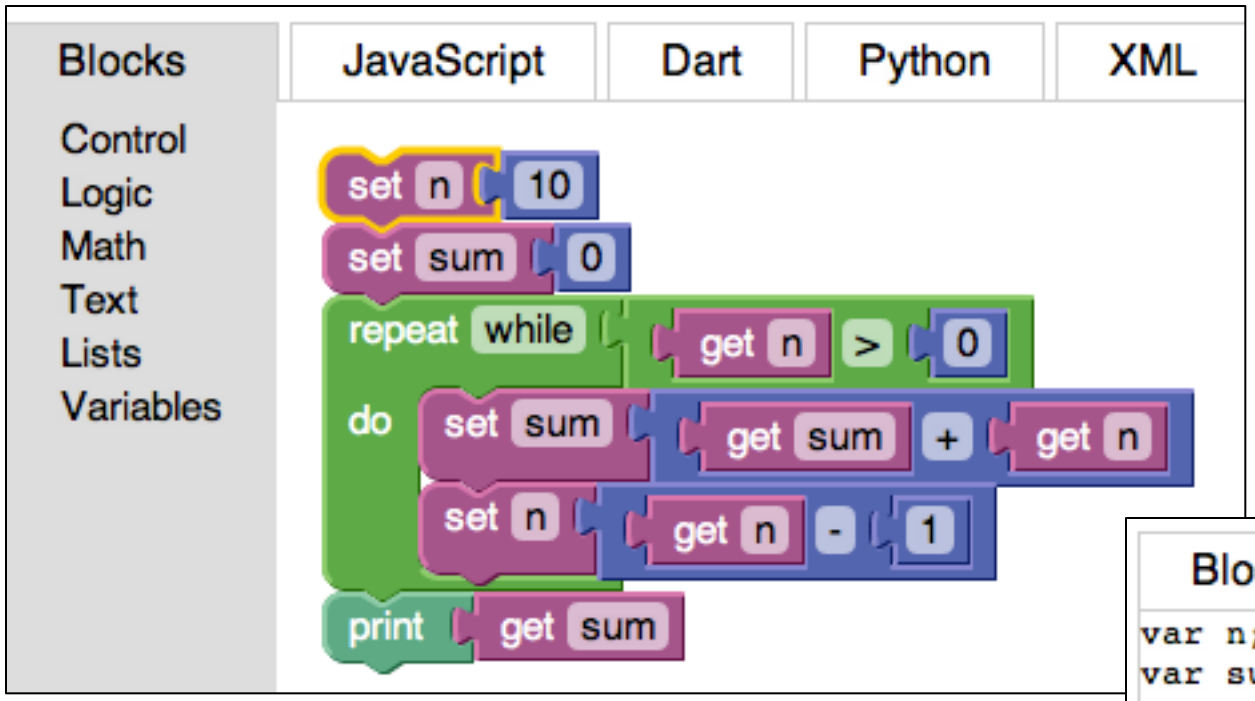
MIT App Inventor: 195,000 users and growing

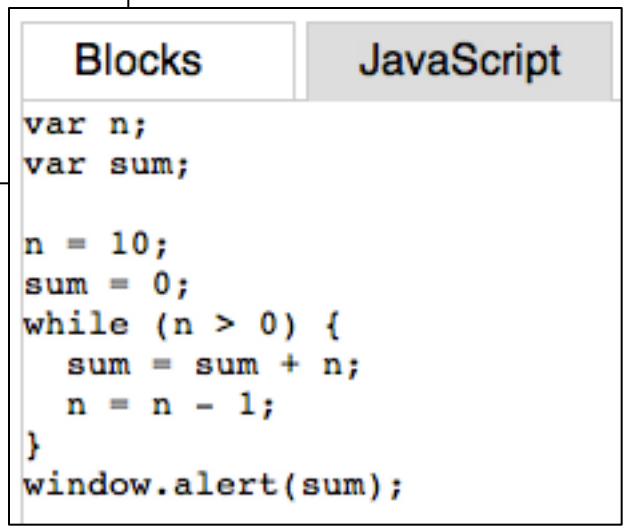
StarLogo TNG: 120,000 downloads

Blockly: Being developed as user PL for Google products

Also: BYOB/Snap, Panther, WebLogo, TaleBlazer, TurtleArt, PicoBlocks, ModKit, WaterBear, …

Blockly (Neil Fraser @ Google)

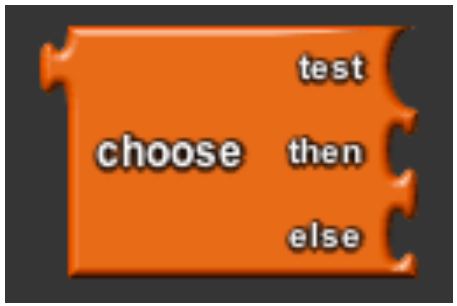


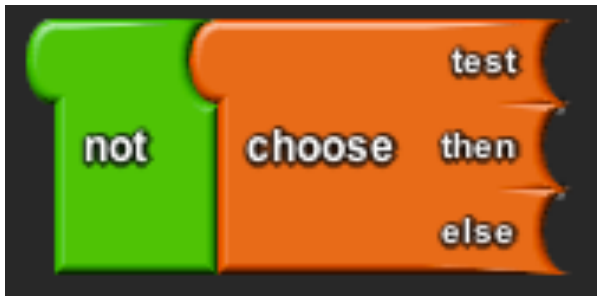


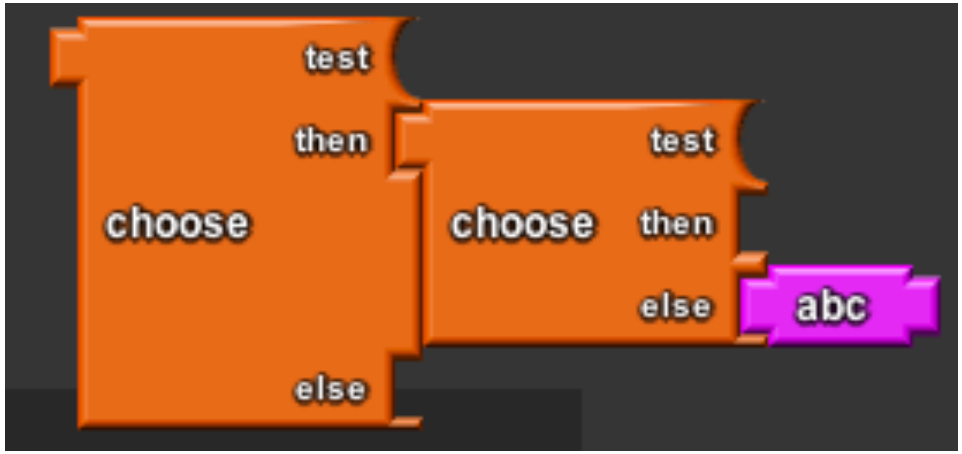
http://neil.fraser.name/software/blockly/demos/code/

Why Care: Visualizing Features

Example: choose block (if expression) in TurtleBlocks

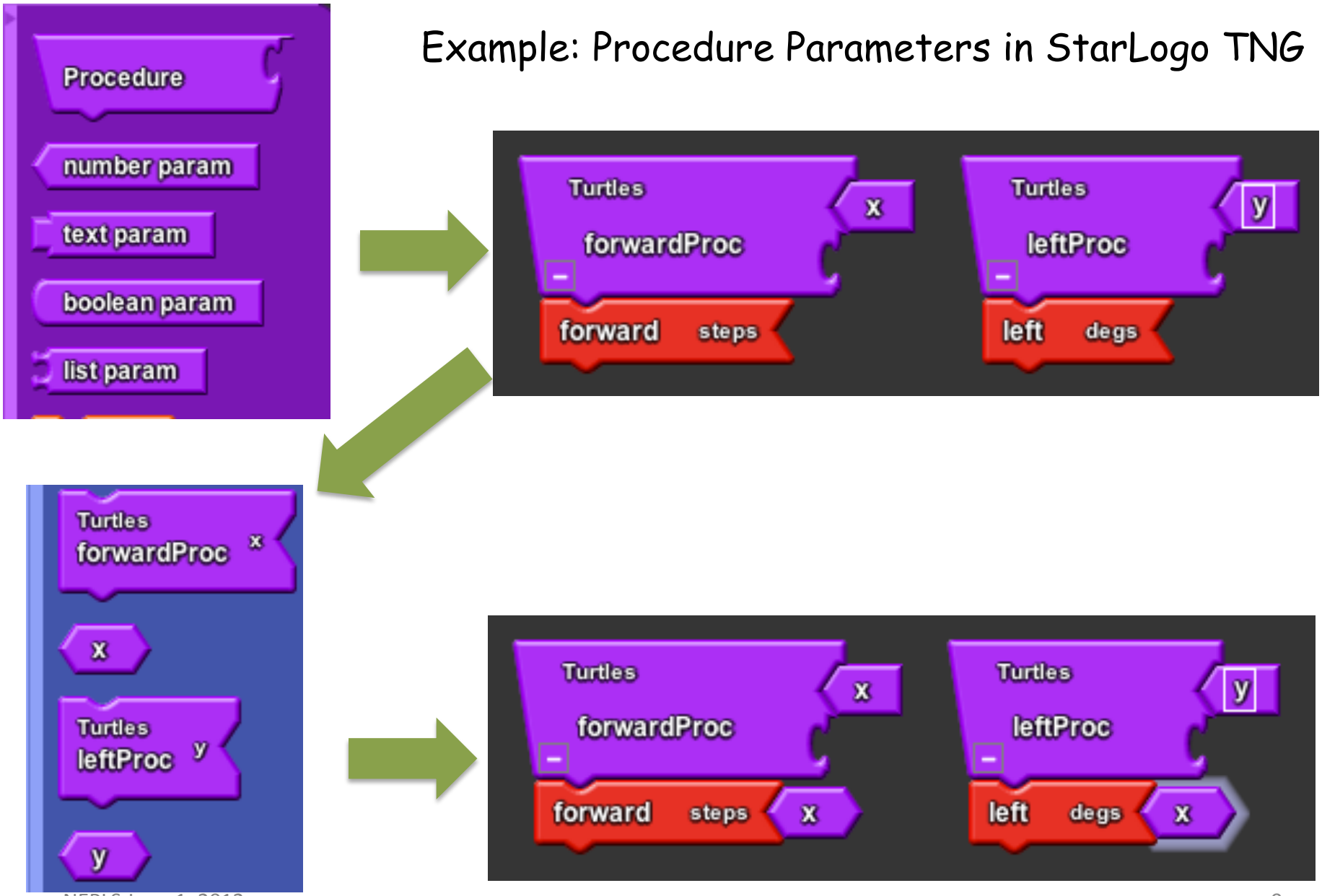




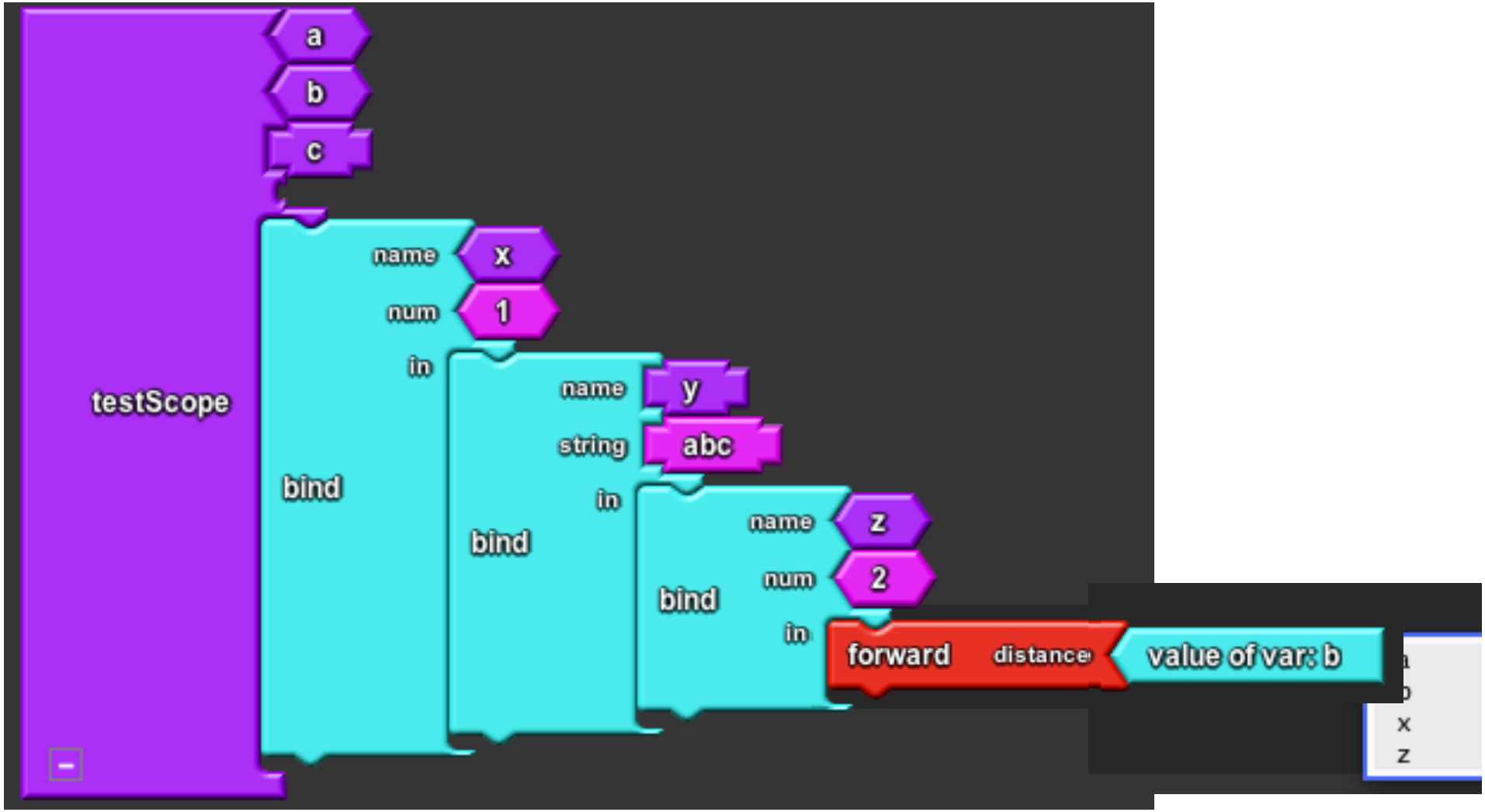


Why Care: Confusing Features

Example: Procedure Parameters in StarLogo TNG

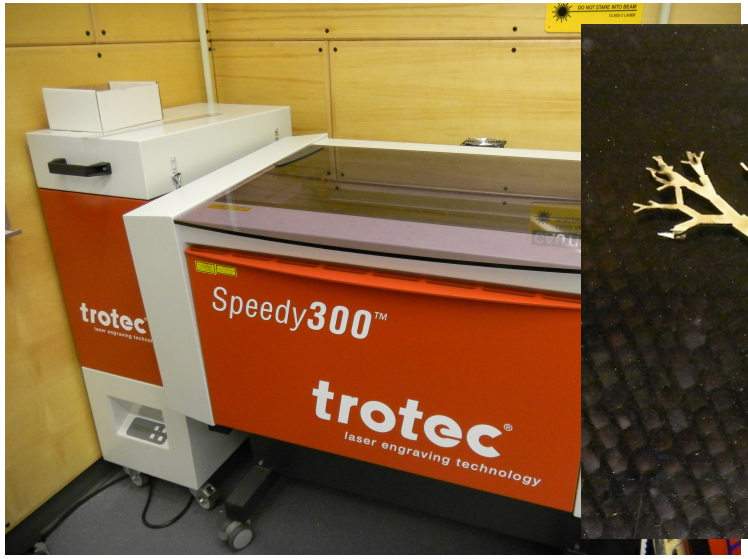


Variable Scope in TurtleBlocks

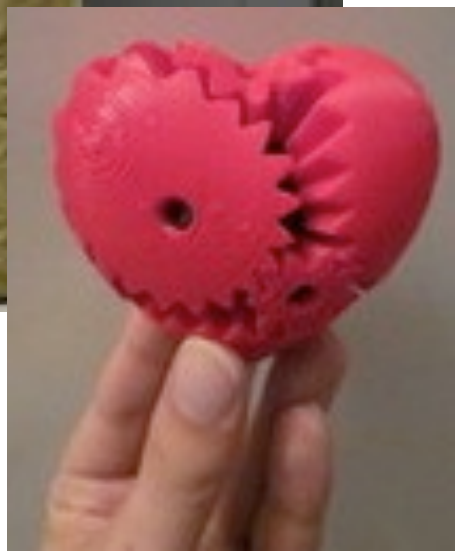


Rapid prototyping @ Wellesley

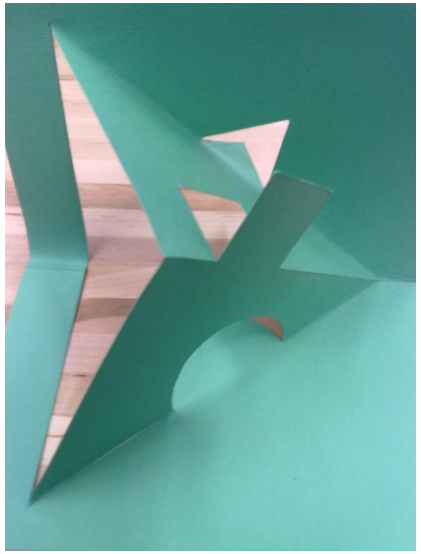
Laser cutter



3D Printer



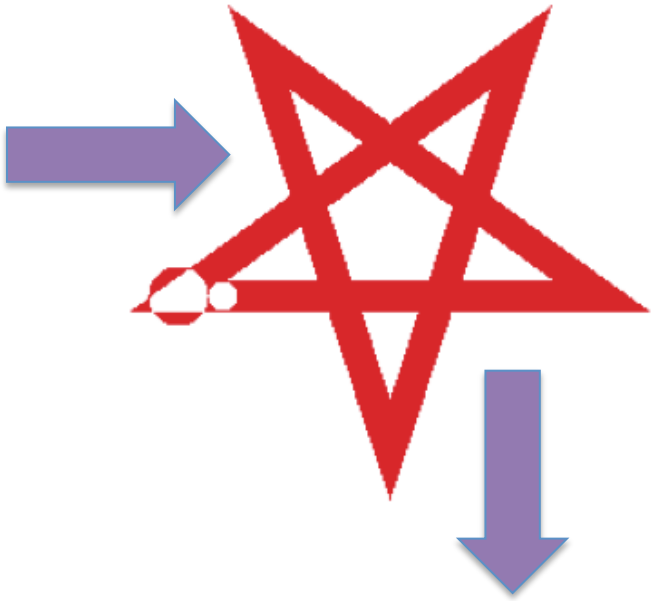
Desktop vinyl cutter



TurtleBlocks

TurtleBlocks program

turtle drawing



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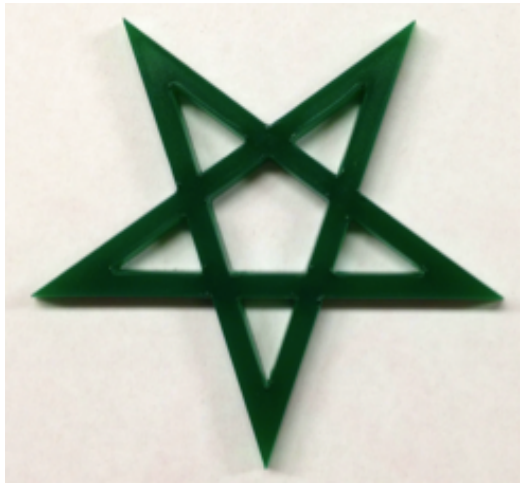
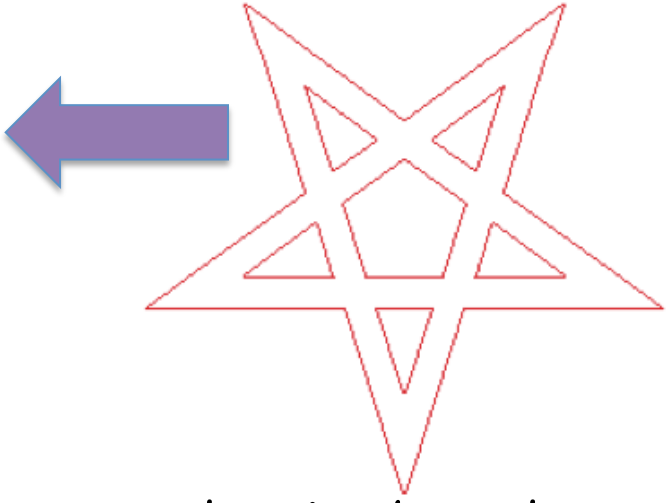
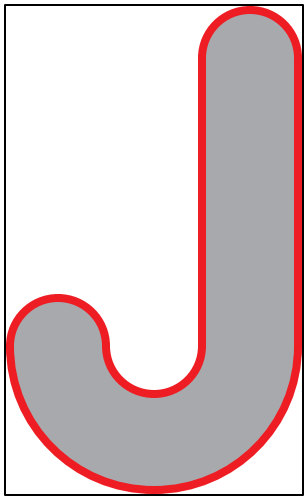


acrylic

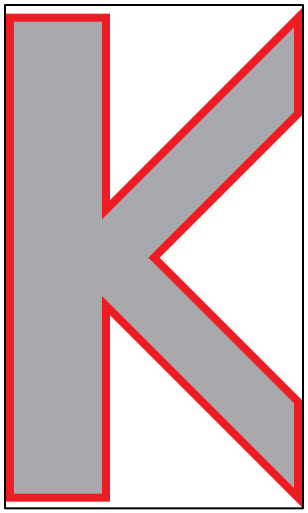


drawing boundary

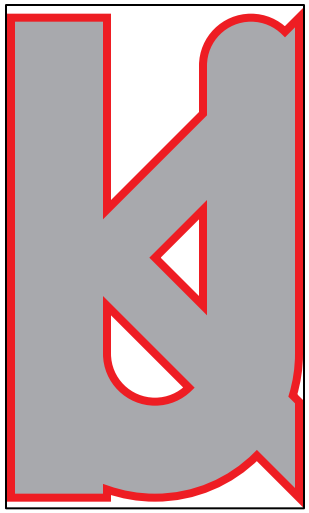
Constructive Area Geometry



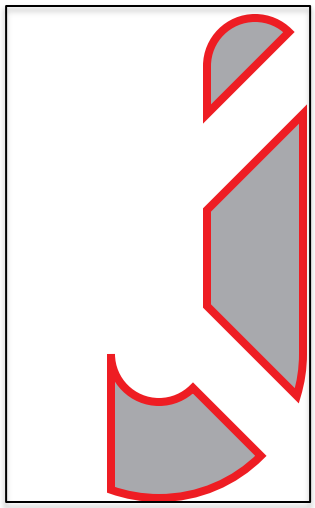
J



K

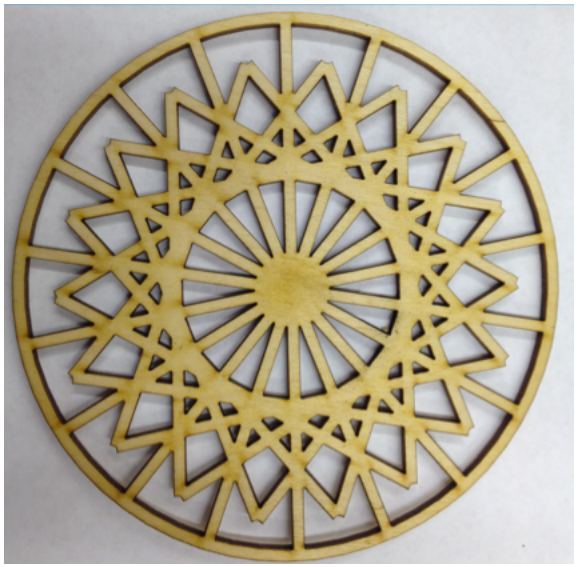


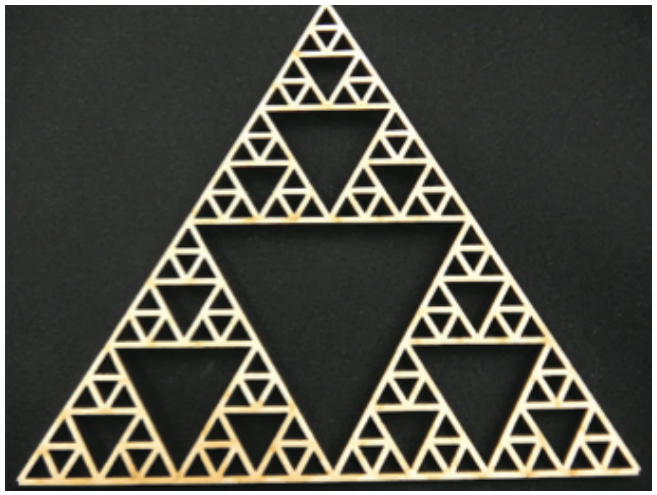
union(J,K)

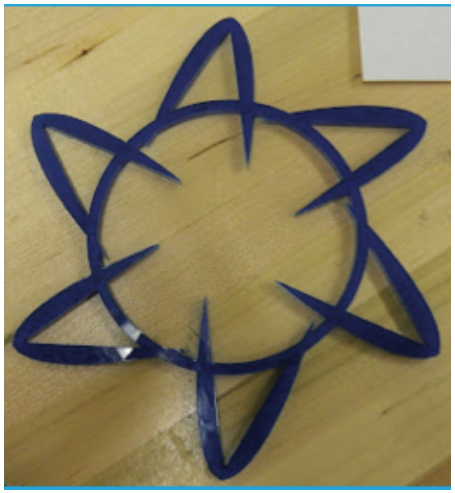


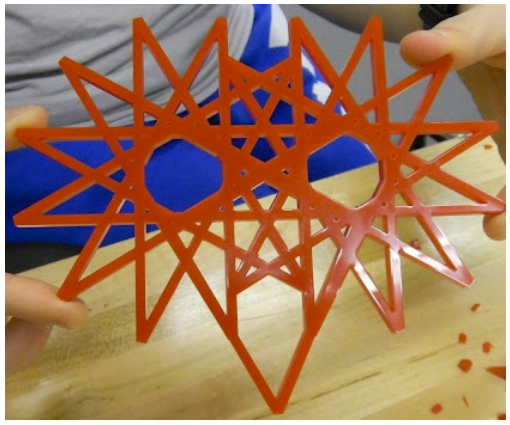
difference(J,K)

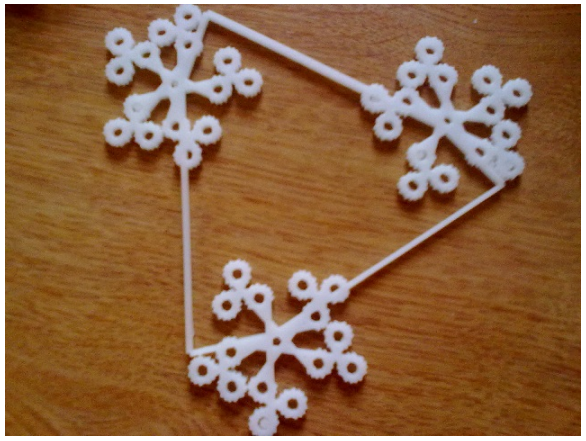
TurtleBlocks Artifacts





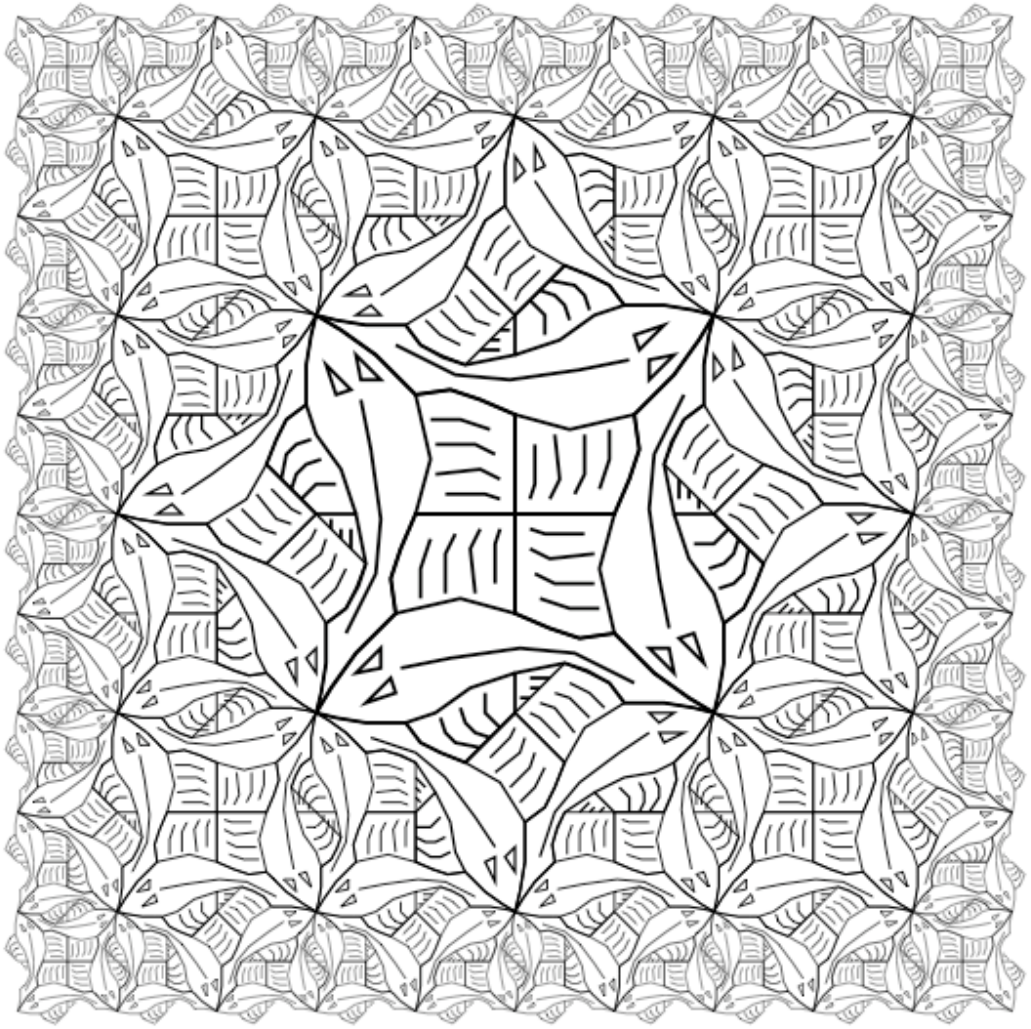




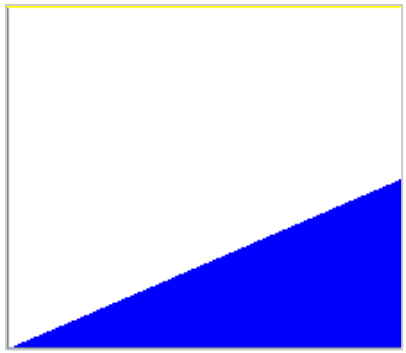


Peter Henderson's Picture Language

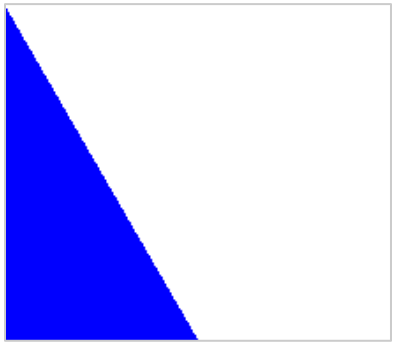
- Described in his paper "Functional Geometry" (1982)
- Popularized in Abelson and Sussman's *Structure and Interpretation of Computer Programs*
- Used in Wellesley College *Introduction to Programming* course



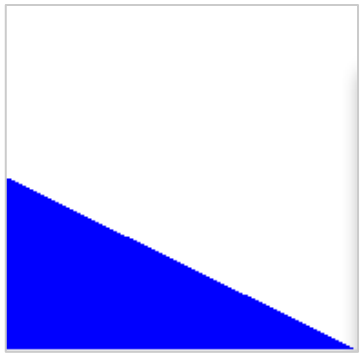
Picture Combinators



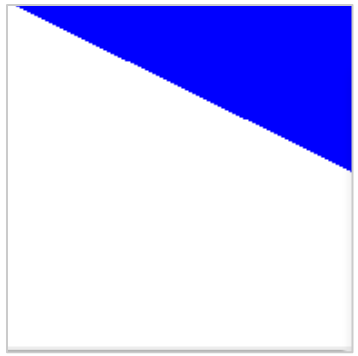
bw



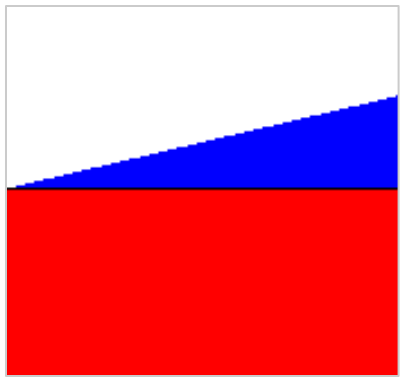
clockwise90(bw)



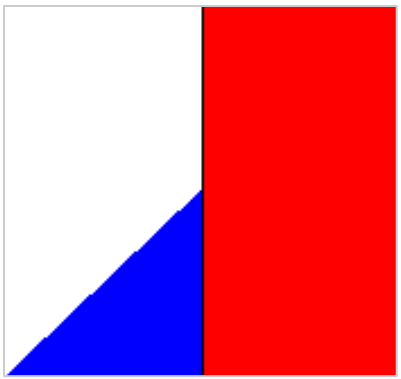
flipHorizontally(bw)



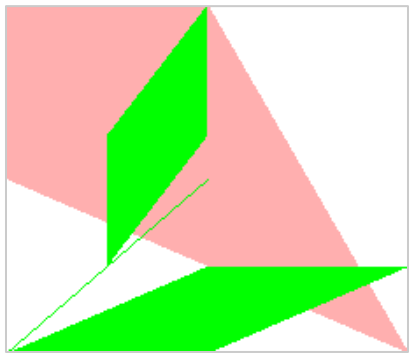
flipVertically(bw)



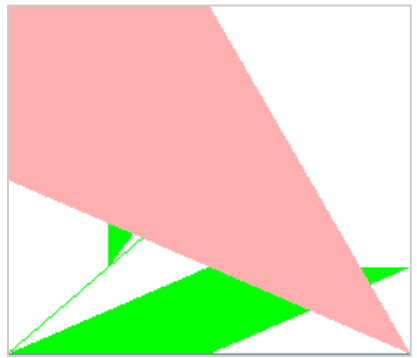
above(bw,rp)



beside(bw, rp)



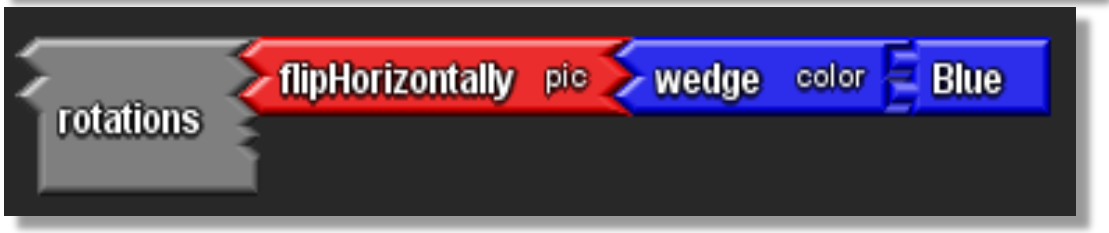
overlay(leaves,kite)



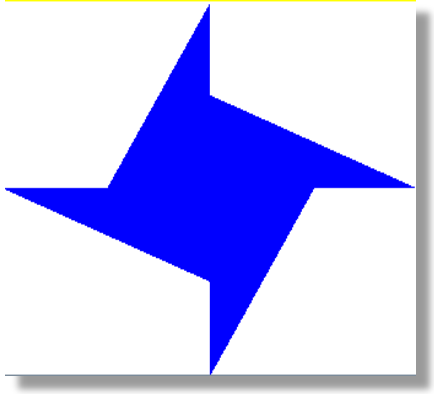
overlay(kite,leaves)

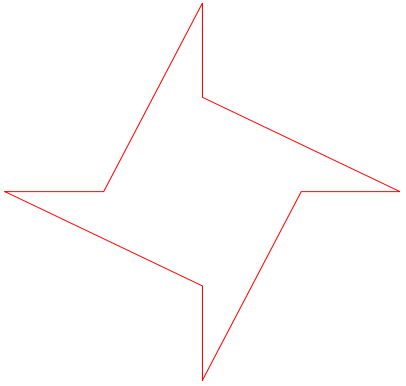
PictureBlocks: Cutting

PictureBlocks program



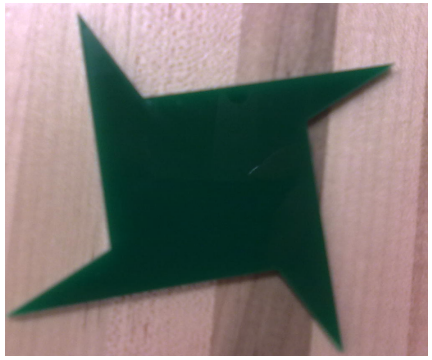
resulting picture





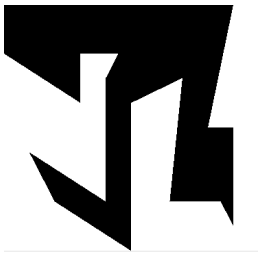
picture boundary

acrylic artifact

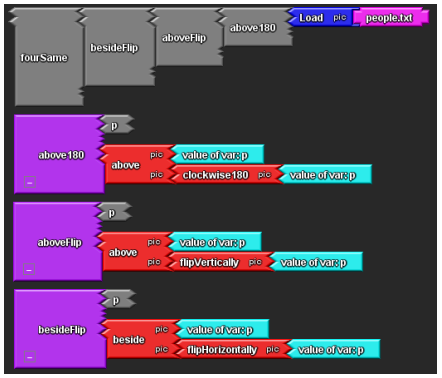


PictureBlocks: Sketching & Engraving

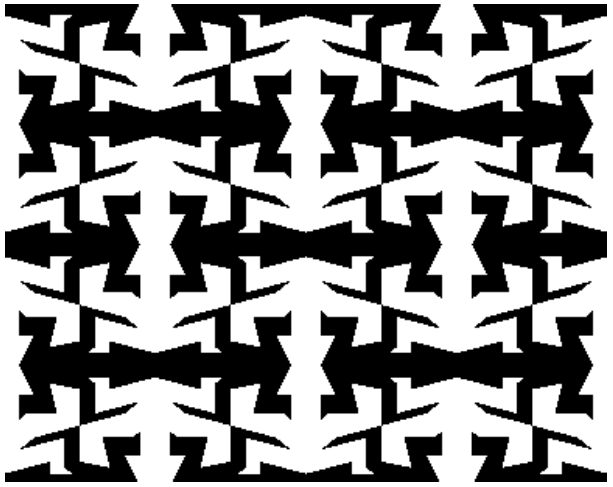
user sketch

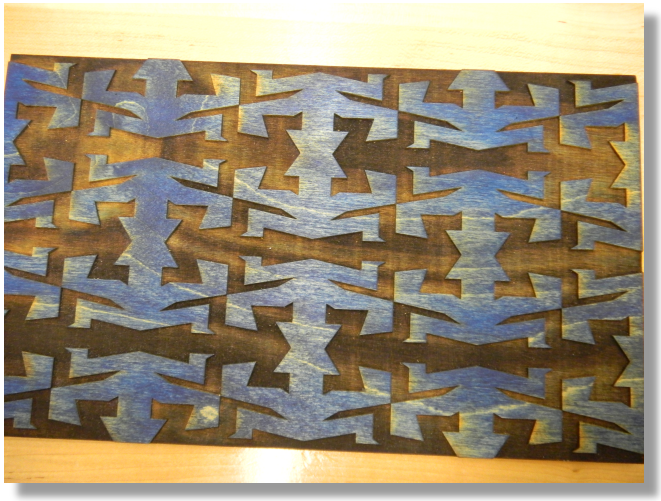


PictureBlocks program

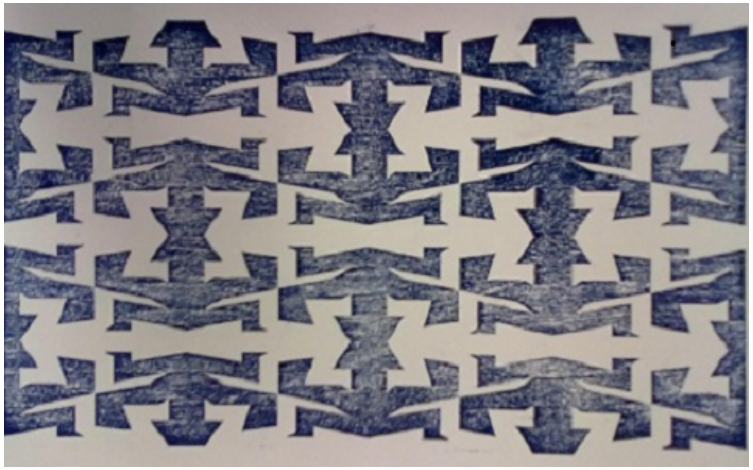


resulting picture



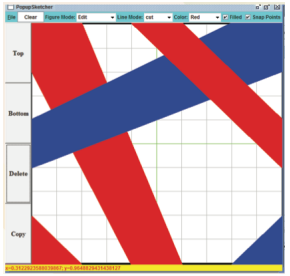


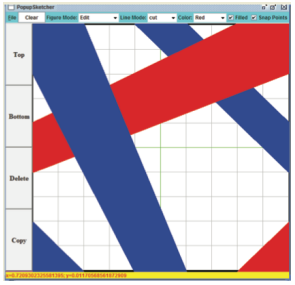
wood engraving

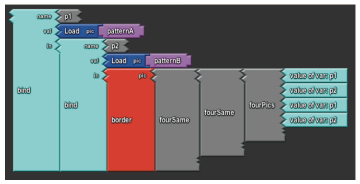


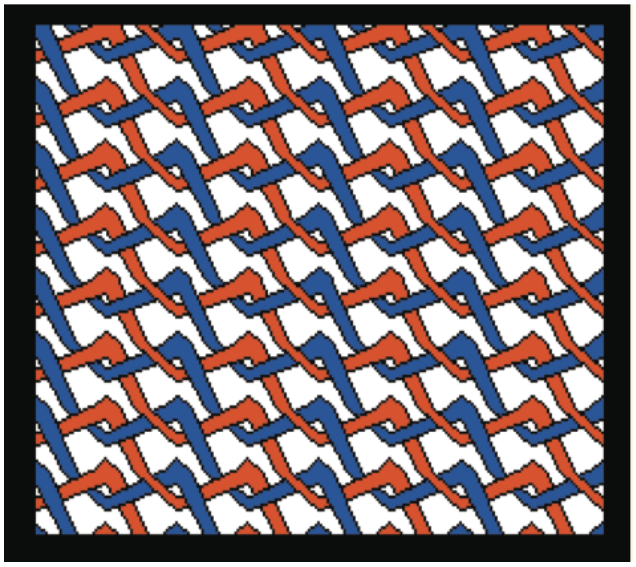
print from engraving

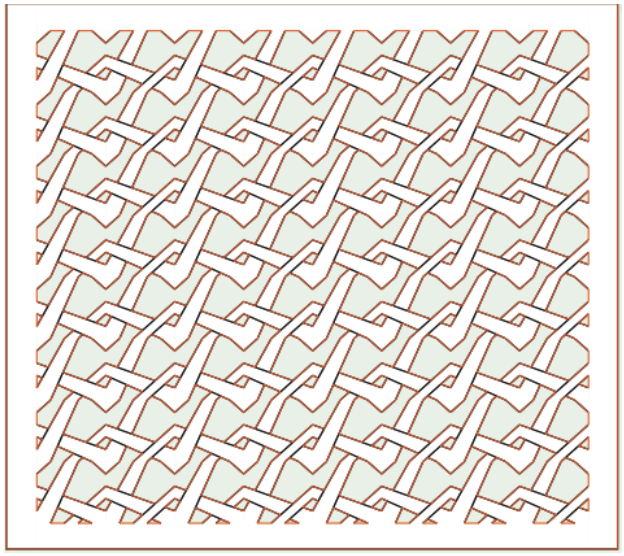
PictureBlocks: Engraving + Cutting

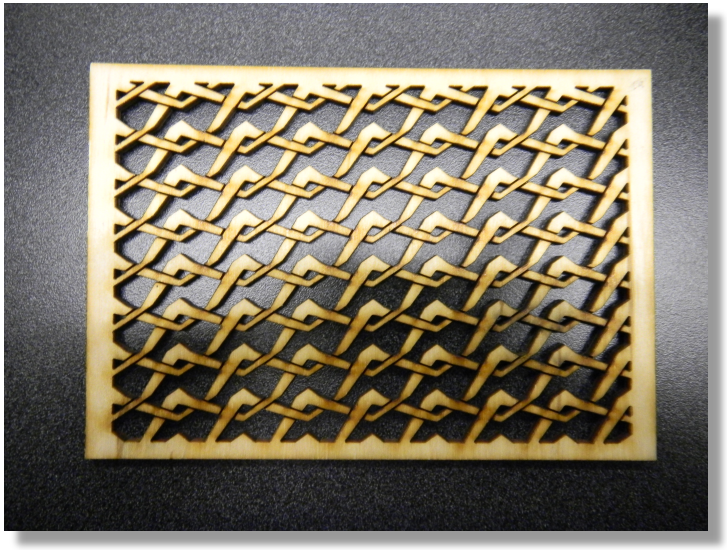










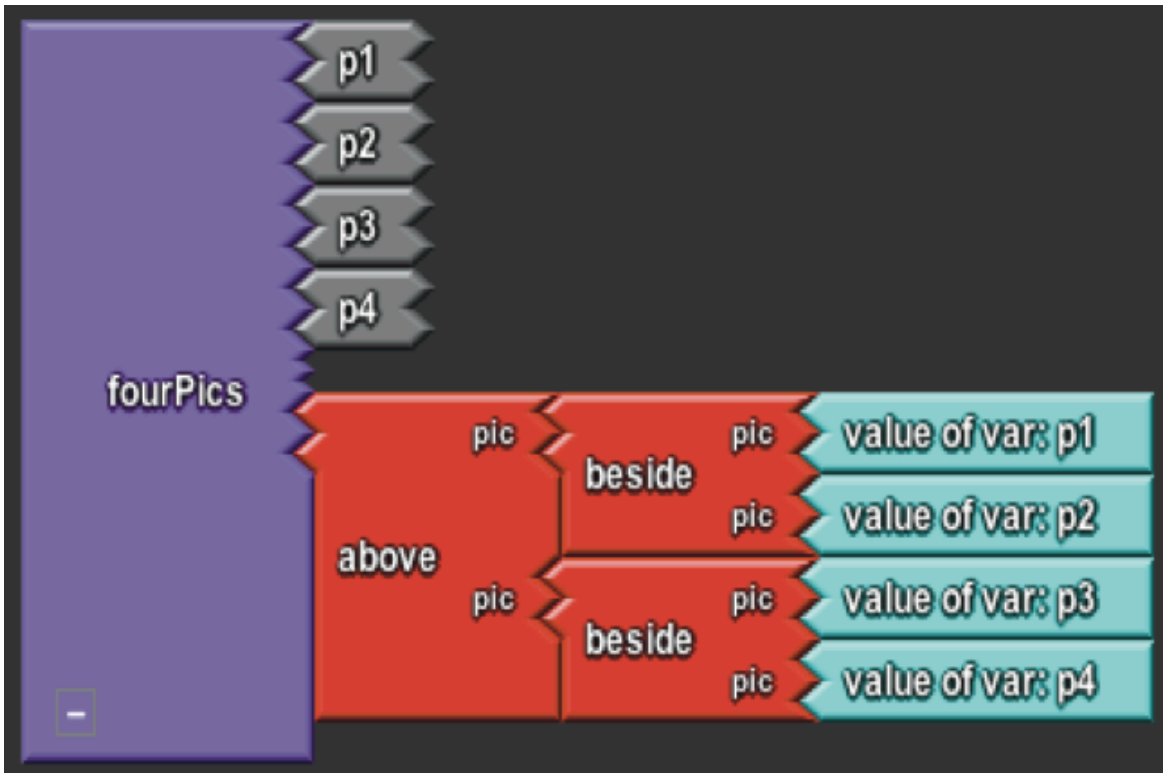


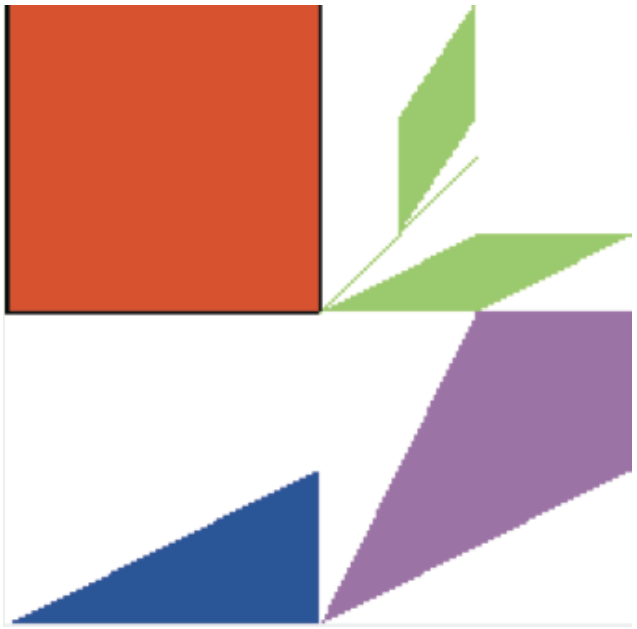
Next Steps

- This summer: improving blocks programming in App Inventor
  - fix broken StarLogo-like procedure parameters
  - add local variables
  - converting between blocks and text languages
  - copying blocks between programs.
- Porting TurtleBlocks & PictureBlocks to a web-based blocks environment.
- Environments for 3D artifacts and popups
- Support for debugging and visualization of dynamic program execution in blocks languages.
- Blocks language generators

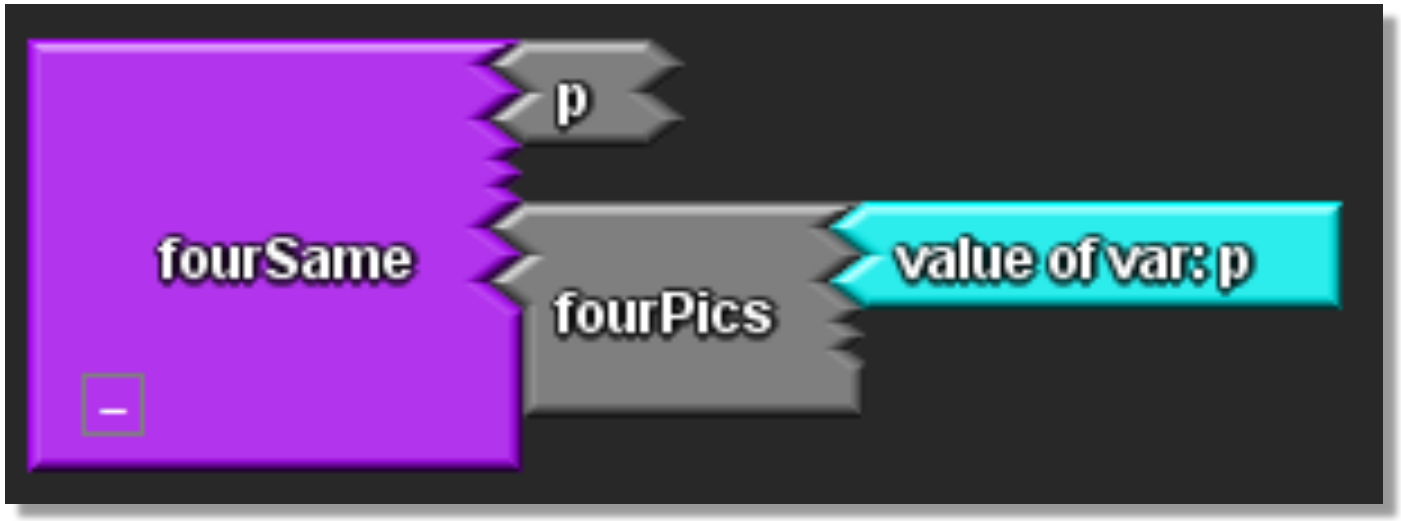
Questions?

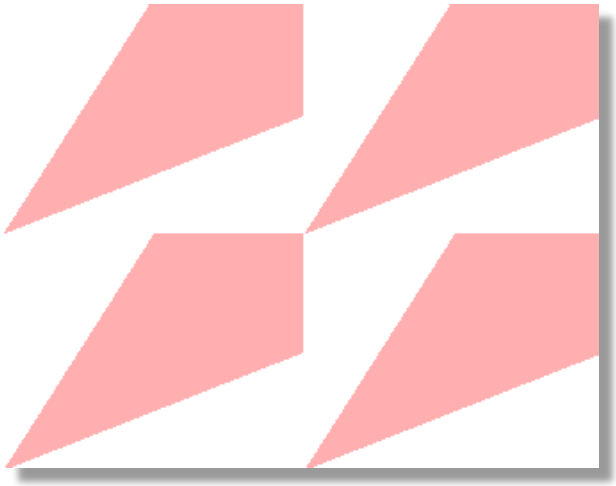
PictureBlocks: fourPics Procedure





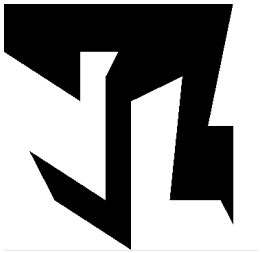
PictureBlocks: fourSame Procedure

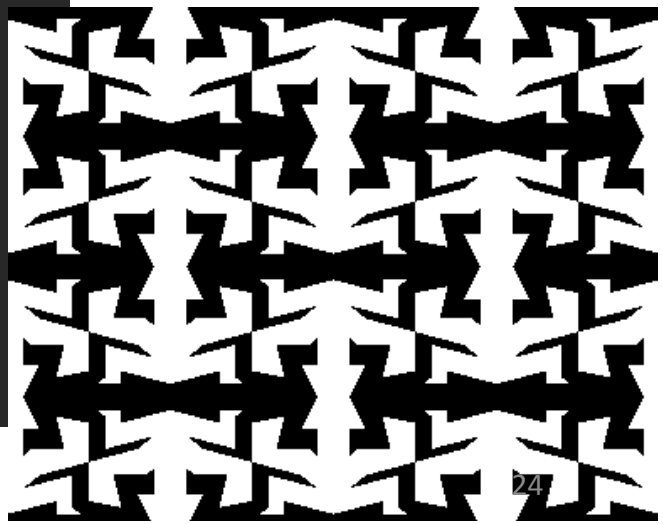




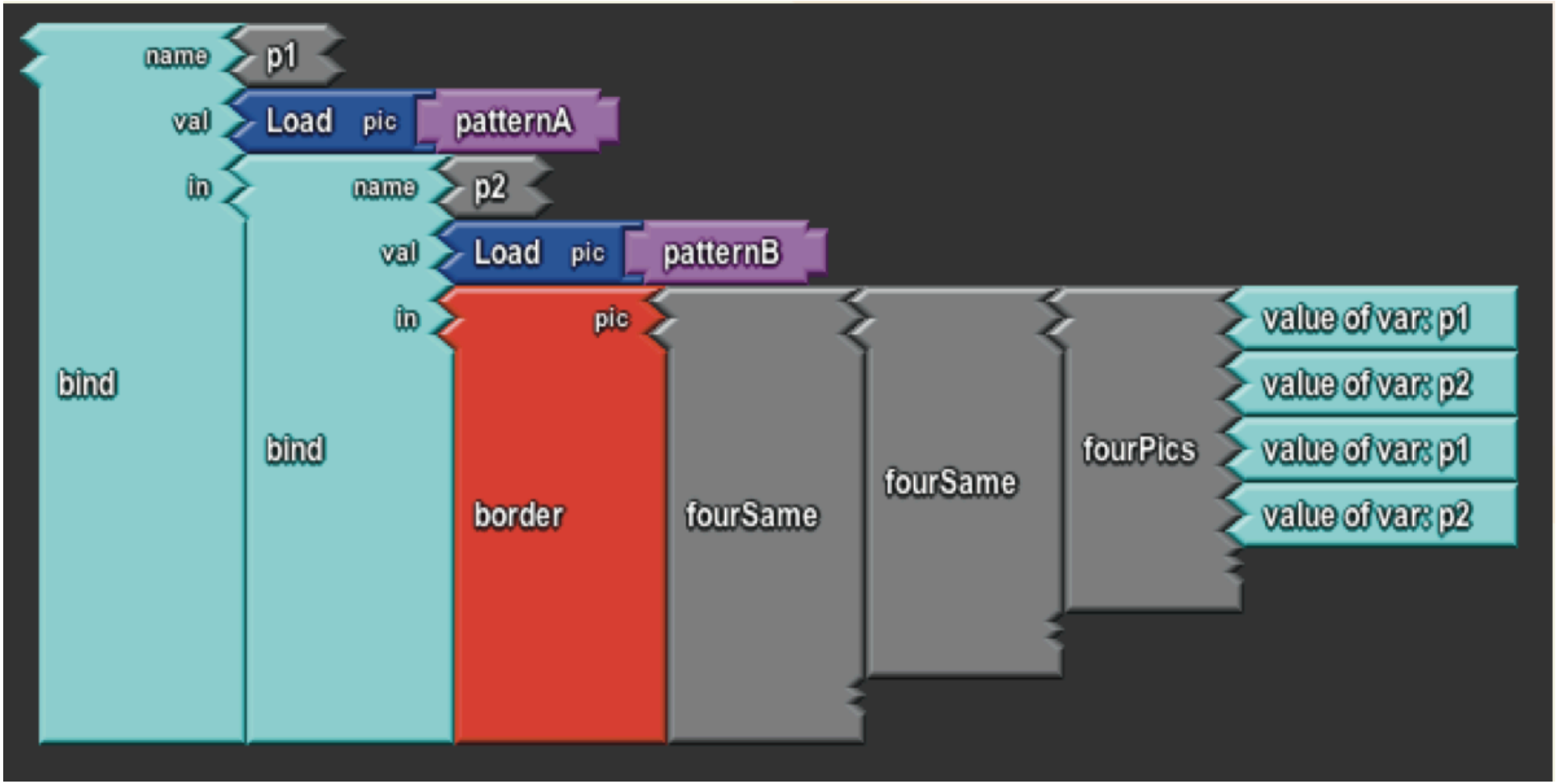
…options


fourSame
besideFlip
aboveFlip
above180
Load pic people.txt
above180
p
above
pic value of var: p
pic clockwise180 pic value of var: p
aboveFlip
p
above
pic value of var: p
pic flipVertically pic value of var: p
besideFlip
p
beside
pic value of var: p
pic flipHorizontally pic value of var: p





PictureBlocks: Knitting Program



PictureBlocks Designs