TYPES FOR ALLOY: FROM PROGRAMMING TO MODELLING

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BROWN UNIVERSITY

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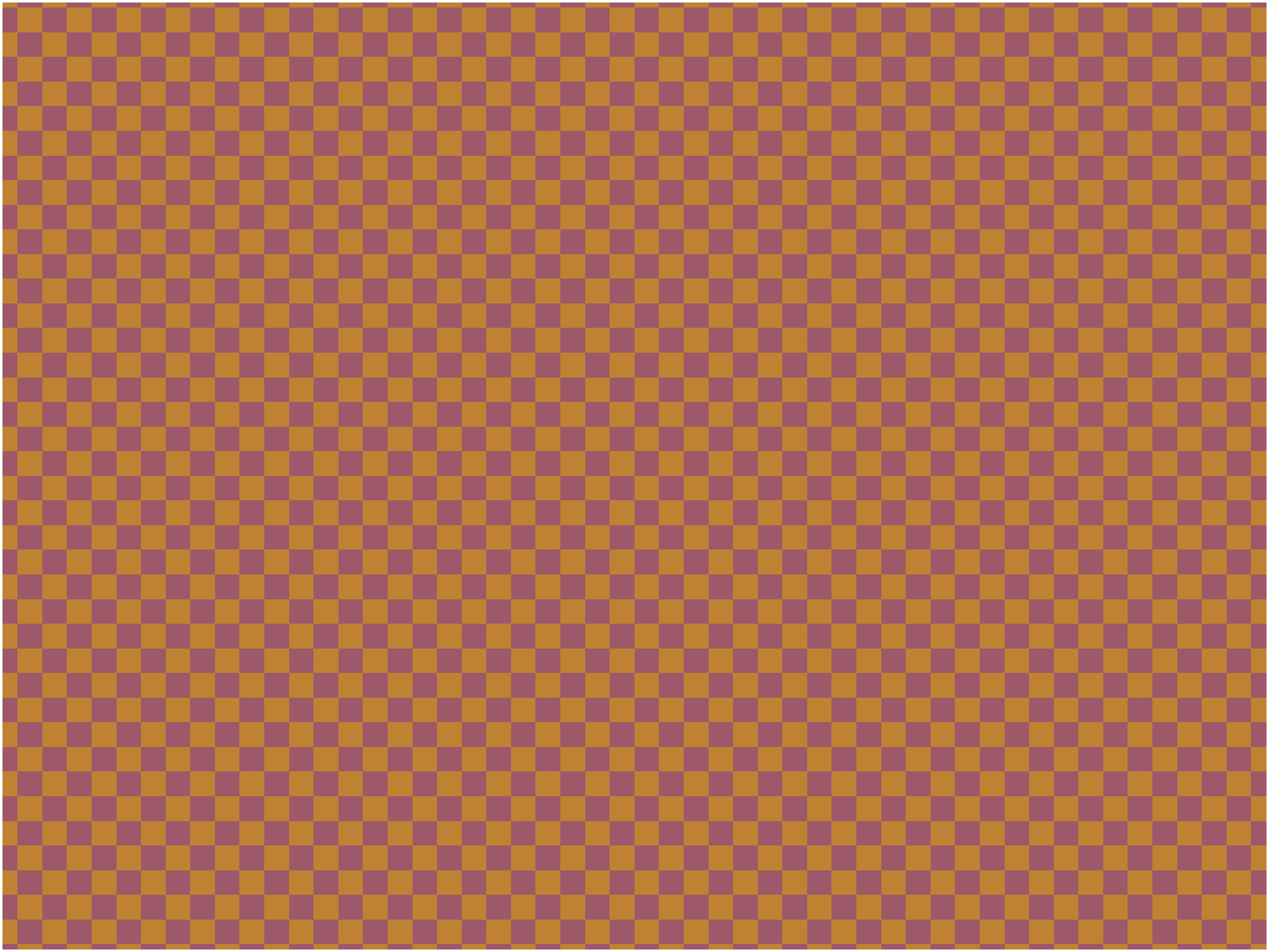
(More Precisely ...)

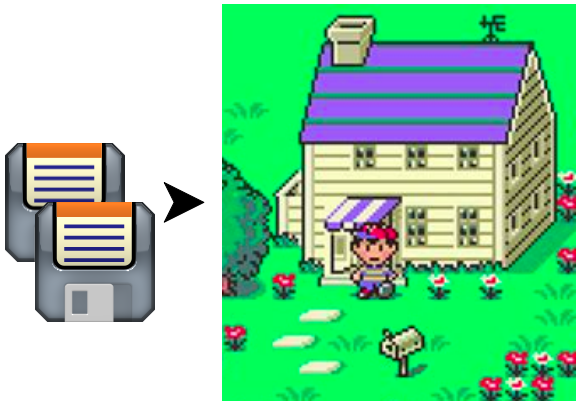
TYPES FOR FROGLET



PROGRAMMING IS HARD!

Imagine .... the year is 19XX

Your DVD rental website
is doing great business



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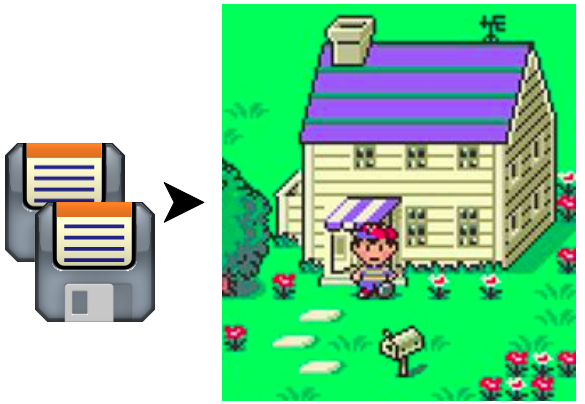

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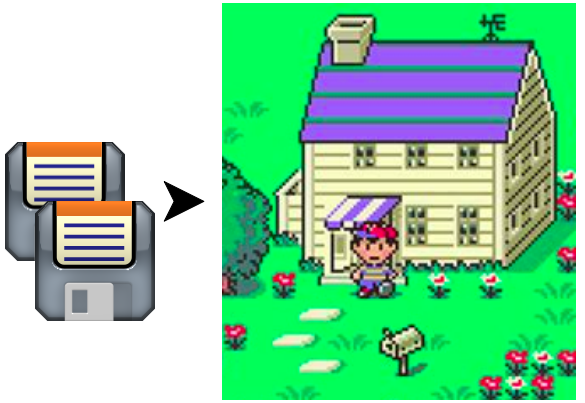

Idea: track the origin of every HTTP Event

Q. Does it work?

PROGRAMMING IS HARD!

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Code has to say:

- WHAT to do, and
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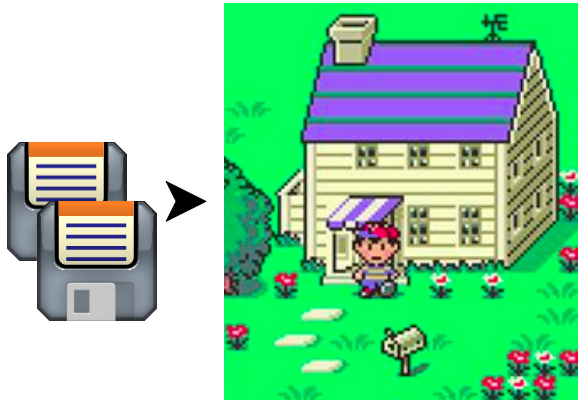
Alloy lets you focus on the WHAT

ALLOY FOR DEBUGGING DESIGNS



ALLOY FOR DEBUGGING DESIGNS

Alloy model

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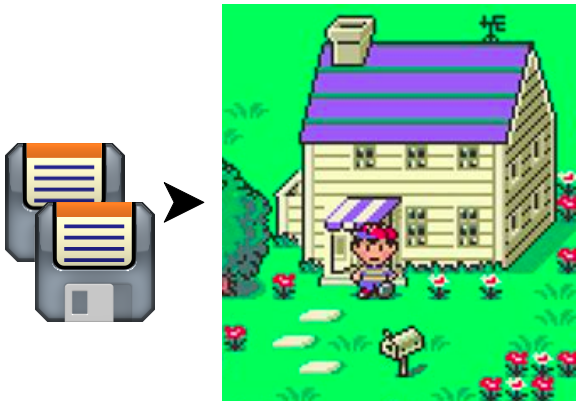

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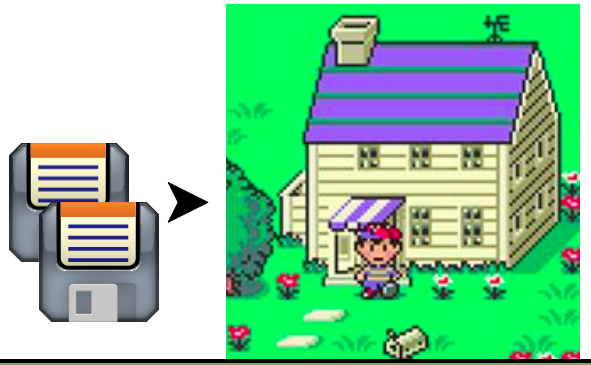

Running a model kicks off a search for counterexamples

For our DVD website, a counterexample SHOWS how a forgery can happen – even if we track one origin

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check { no good, evil: Server | ... }
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ALLOY FOR DEBUGGING DESIGNS

Step 1: Outline your data structures

Step 2: Write formal properties

Step 3: Study the counterexamples

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Lots of successes: amazon at&t NETFLIX

ALLOY FOR DEBUGGING DESIGNS

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Great!

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.... Why doesn't ALL production software come with an Alloy model?

One reason: models are tricky to write!

Alloy gotchas

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- r is a set
- response is a relation
- . is relational join
- ^ is transitive closure

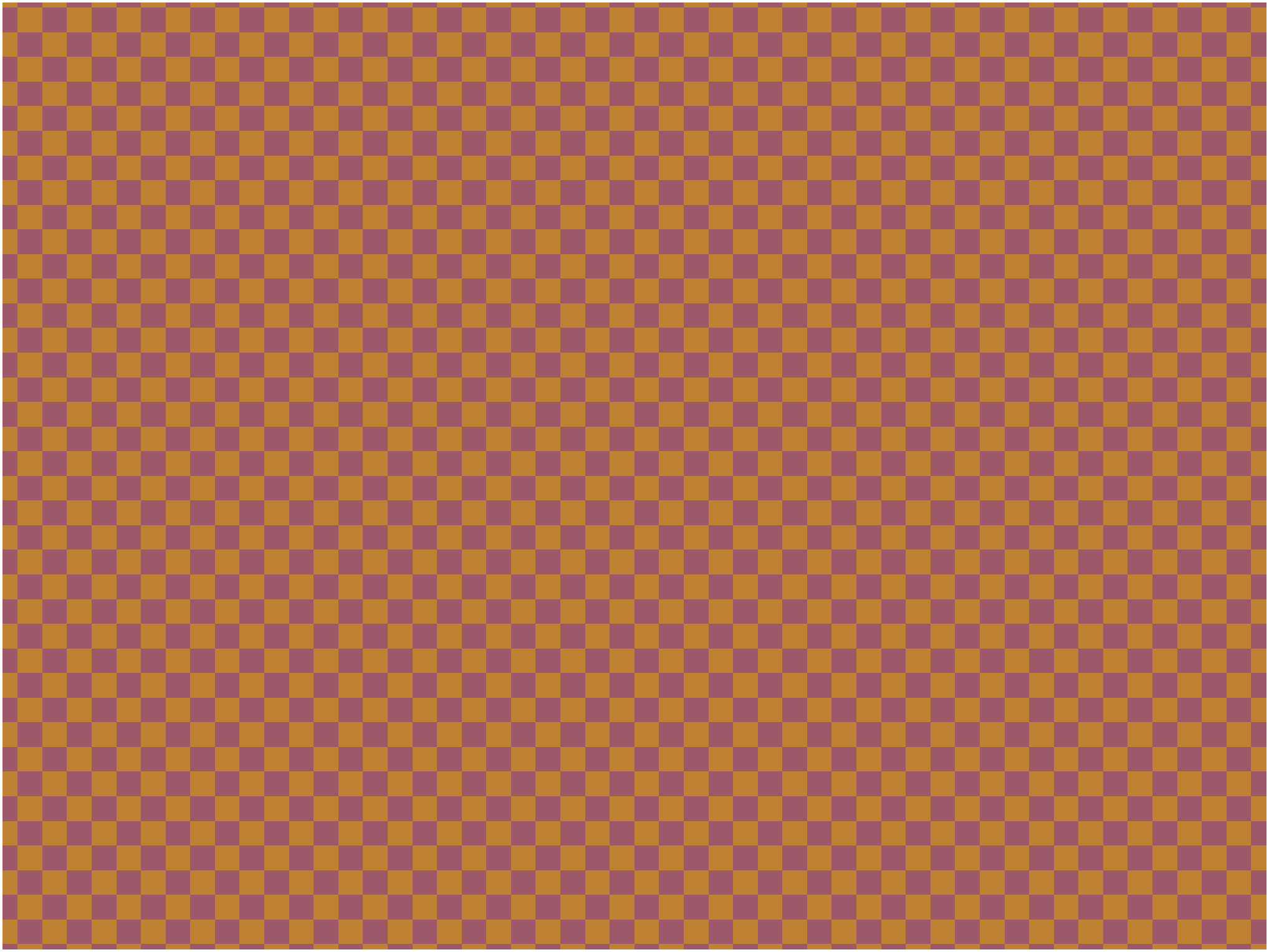
ALLOY GOTCHAS

Alloy gotchas

In short:

1. Alloy is scripting for set theory
   – Very forgiving of type mixups

2. Alloy is NOT a programming language
   – Intuitions can be misleading




logic for systems

RQ. How to teach Alloy to programmers?

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Important for pros, too

VISION: LANGUAGE LEVELS

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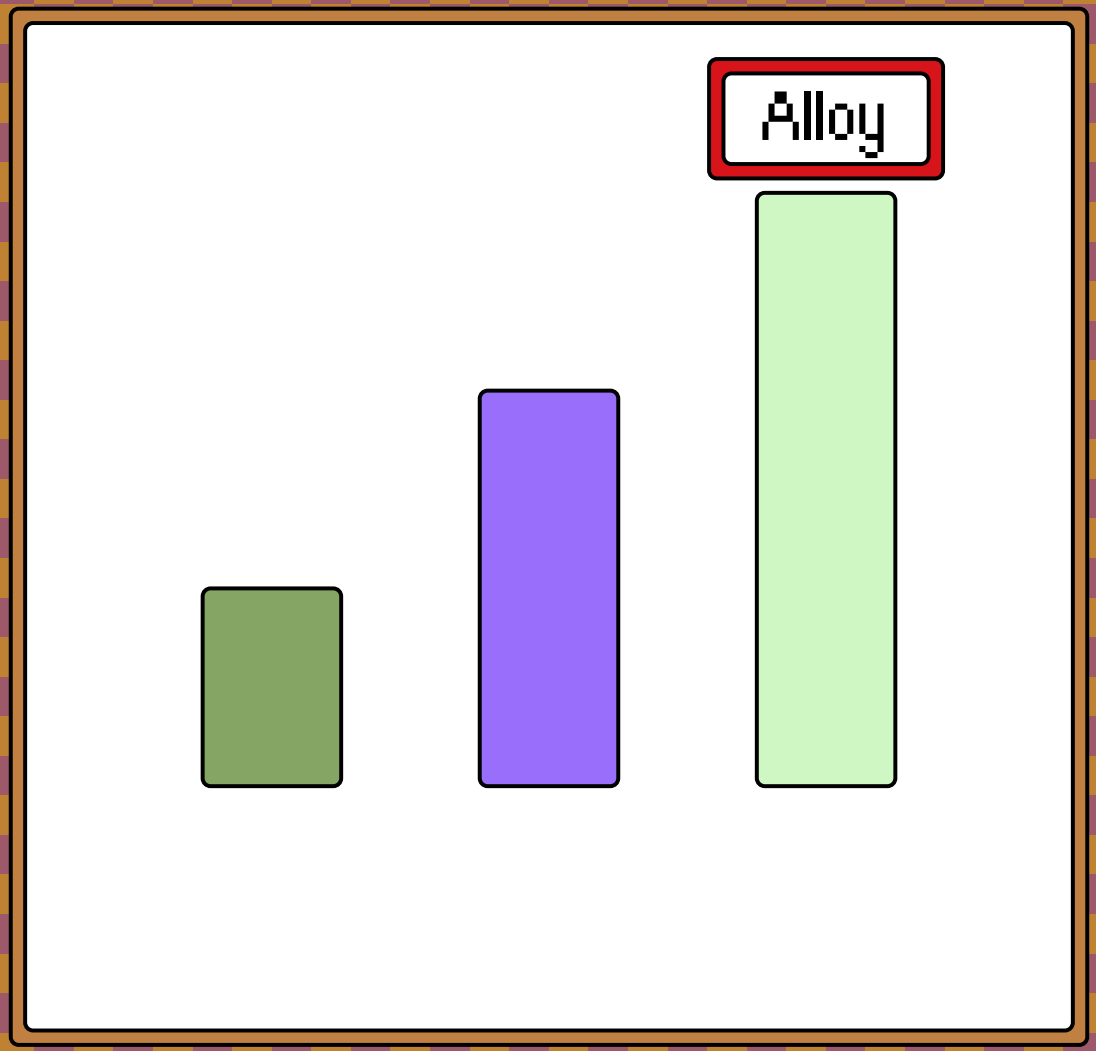

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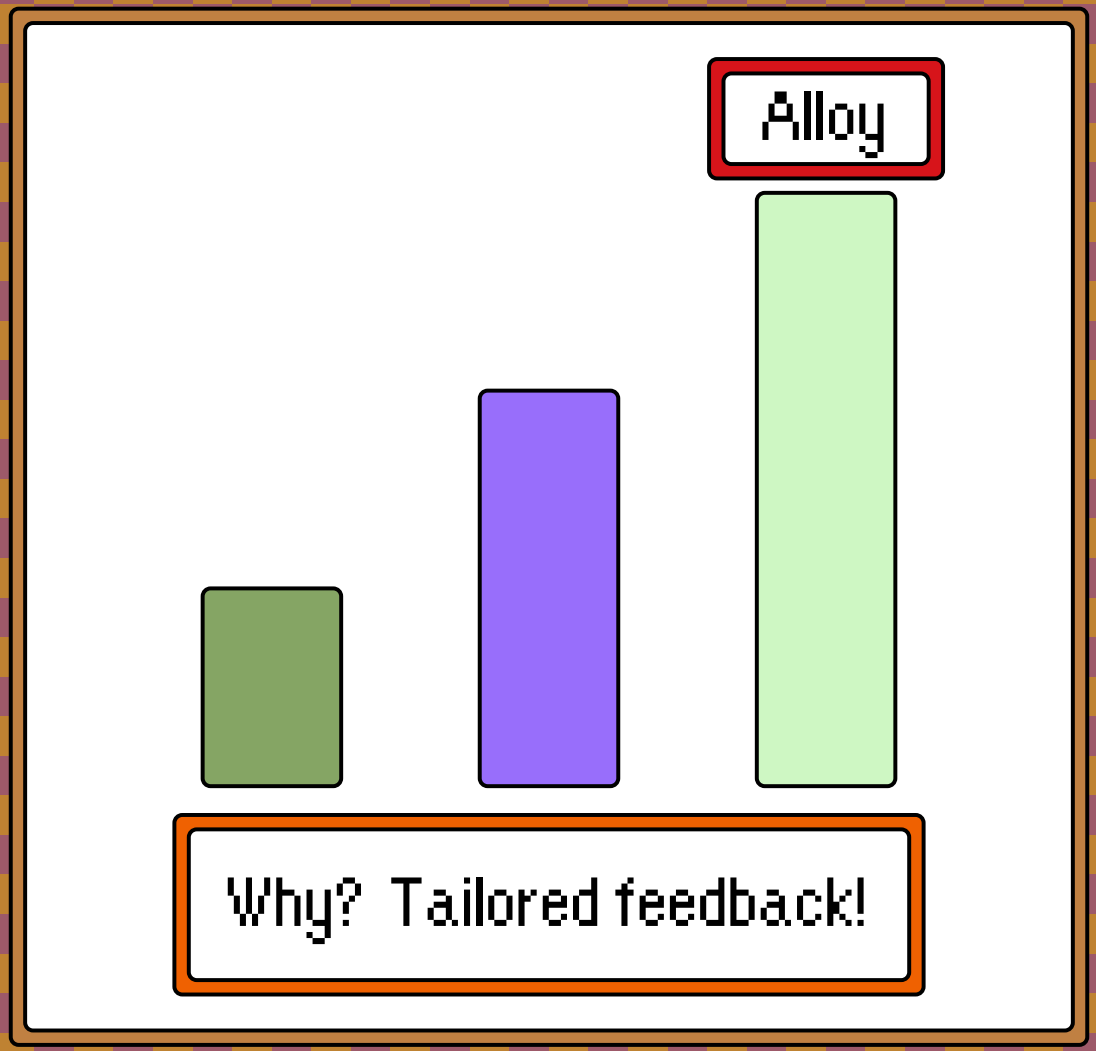

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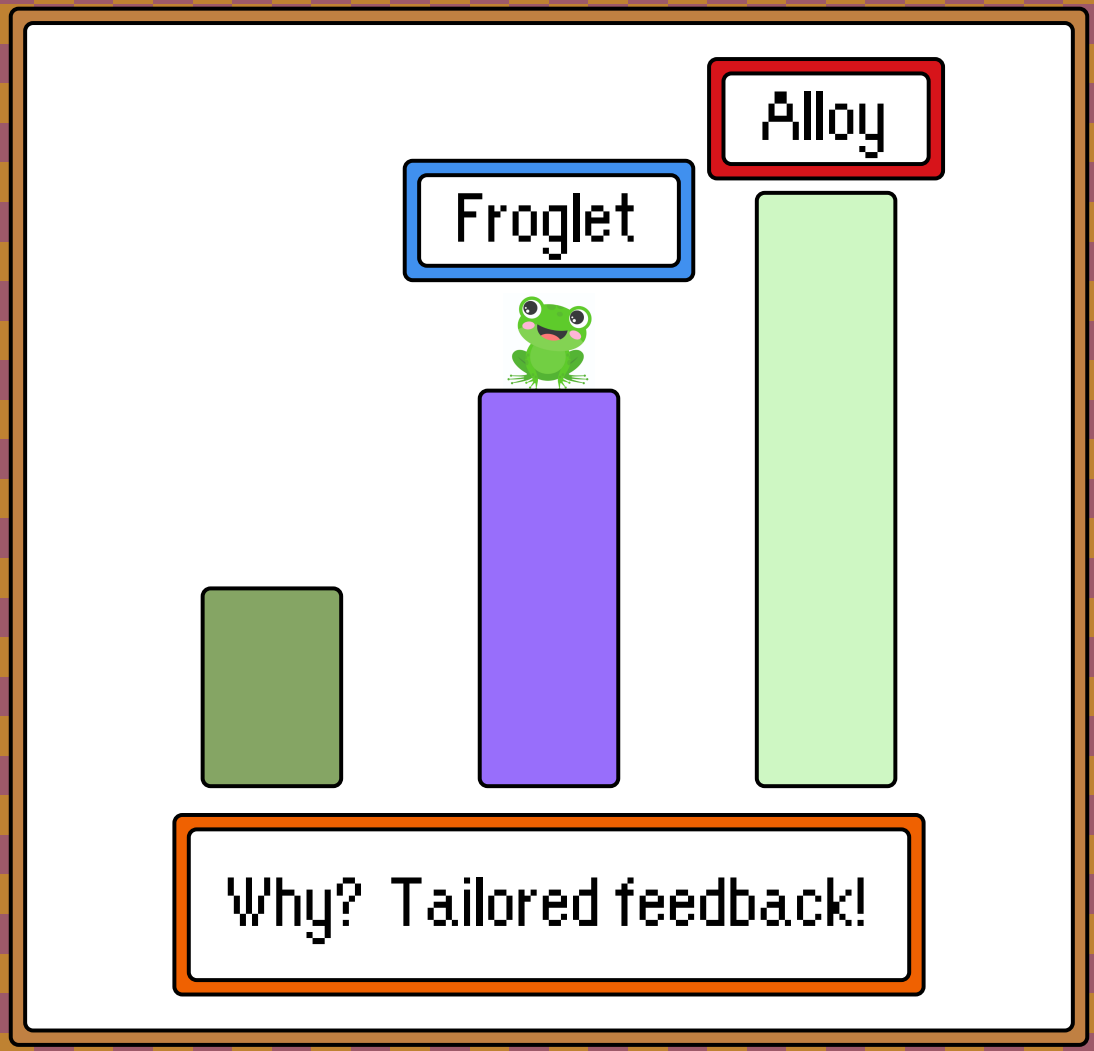

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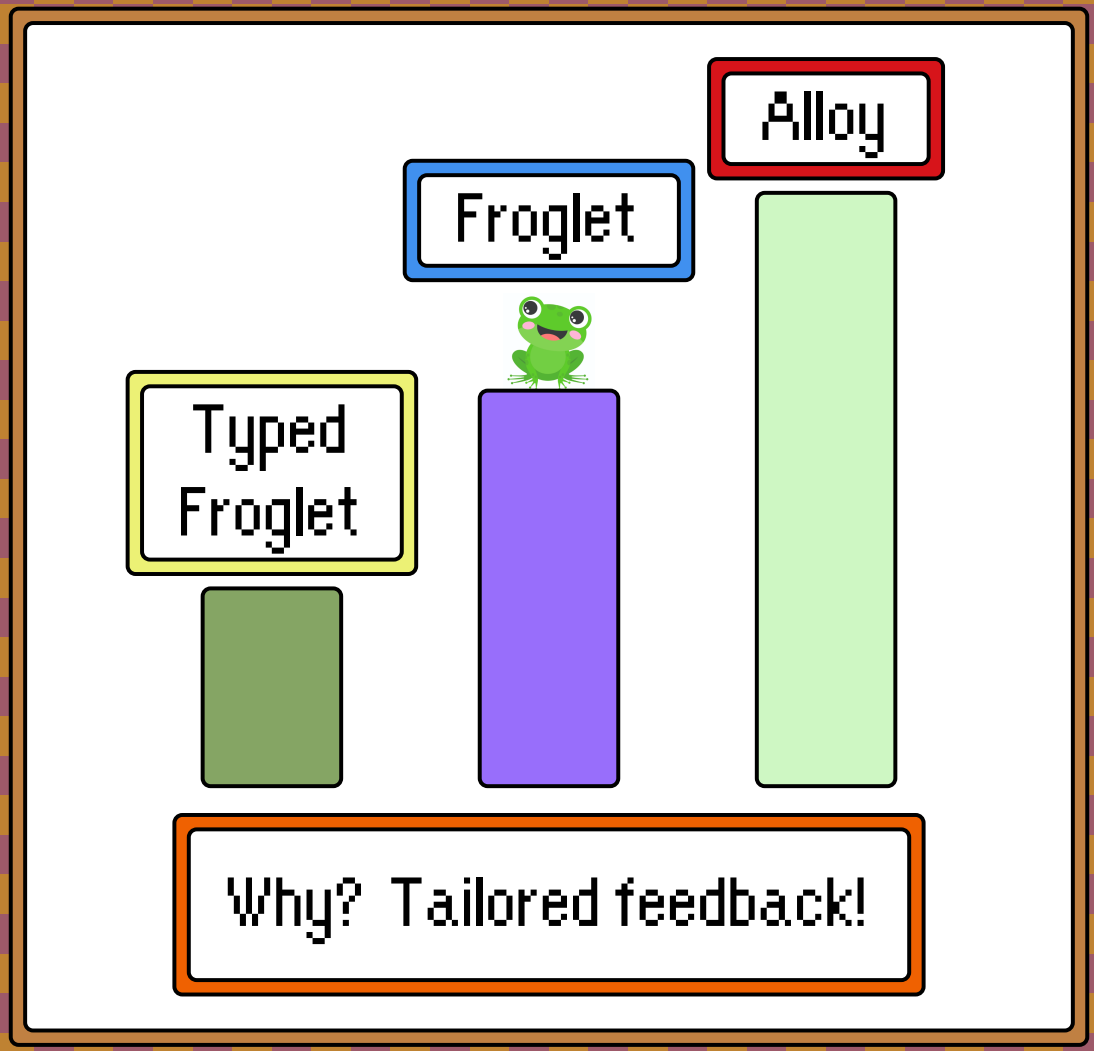

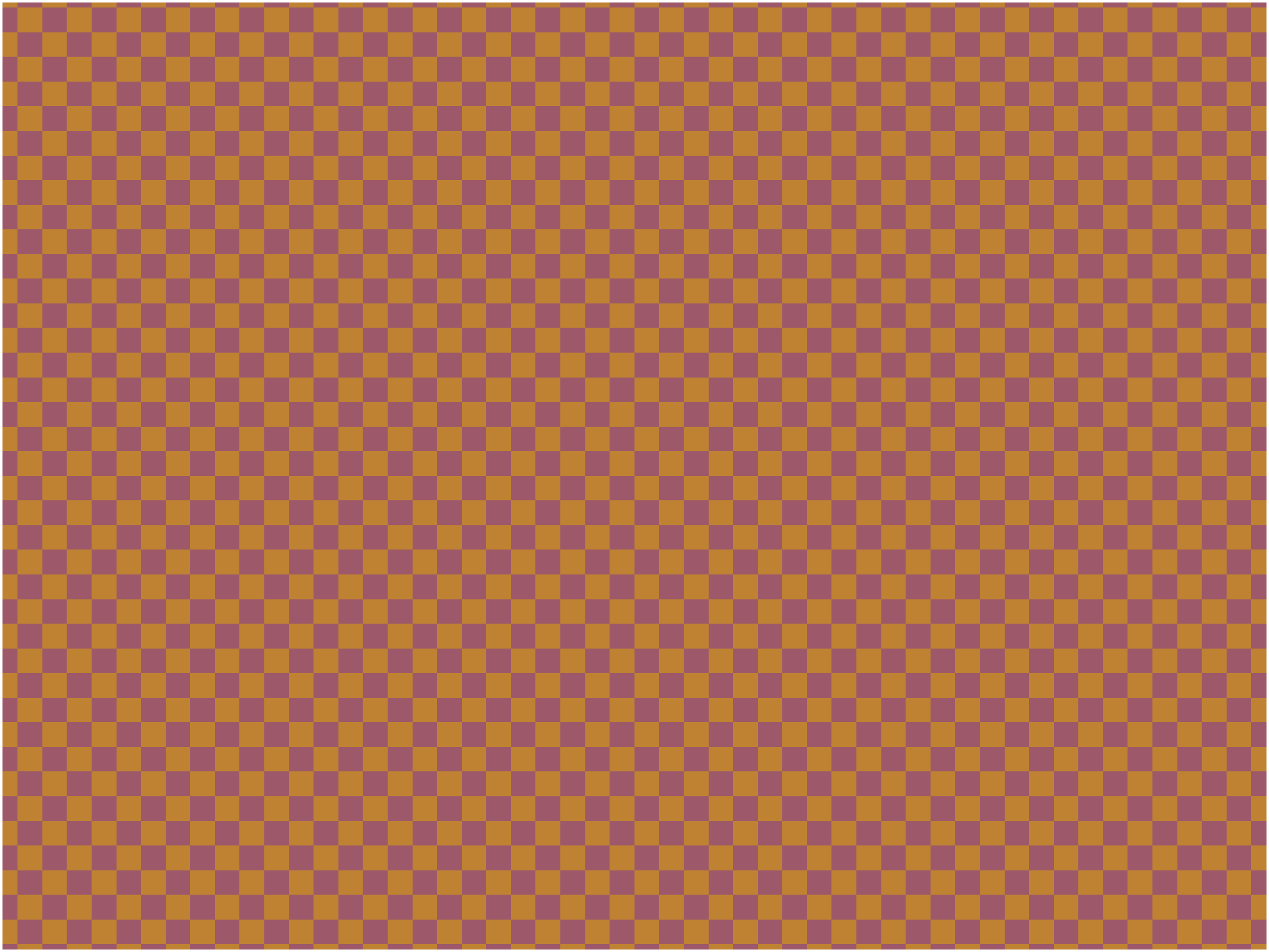

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A functions-first subset of Alloy

- Models contain only:
  + data structures
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- a.b is a field access

- No relational algebra

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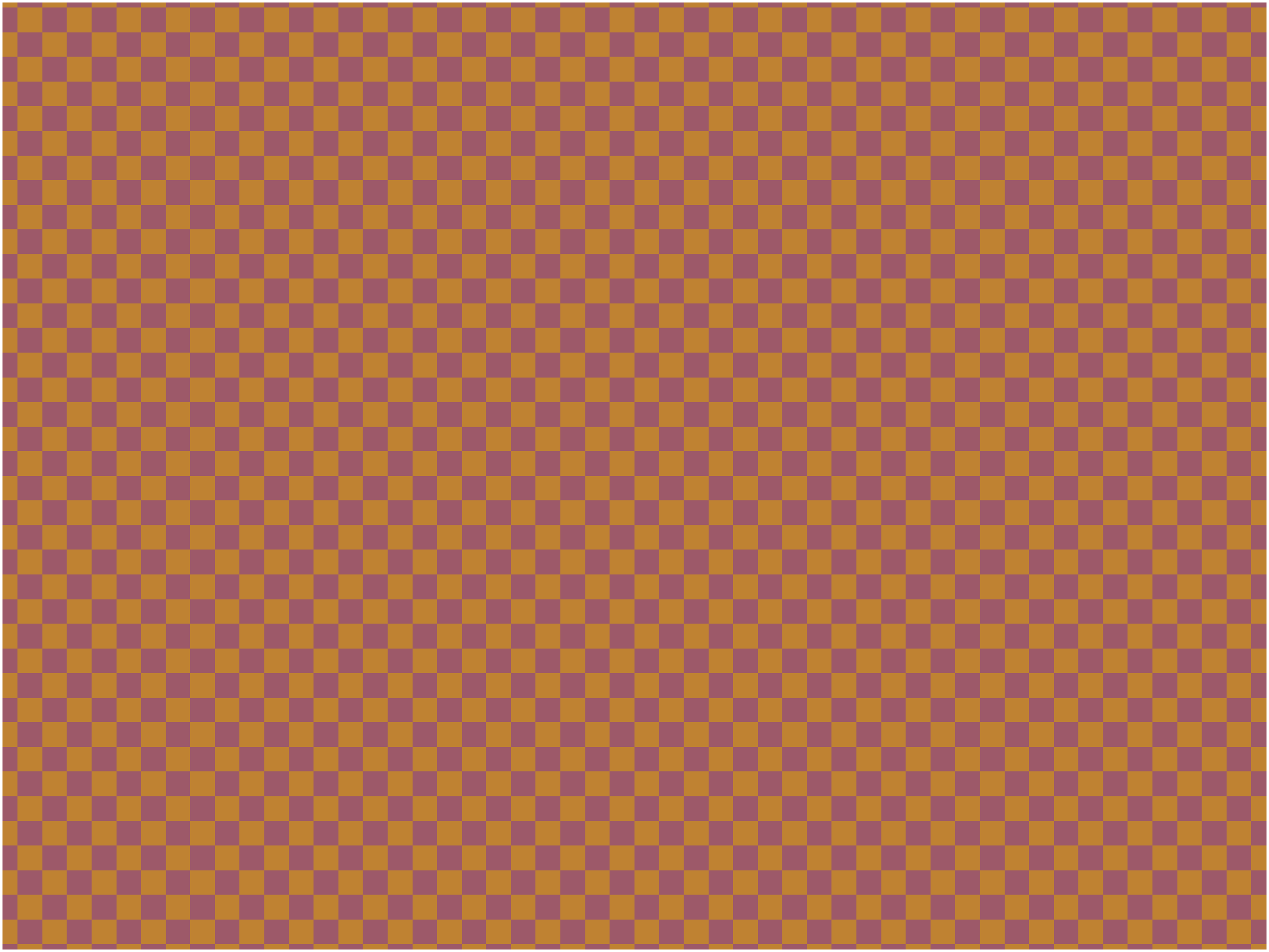

TYPED FROGLET (2023)

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Types to catch and explain mistakes

- Goal: be like Java
  - \+ build on intuitions
- a.b checks for valid fields
- Allow untyped libraries

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Instead, use a library:

not reachable[r, r, response, embeds]

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Challenge: Will types help us migrate to Alloy?

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Pop Quiz: What should this do?

CS2 in prereqs.CS1

(Valid in Alloy)

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"Should totally have an error, because this syntax makes no sense"

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"Good riddance! What a travesty that would be"

"No I just... no.... what's even happening...."

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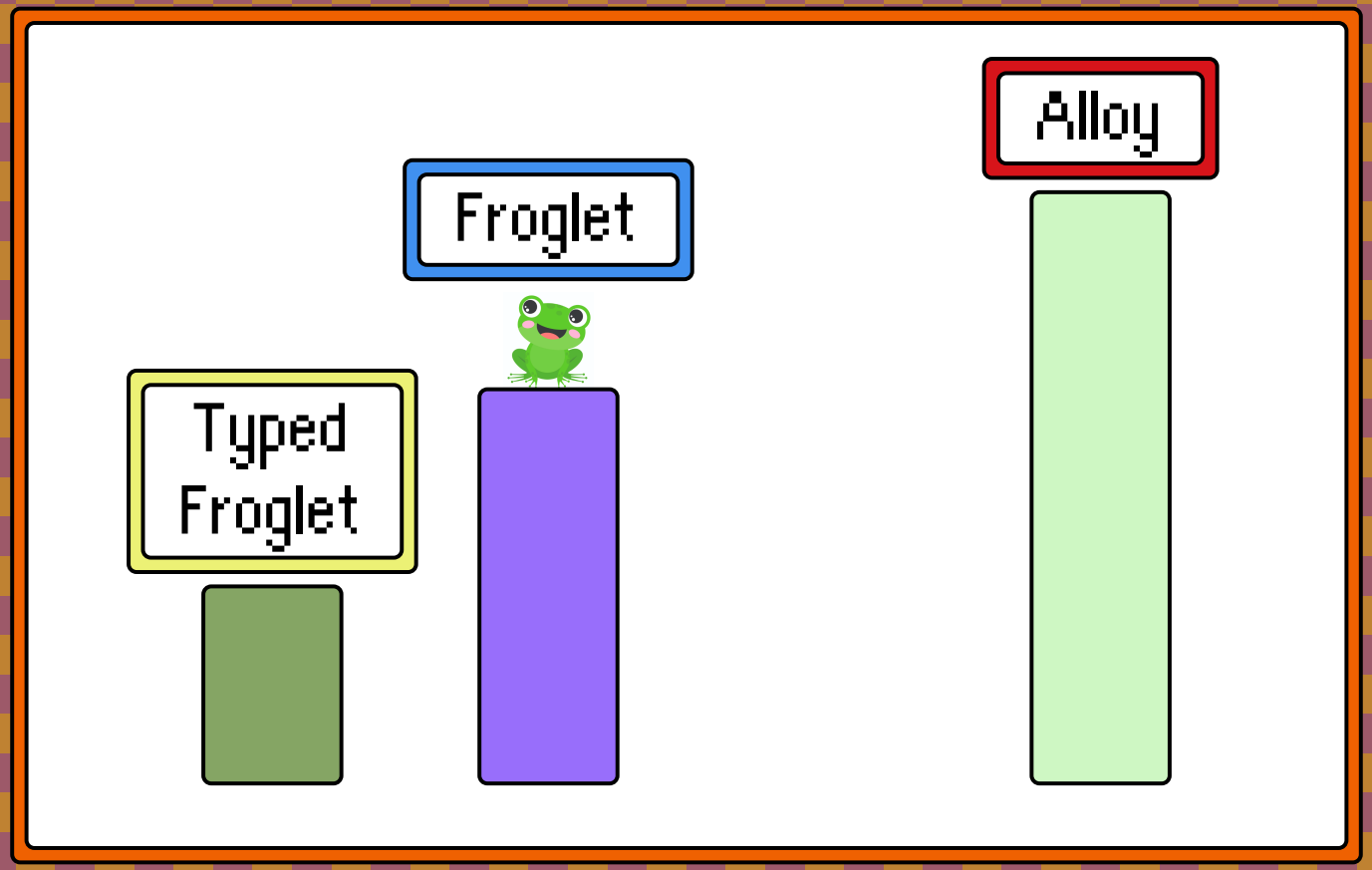

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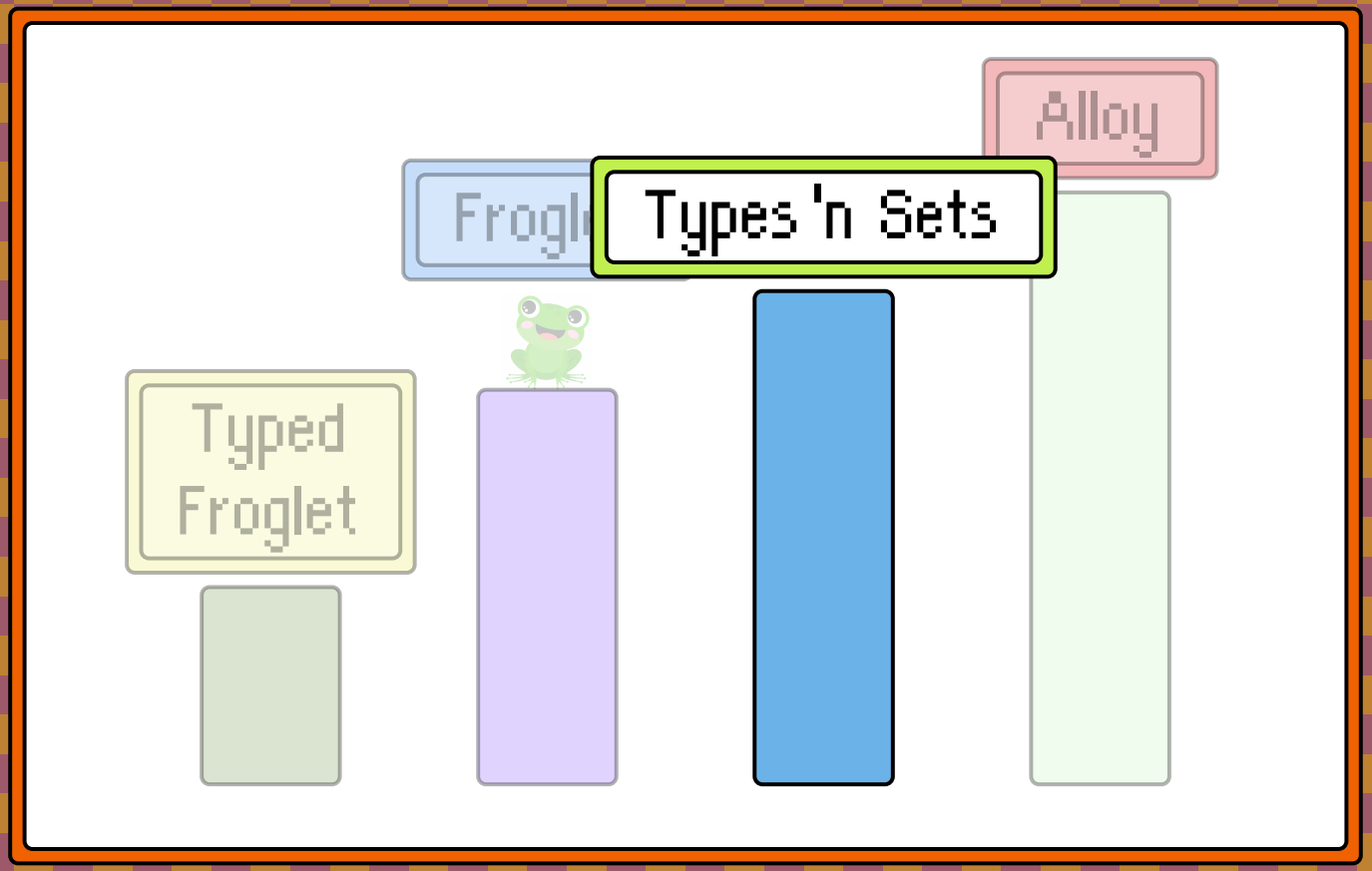


THE END

TYPES FOR FROGLET

Goal: Java-style types to help programmers learn Alloy

Some Challenges:

- How to type libraries?
- Are Java types enough?
- Will types help teach sets?