DEUCE

A Lightweight UI For Structured Editing

Brian Hempel, Justin Lubin, Grace Lu, and Ravi Chugh

THE UNIVERSITY OF CHICAGO

Unstructured text is clumsy

```
ñjò–|I[AÍÕÓnLE…@iq6Èûâ8€tù.À,:◊ÿc;:2πU¨LZ™Yz±ï
ÒJ#|suurü=⁄{~’Ïə̀ÀûÛ˘«<›˙bN™‡EvPèÆêÛN¸Ω≥>n˚ƒTπc"
ª√≤õÕ…+Tã@$TwhJ<ÏÚ%(8˝ÎÛFz5£:Ø‹¡I–^∂9*™s*˘˙Ïuj
±[î!ùØ$3áUà·Î•'Œ◊≥≥´ë\ÏÌ\Ä”dfi<u¥v£ıŸzáõ(cõ÷◊·≥
'o¶ç±d,¥fl3˚ßH?_¡˜’√‹Œz¢§“ÀK*Ã«?<`öÓæN(HRXU¯â˘á
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o,U)è#æ·Jªfi†ÌÕí2ÜdHÃì2˚@’jÀ=·Ú°@*qx]bèuSzÃµxKø
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(hidden syntax error)

Problem for Beginners

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Arrows are reserved for cases and anonymous functions. Maybe you want > or >=
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Structure must come from your head!

Problem for Experts

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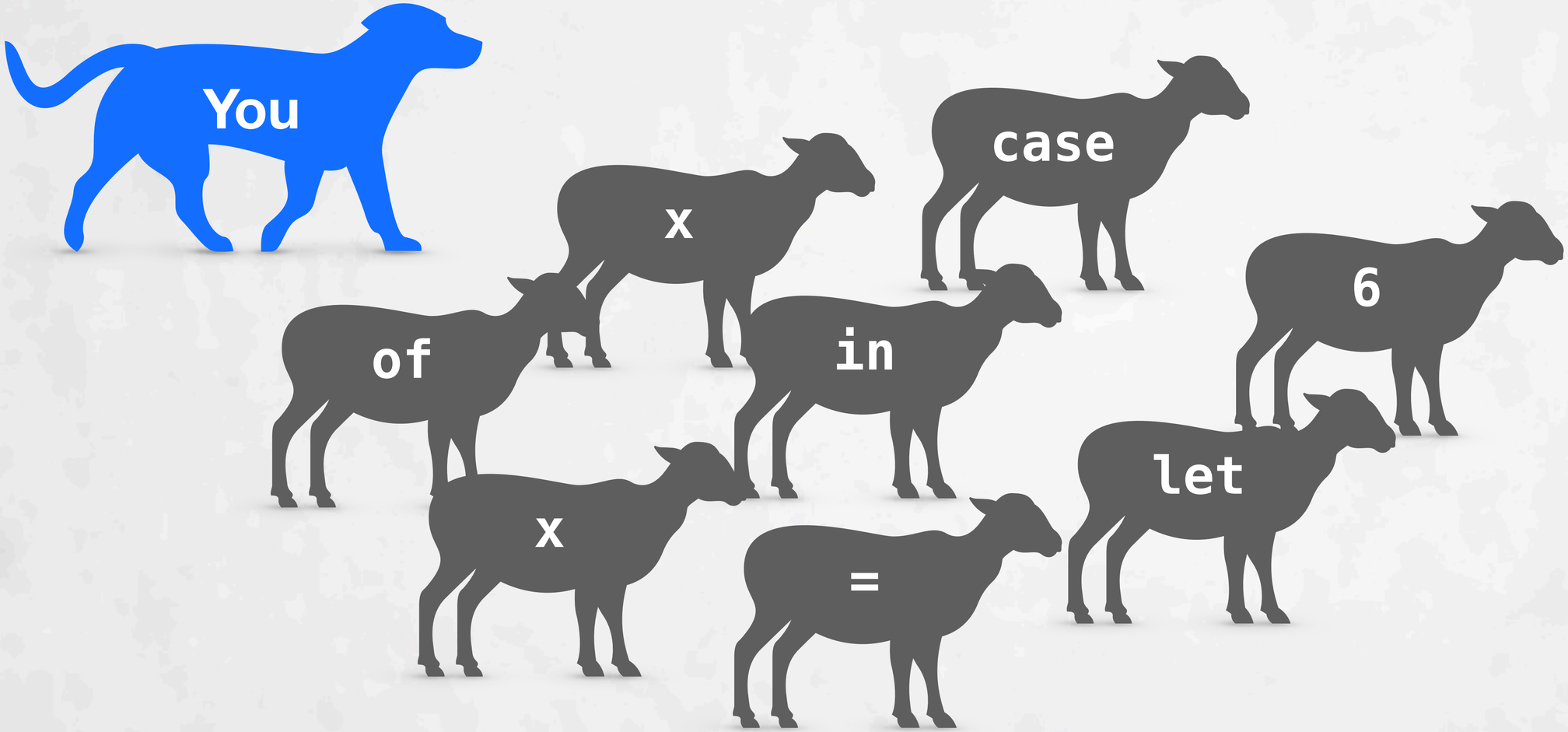
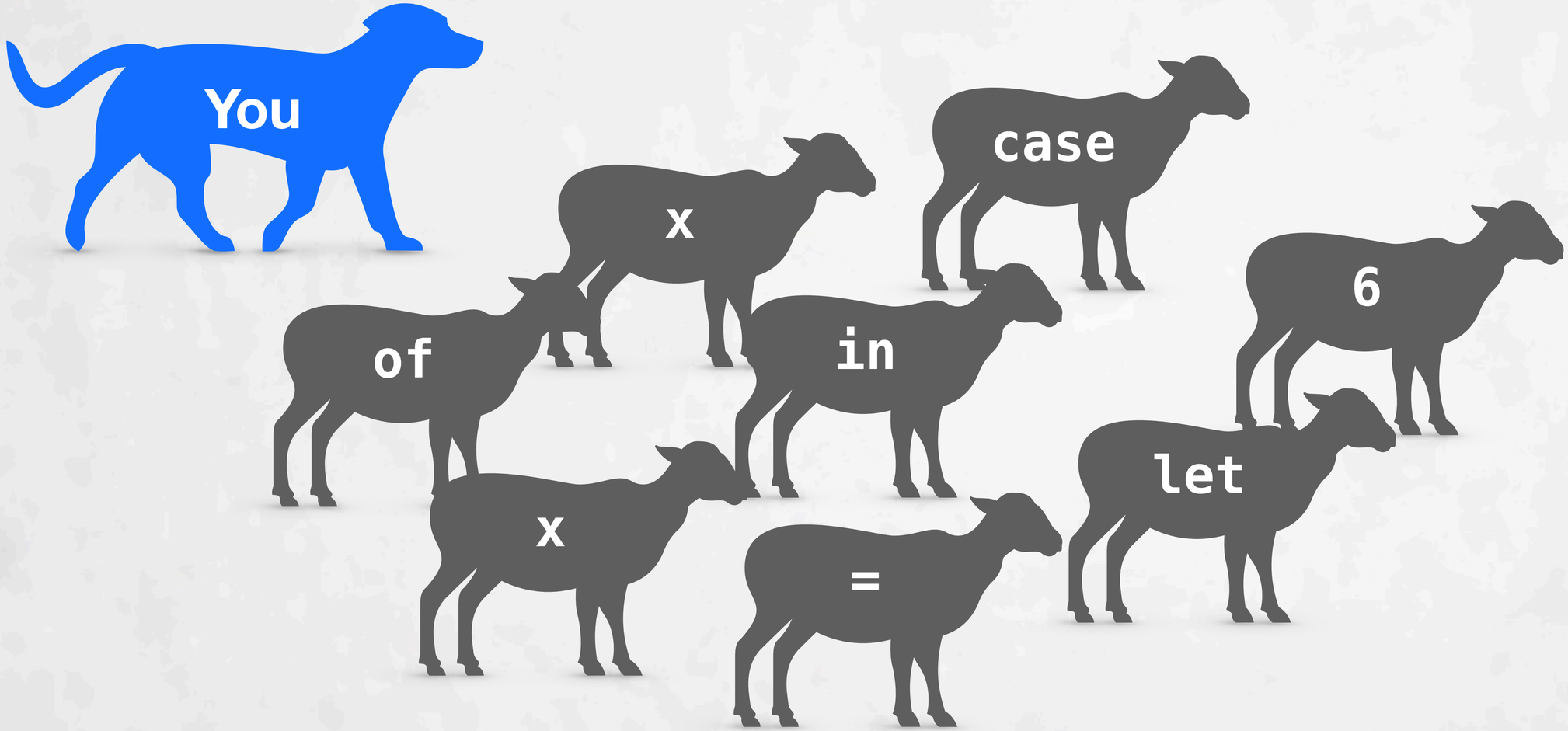
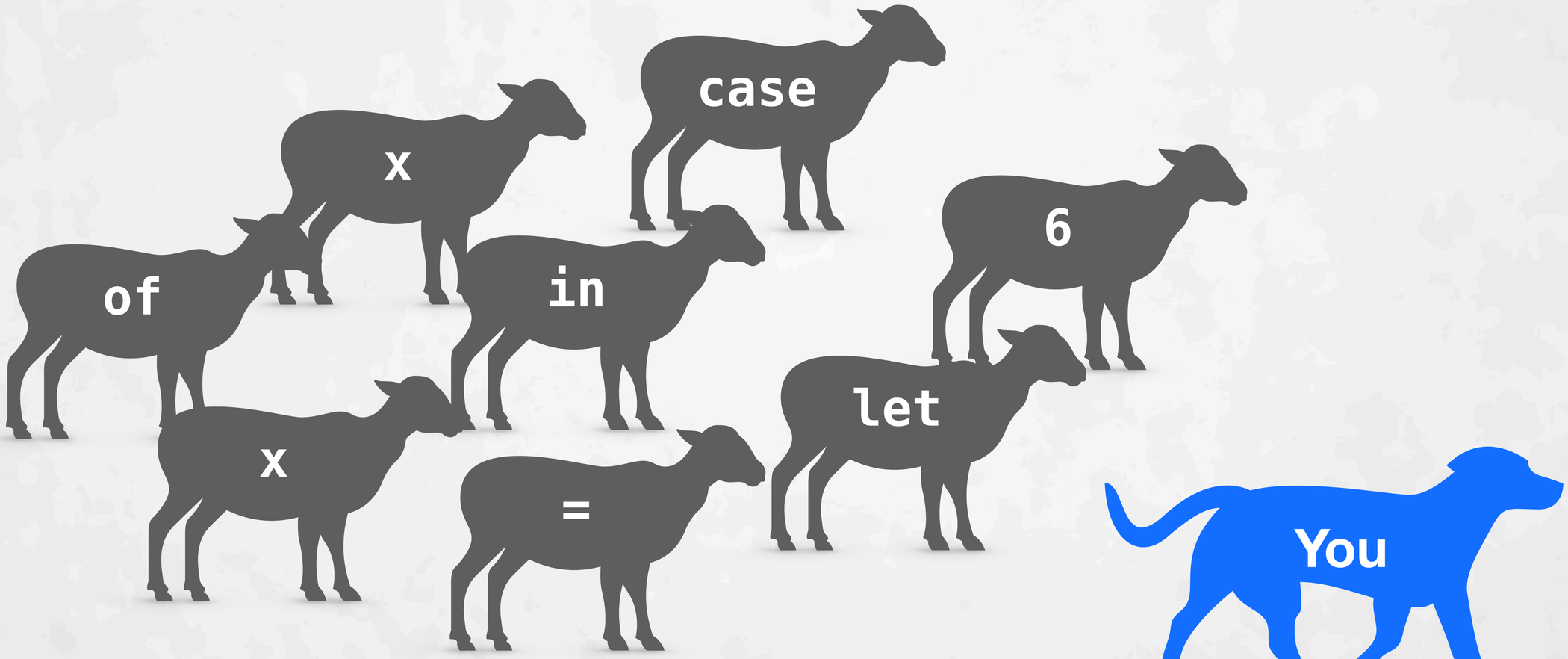


Problem for Experts



Spend time herding text!

Problem for Experts



Spend time herding text!

Problem for Experts

Spend time herding text!

Your program isn’t text.

Your program isn’t text.
It’s an AST.

Text Changes

Text Changes

≠

Text Changes

≠

AST Changes

Structured Editors

Structured Editors

Scratch

(Maloney et al. 2010; Resnick et al. 2009)

Structured Editors

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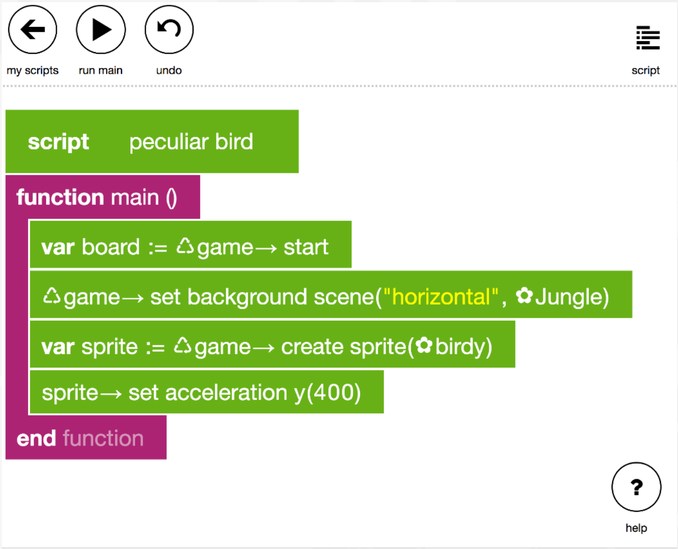

TouchDevelop

(Tillmann et al. 2012)

Structured Editors

Scratch

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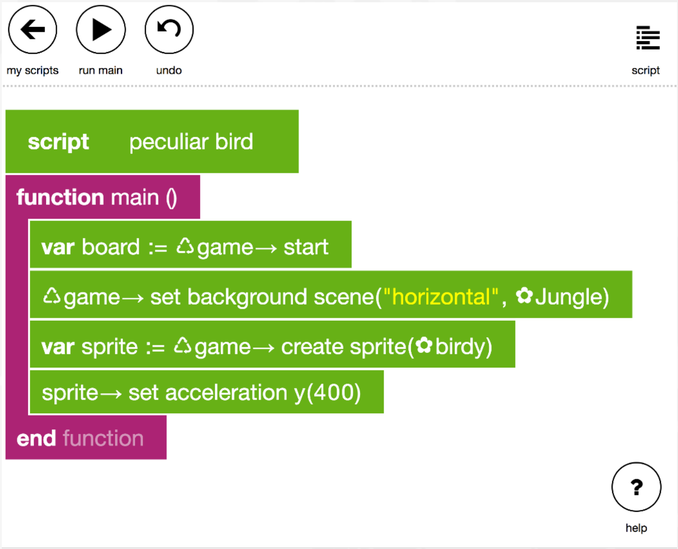

TouchDevelop

(Tillmann et al. 2012)

UI challenges; Experts still use plain text

Traditional Refactoring

Traditional Refactoring

Text-Select **Menu** **Configure**

Traditional Refactoring

Text-Select Menu Configure

```
@Override
public ConvexOptimizer getOptimizer() {
    if (optimizer == null) {
        Solver solver = new Solver.Builder().model(this).configure(conf()).build();
        this.optimizer = solver.getOptimizer();
    }
    return optimizer;
}

/**Returns the parameters of the neural network as a flattened row vector
 * @return the parameters of the neural network
 */
@Override
public INDArray params() {
    return paramsFlattened;
}

@Override
public INDArray getParam(String param) {
    return params.get(param);
}
```

(Deeplearning4j in Eclipse)

Traditional Refactoring

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```

Move... ⌥⌘V
Change Method Signature... ⌥⌘C
Extract Method... ⌥⌘M
Extract Interface...
Extract Superclass...
Use Supertype Where Possible...
Pull Up...
Push Down...
Extract Class...
Introduce Parameter Object...

(Deeplearning4j in Eclipse)

Traditional Refactoring

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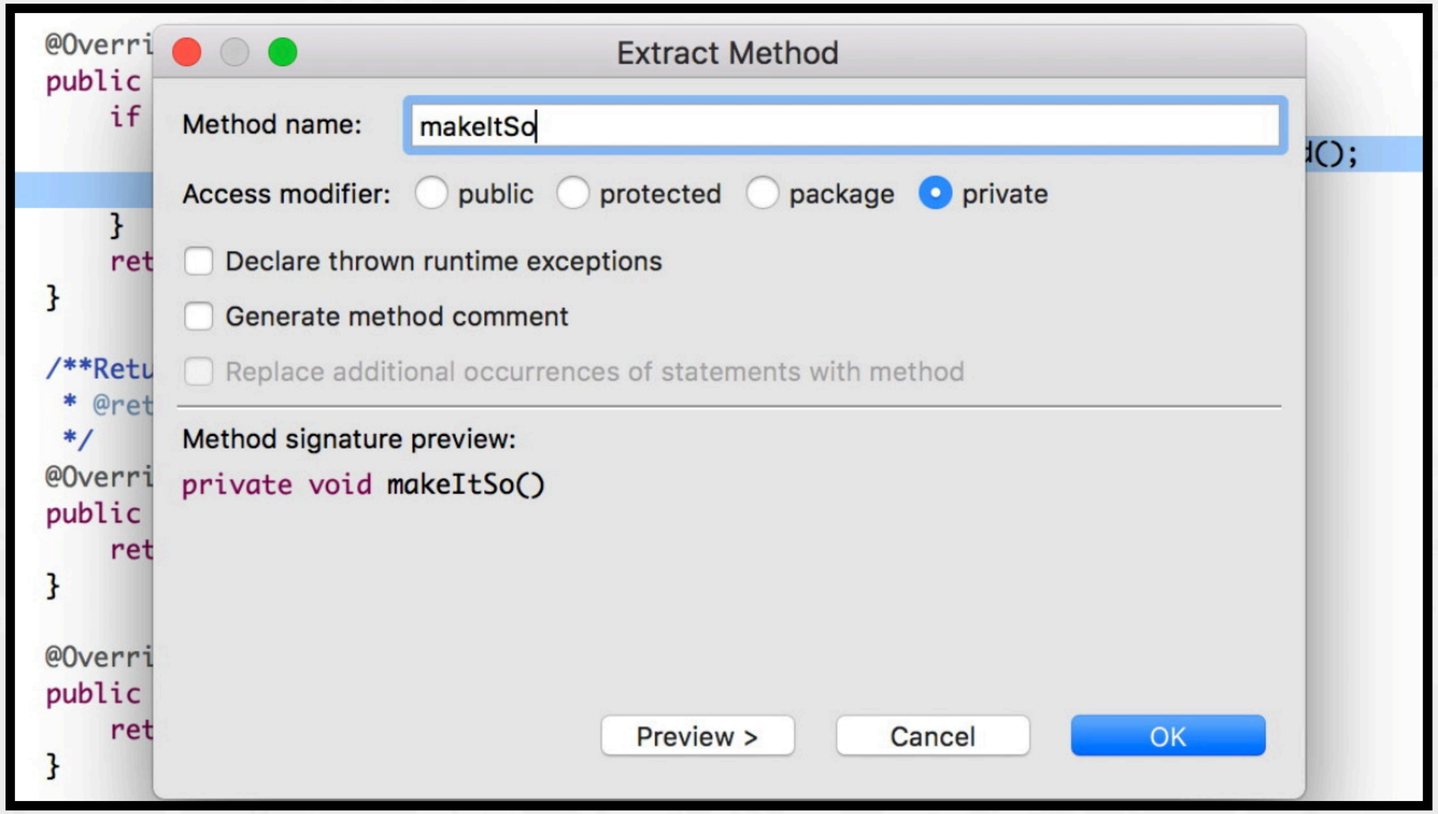

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✗ Awkward

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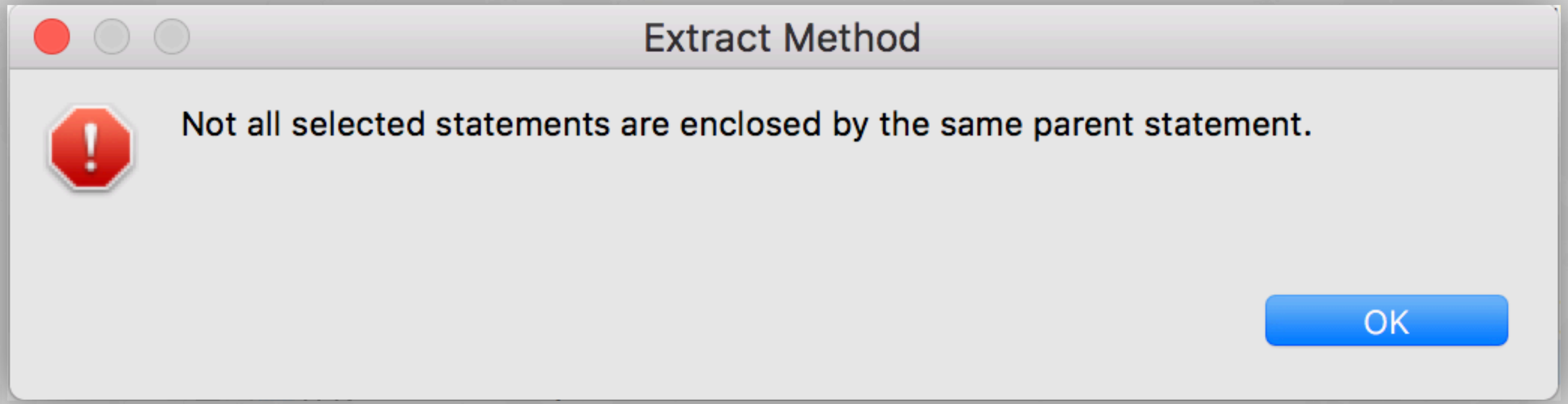

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Text-Select **Menu** **Configure**

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✗ Multiple Selections

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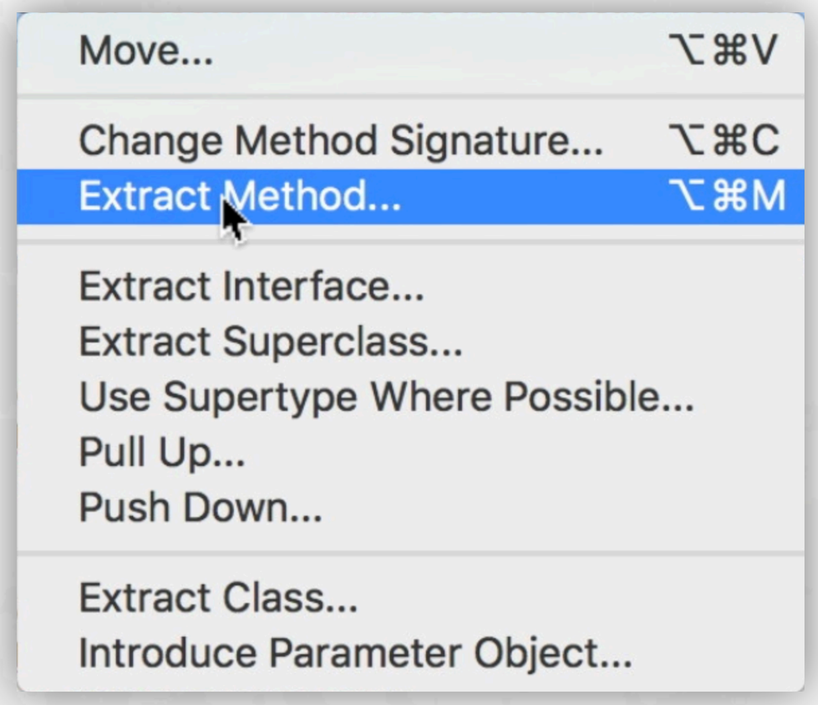

Traditional Refactoring

Text-Select

- ✗ Awkward
- ✗ Multiple Selections

Menu

- ✗ Many Options

Configure

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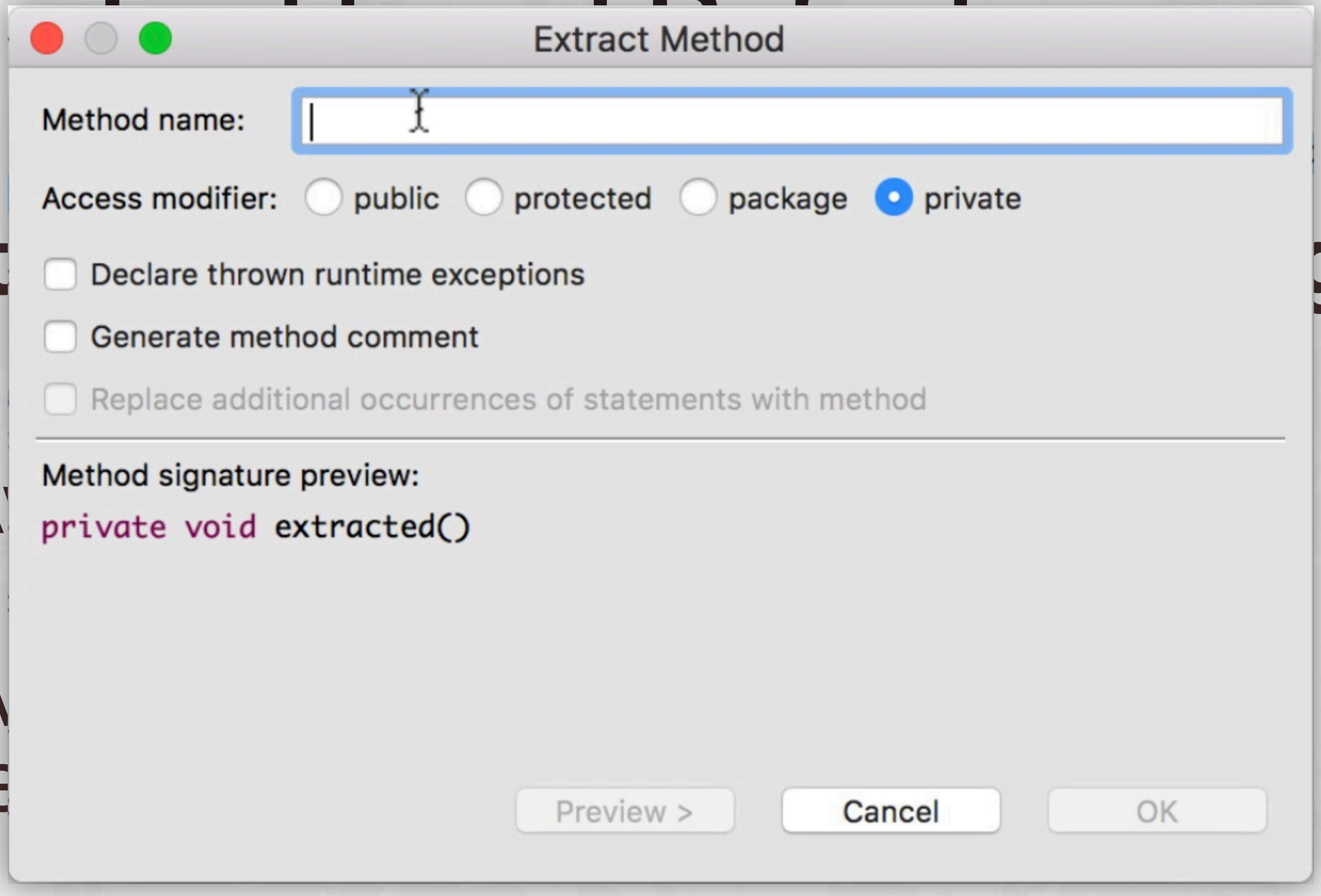

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Text-Select

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Menu

- ✗ Many Options

Configure

- ✗ Dialogs

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Deuce

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Deuce

Structure Select

```
(def image1
  (let [width height]
  (let [x y] [50 65]
    (image "lightgrey"

(def main
  (draw (concat [ image
```

Menu

✗ Many Options

Configure

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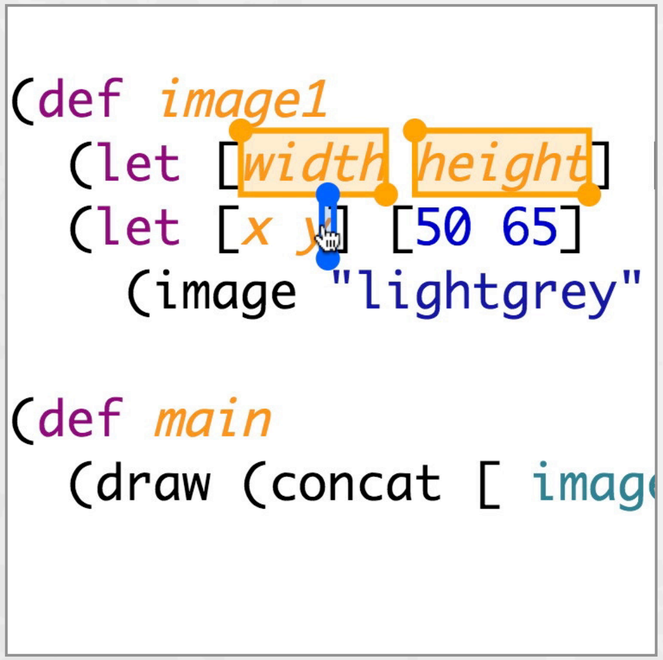
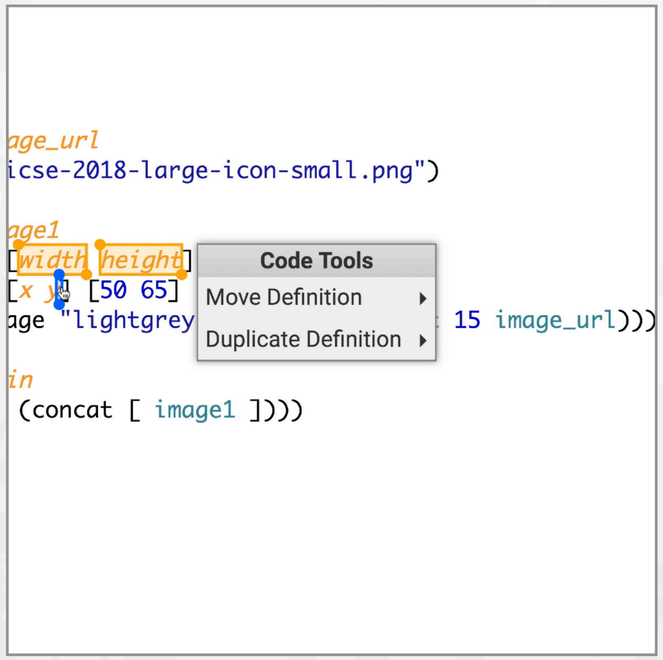
Deuce

Structure Select



Short Menu



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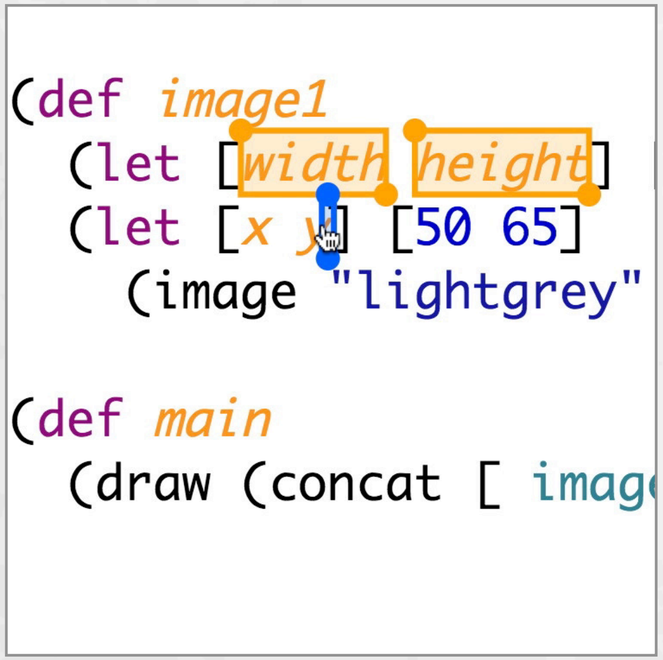

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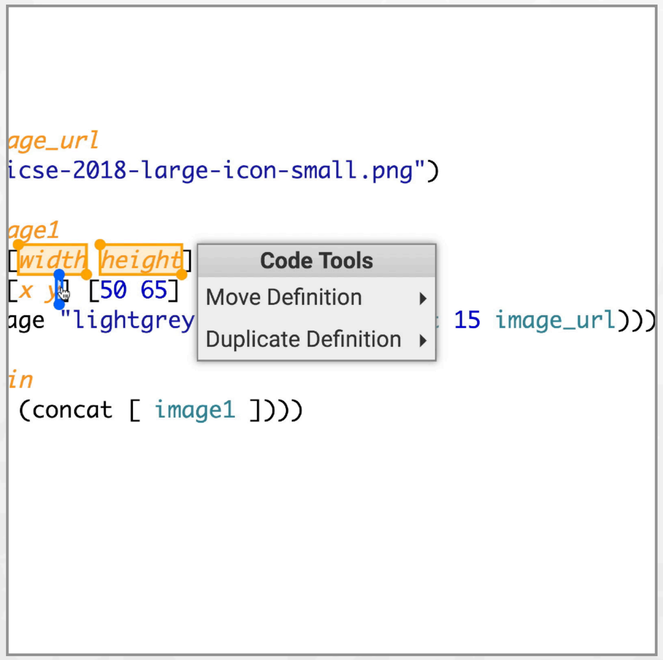

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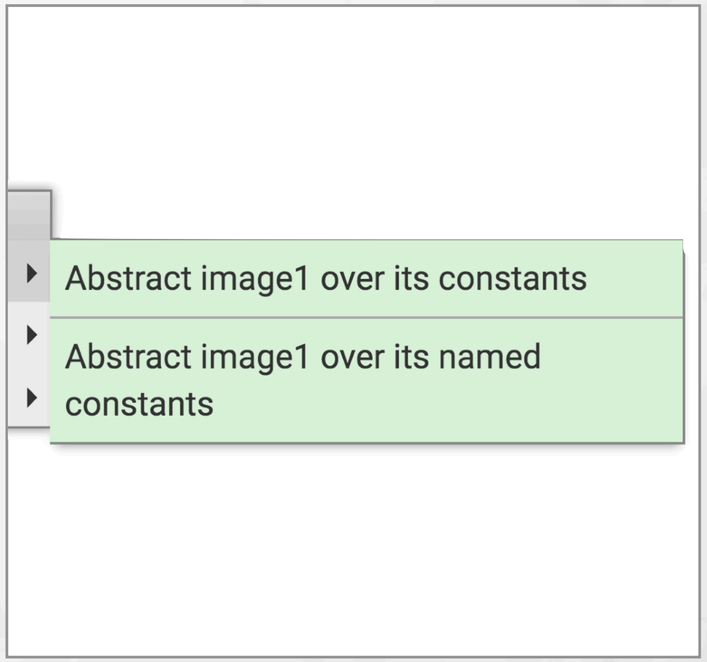

Demo

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

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  "img/icse-2018-large-icon-small.png")

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
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Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-

(def image1
  (image "lightgrey" 50 65 283 254 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable

Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable
  - Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.

(def image1
  (let width 283
    (image "lightgrey" 50 65 width 254 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable
  - Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small

(def image1
  (let width 283
  (let height 254
    (image "lightgrey" 50 65 width height 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable
  - Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
  (let height 254
    (image "lightgrey" 50 65 width height 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
  (let height 254
    (image "lightgrey" 50 65 width height 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
  (let height 254
    (image "lightgrey" 50 65 width height 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variable

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-

(def image1
  (let width 283
  (let height 254
    (image "lightgrey" 50 65 width height 15 image_url))

(def main
  (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variables
- Make Equal with Single Variable
- Make Equal by Copying
- Swap Expressions

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
1  (def image_url
2    "img/icse-2018-large-
3
4  (def image1
5    (let width 283
6    (let height 254
7    (let [x y] [50 65]
8      (image "lightgrey" x y width height 15 image_url))))
9
10 (def main
11   (draw (concat [ image1 ])))
```

Code Tools

- Create Function from Arguments
- Introduce Variables
- Make Equal with Single Variable
- Make Equal by Copying
- Swap Expressions

Introduce Variables

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let width 283
  (let height 254
  (let [x y] [50 65]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
1  (def imag
2    "img/ic                    n-small.png")
3
4  (def imag
5    (let width 283
6    (let height 254
7    (let [x y] [50 65]
8      (image "lightgrey" x y width height 15 image_url))))
9
10 (def main
11   (draw (concat [ image1 ])))
```

Code Tools
- Move Definition
- Duplicate Definition

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitl*

Undo Re

Run

Code Tools

- Create Function from Definition
- Create Function from Arguments
- Rename *width*
- Inline Definition

```
(def imag
  "img/ic                    g")

(def imag
  (let width 283
  (let height 254
  (let [x y] [50 65]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
1  (def imag
2    "img/ic                    n-small.png")
3
4  (def imag
5    (let width 283
6    (let height 254
7    (let [x y] [50 65]
8      (image "lightgrey" x y width height 15 image_url))))
9
10 (def main
11   (draw (concat [ image1 ])))
```

Code Tools

- Move Definition
- Duplicate Definition

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
1  (def imag
2    "img/ic
3
4  (def imag
5    (let [width height] [283 254]
6    (let [x y] [50 65]
7      (image "lightgrey" x y width height 15 image_url))))
8
9  (def main
10   (draw (concat [ image1 ])))
```

Code Tools
- Move Definition ▸ Move width
- Duplicate Definition ▸

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [width height] [283 254]
  (let [x y] [50 65]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

Code Tools
Move Definition
Duplicate Definition

```
(def imag
  "img/ic -small.png")

(def imag
  (let [width height] [283 254]
  (let [x y] [50 65]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
1 (def image
2   "img/ics
3
4 (def image1
5   (let [x y width height] [50 65 283 254]
6     (image "lightgrey" x y width height 15 image_url)))
7
8 (def main
9   (draw (concat [ image1 ])))
```

Code Tools

- Move Definition
  - Move width and height
- Duplicate Definition

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [x y width height] [50 65 283 254]
    (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Untitled *

Code Tools
- Create Function from Definition
- Inline Definition
- Make Single Line

Run

```
(d
                    small.png")

(def image1
  (let [x y width height] [50 65 283 254]
    (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Untitled *

Code Tools

Create Function from Definition

Inline Definition

Make Single Line

Abstract image1 over its constants

Abstract image1 over its named constants

```
(def image1
  (let [x y width height] [50 65 283 254]
    (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ image1 ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Untitled *

Code Tools

- Create Function from Definition
  - Abstract image1 over its constants
  - Abstract image1 over its named constants
- Inline Definition
- Make Single Line

```
(d

(def image1 (\(x y width height bgColor padding)
  (image bgColor x y width height padding image_url)))

(def main
  (draw (concat [ (image1 50 65 283 254 "lightgrey" 15) ]
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Untitled *

Code Tools

- Create Function from Definition
  - Abstract image1 over its constants
  - Abstract image1 over its named constants
- Inline Definition
- Make Single Line

```
(d

(def image1 (\(x y width height)
  (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ (image1 50 65 283 254) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1 (\(x y width height)
  (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ (image1 50 65 283 254) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Code Tools

- Remove Arguments
- Swap Variable Names and Usages
- Swap Variable Usages
- Inline Definitions

Current file: *Untitled **

Undo Redo Clean U Run

```
(def image_url
  "img/icse-2018-larg

(def image1 (\(x y width height)
  (image "lightgrey" x y width height 15 image_url)))

(def main
  (draw (concat [ (image1 50 65 283 254) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean U

Code Tools

Remove Arguments

Swap Variable Names and Usages

Swap Variable Usages

Inline Definitions

Remove Arguments

Run

```
(def image_url
  "img/icse-2018-larg

(def image1 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (image1 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (image1 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Un

Undo

Run

Code Tools

- Create Function from Definition
- Rename *image1*
- Inline Definition

```
(def ima
  "img/t                    png")

(def image1 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (image1 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Un

Undo

Run

Code Tools

Create Function from Definition

Rename *image1*

Inline Definition

Rename *image1* to...

```
(def ima
  "img/

(def image1 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (image1 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: Un

Undo

Run

Code Tools

Create Function from Definition

Rename *image1*

Inline Definition

Rename *image1* to *icse2018*

icse2018

```
(def ima
  "img/

(def image1 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (image1 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def icse2018 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (icse2018 50 65) ])))
```

Raw
Stretchy
Sticky

Sketch-n-Sketch File Code Tools Output Tools View Options

Current file: *Untitled **

Undo Redo Clean Up Run

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def icse2018 (\(x y)
  (image "lightgrey" x y 283 254 15 image_url)))

(def main
  (draw (concat [ (icse2018 50 65) ])))
```

Raw
Stretchy
Sticky

Deuce

Structure Select

Short Menu

Defaults

Deuce

Structure Select

Short Menu

Defaults

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [width height] [324 200]
  (let [x y] [100 100]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Deuce

Structure Select

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [width height] [324 200]
  (let [x y] [100 100]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu

Code Tools

- Create Function from Definition ▸
- Inline Definition ▸
- Make Single Line ▸

Code Tools

- Move Definition ▸
- Duplicate Definition ▸

Defaults

Deuce

Structure Select

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [width height] [324 200]
  (let [x y] [100 100]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu

Code Tools

- Create Function from Definition ▸
  - Abstract image1 over its constants
  - Abstract image1 over its named constants
- Inline Definition ▸
- Make Single Line ▸

Code Tools

- Move Definition ▸
  - Move width and height
- Duplicate Definition ▸

Defaults

Deuce more effective than Traditional?

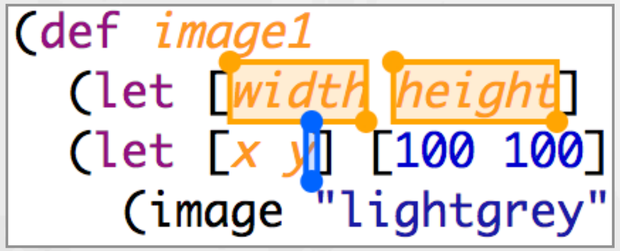
Deuce more effective than Traditional?

Deuce preferred to Traditional?

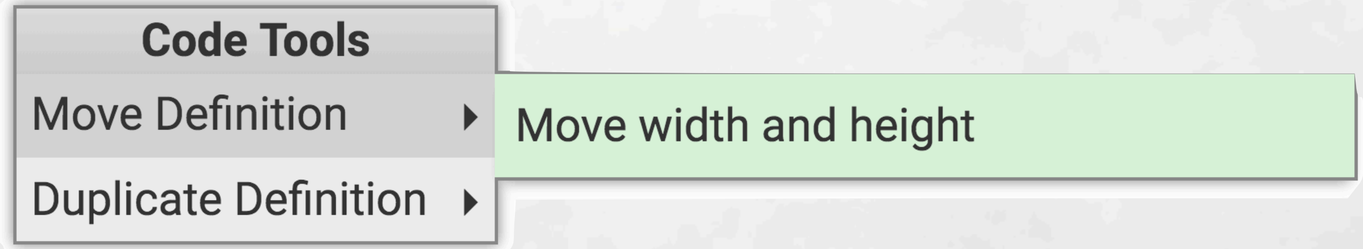
Deuce

Deuce

Structure Select



Short Menu



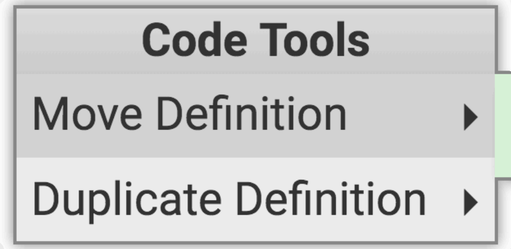
Defaults

Deuce “Box-Select Mode”

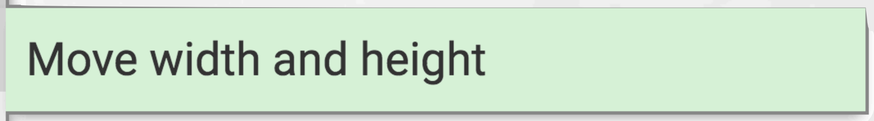
Structure Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu



Defaults



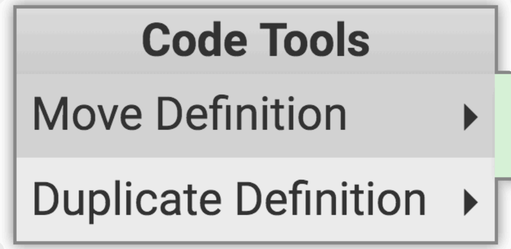
Traditional

Deuce “Box-Select Mode”

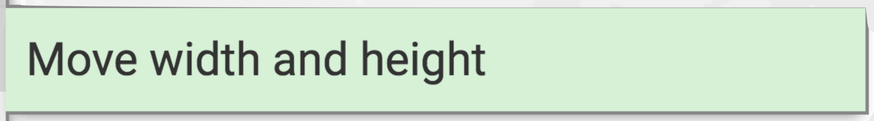
Structure Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu



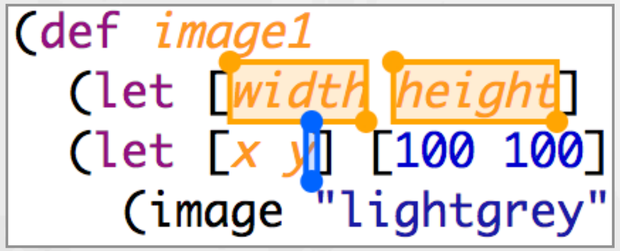
Defaults



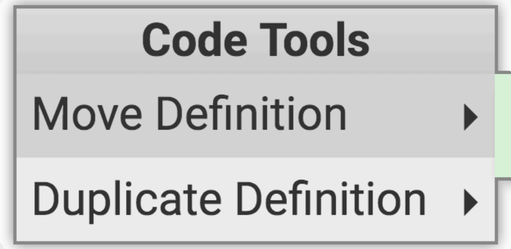
Traditional “Text-Select Mode”

Deuce “Box-Select Mode”

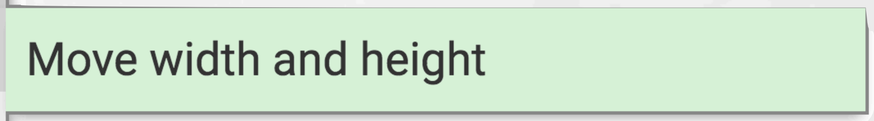
Structure Select



Short Menu



Defaults



Traditional “Text-Select Mode”

Text Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Deuce “Box-Select Mode”

Structure Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu

Code Tools

Move Definition ▸

Duplicate Definition ▸

Defaults

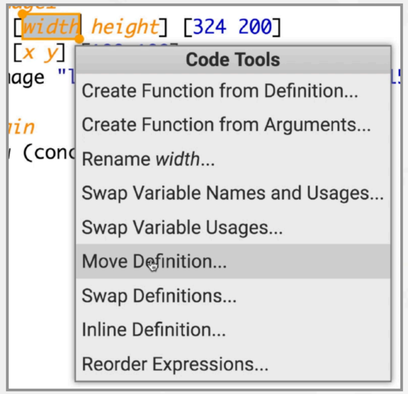
Move width and height

Traditional “Text-Select Mode”

Text Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Right-Click Menu

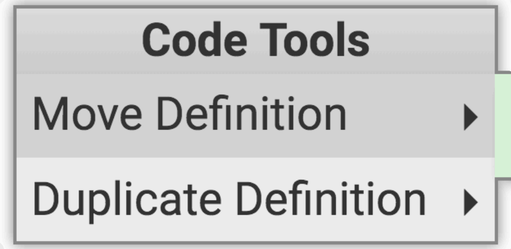


Deuce “Box-Select Mode”

Structure Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Short Menu



Defaults

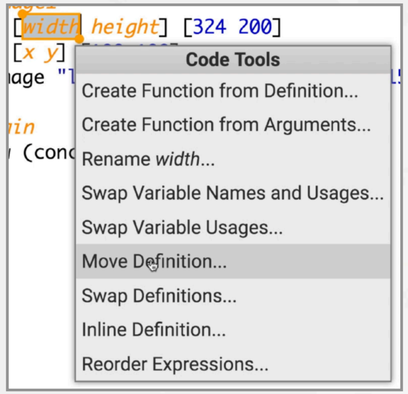
Move width and height

Traditional "Text-Select Mode"

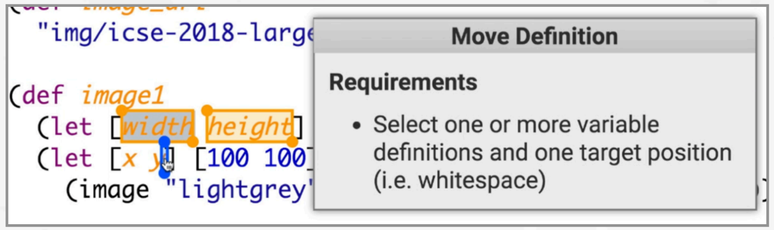
Text Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

Right-Click Menu



Select Arguments

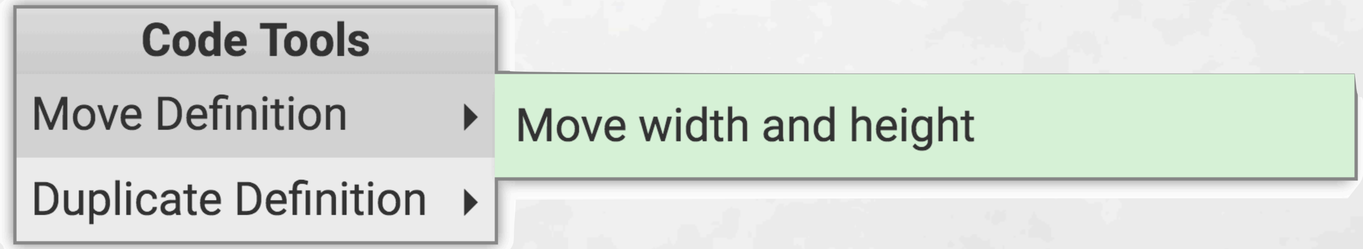


Deuce "Box-Select Mode"

Structure Select

```
(def image1
  (let [width height]
  (let [x y] [100 100]
    (image "lightgrey"
```

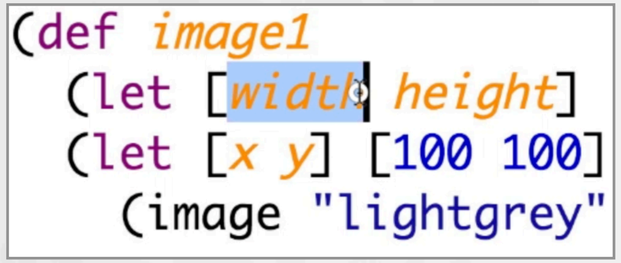
Short Menu



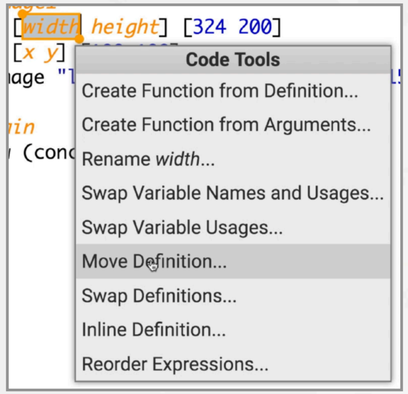
Defaults

Traditional "Text-Select Mode"

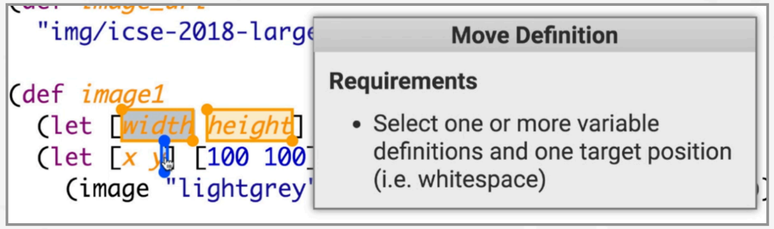
Text Select



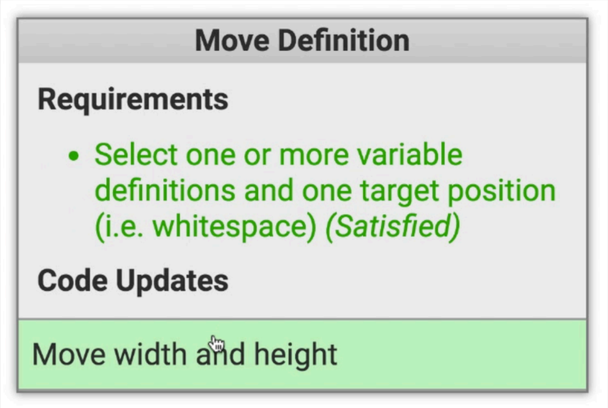
Right-Click Menu



Select Arguments

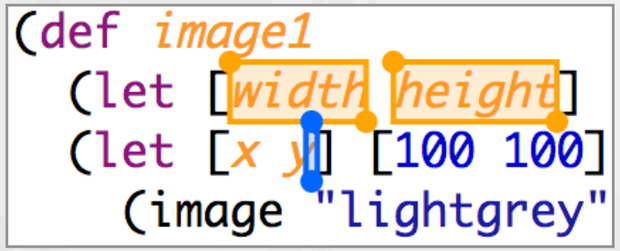


Defaults

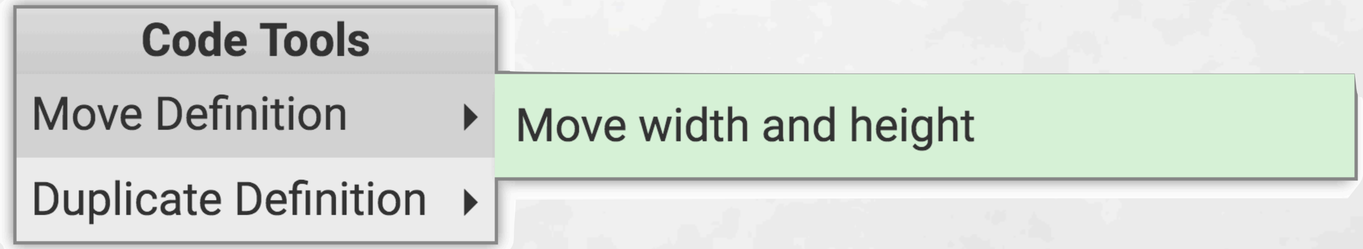


Deuce "Box-Select Mode"

Structure Select



Short Menu

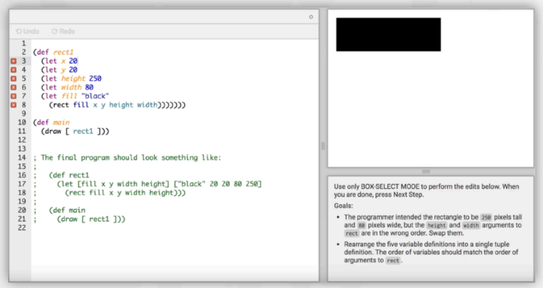


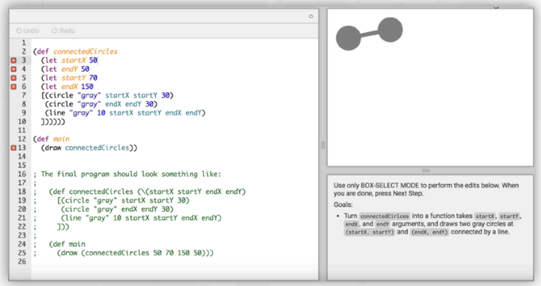
Defaults

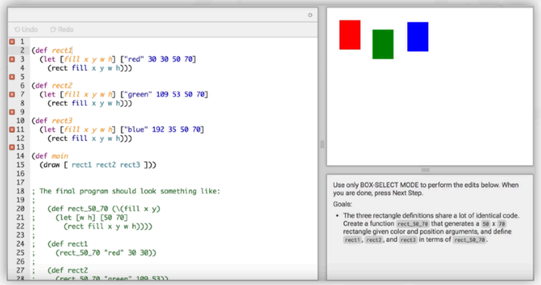
Tutorial

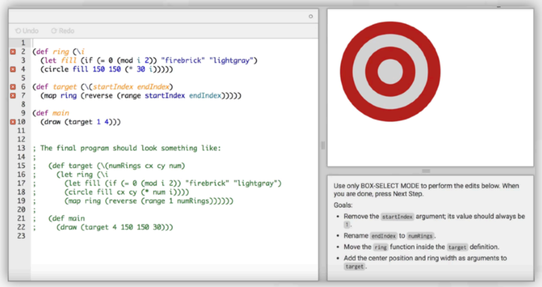
Tutorial

Head-to-Head Tasks (2x; once per mode)



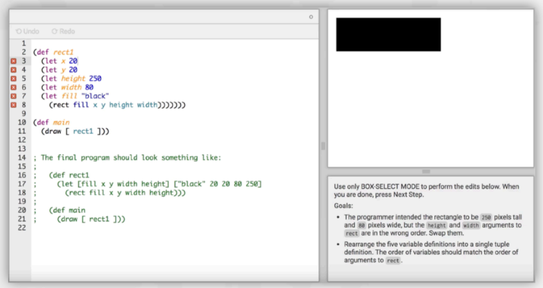


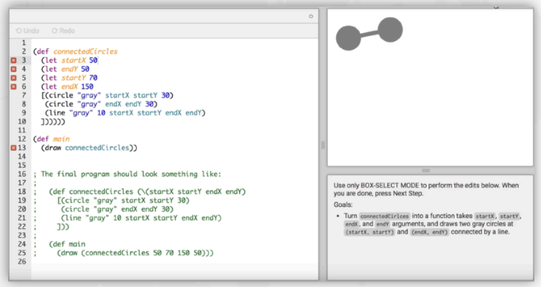


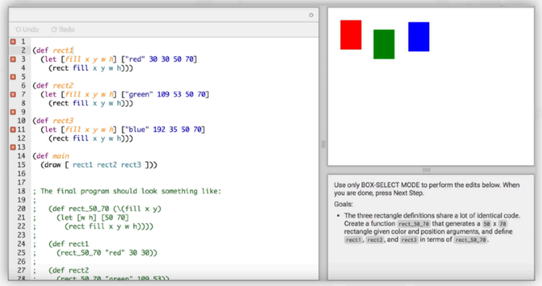


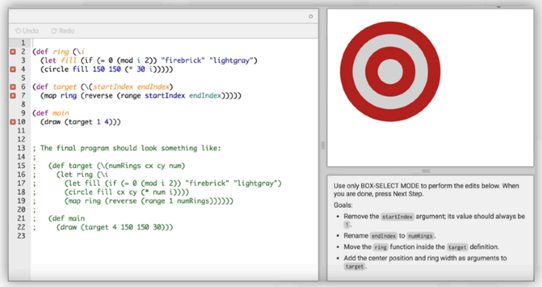
Tutorial

Head-to-Head Tasks (2x; once per mode)

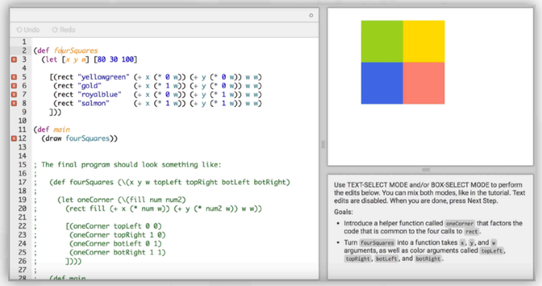


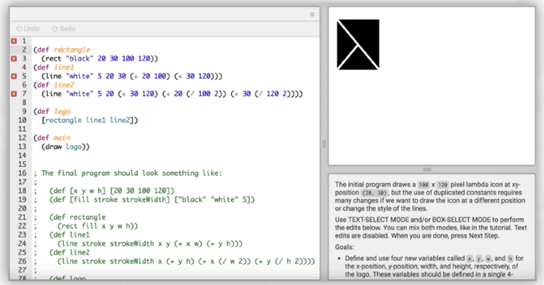






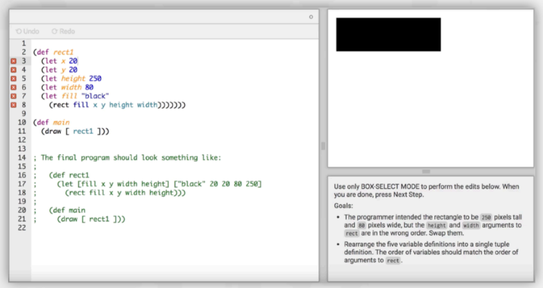
Mix & Match Tasks (free to use both modes)

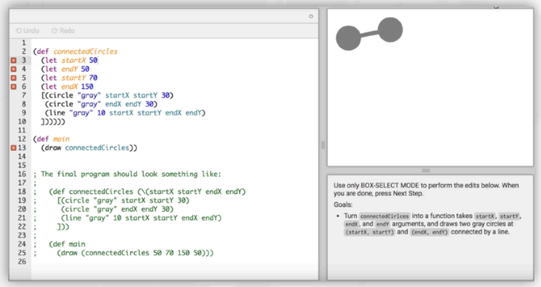


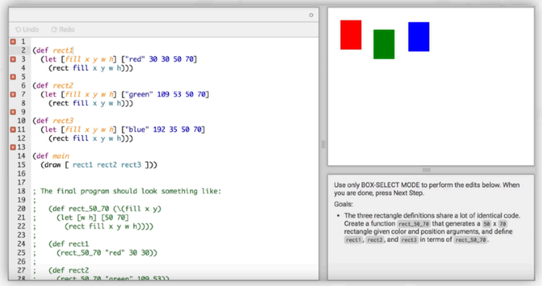


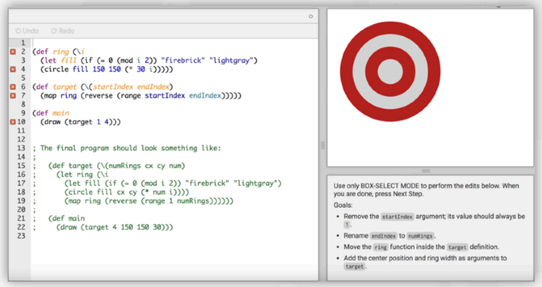
Tutorial

Head-to-Head Tasks (2x; once per mode)









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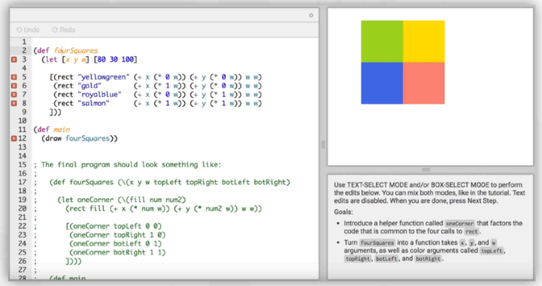
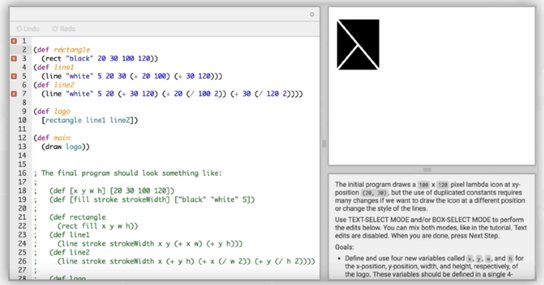


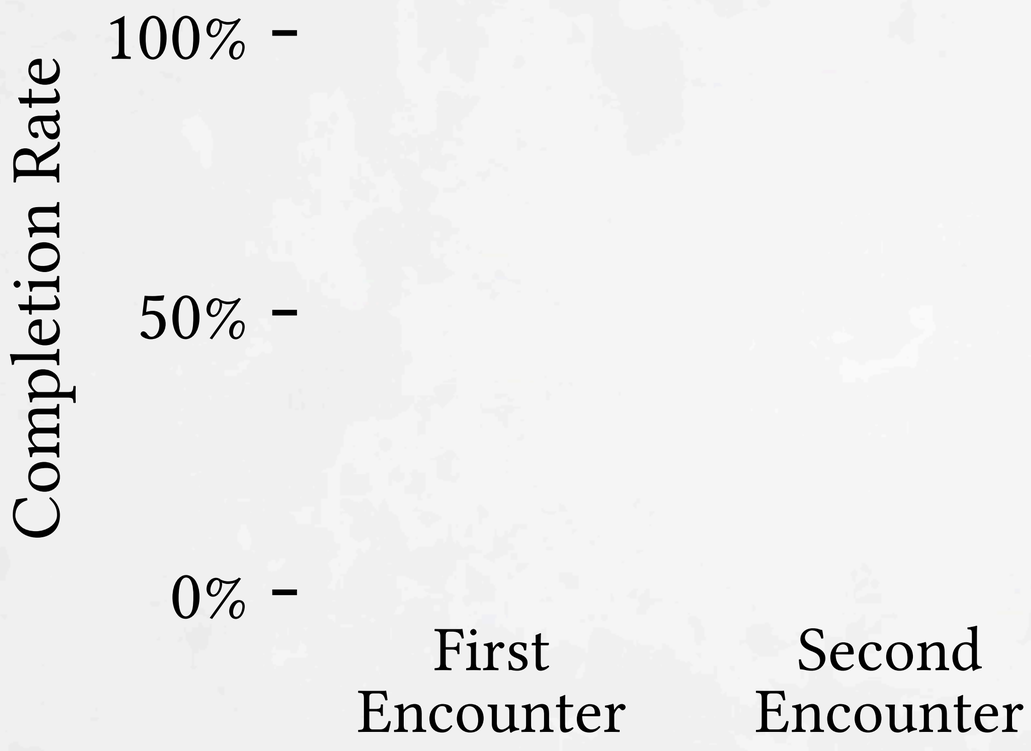


Exit Survey

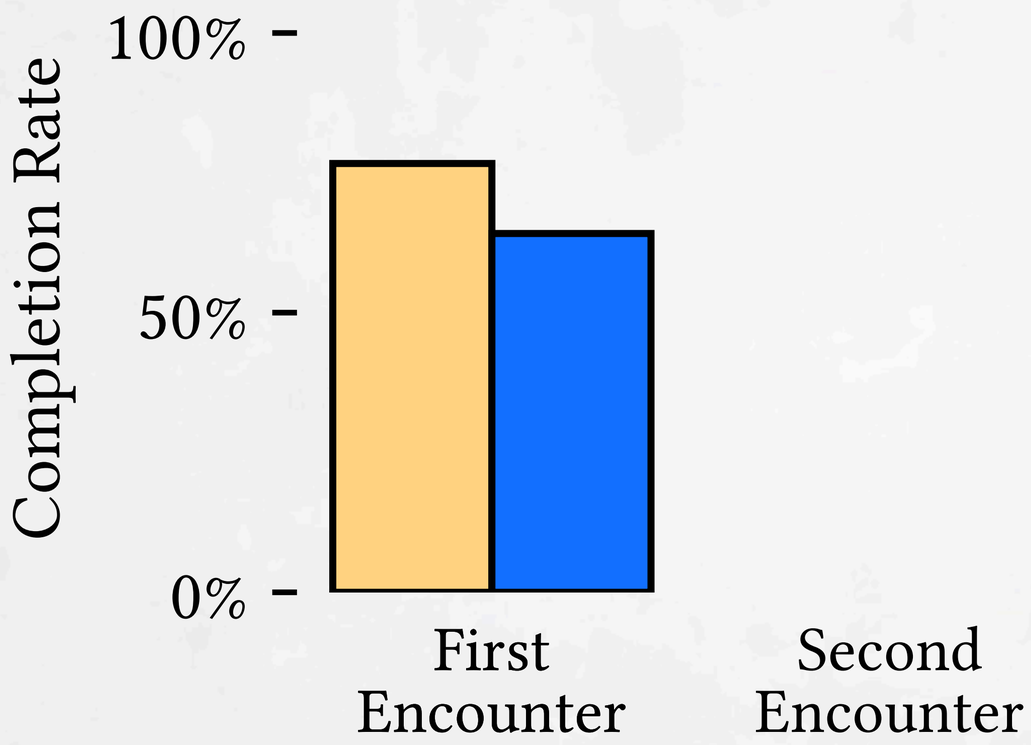
Deuce more effective than Traditional?

Deuce more effective than Traditional?

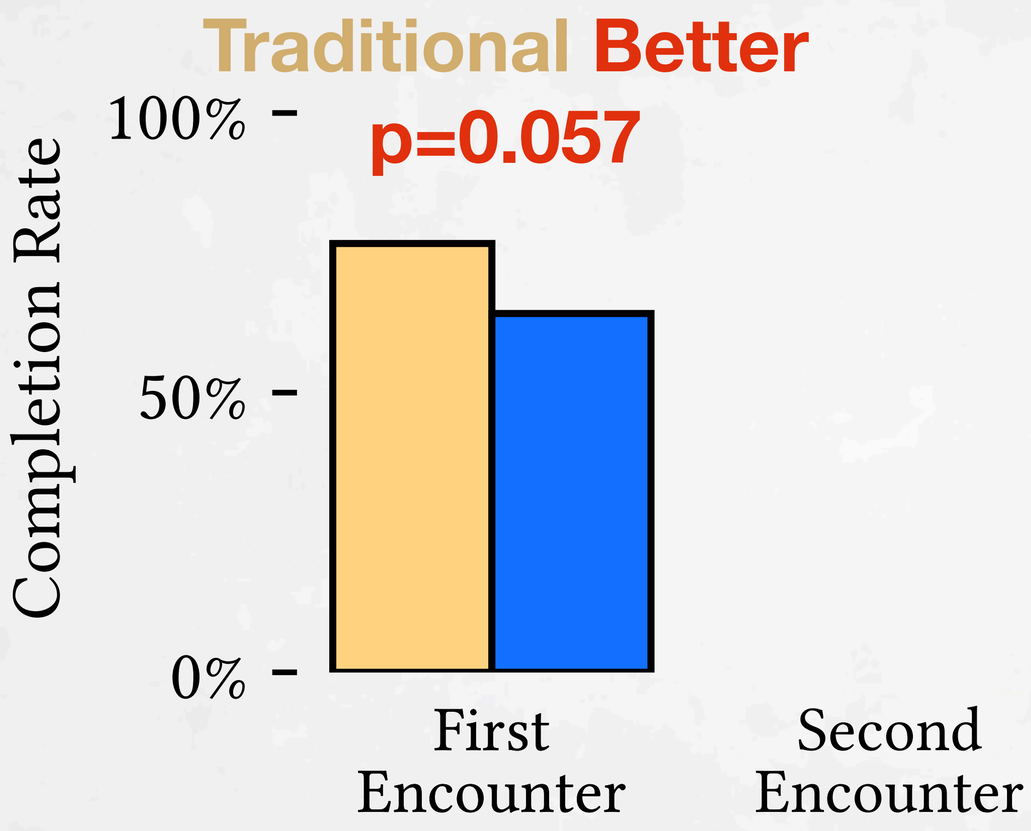
Deuce more effective than Traditional?



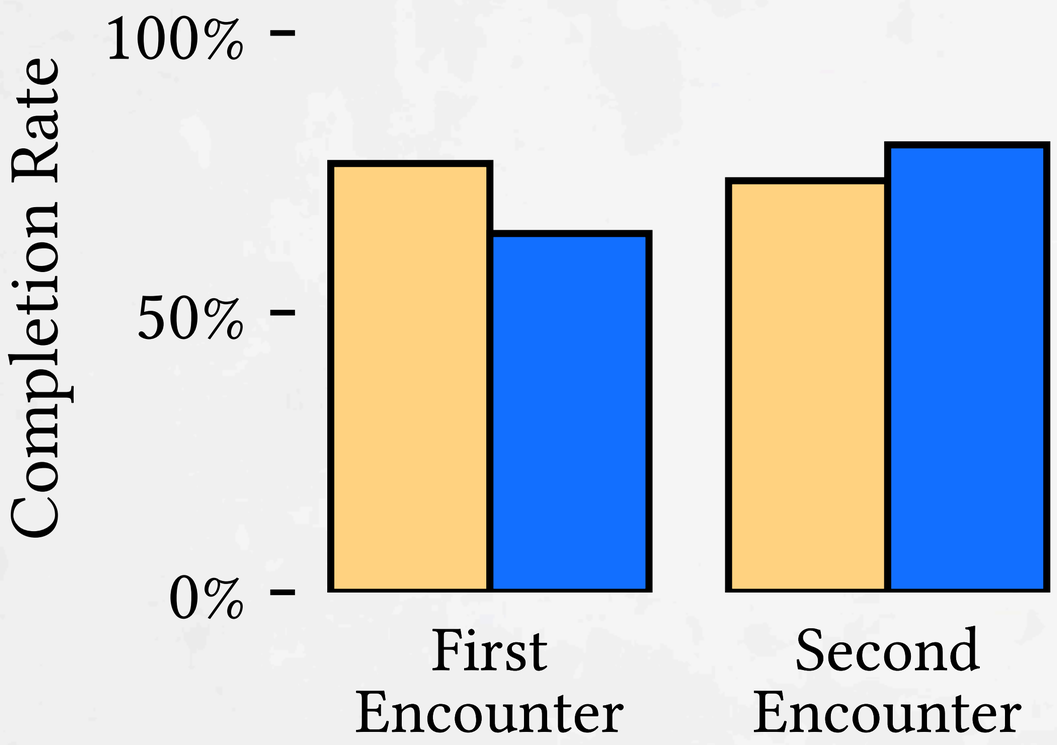
Deuce more effective than Traditional?



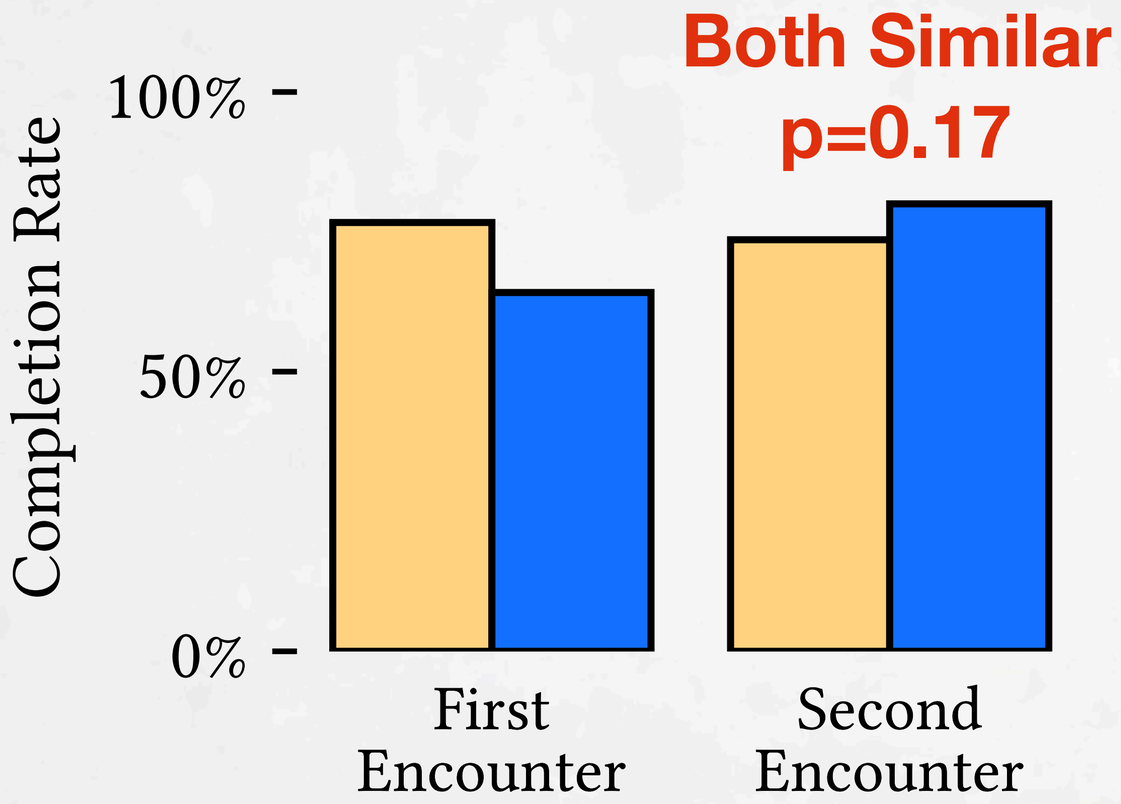
Deuce more effective than Traditional?



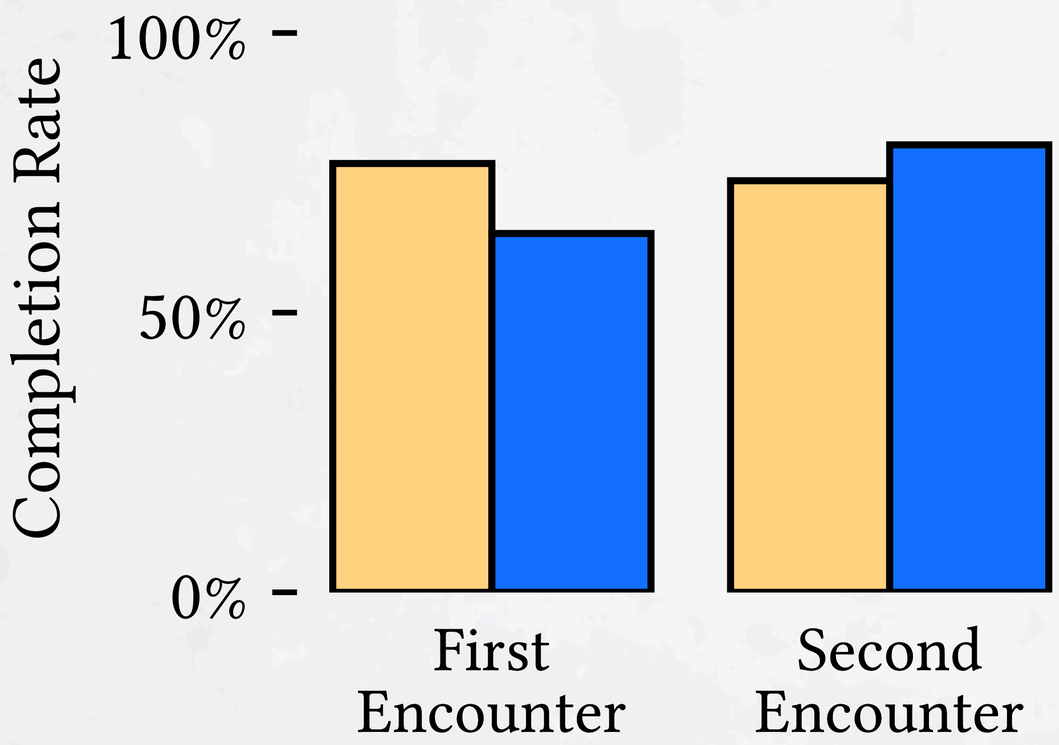
Deuce more effective than Traditional?



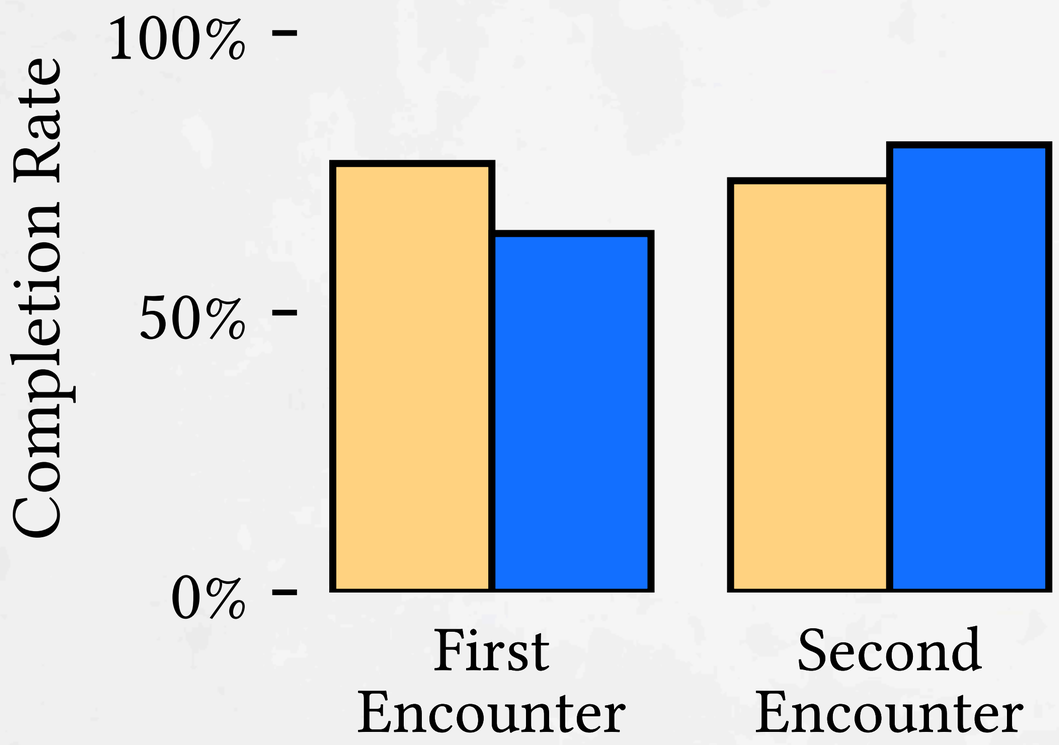
Deuce more effective than Traditional?



Deuce more effective than Traditional?



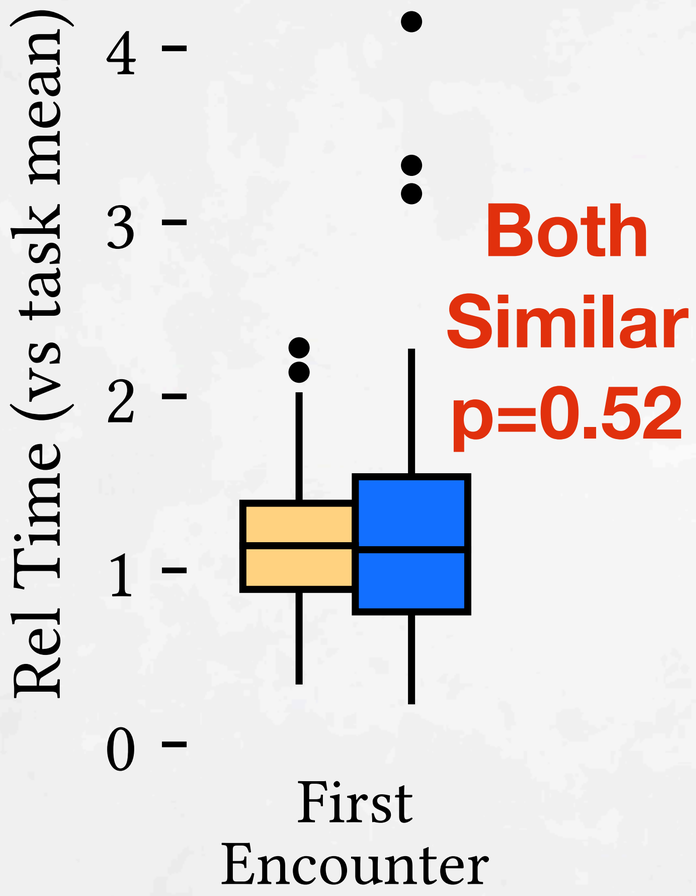
Deuce more effective than Traditional?



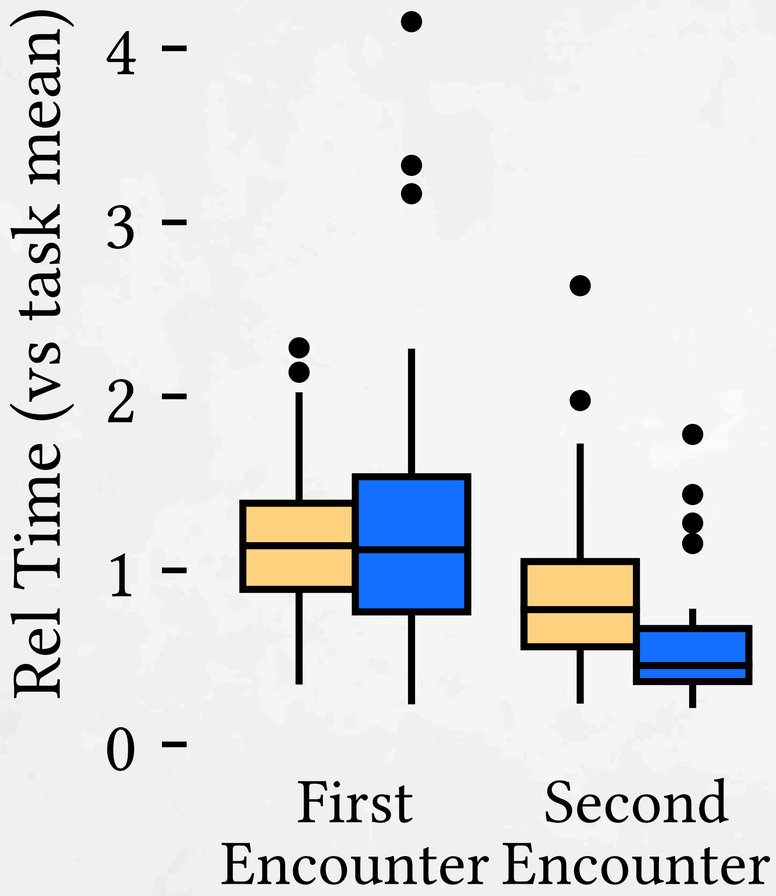
Deuce doesn't help discoverability

Deuce more effective than Traditional?

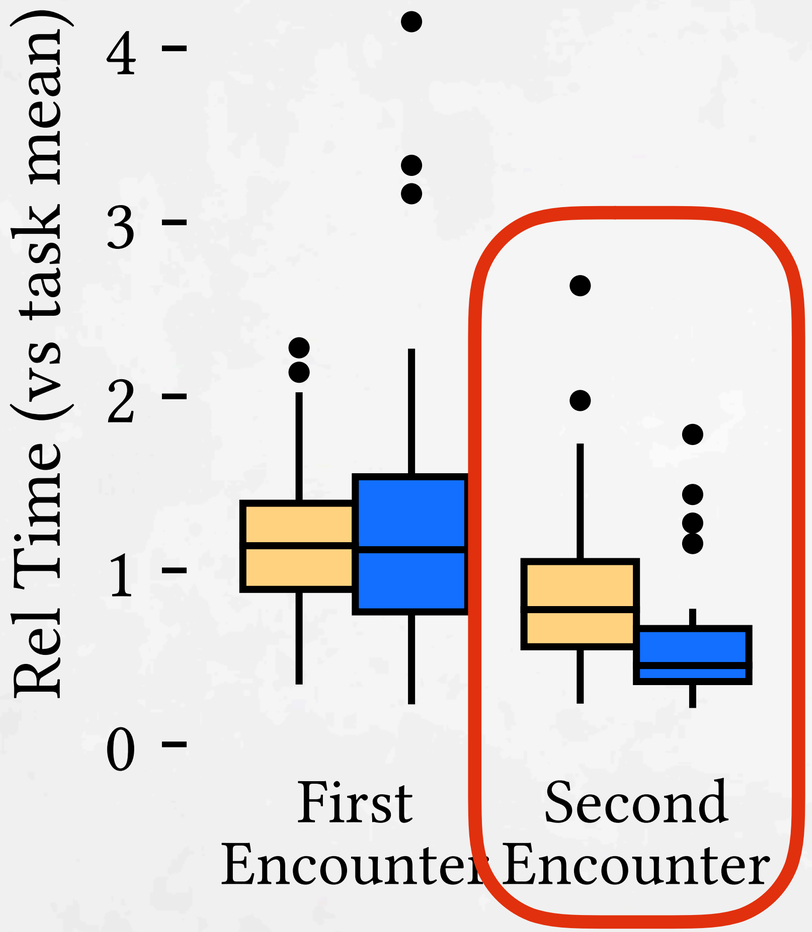
Deuce more effective than Traditional?



Deuce more effective than Traditional?

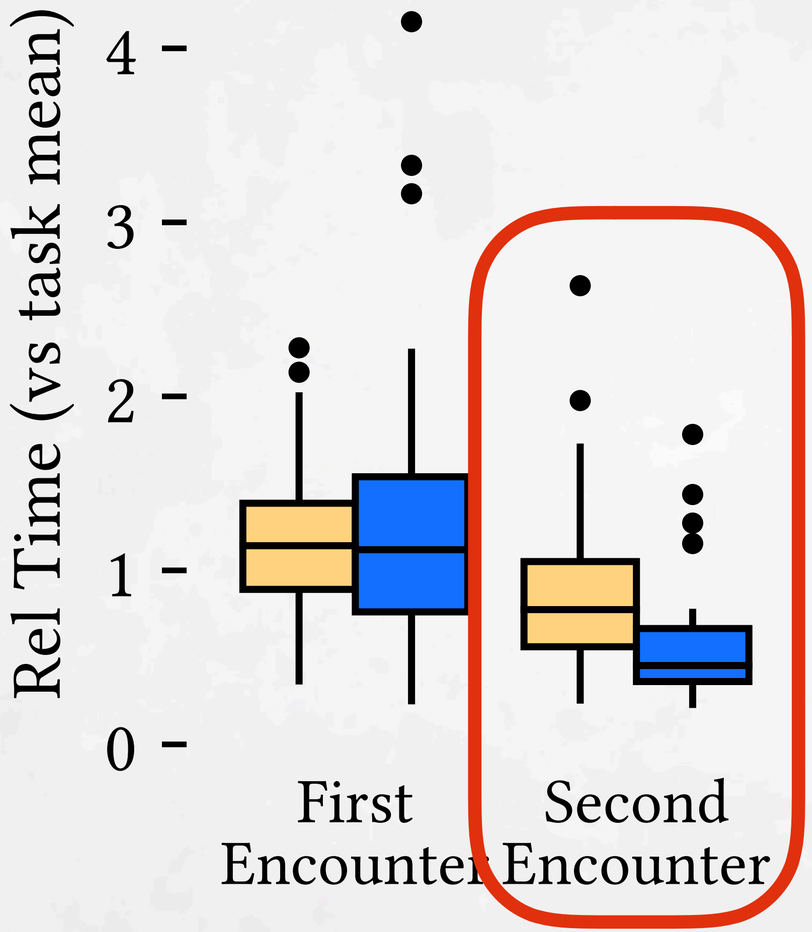


Deuce more effective than Traditional?



Deuce
36% faster
p<0.01

Deuce more effective than Traditional?



Deuce
36% faster
p<0.01

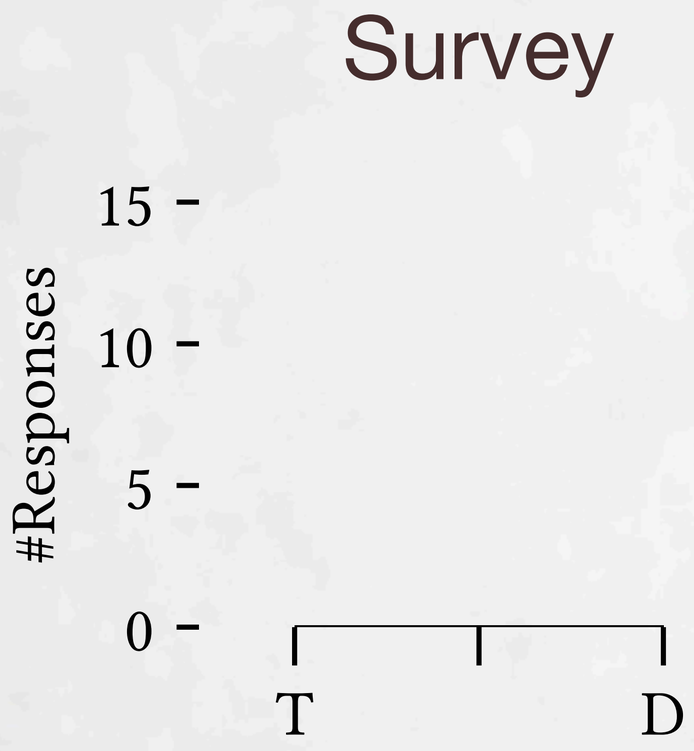
Deuce may be faster once learned

Deuce preferred to Traditional?

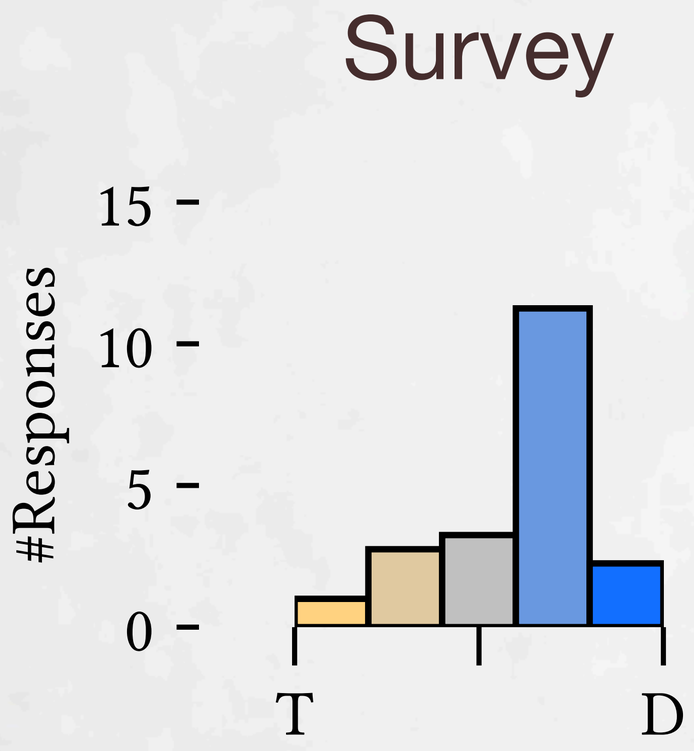
Deuce preferred to Traditional?

Survey

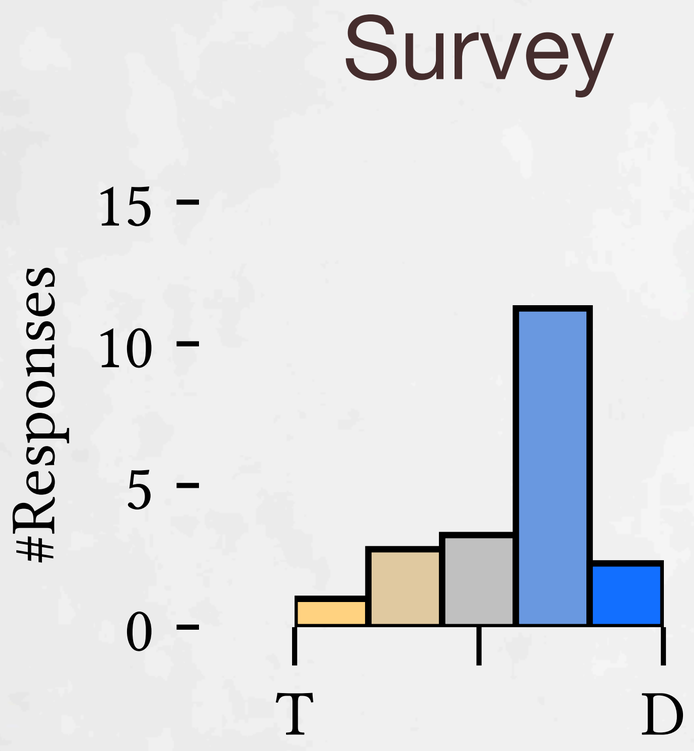
Deuce preferred to Traditional?



Deuce preferred to Traditional?



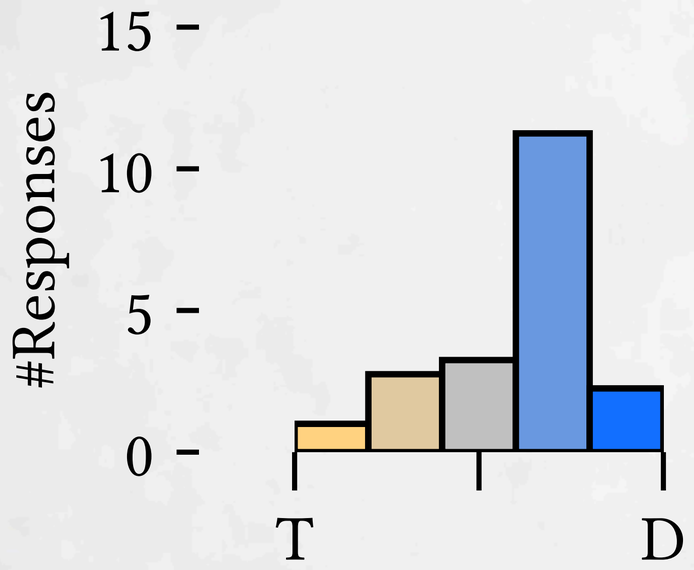
Deuce preferred to Traditional?



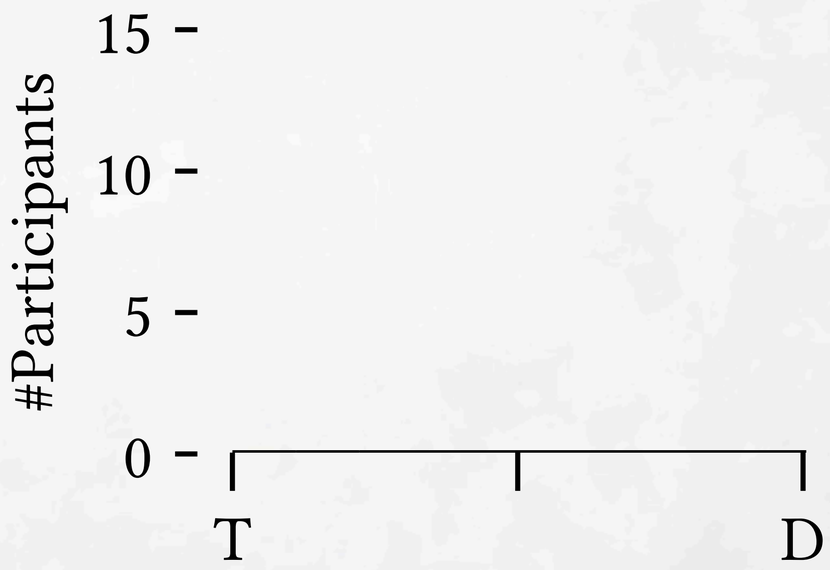
Modest subjective preference for Deuce

Deuce preferred to Traditional?

Survey



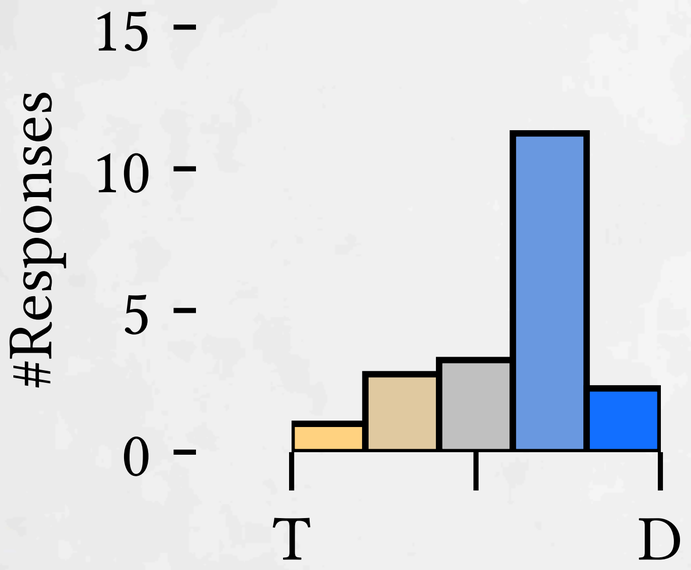
Observed



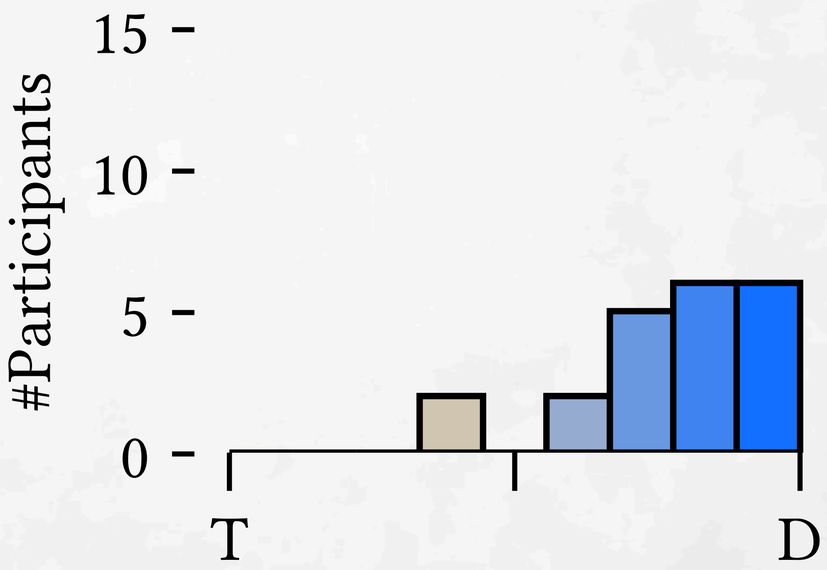
Modest subjective preference for Deuce

Deuce preferred to Traditional?

Survey



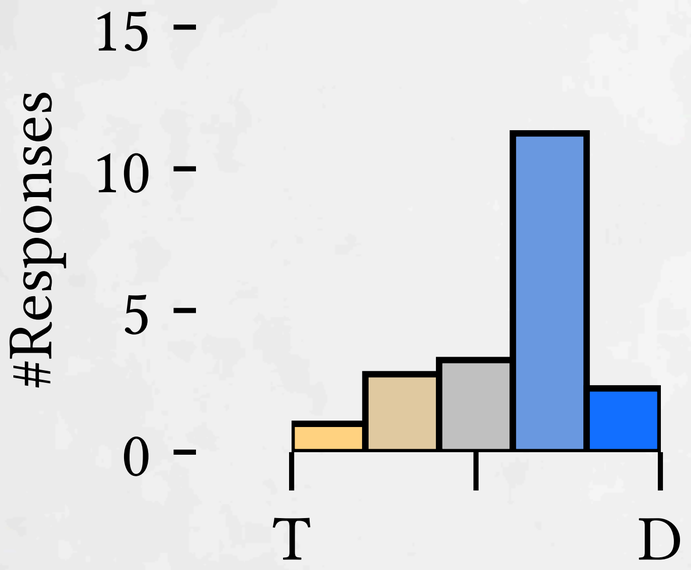
Observed



Modest subjective preference for Deuce

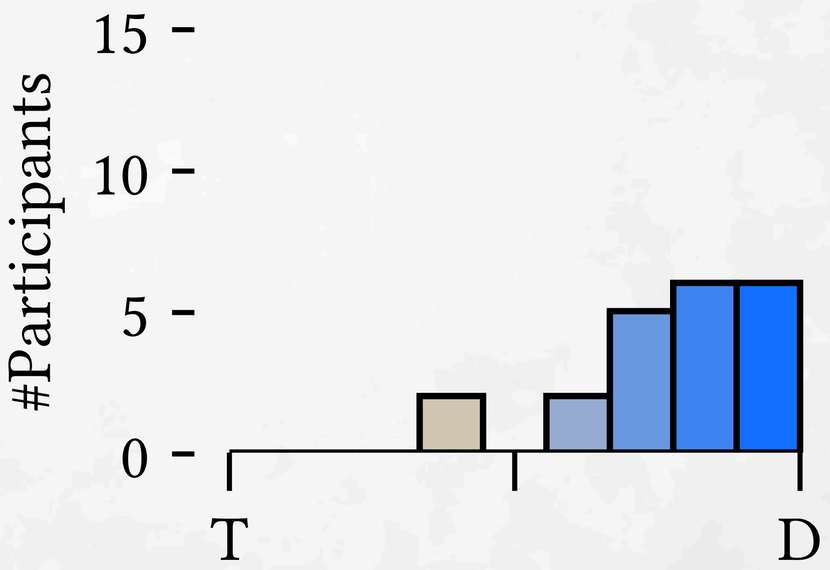
Deuce preferred to Traditional?

Survey



Modest subjective preference for Deuce

Observed



Almost everyone used Deuce more

Mix & Match Tool Usage

Mix & Match Tool Usage

Rename

Make Equal with Single Variable

Introduce Variable(s)

Add Argument(s)

Create Function from Arguments

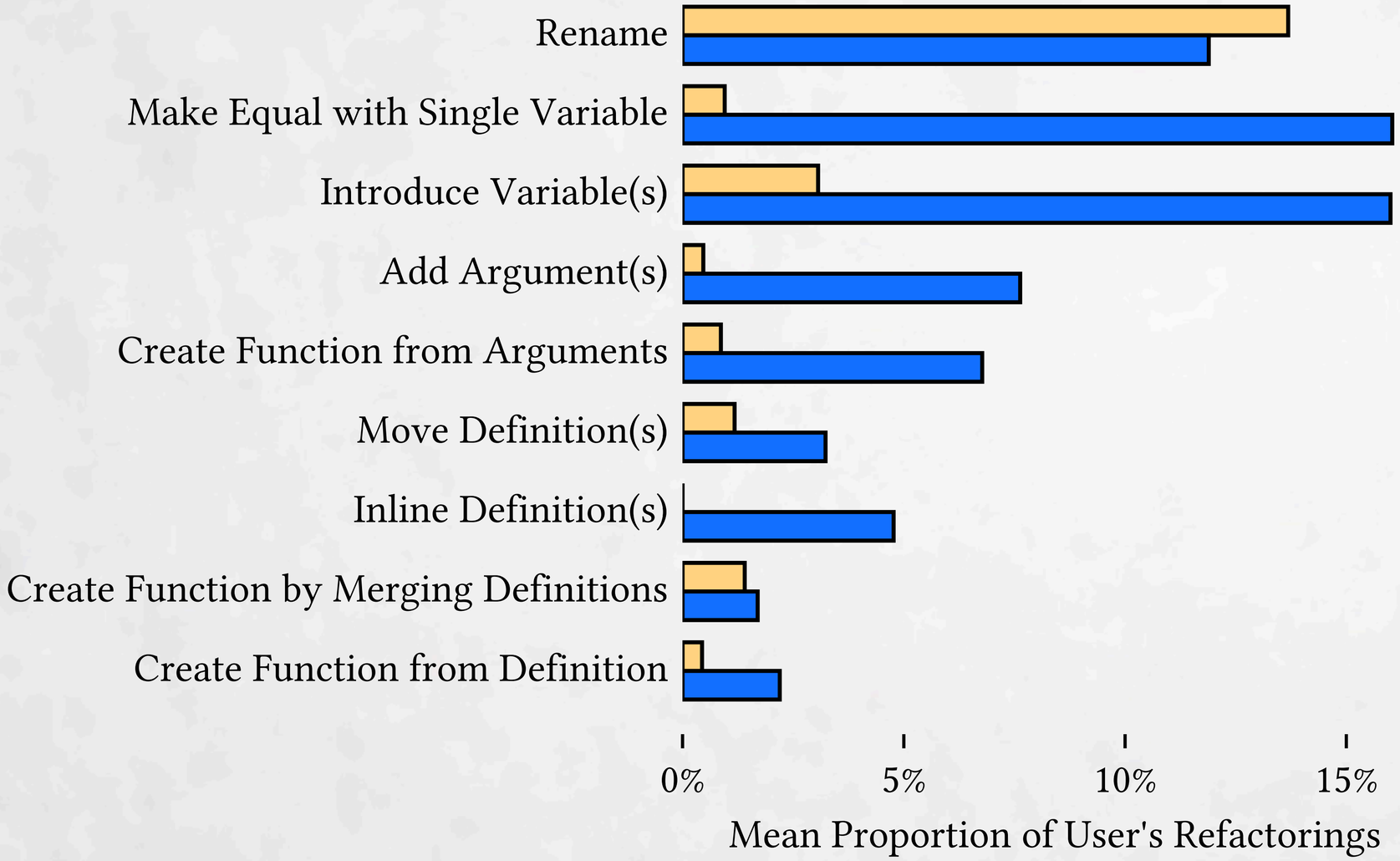
Move Definition(s)

Inline Definition(s)

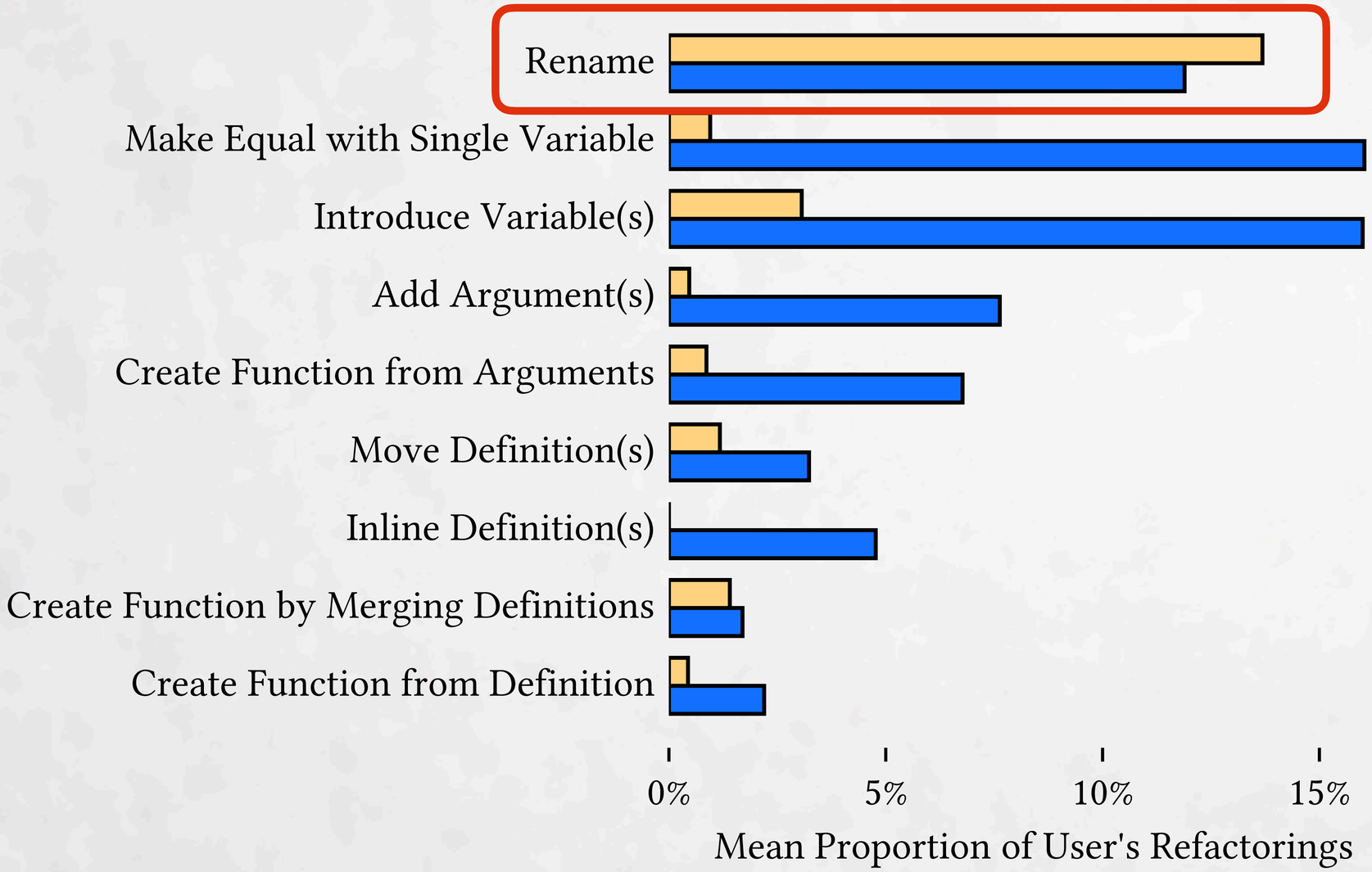
Create Function by Merging Definitions

Create Function from Definition

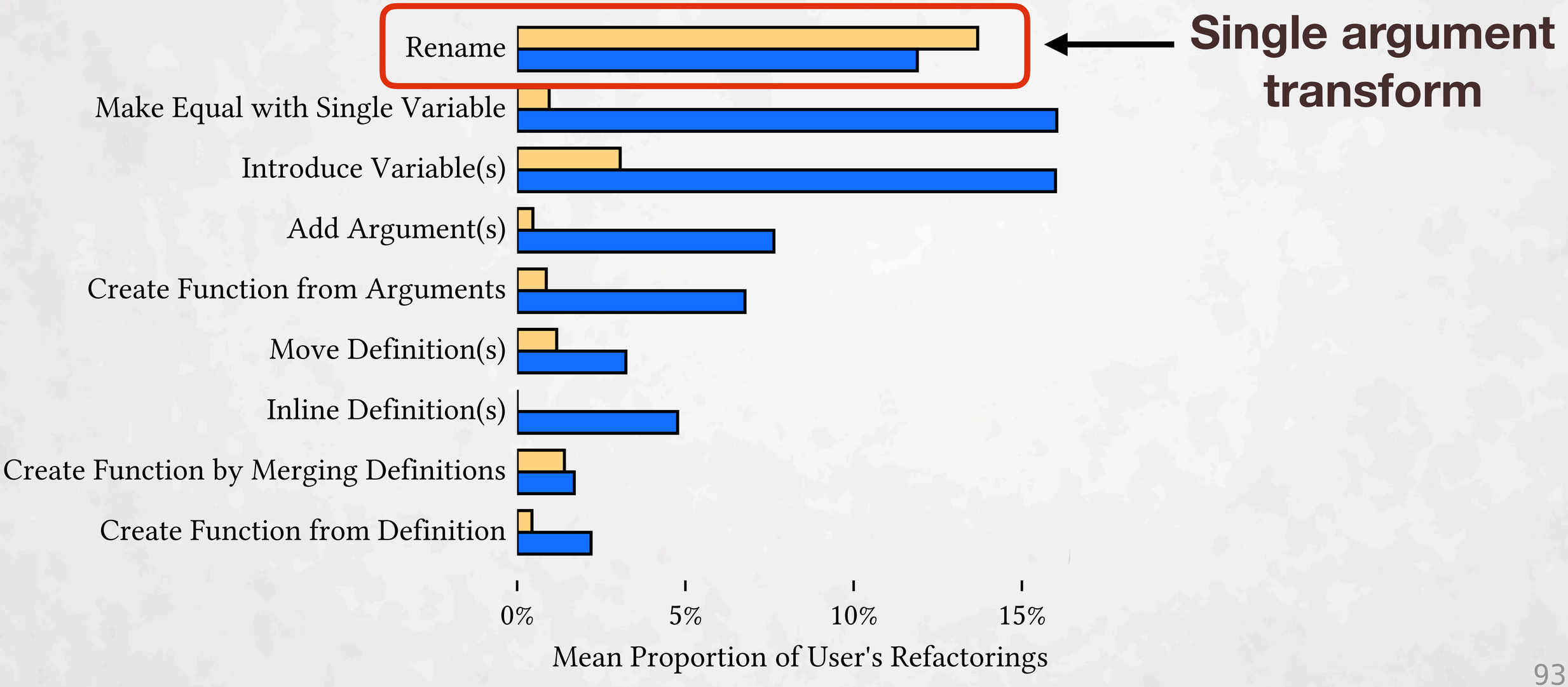
Mix & Match Tool Usage



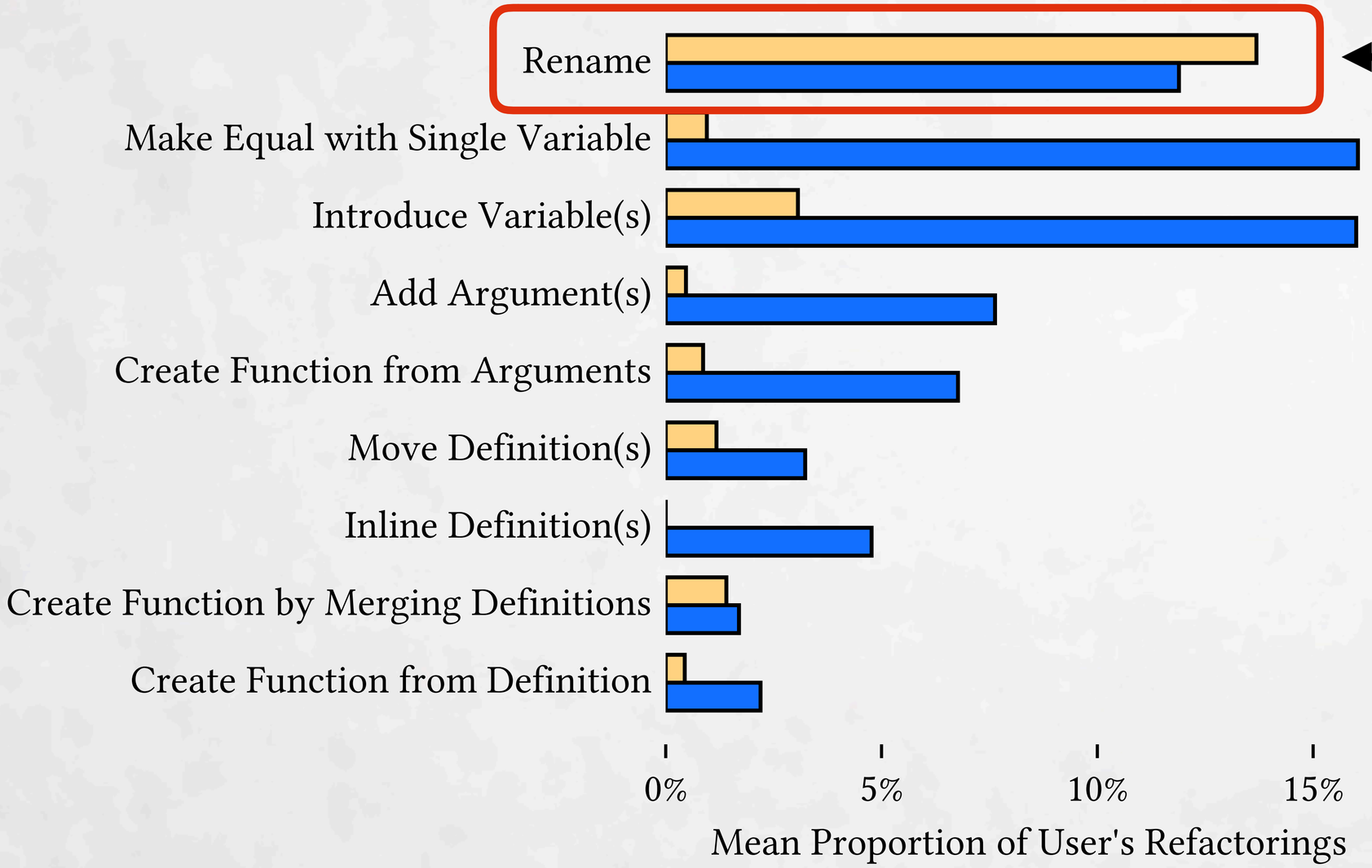
Mix & Match Tool Usage



Mix & Match Tool Usage



Mix & Match Tool Usage



Single argument transform

Hypothesis: Deuce better for multi-argument transformations

Deuce vs Traditional

Deuce vs Traditional

Traditional may be better for learning

Deuce vs Traditional

Traditional may be better for learning

Deuce may be faster once learned

Deuce vs Traditional

Traditional may be better for learning

Deuce may be faster once learned

Deuce strongly preferred

Future Work

Future Work

UI concerns for larger programs

Future Work

UI concerns for larger programs

How to encourage refactoring?

Future Work

UI concerns for larger programs

How to encourage refactoring?

DSL for defining new transformations

Future Work

UI concerns for larger programs

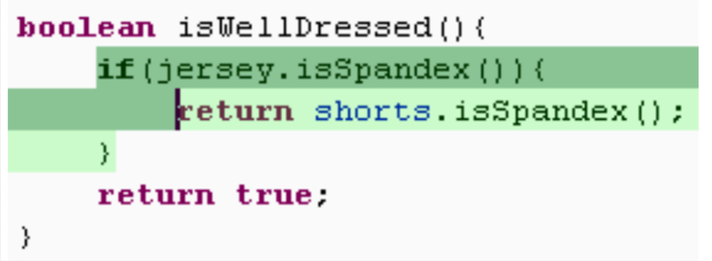
How to encourage refactoring?

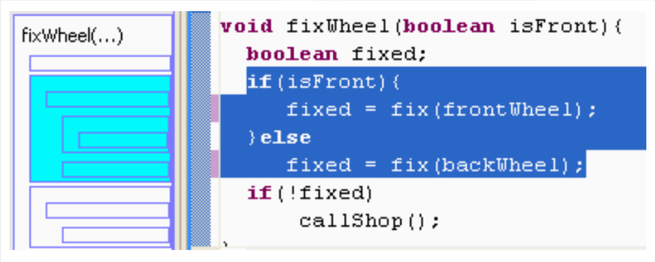
DSL for defining new transformations

Real languages in existing editors

Related Work

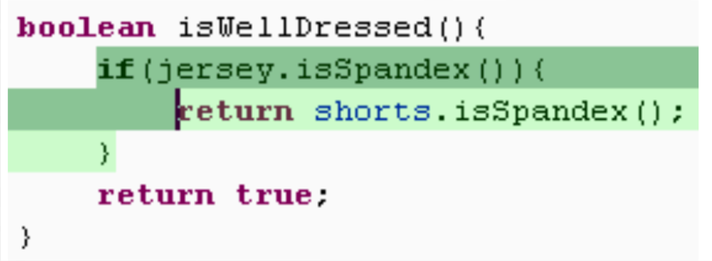
Related Work

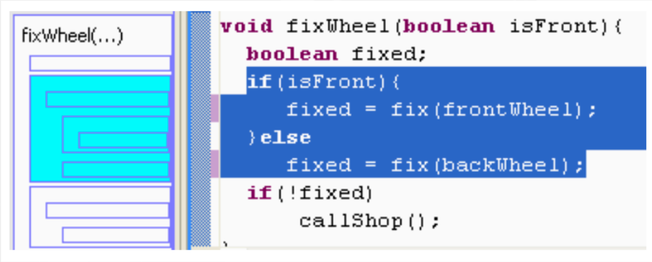




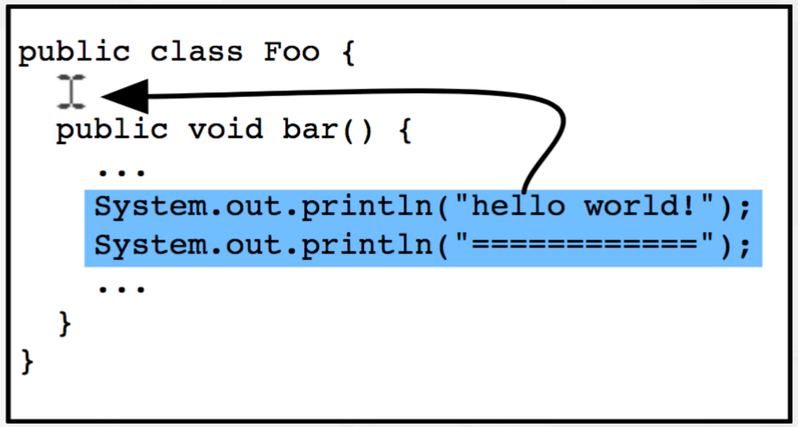
Selection Assist + Box View
(Murphy-Hill and Black 2008)

Related Work





Selection Assist + Box View
(Murphy-Hill and Black 2008)



DNDRefactoring
(Lee et al. 2013)

Related Work

```
boolean isWellDressed(){
    if(jersey.isSpandex()){
        return shorts.isSpandex();
    }
    return true;
}
```

```
fixWheel(...)
void fixWheel(boolean isFront){
    boolean fixed;
    if(isFront){
        fixed = fix(frontWheel);
    }else
        fixed = fix(backWheel);
    if(!fixed)
        callShop();
```

Selection Assist + Box View
(Murphy-Hill and Black 2008)

```
public class Foo {
  public void bar() {
    ...
    System.out.println("hello world!");
    System.out.println("============");
    ...
  }
}
```

DNDRefactoring
(Lee et al. 2013)

```
swapped = false
for each (var int i : 1 .. n - 1)
    if (vals[i] < vals[i - 1])
        var int t = vals[i]
        vals[i] = vals[i - 1]
        vals[i - 1] = t
        swapped = true
```

Greenfoot
(Brown et al. 2016)

```
public class Distance
{
    Computes the distance between two points.
    public static final double main(double x1, doubl
    {
        return √((x2 - x1)² + (y2 - y1)²);
    }
}
```

Barista
(Ko and Myers 2006)

```
public Color getDefaultColor() {
    return
}
navy
R: 0  G: 0  B: 128
Enter
public Color getDefaultColor() {
    return new Color(
        0,
        0,
        128); // navy
}
```

Graphite
(Omar et al. 2012)

Structure Select

```
(def image_url
  "img/icse-2018-large-icon-small.png")

(def image1
  (let [width height] [324 200]
  (let [x y] [100 100]
    (image "lightgrey" x y width height 15 image_url))))

(def main
  (draw (concat [ image1 ])))
```

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Short Menu

Code Tools

- Create Function from Definition ▸
- Inline Definition ▸
- Make Single Line ▸

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Defaults

- Abstract image1 over its constants
- Abstract image1 over its named constants

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Defaults

Deuce provides ***streamlined structural editing*** in a ***familiar text-based environment***.

Structure Select

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Defaults

Search “sketch n sketch” to play with Deuce

Thank you!

Structure Select

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Search “sketch n sketch” to play with Deuce

Extra Slides

$$
\begin{array}{rcl}
\textit{program} & ::= & \bullet\ \boxed{\texttt{(def}\ x_0\ \mathbf{e}_0\texttt{)}}\ \bullet\ \cdots\ \bullet\ \boxed{\texttt{(def main}\ \mathbf{e}\texttt{)}} \\
e & ::= & c \mid x \mid (\lambda\ \mathbf{p}\ \mathbf{e}) \mid (\mathbf{e}_1\ \mathbf{e}_2) \mid [\mathbf{e}_1 \mid \mathbf{e}_2] \\
 & \mid & (\boxed{\texttt{let}\ \mathbf{p}\ \mathbf{e}_1}\ \mathbf{e}_2) \mid (\texttt{case}\ \mathbf{e}\ \boxed{(\mathbf{p}_1\ \mathbf{e}_1)}\ \cdots) \\
p & ::= & c \mid x \mid [] \mid [\mathbf{p}_1 \mid \mathbf{p}_2]
\end{array}
$$

Expressions $\mathbf{e} ::= \bullet\ \boxed{e}\ \bullet$ Patterns $\mathbf{p} ::= \bullet\ \boxed{p}\ \bullet$

Figure 1: Syntax of LITTLE. The orange boxes and blue dots identify features for structural selection.

```
EditorState = { code: Program, selections: Set Selection }
ActiveState = Active | NotYetActive | Inactive
Options     = NoOptions | StringOption String
Result      = { description: String, code: Program }

CodeTool =
  { name : String
  , requirements : String
  , active : EditorState -> ActiveState
  , run : (EditorState, Options) -> List Result }
```

Figure 2: Code tool interface.

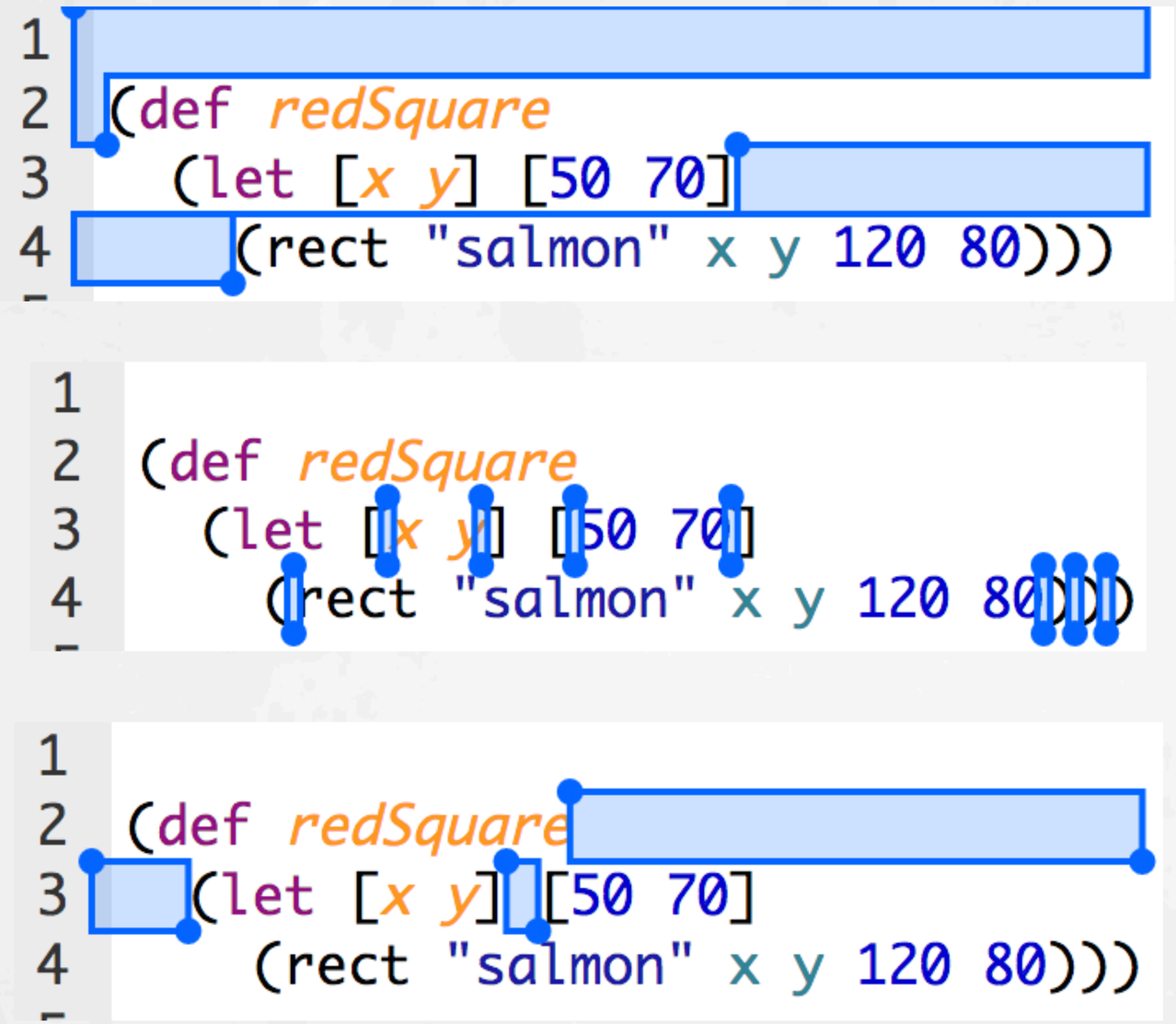


Figure 3: Example target positions.

Code Tools

Create Function from Definition...

Create Function from Arguments...

Create Function by Merging Definitions...

Add Argument...

Remove Argument...

Reorder Arguments...

Rename Variable...

Introduce Local Variable...

Swap Variable Names and Usages...

Swap Variable Usages...

Make Equal with Single Variable...

Make Equal by Copying...

Move Definition...

Swap Definitions...

Inline Definition...

Duplicate Definition...

Reorder Expressions...

Swap Expressions...

Make Single Line...

Make Multi-line...

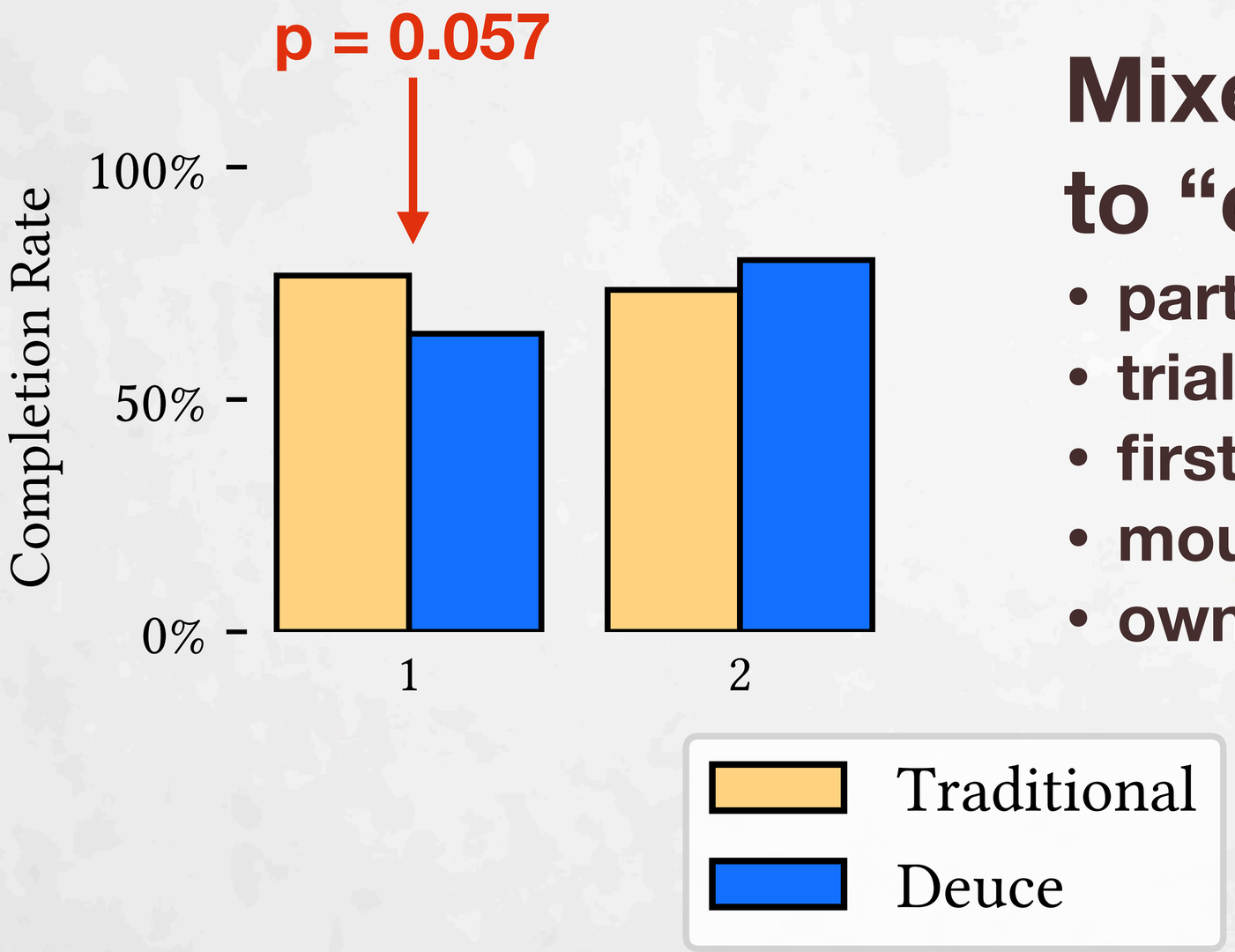
Align Expressions...

Head-to-Head Tasks

Mixed effects model to "control" for:

- participant skill
- trial number
- first/second encounter
- mouse/trackpad
- own/our computer

Head-to-Head Tasks



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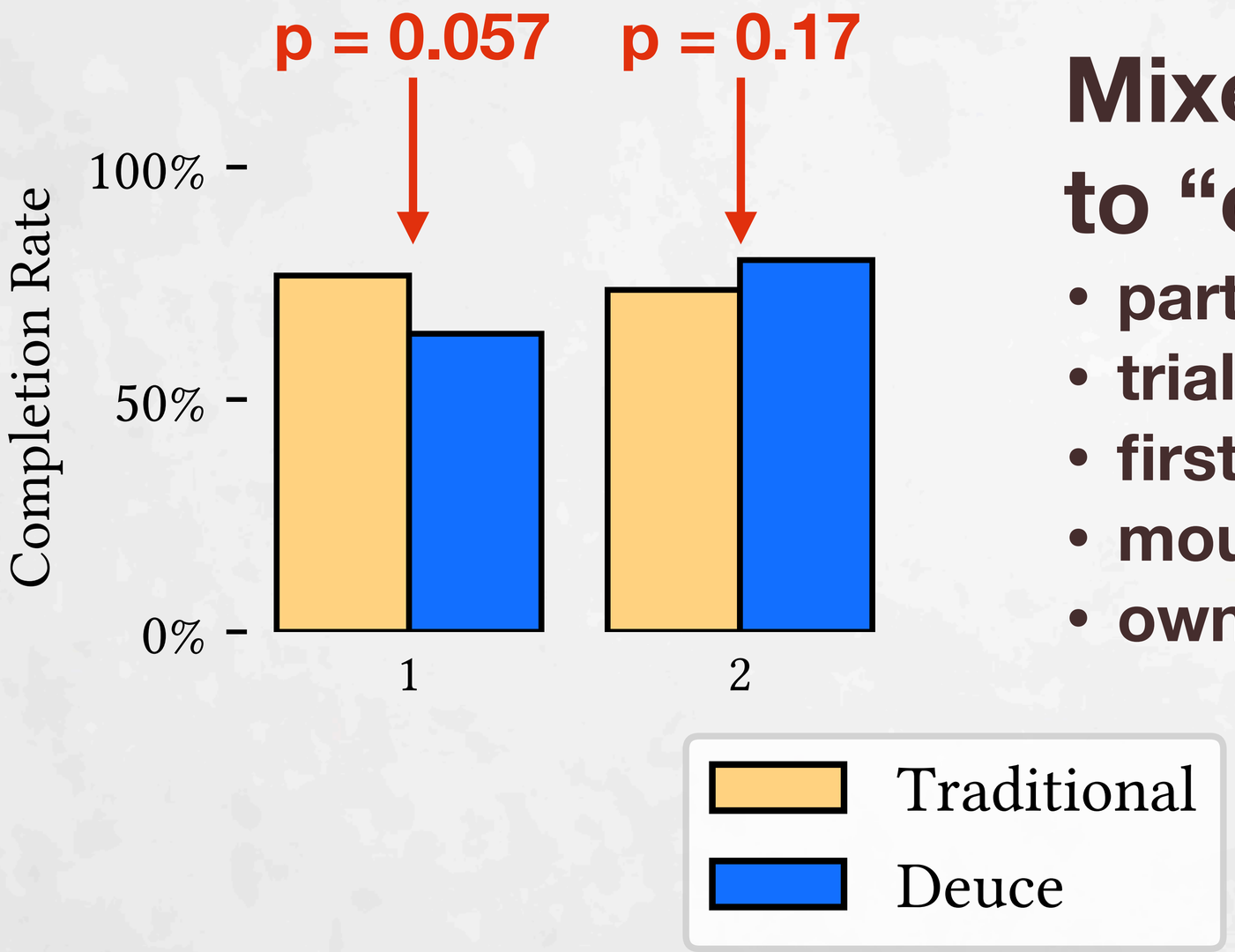
Head-to-Head Tasks



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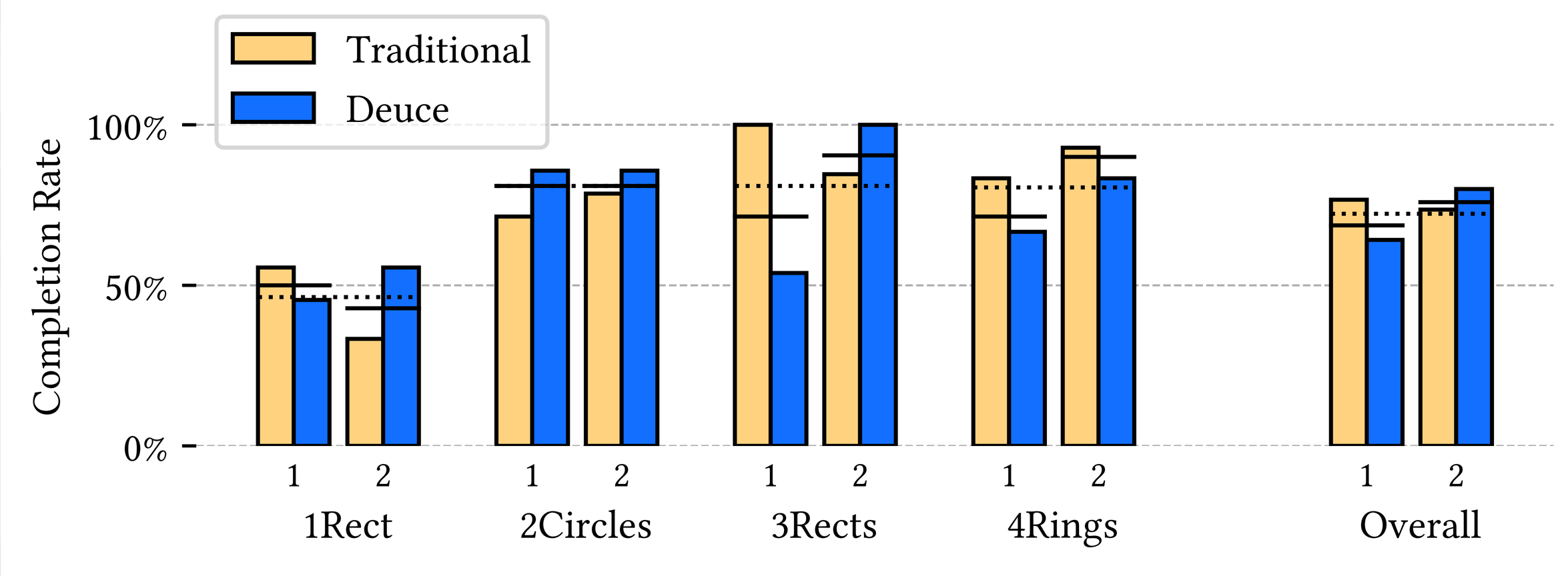
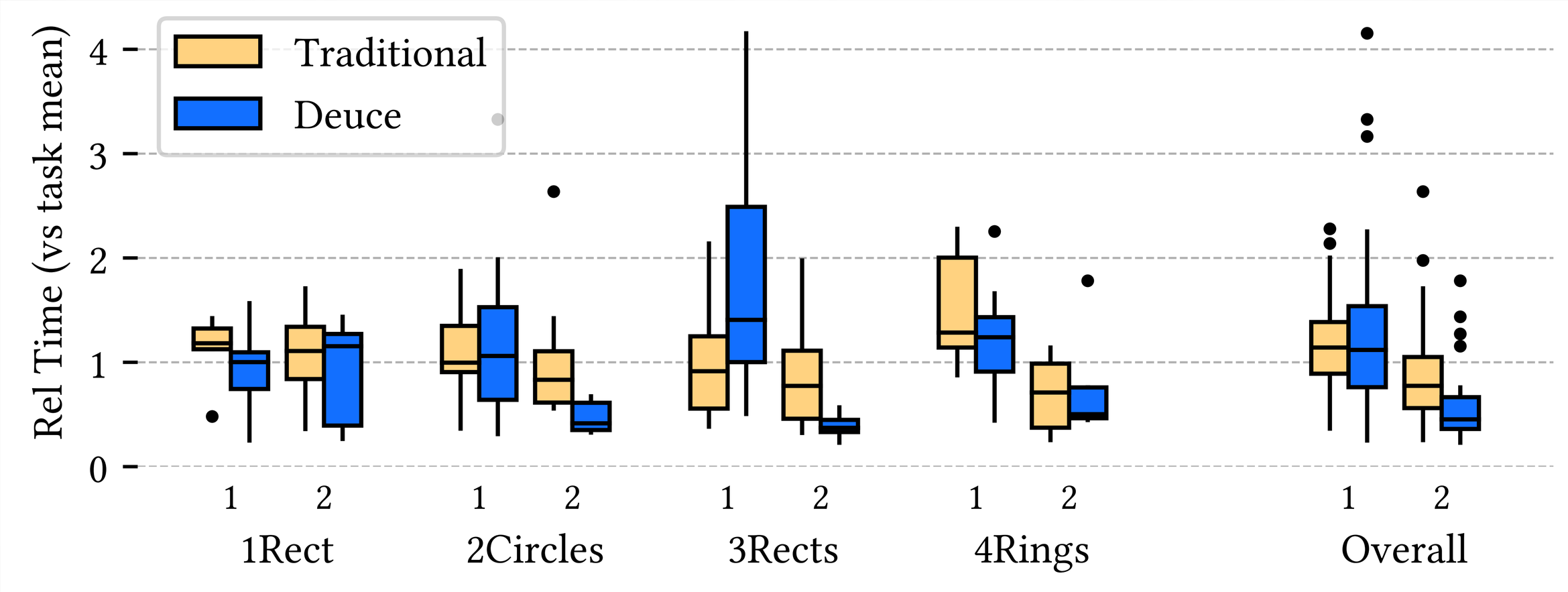
Head-to-Head Tasks

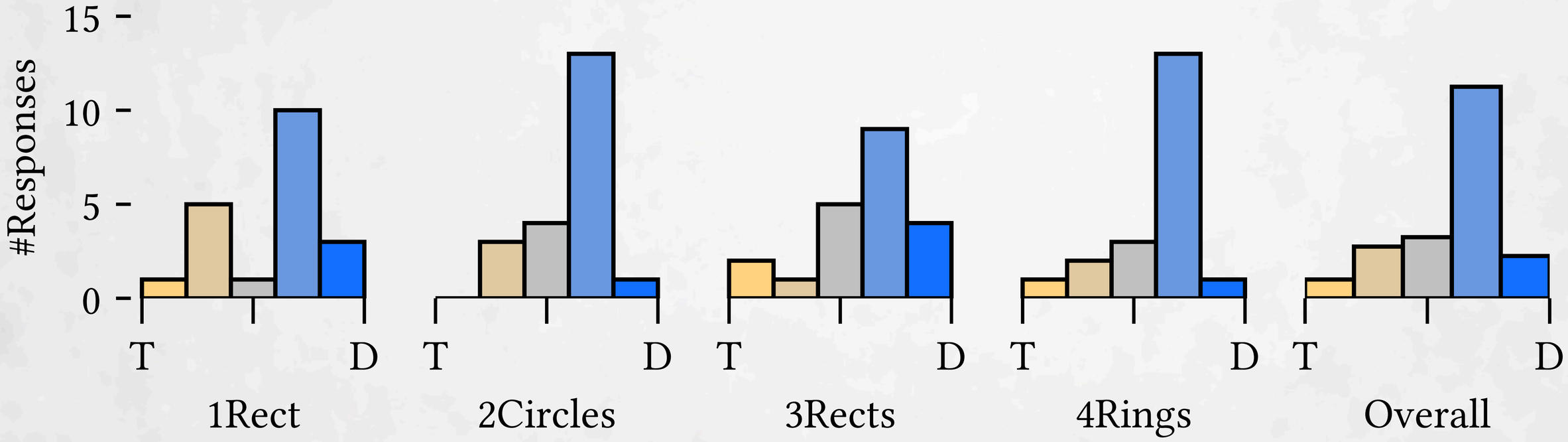


Head-to-Head Tasks



Head-to-Head Tasks

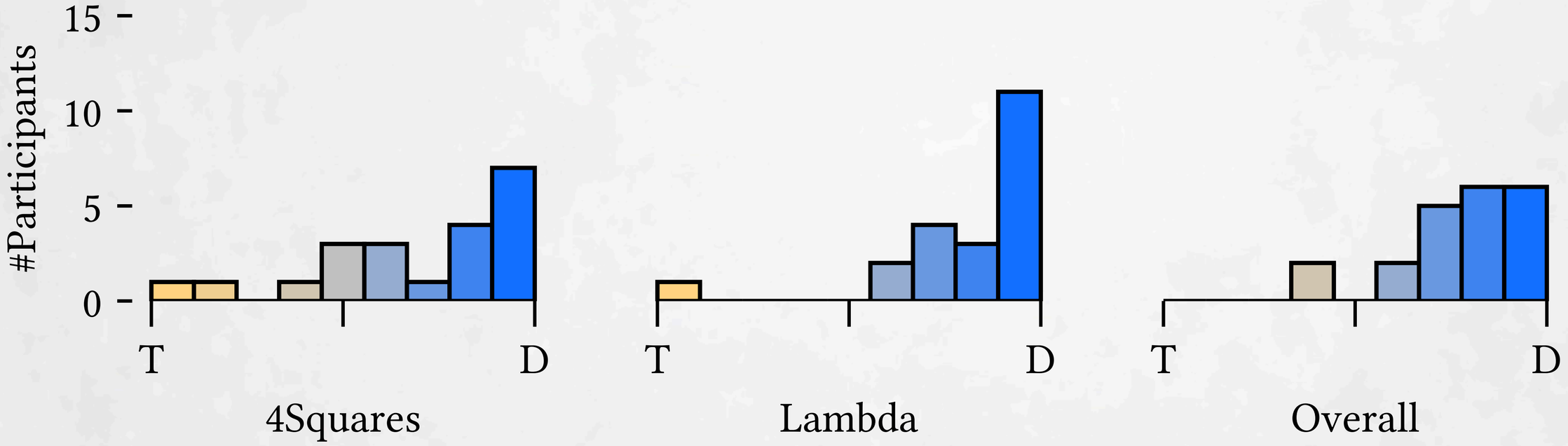
"Which interaction worked better for the … task?"



Modest subjective preference for Deuce

Mix & Match Tasks

What did participants actually use?



Deuce preferred by almost all users.