Semi-Automated SVG Programming via Direct Manipulation

Brian Hempel and Ravi Chugh
Direct Manipulation
Direct Manipulation

Drawing

Documents

And so many more...
But not for one application...
import math
import svgwrite

drawing = svgwrite.Drawing("sphere.svg")

radius = 250
centerX = 600
centerY = 400
highlightX = centerX + radius/3
highlightY = centerY + radius/3

spacing = 20

def distance(x1,y1,x2,y2):
    return math.sqrt((x2-x1)**2 + (y2-y1)**2)

for x in range(centerX-radius, centerX+radius+spacing, spacing):
    for y in range(centerY-radius, centerY+radius+spacing, spacing):
        if distance(x, y, centerX, centerY) < radius:
            circle = drawing.circle(center=(x,y), r=spacing/2, fill="blue")
            drawing.add(circle)

drawing.save()
Programming

```python
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drawing.save()
```
Program
Program
Program
Refactored Program
Better for both experts and non-experts

Refactored Program
DM
DM + Code
Existing Approach: DM + Code
Existing Approach: DM + Code

Bret Victor, “Drawing Dynamic Visualizations”
Existing Approach: DM + Code

Bret Victor, “Drawing Dynamic Visualizations”

Toby Schachman, “Apparatus”
DM + Code
Code + DM
Our Approach: Code + DM

Chugh et al. [PLDI ’16]
Our Approach: Code + DM

Chugh et al. [PLDI '16]
[PLDI '16] Code First, Then DM
Goal:
Less Keyboard, More Mouse.
Draw
Draw
Relate
New DM Tools

Draw

Relate

Abstract
New DM Tools

Draw

Relate

Abstract
New DM Tools

Draw  Relate  Abstract

New DM Tools

Draw  Relate  Abstract
Demo

Draw

Relate

Abstract
Demo

Draw

Relate

Abstract
Programming in 2015

Sketch-n-Sketch
Draw

Programming in 2015

Relate

Abstract

Sketch-n-Sketch
let rect1 = ...
let line2 = ...
let line3 = ...
Programming in 2015

let rect1 = ...
let line2 = ...
let line3 = ...

Sketch-n-Sketch
Programming in 2015

Sketch-n-Sketch
let rect1_x = ...
let rect1_y = ...

let rect1 = ...

let line2 = ...
let line3 = ...

Programming in 2015

Sketch-n-Sketch
Programming in 2015

let rect1_x = ...
let rect1_y = ...
let rect1 = ...
let line2 = ...
let line3 = ...
let rect1_x = ...
let rect1_y = ...
let rect1 = ...
let line2 = ...
let line3 = ...
Programming in 2015

Sketch-n-Sketch
let group x y size =
    let rect1 = ...
    let line2 = ...
    let line3 = ...
  group 0 0 999999
let group x y size =
  let rect1 = ...
  let line2 = ...
  let line3 = ...
  group 0 0 999999
let group x y size =
       let rect1 = ...
       let line2 = ...
       let line3 = ...
    group 0 0 999999
let group x y size =
  let rect1 = ...
  let line2 = ...
  let line3 = ...
  group 0 0 999999
Programming in 2015

Sketch-n-Sketch
Draw

Sketch-n-Sketch

Relate

Abstract

Sketch-n-Sketch++
(def polygon7_bot (+ (+ (* 0.5! ...
(def k3105 (/ (- (+ (- polygon6...  
(def polygon7_top (- (* 0.5! (+...  
(def [polygon5_right k3038] [(-...
(def k3061 (/ (- (+ polygon5_ri...  
(def polygon6_bot (- (+ (- poly...
(def k3063 (/ (- (+ polygon6_bo...  
(def polygon5_top (- polygon6_t...  
(def k3103 (/ (- (+ (- polygon5...  
(def [k3041 polygon5_bot] [(- p...
(def k3134 (/ (- (+ k3041 helpe...  
(def k3141 (/ (- (+ k3038 helpe...
(def polygon7_bot (+ (+ (* 0.5!...)
(def k3105 (/ (- (+ (- polygon6...)
(def polygon7_top (- (* 0.5! (+...
(def [polygon5_right k3038] [(-...)
(def k3061 (/ (- (+ polygon5_ri...)
(def polygon6_bot (- (+ (- poly...
(def k3063 (/ (- (+ polygon6_bo...)
(def polygon5_top (- polygon6_t...)
(def k3103 (/ (- (+ (- polygon5...)
(def [k3041 polygon5_bot] [(- p...)
(def k3134 (/ (- (+ k3041 helpe...)
(def k3141 (/ (- (+ k3038 helpe...
; Top-LevelDefs
(def rect1 ...)
(def line2 ...)
(def line3 ...)

;Main Expression
[ rect1 ... ]
Refactor Programs of Arbitrary Structure
Sketch-n-Sketch

Sketch-n-Sketch++

Additional Interaction to Resolve User Intent
Program
Program
Program

Domain-specific
Program

General

Domain-specific
Program

General

Domain-specific
Program

General

Domain-specific
Program

General

Domain-specific
Program

General

Domain-specific
Program

General

Domain-specific
Related Work

DM + Code

DDV
Apparatus
Related Work

DM + Code
  DDV
  Apparatus

Programming by Example
  Chimera
  Metamouse
  Mondrian
Related Work

Programming by Example
- Chimera
- Metamouse
- Mondrian

DM + Code
- DDV
- Apparatus

Domain Apps
- Parametric CAD
- Procedural modeling
Related Work

**Programming by Example**
- Chimera
- Metamouse
- Mondrian

**Domain Apps**
- Parametric CAD
- Procedural modeling

**Constraint Oriented Systems**
- Sketchpad
- ThingLab
- Juno-2

**DM + Code**
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Related Work

**Programming by Example**
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**Domain Apps**
- Parametric CAD
- Procedural modeling

**DM + Code**
- DDV
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**Constraint Oriented Systems**
- Sketchpad
- ThingLab
- Juno-2

**Code + DM**
- Wang et al.
- Live PBE
- McDirmid’s Demos
- Sketch-n-Sketch
Our Approach

Start with *general-purpose* language

add D.M. features.
Goal: Less Keyboard, More Mouse.
Sketch-n-Sketch
https://ravichugh.github.io/sketch-n-sketch

Demos on YouTube
Sketch-n-Sketch

https://ravichugh.github.io/sketch-n-sketch

Demos on YouTube

Just google “sketch n sketch”
Thank you!
Extra Slides
Traces

\[
\text{let } a = 3 \text{ in }
\]
Traces

let a = 3 in
let b = 5 in
Traces

\[
\text{let } a = 3 \text{ in } \\
\text{let } b = 5 \text{ in } \\
a + b
\]
Traces

let a = 3 in
let b = 5 in
a + b

⇓
Traces

\[
\begin{align*}
\text{let } a &= 3 \quad \text{in} \\
\text{let } b &= 5 \quad \text{in} \\
a + b \\
\downarrow \\
8
\end{align*}
\]
Traces

let a = $3^a$ in
let b = 5 in
a + b

⇓

8
Traces

\[
\text{let } a = 3^a \text{ in }
\]
\[
\text{let } b = 5^b \text{ in }
\]
\[
a + b
\]
\[
\downarrow
\]
\[
8
\]
Traces

let \( a = 3^a \) in

let \( b = 5^b \) in

\( a + b \)

\( \downarrow \)

\( 8^{a+b} \)