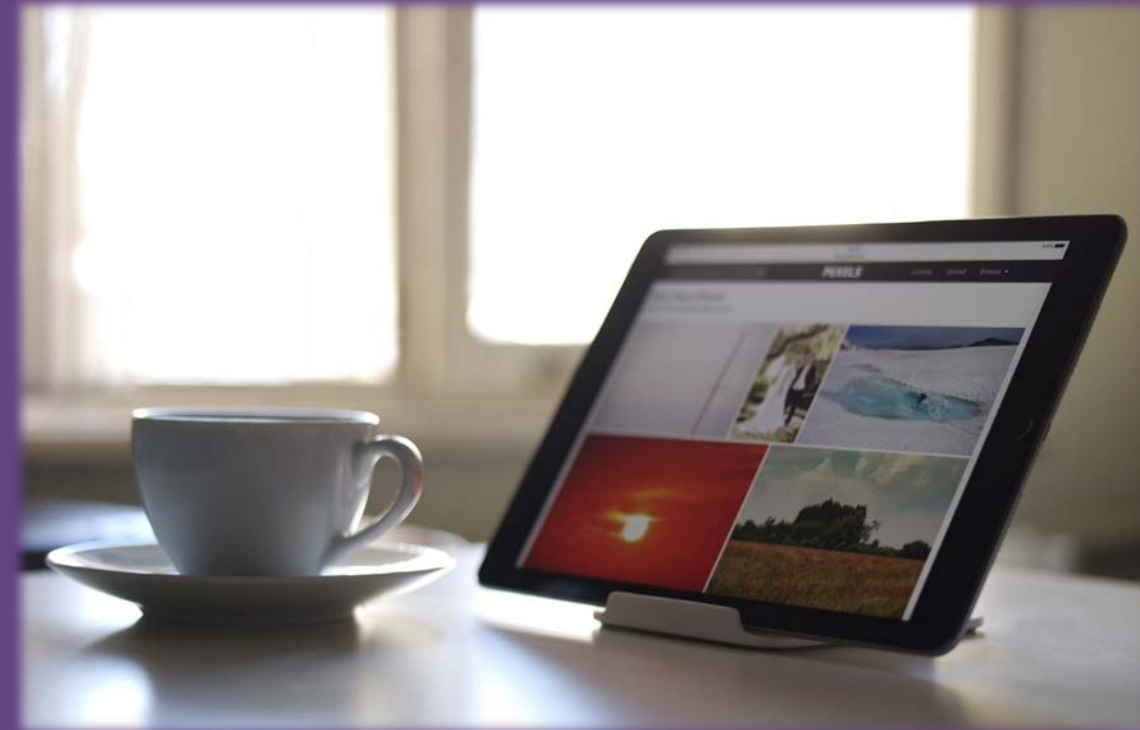


Genie: Input Retargeting on the Web through Command Reverse Engineering

Amanda Swearngin, Andrew J. Ko, James Fogarty





Culture¹ and gender² affect usability, appeal, and trustworthiness of a website.



People with motor disabilities may need to use alternate devices to interact with the web¹.



Blind people frequently use screen readers to navigate and operate web interfaces¹.

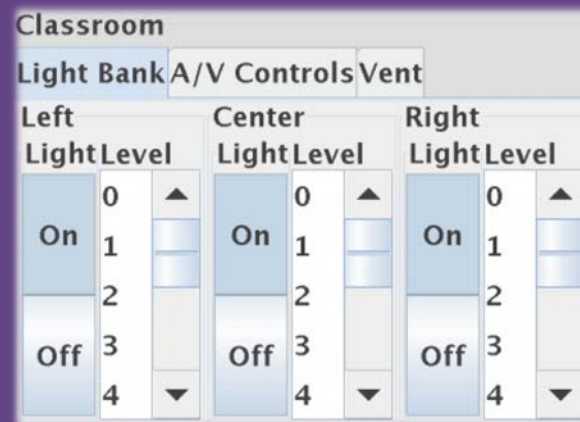


```
94 <img alt="Placeholder image" data-bbox="280 0 550 30" class="image/gif;base64,R01GOD1HAQ8A1AAAFVWQMACTH..."/>
95 <div class="container">
96   <div class="carousel-caption">
97     <h1>One more for good measure.</h1>
98     <p>Cras justo odio, dapibus ac facilisis in, egestas eget quam. Donec id elit sed purus consectetur elit. Vestibulum tincidunt consectetur a dolor. Nullam quis hendrerit dolor, nibh purus ultricies tincidunt in, leo non dolor sed congue elit. Duis in odio viverra mauris, aliquam erat nunc dictum est.</p>
99     <p><a class="btn btn-lg btn-primary" href="#" role="button">Browse gallery</a></p>
100   </div>
101 </div>
102 <a class="left carousel-control" href="#myCarousel" role="button" data-slide="prev">
103   <span class="glyphicon glyphicon-chevron-left" aria-hidden="true"></span>
104   <span class="sr-only">Previous</span>
105 </a>
106 <a class="right carousel-control" href="#myCarousel" role="button" data-slide="next">
107   <span class="glyphicon glyphicon-chevron-right" aria-hidden="true"></span>
108   <span class="sr-only">Next</span>
109 </a>
110 </div><!-- /.carousel -->
111 <!-- Featured Content Section -->
112 <div class="container">
113   <div class="row">
114     <div class="col-md-4"></div>
115     <div class="col-md-4"><h2>FEATURED CONTENT</h2></div>
116     <div class="col-md-4"></div>
117   </div>
118 </div><!-- /container -->
```

Interface Adaptation: 3 prior approaches

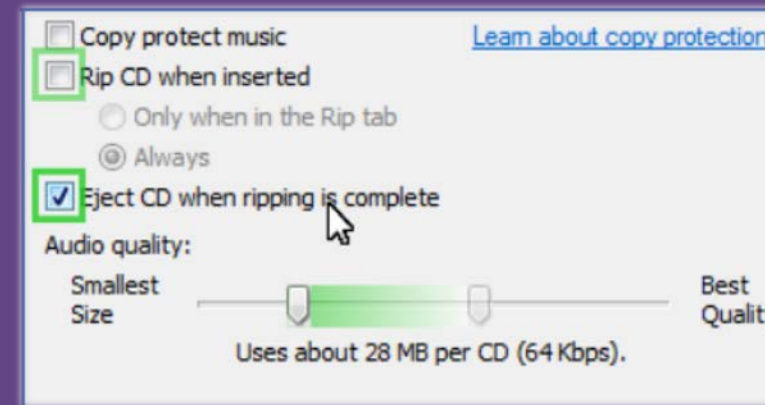
Personalized Interfaces

SUPPLE³



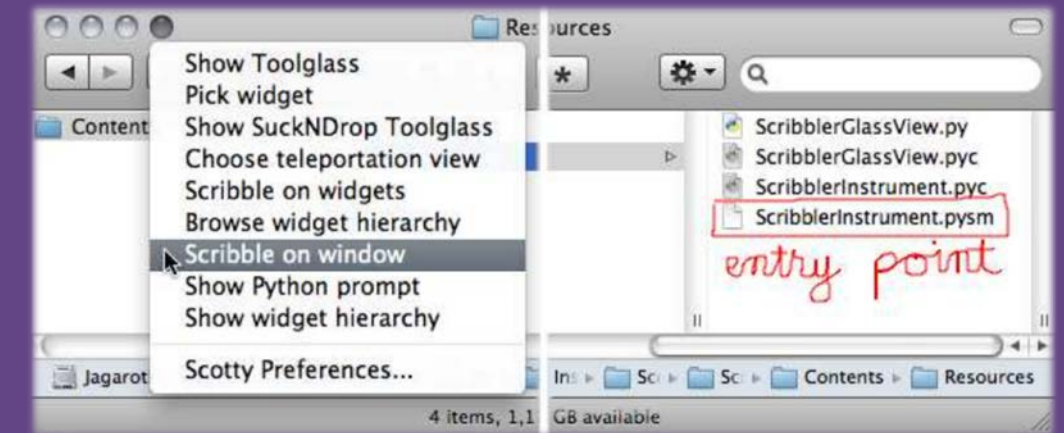
Pixel-Based Analysis

Prefab²

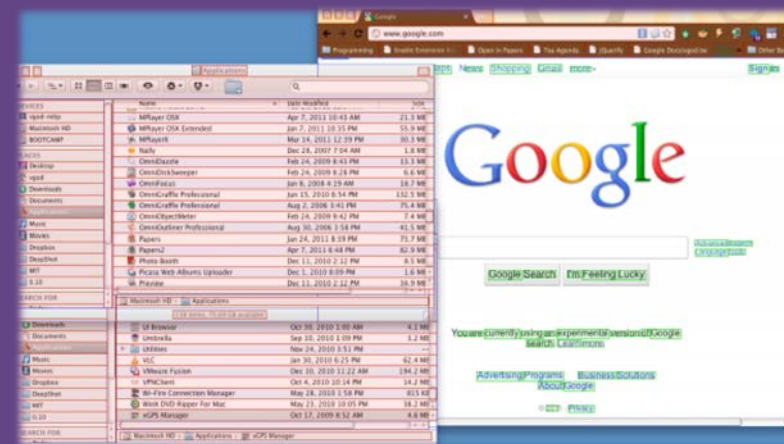


Runtime Toolkit Modification

Scotty⁴



PAX³



Program Analysis

```
1  * @Link https://999
2  *
3  * @package _S
4  *
5  *
6  *
7  *
8  *
9  *
10 *
11 *
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90 *
91 *
92 *
93 *
94 *
95 *
96 *
97 *
98 *
99 *
100 *
```

```
function_exists( 'incode_starter_setup' ) ) :
/**
 * Sets up theme defaults and registers support for various WordPress
 * Note that this function is hooked into the after_setup_theme hook, which
 * runs before the init hook. The init hook is too late for some features, such
 * as indicating support for post thumbnails.
 */
function incode_starter_setup() {
    /* Make theme available for translation.
    * Translations can be filed in the /languages/ directory. Please see the
    * If you're building a theme based on incode_starter, please do not
    * to change incode_starter to the name of your theme.
    */
    load_theme_textdomain( 'incode_starter', get_template_directory() . '/languages' );
    load_theme_textdomain( 'incode_starter', get_template_directory() . '/languages' );
}
```


Genie

Enables new interactions on the web through
program analysis and input retargeting.

Automatic Speech Input

Navigate a website.

The screenshot shows the PayPal homepage in a browser window. The browser's address bar displays "PayPal, Inc. [US] https://www.paypal.com/us/home". The main content area features the PayPal logo and navigation links for "PERSONAL", "BUSINESS", "SEND", and "REQUEST". A large heading reads "Global Purchase Protection. Music to Your Ears." Below this, a sub-headline states "If the description sounded better than what showed up, PayPal can cover you." Two buttons are visible: "Log into Your Account" and "Watch the Video". A red dashed box highlights a "Genie Interface" overlay on the right side of the page. This interface contains a list of commands with bolded text labels and descriptions. The commands listed are: "Get started: Learn more, Explore account", "Pay pal: Logo, Home, Us", "Sign up: Button, Account selection, Small, Us", "Site feedback: Feedback", and "Watch video: Watch the video, Player". At the bottom of the overlay, it says "11 more commands." with a downward arrow.

Genie Interface

Automatic Speech Input

Use your voice to play a game.

The screenshot shows a web browser window at hextris.io. The main content area features a large hexagonal graphic with the word "Hextris" in the center. Above the hexagon, it says "HIGH SCORE 1072". Below the hexagon is a play button icon with the text "Play!". At the bottom of the page, there are social media links for Facebook and Twitter, and app store download buttons for Google Play and the App Store. On the right side of the browser, a speech input extension is open, displaying a list of commands and their associated actions.

Speak a command...	
Find:	Text, 470, Icon
Handle click:	Handle click before, Show help
Pause P:	Pause
Start:	Handler, Check visual elements, 1, Resume game
Toggle:	Tools
Enter:	1, Resume game
Left:	Main hex, Rotate, 1
Q:	Toggle, tools
Right:	Main hex, Rotate, 1
4 more commands... ▼	

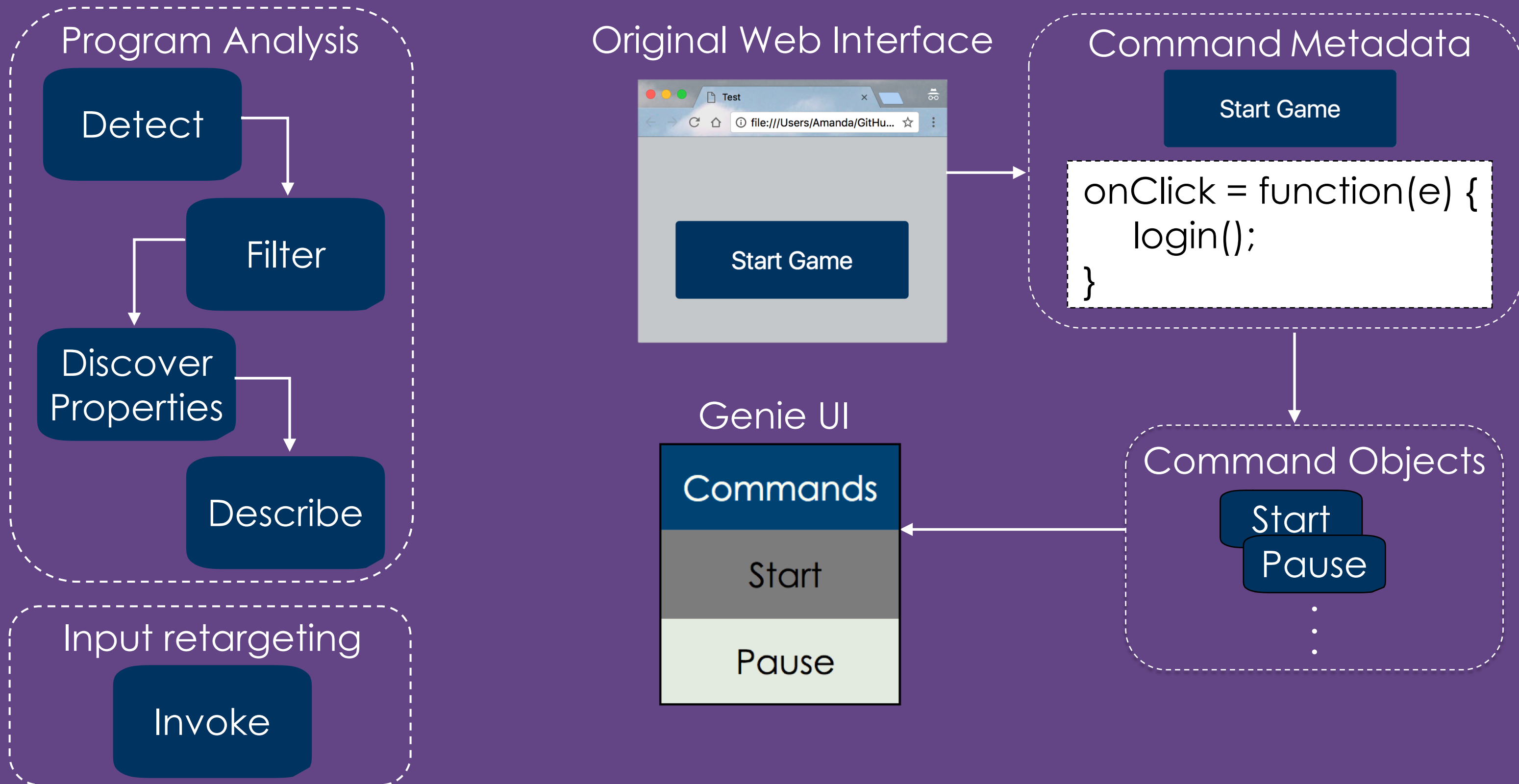
Overview

Program Analysis & Input Retargeting

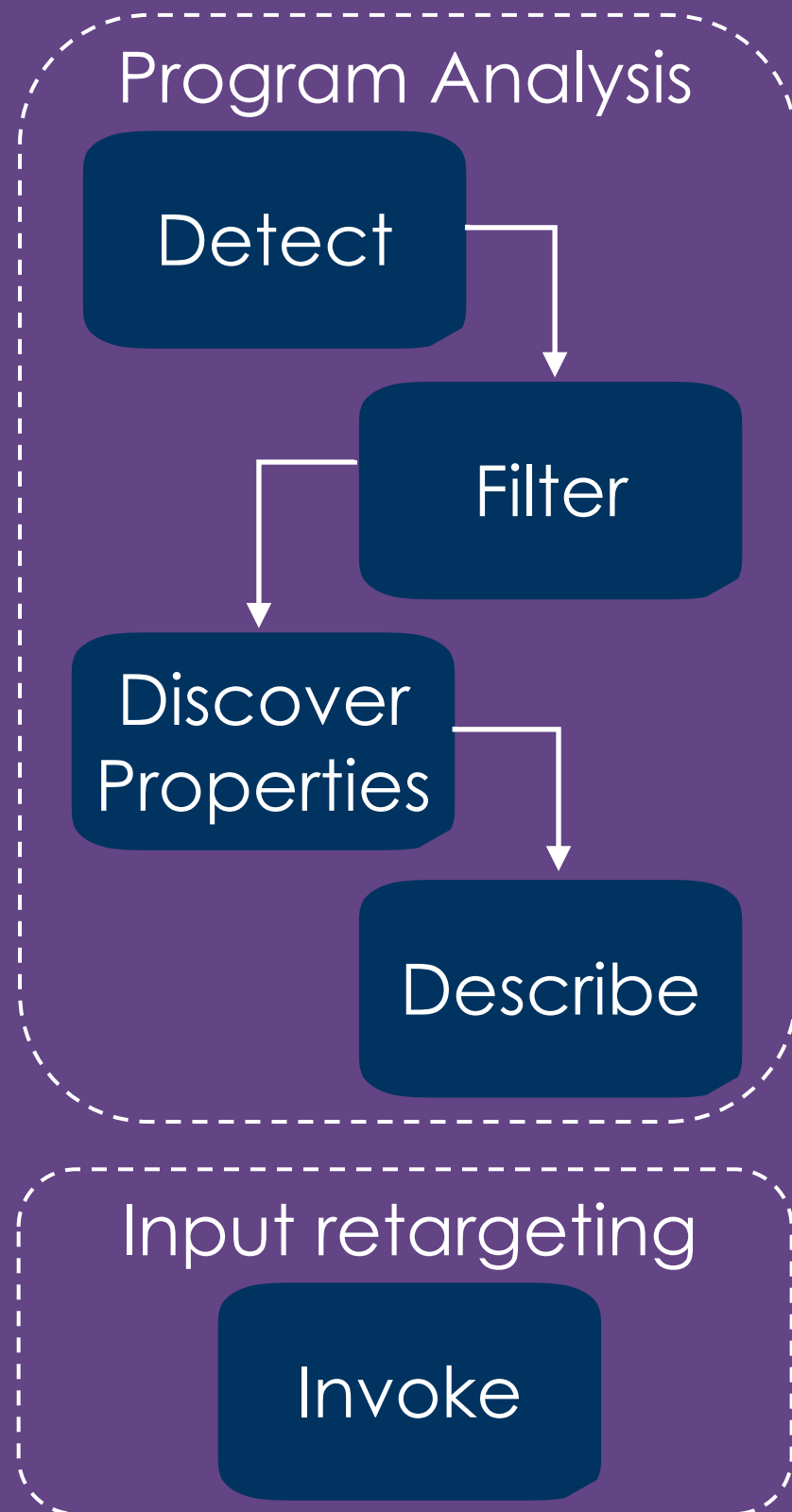
System Details

Demonstration

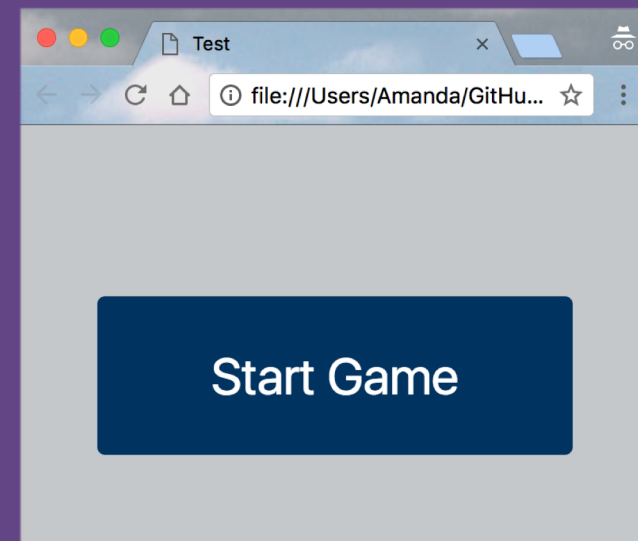
Program Analysis



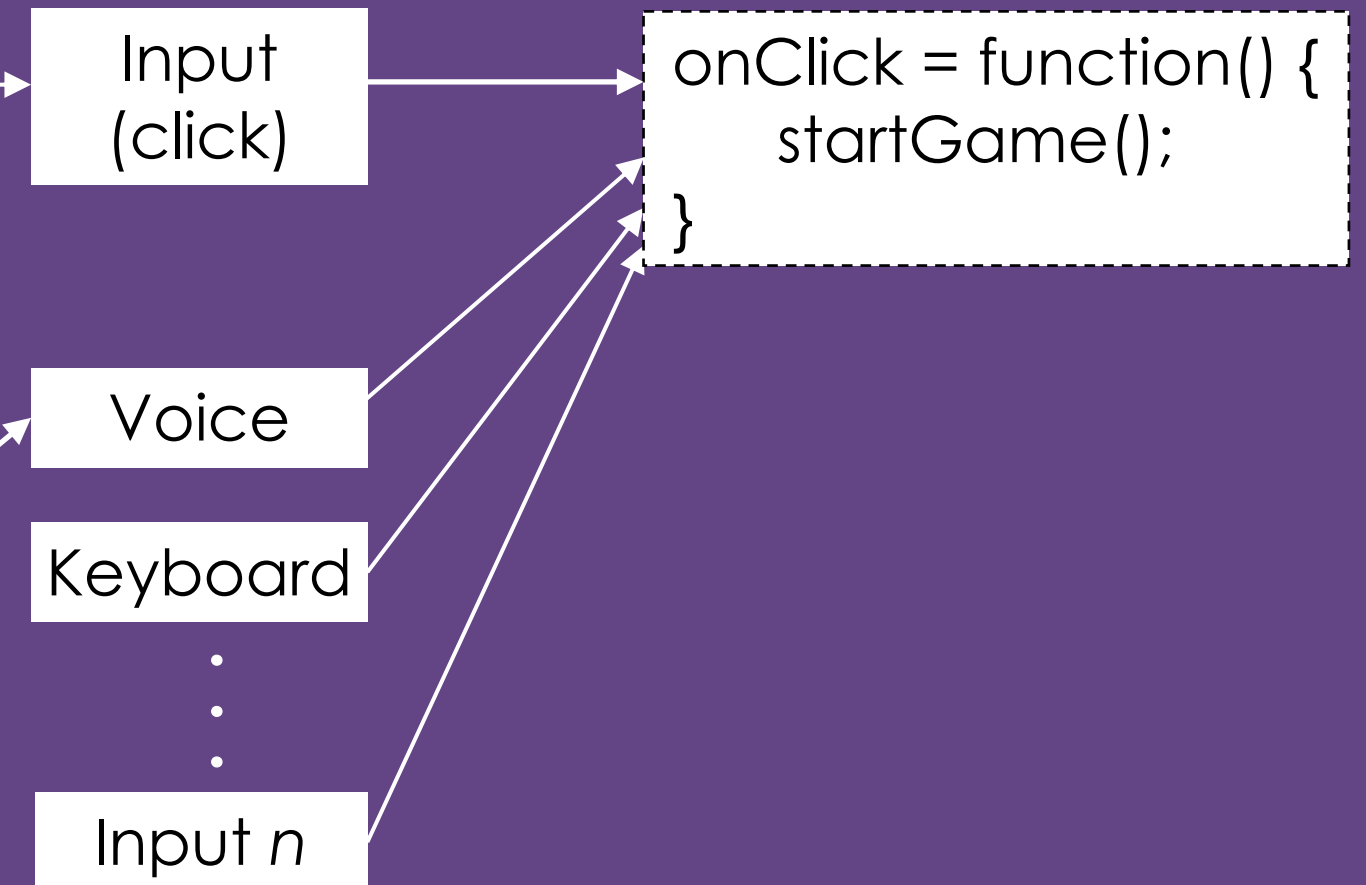
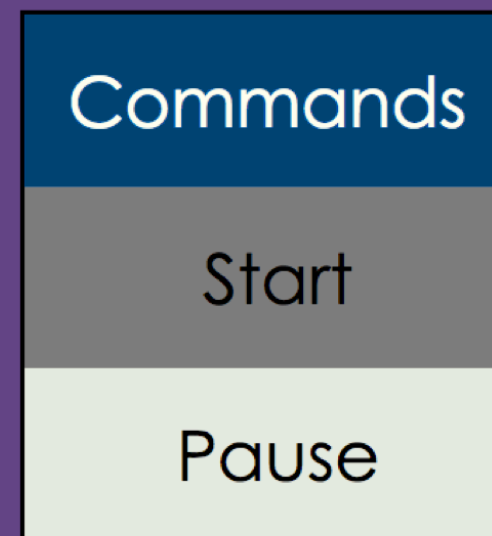
Input Retargeting



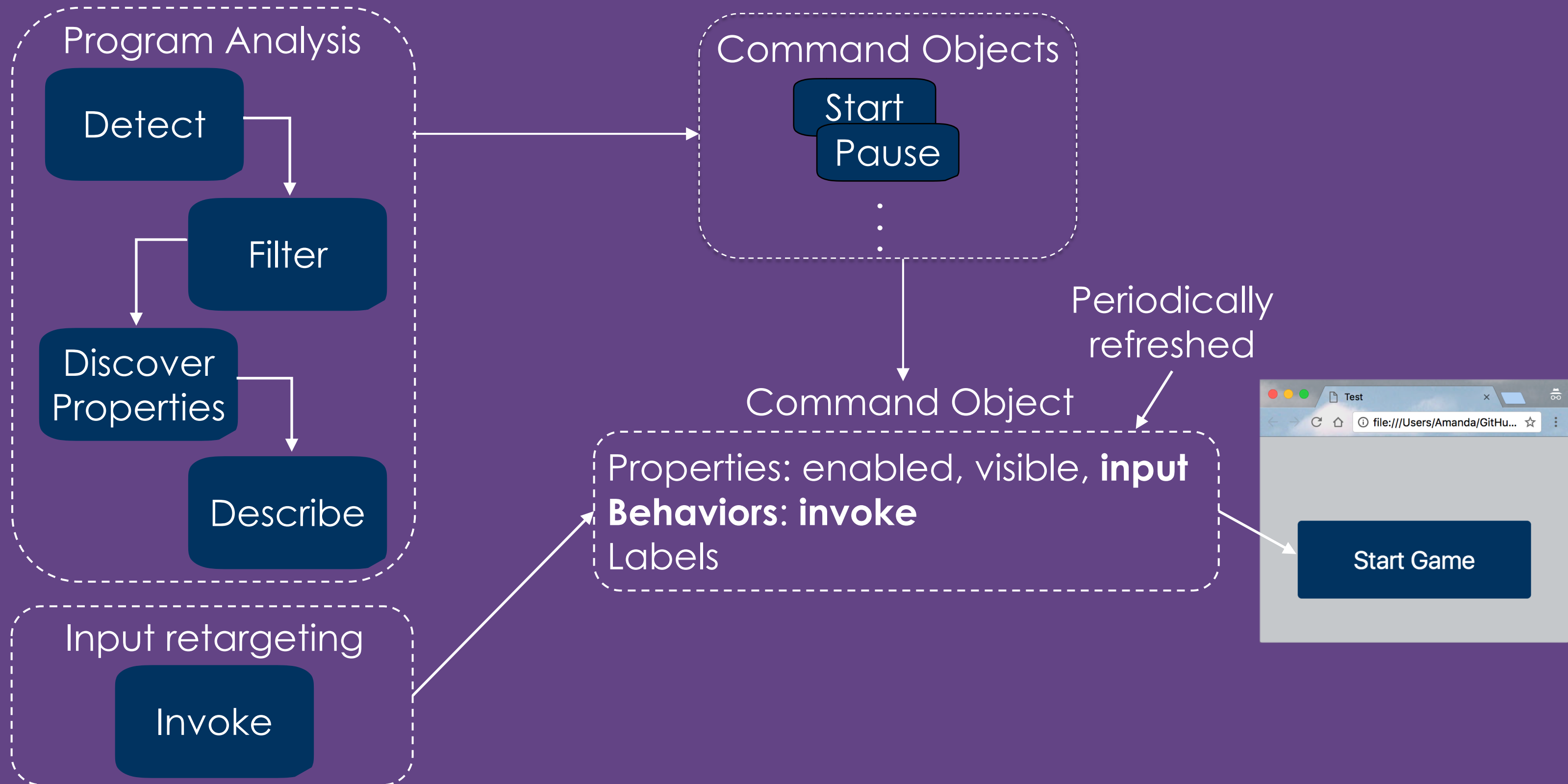
Original Web Interface



Genie UI



Dynamic Command Objects



Overview

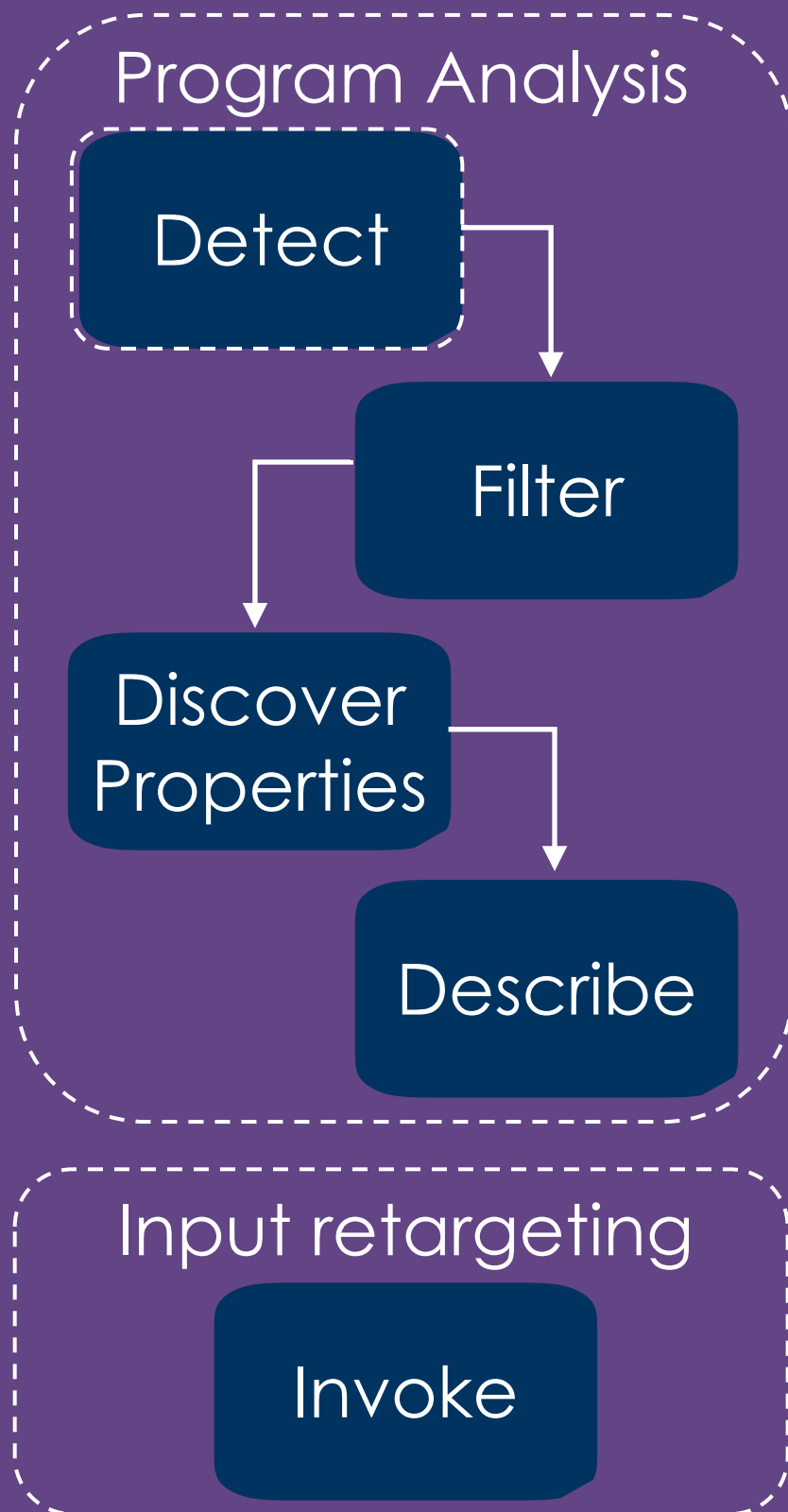
Program Analysis & Input Retargeting

System Details

Demonstration

Detecting Commands

What is a command?



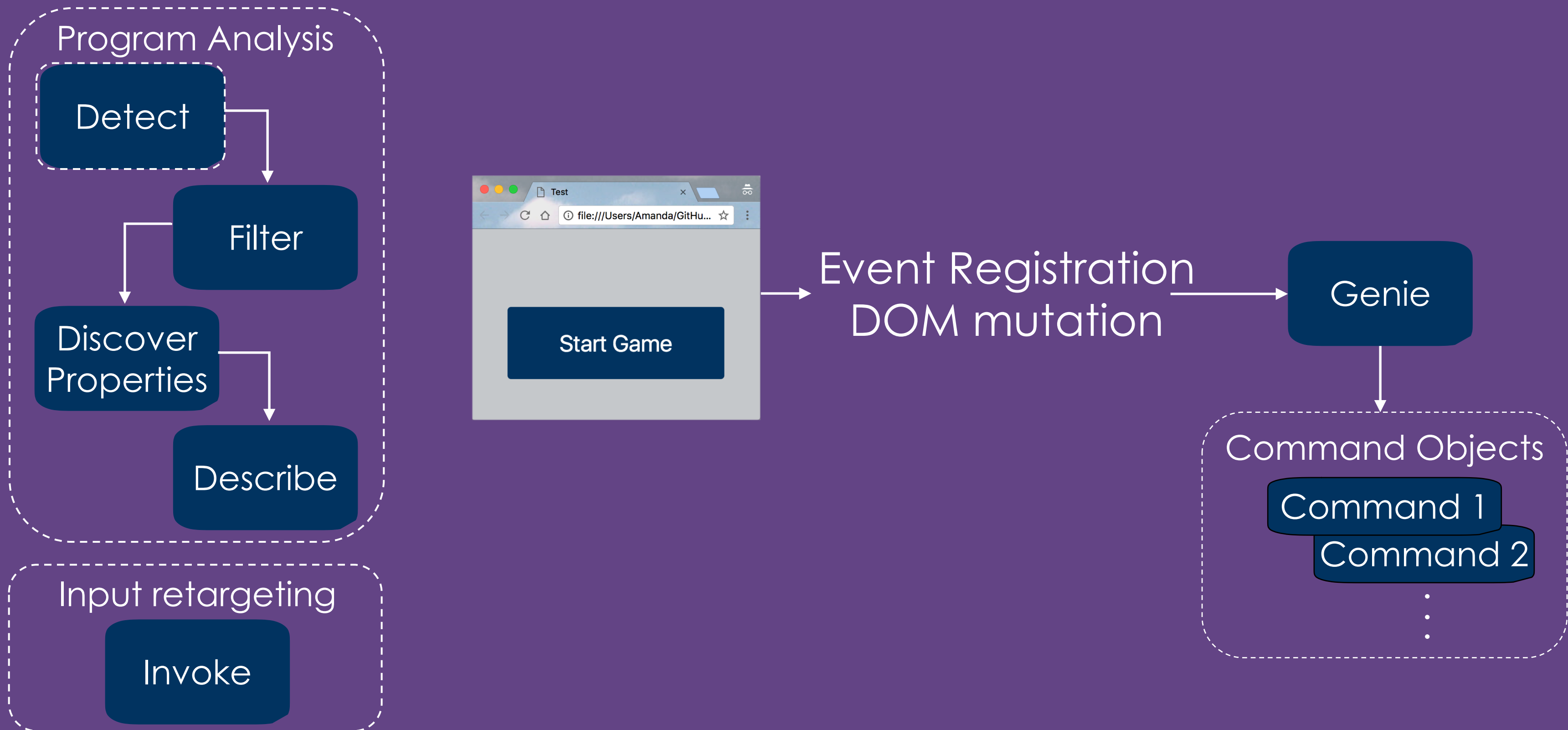
Event

OR

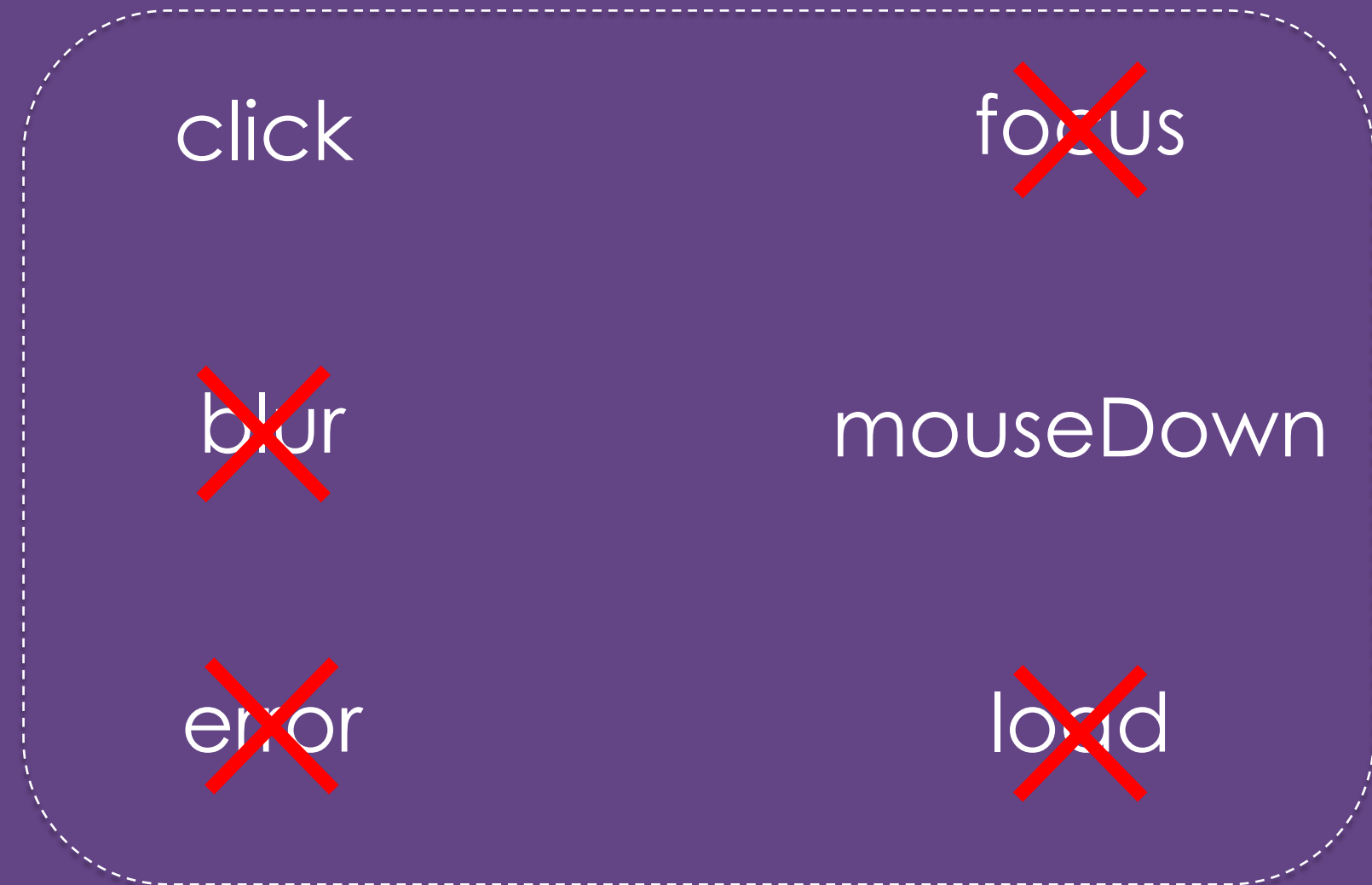
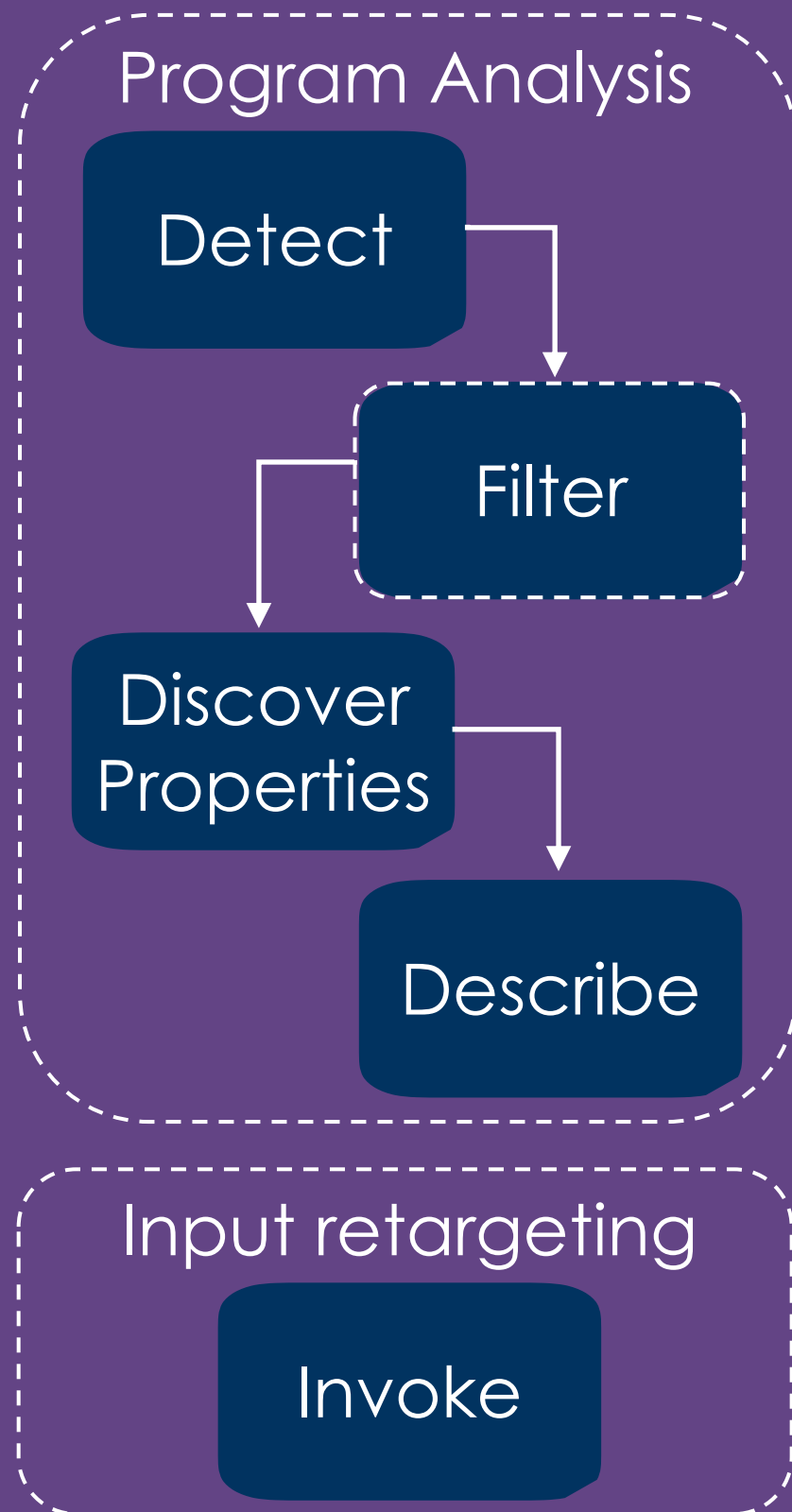
Interactive Element



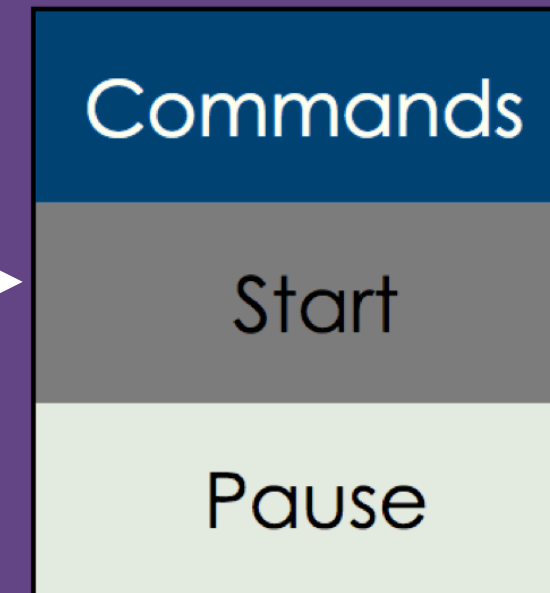
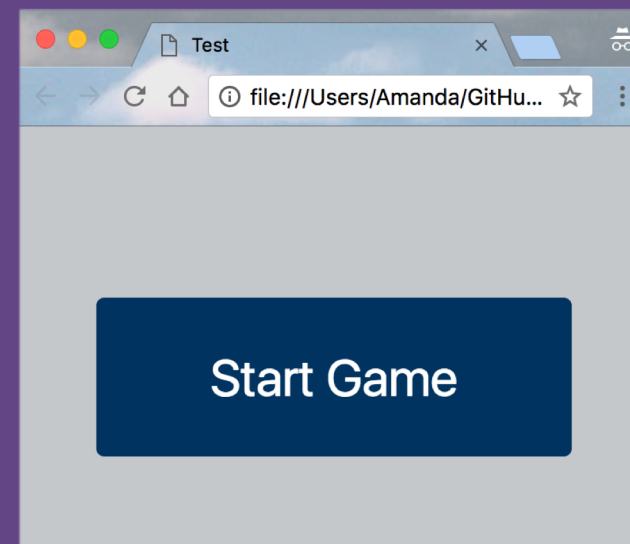
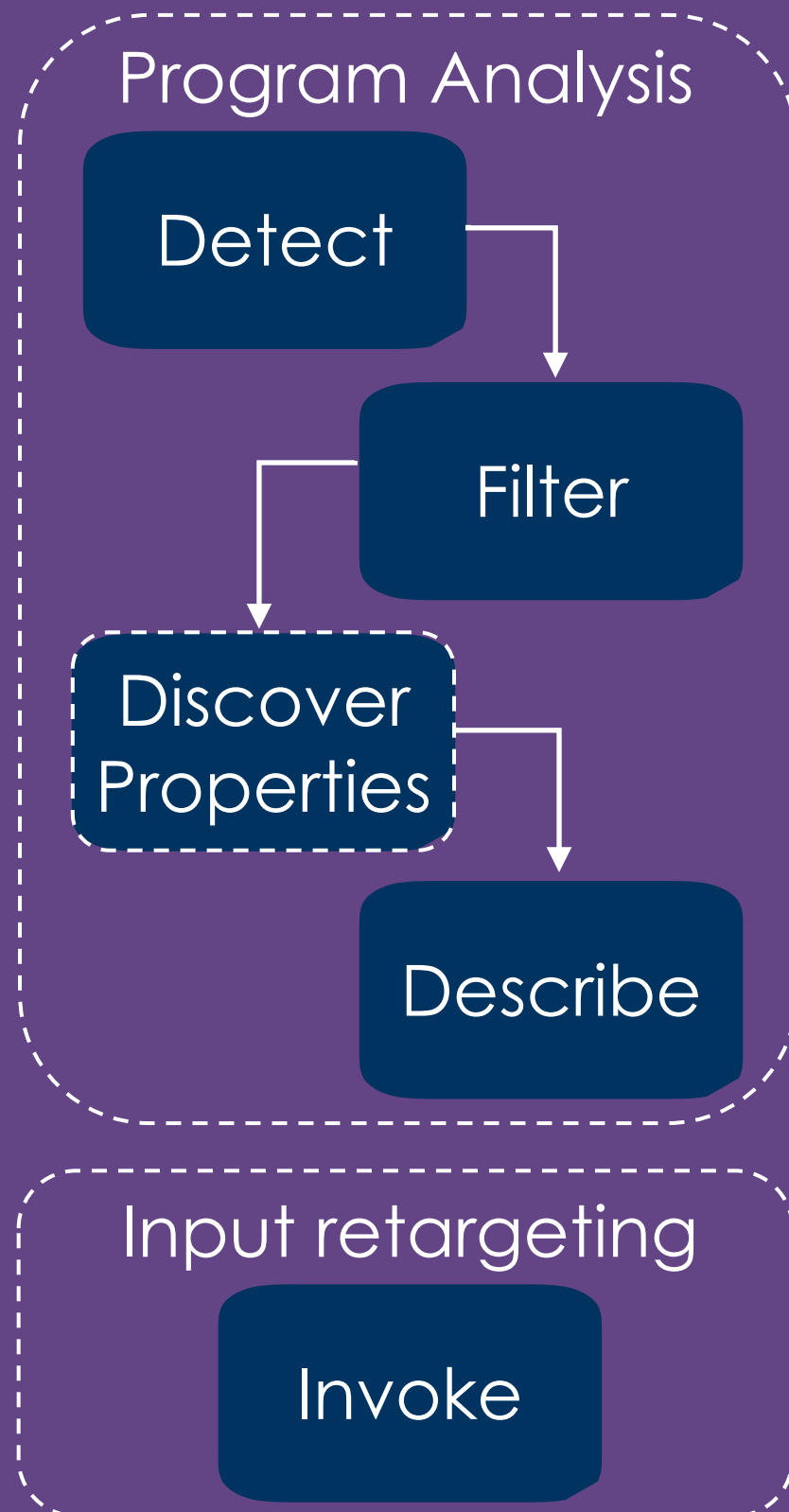
Detecting Commands



Filtering Commands



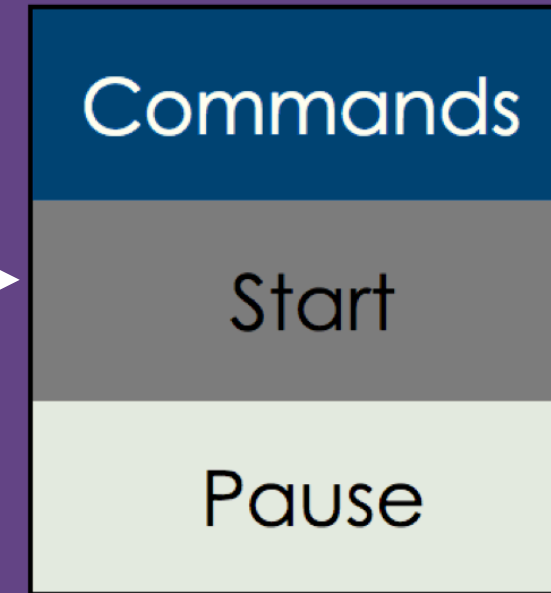
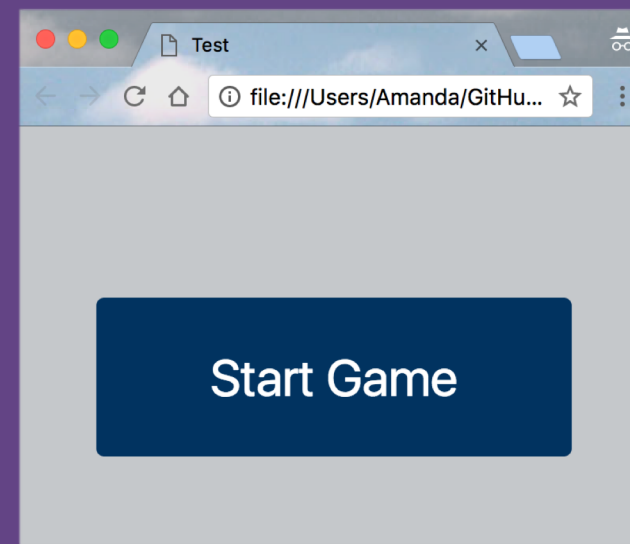
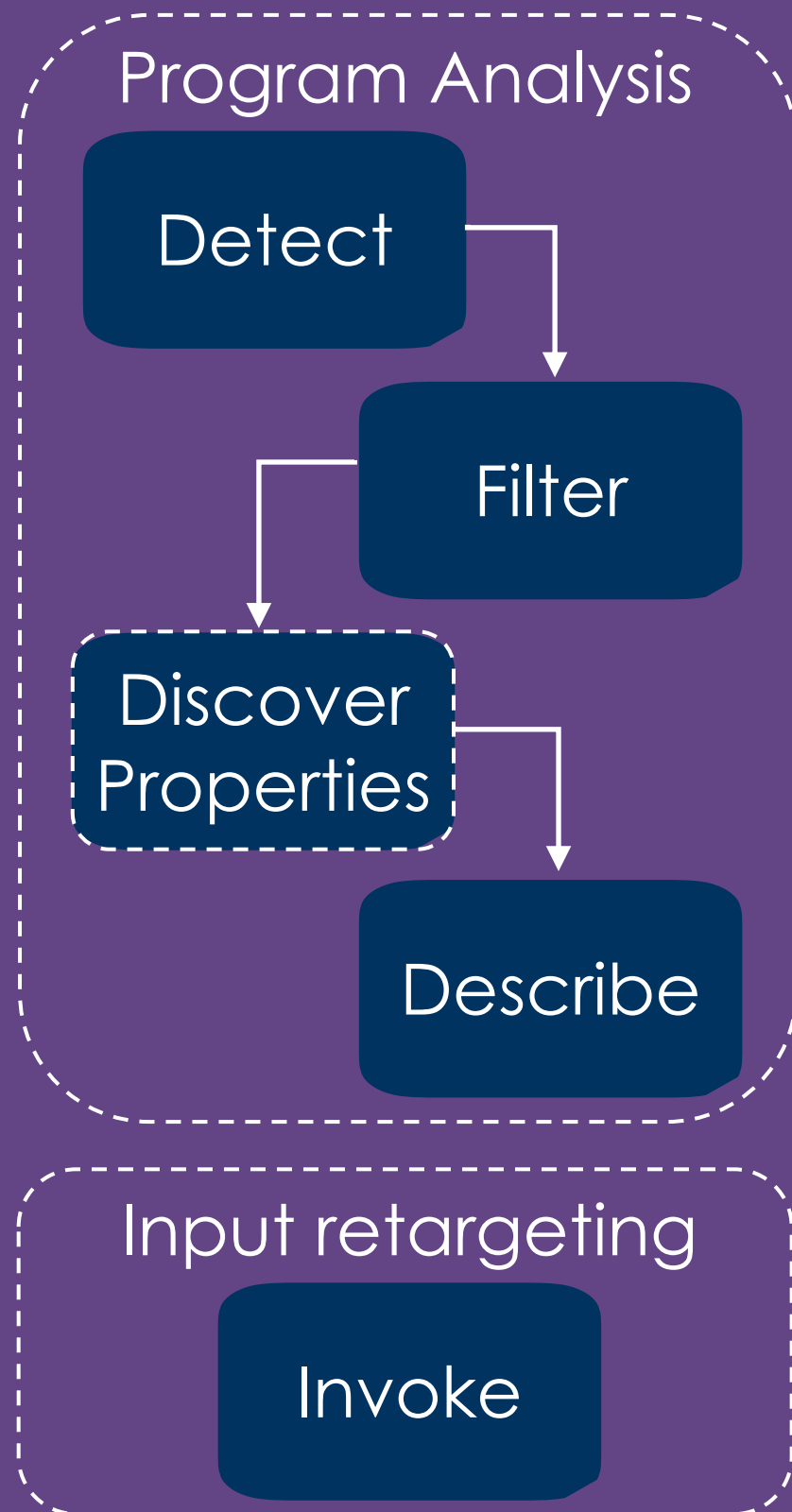
Discovering Properties



enabled

```
onClick = function handleStartGame(e) {  
  var startBtn = $("#startBtn");  
  if(!startBtn.attr("disabled")) {  
    startBtn.attr("disabled", true);  
    startGame();  
  }  
}
```

Discovering Properties



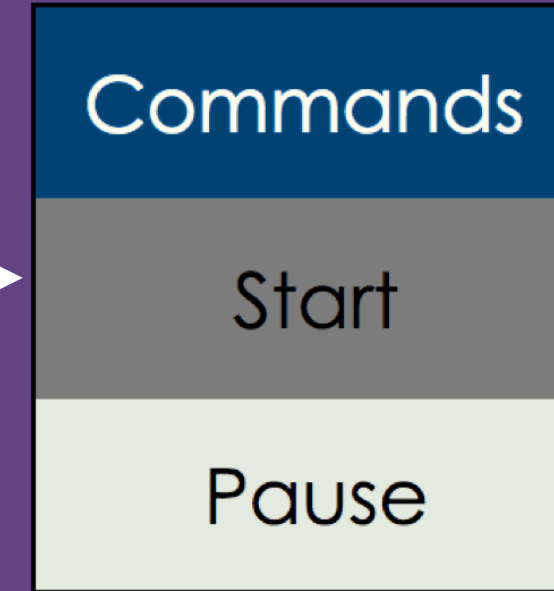
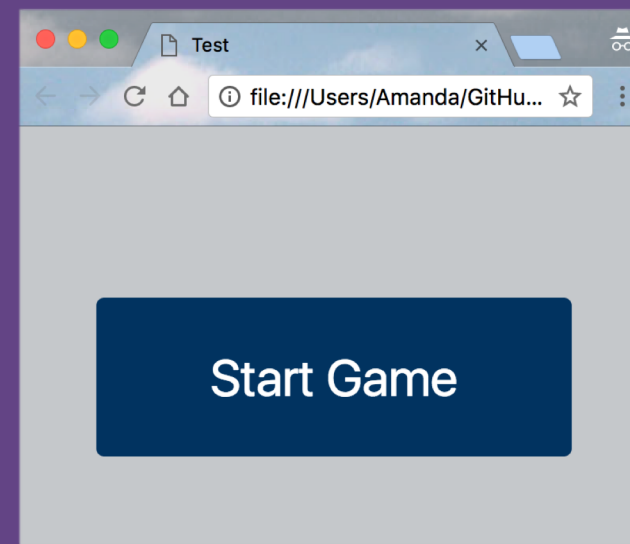
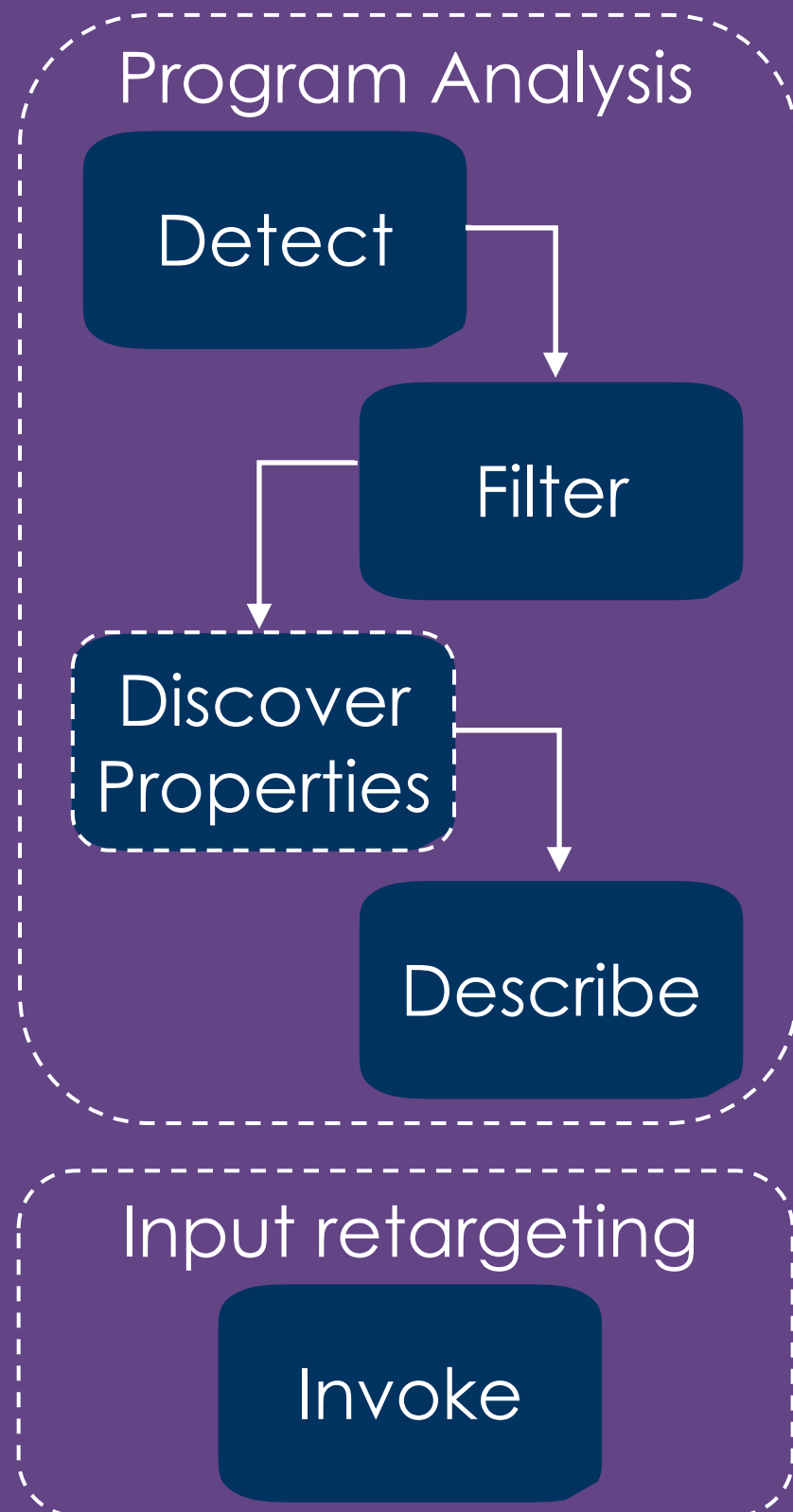
enabled

visible

CSS

DOM Attributes

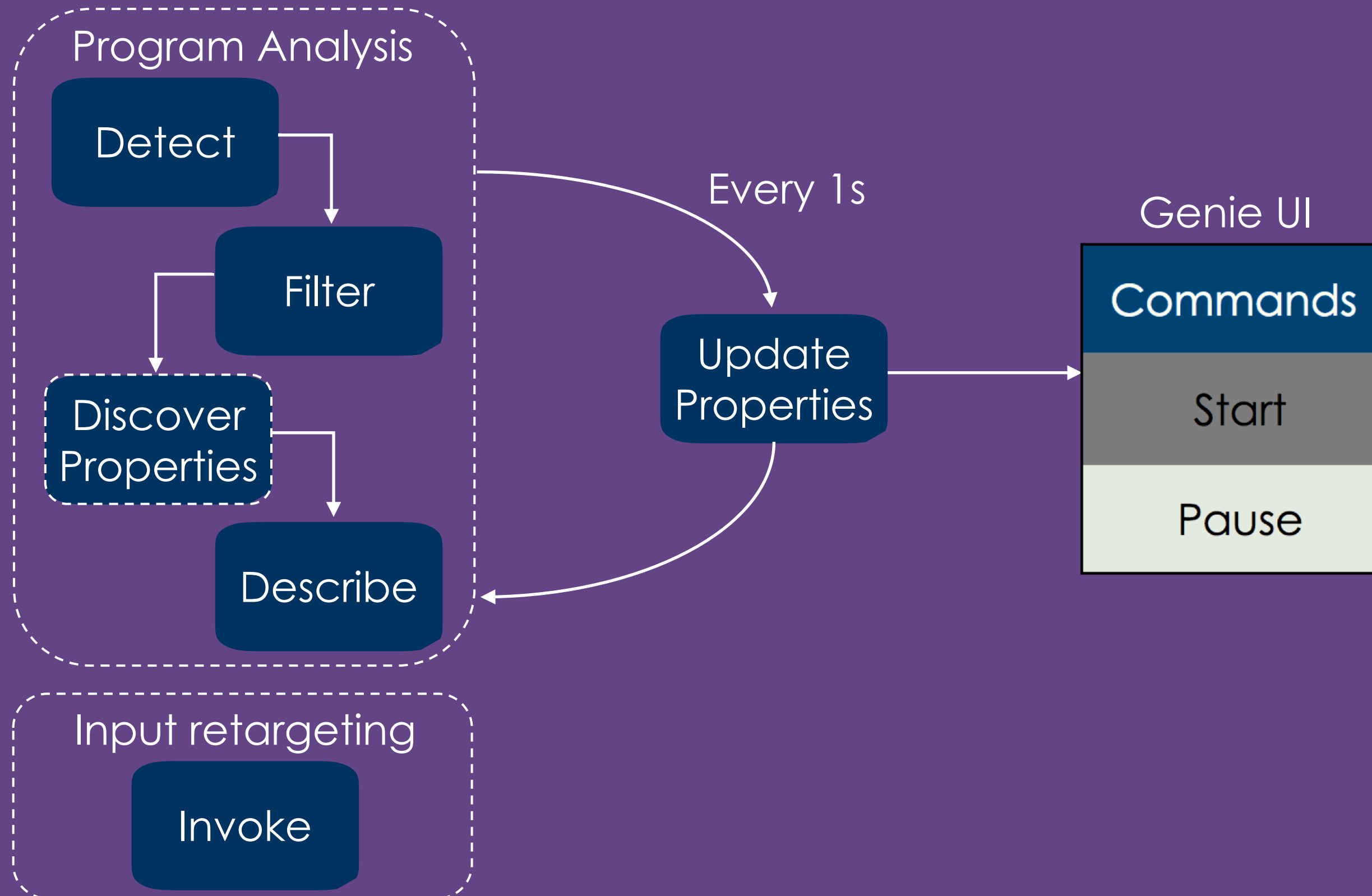
Discovering Properties



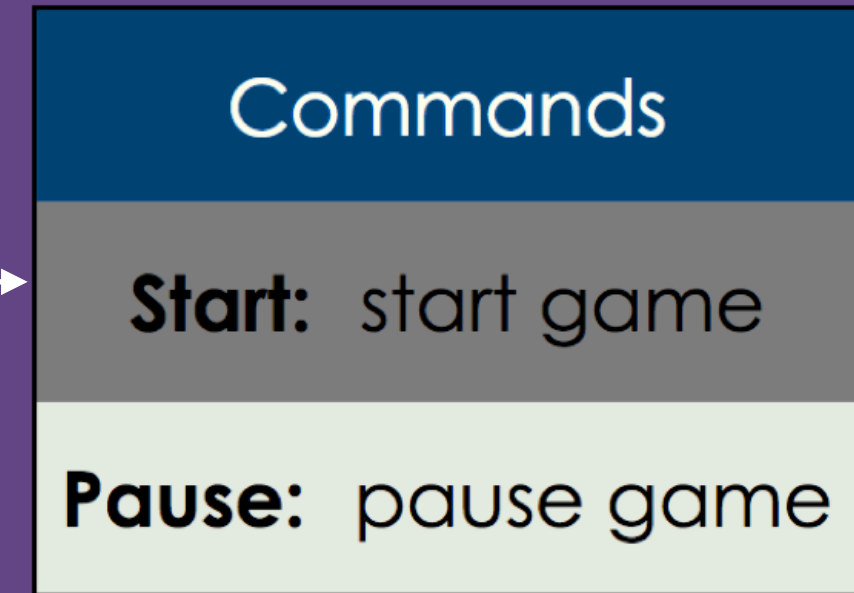
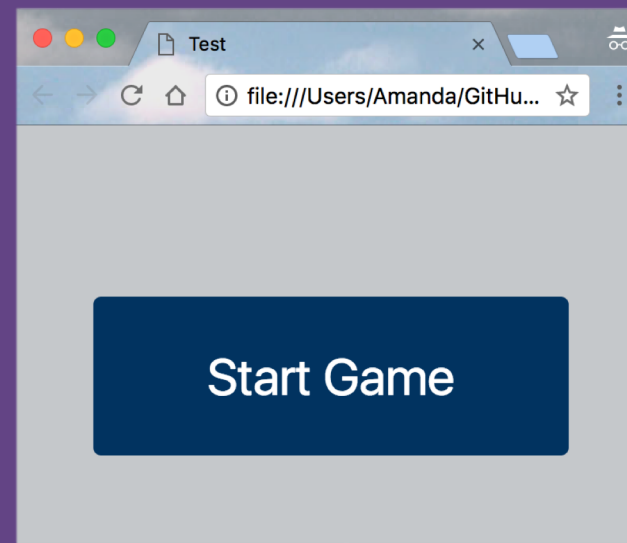
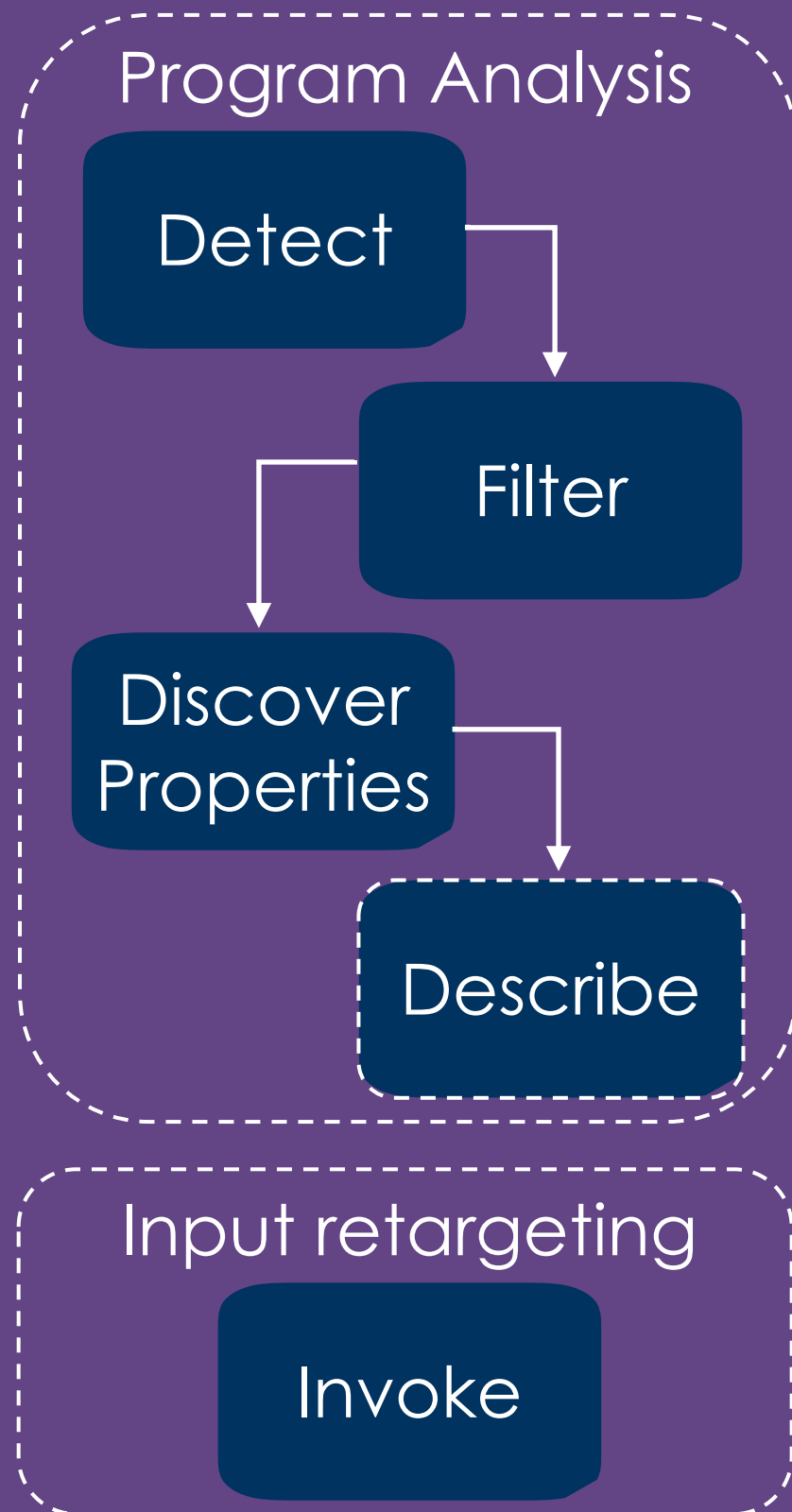
enabled
visible
input

```
onKeyDown = function keyDownHandler(e) {  
  if (e.keyCode == 13) {  
    submitOnEnter();  
  }  
}
```

Discovering Properties



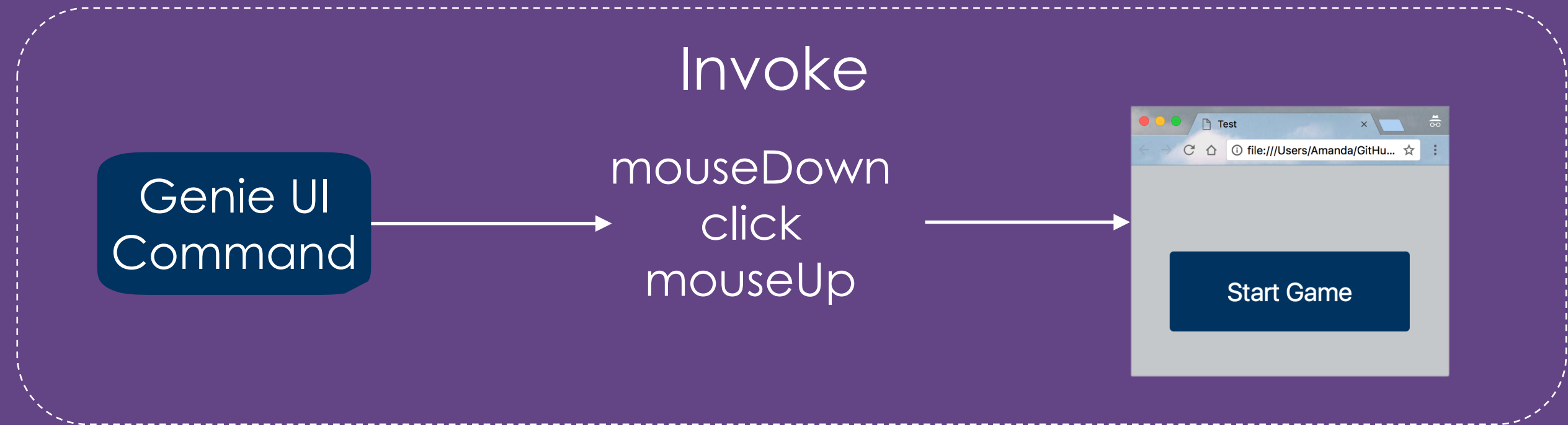
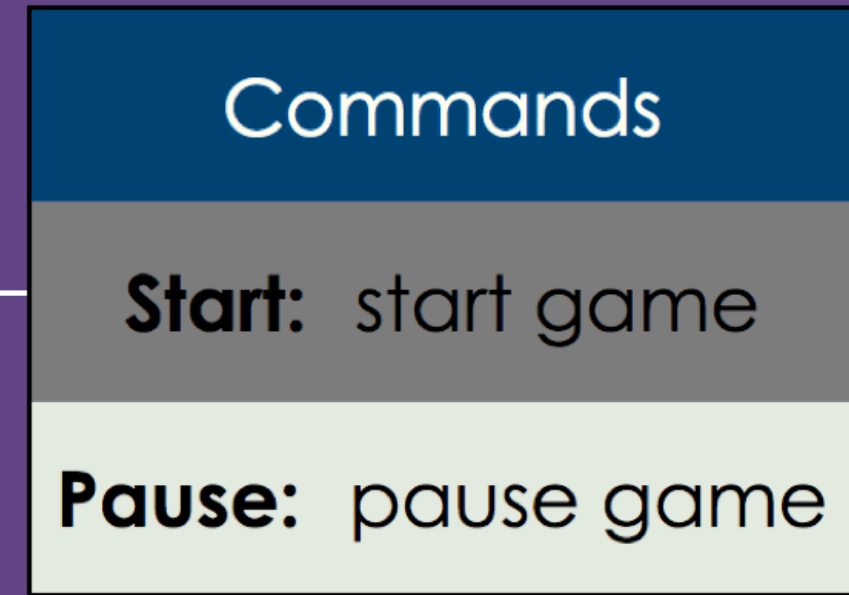
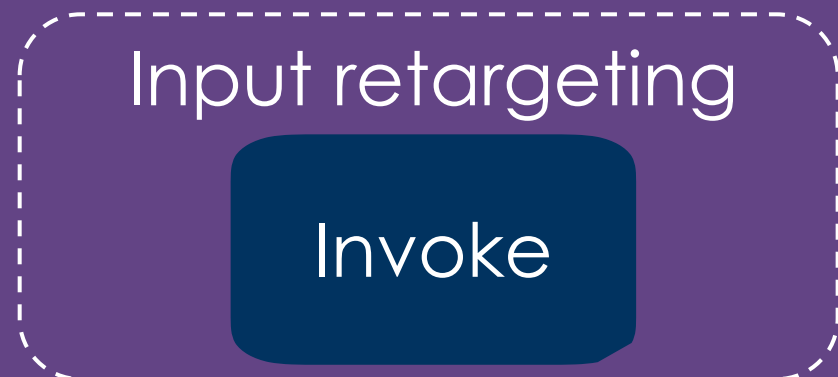
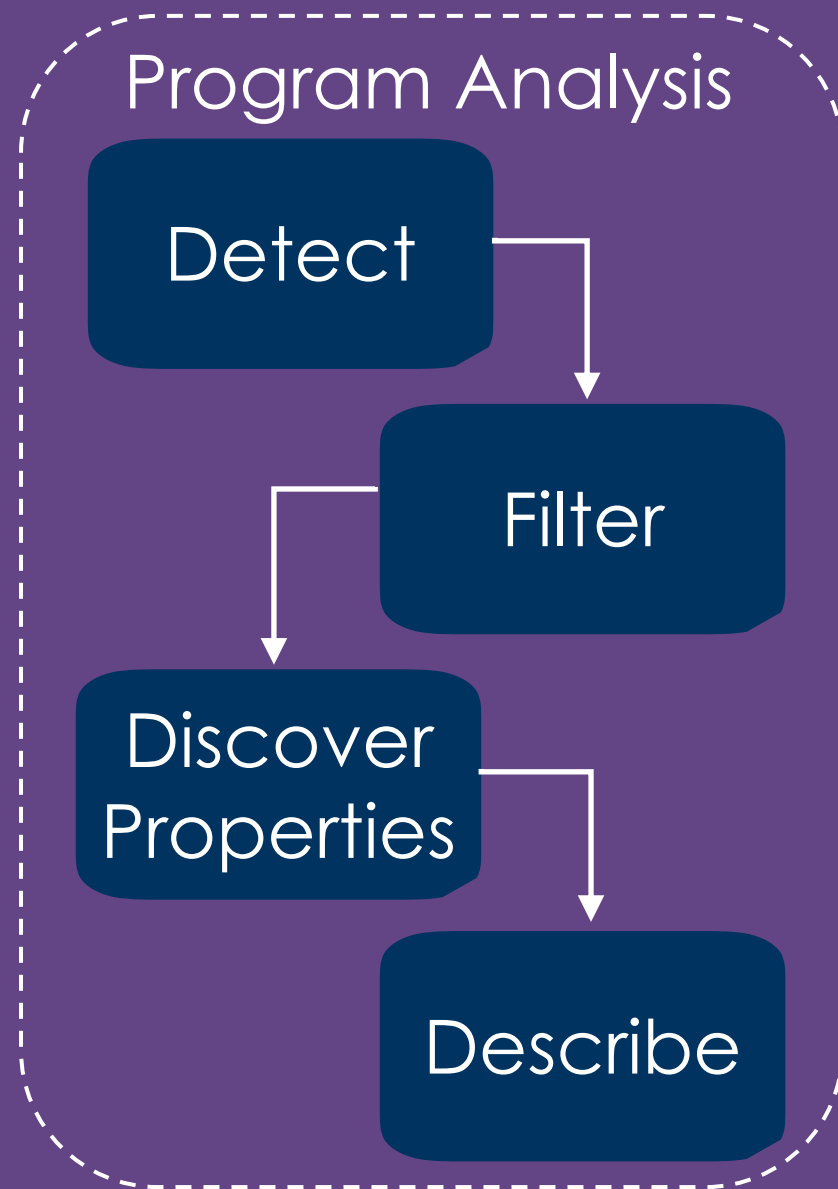
Describing Commands



```
onClick = function handleStartGame(e) {
  var startBtn = $("#startBtn");
  if(!startBtn.attr("disabled")) {
    startBtn.attr("disabled", false);

    // start the game if any lives remaining
    if(livesRemaining >= 0) {
      startGame();
    }
  }
}
```


Invoking Commands

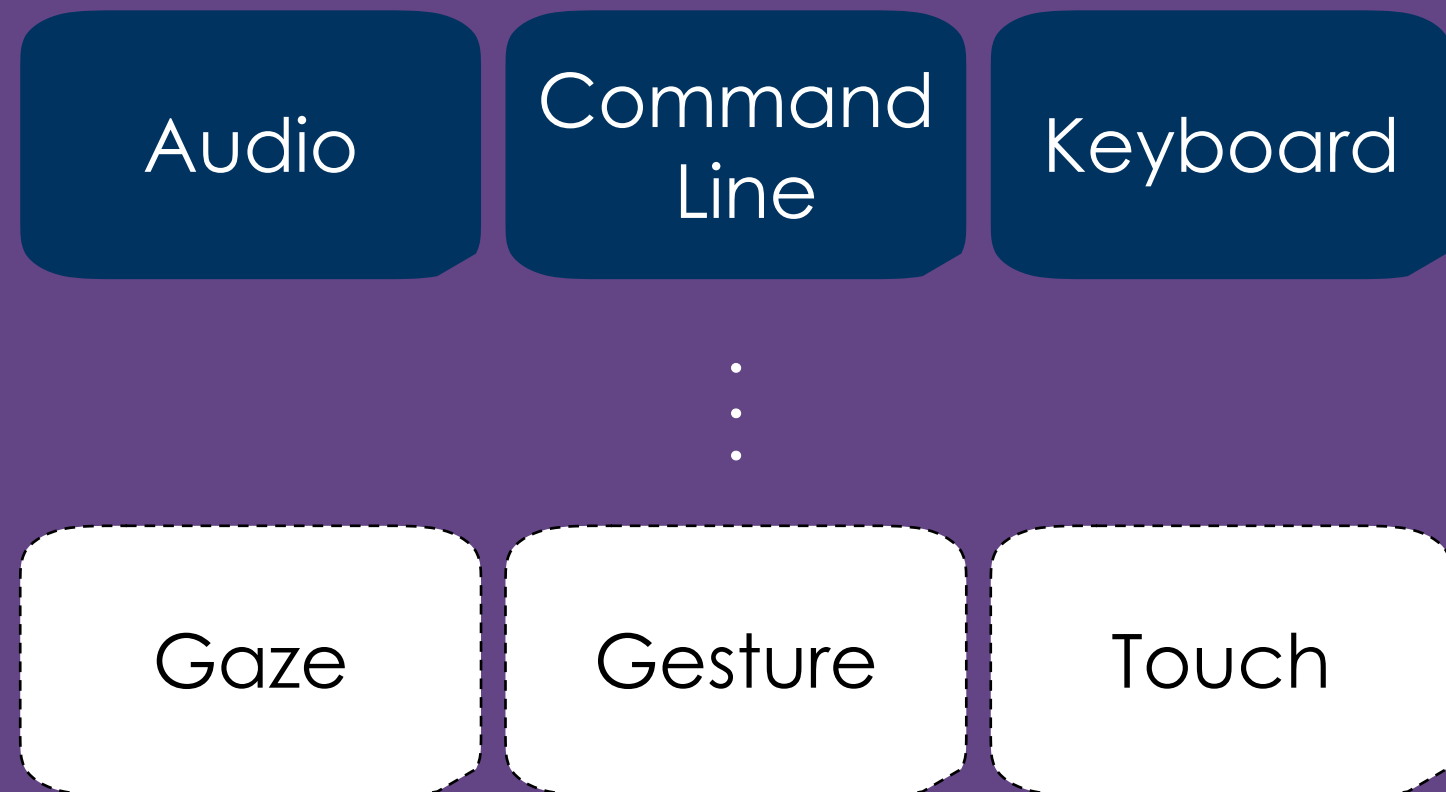


Demonstration

4 example applications
3 types of input

Built with Genie API

- HTML/CSS
- Translation layer
- Small amount of code



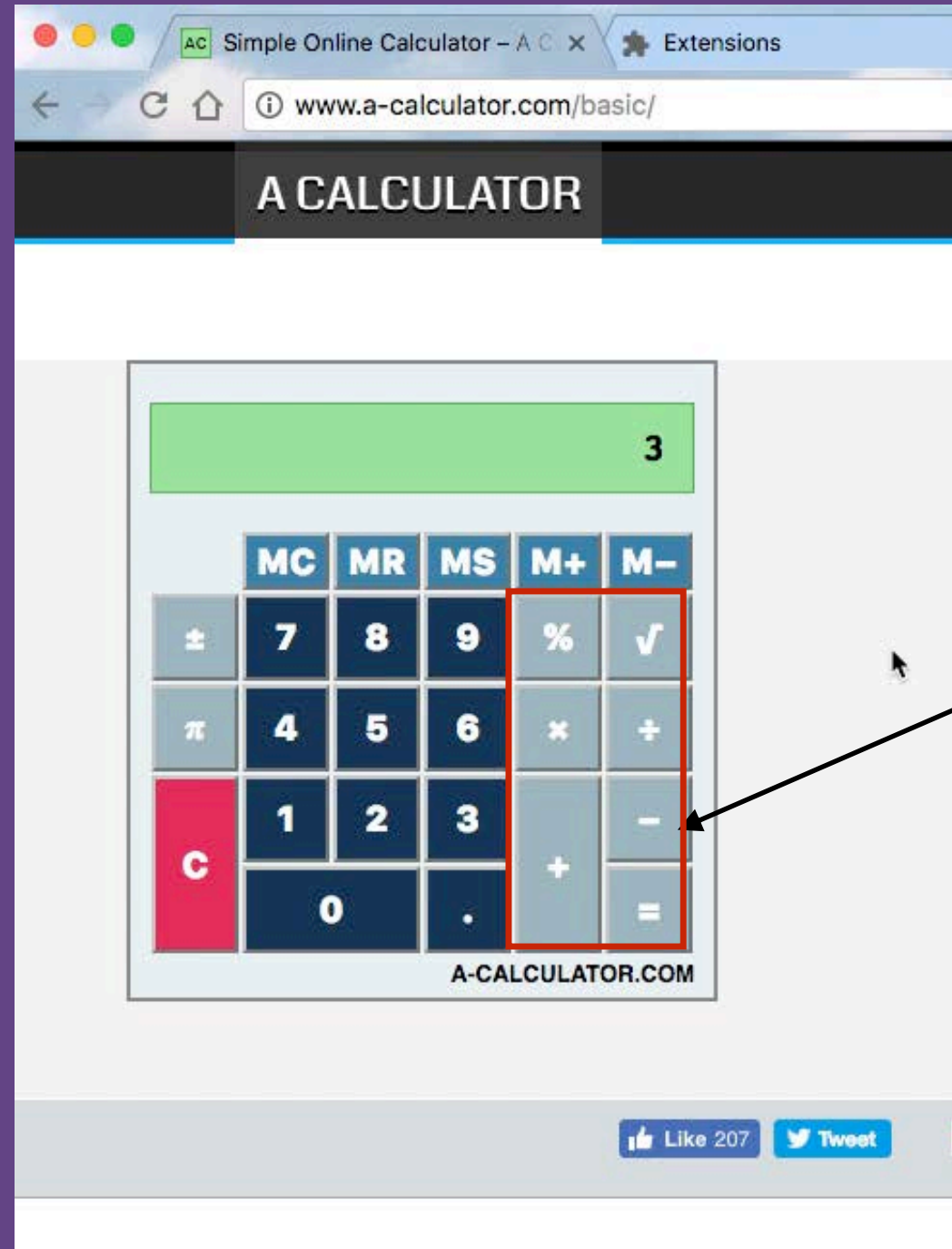
Possible Input Types

Keyboard Shortcuts

The screenshot shows a web browser window with two tabs: "2048" and "Extensions". The address bar shows the URL "https://gabrielecirulli.github.io/2048/". The game interface includes a large "2048" title, a "SCORE 0" and "BEST 8" display, a "New Game" button, and a 4x4 grid with a single tile containing the number "2". A "Keyboard shortcuts" popup is open on the right, listing: "shift + k ---Keep going: Try again, Keep playi...", "shift + s ---Set notice closed: Storage, True, Notice...", "shift + t ---Start: Keep going, Try agai...", and "shift + r ---Try again: Retry button". A "Close" button is in the top right of the popup. Two arrows point from the text "No shortcut for 'New Game'" to the "New Game" button and the "shift + r" entry in the popup. Another arrow points from the text "Type Shift+T to 'Try Again'" to the "shift + t" entry in the popup.

No shortcut for "New Game"
Type Shift+T to "Try Again"

Keyboard Shortcuts



Type "33"

Type "Ctrl+d"

Type "11"

Type "Enter"

Missing keyboard shortcuts

Command-Line Input

Creating a meeting

The screenshot shows the 30boxes.com web interface. At the top, there's a navigation bar with "add an avatar", "Amanda", "Settings", "Logout", and "Help". Below that is a search bar and an "ADD" button. The main area is a calendar grid for May. A yellow event titled "meet with Andy" is scheduled for Wednesday, May 10th, from 9am to 10am. A tooltip shows the event details: "9am meet with Andy". At the bottom, a command-line interface is visible with the following text:

```
Enter a command.  
Type commands to see the list of available commands...  
andy="add input": "meet with Andy at 9am"  
Macro saved.  
andy
```

Type commands here.

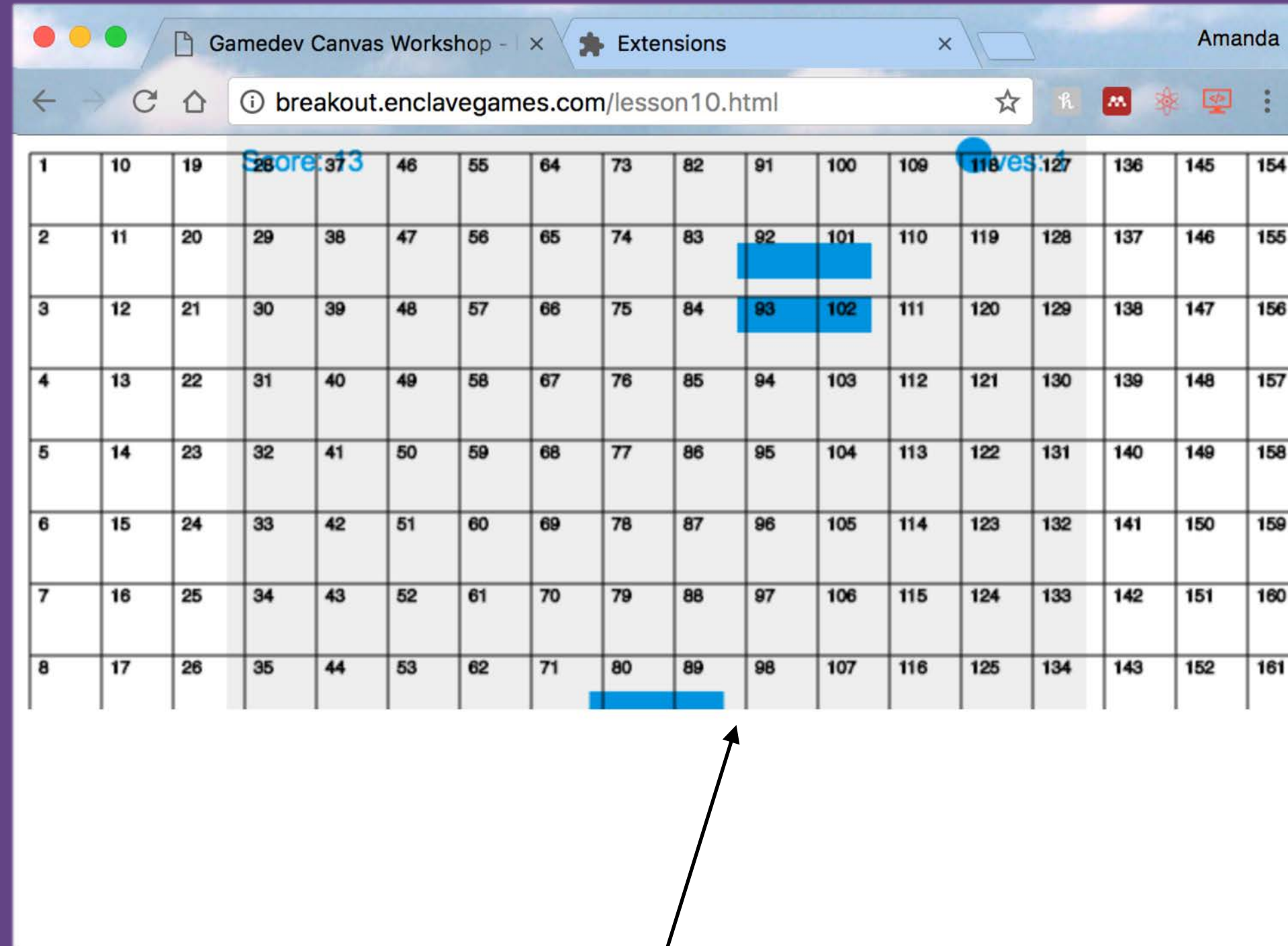
Creating a To-Do list

The screenshot shows the flask.io web interface for a to-do list. The title is "My to-do list 05/04/2017" and there is a "Save This List" button. Below the title is a text input field with the placeholder "Write your next task here...". At the bottom, a command-line interface is visible with the following text:

```
Enter a command.  
Type commands to see the list of available commands...  
paperReview="write task": "Read paper", "save task", "write task": "Write review", "save task", "write  
task": "Submit review", "save task"  
Macro saved.
```

Use typed "to-do reviews."

Keyboard Mouse Input

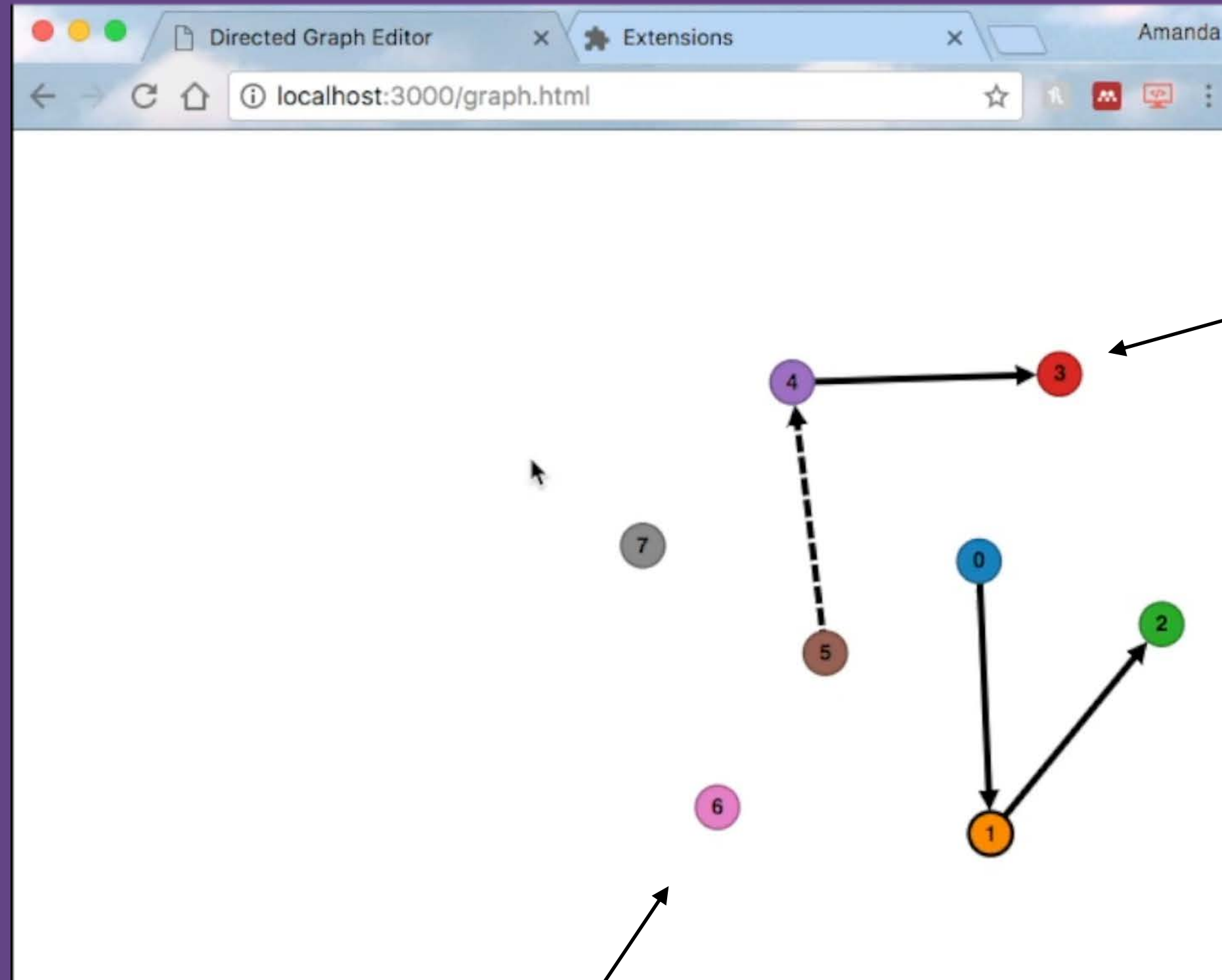


The screenshot shows a web browser window with the URL `breakout.enclavegames.com/lesson10.html`. The browser tabs include "Gamedev Canvas Workshop" and "Extensions". The user's name "Amanda" is visible in the top right. The game interface features a grid of 160 numbered cells (rows 1-8, columns 1-20). The score is 373 and lives are 127. A blue bar is positioned at the bottom of the grid, and a blue circle highlights the lives indicator. A black arrow points from the text below to the bottom of the grid.

1	10	19	28	37	46	55	64	73	82	91	100	109	118	127	136	145	154
2	11	20	29	38	47	56	65	74	83	92	101	110	119	128	137	146	155
3	12	21	30	39	48	57	66	75	84	93	102	111	120	129	138	147	156
4	13	22	31	40	49	58	67	76	85	94	103	112	121	130	139	148	157
5	14	23	32	41	50	59	68	77	86	95	104	113	122	131	140	149	158
6	15	24	33	42	51	60	69	78	87	96	105	114	123	132	141	150	159
7	16	25	34	43	52	61	70	79	88	97	106	115	124	133	142	151	160
8	17	26	35	44	53	62	71	80	89	98	107	116	125	134	143	152	161

Type cell number to move mouse

Keyboard Mouse Input



Add node – click
Add edge –drag

Type cell number to place a node.

Genie

Enables new interactions on the web through *program analysis* and *input retargeting*.

Genie

Key Takeaways

Genie enables interacting with the web
in new ways through *input retargeting*

Genie enables discovering and monitoring
interactive commands through *program analysis*

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