


EventBreak:

**Analyzing the Responsiveness of
Web Applications**

Three horizontal bars of varying lengths and shades of green, stacked vertically, positioned above the authors' names.

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University of California, Berkeley**

Motivation

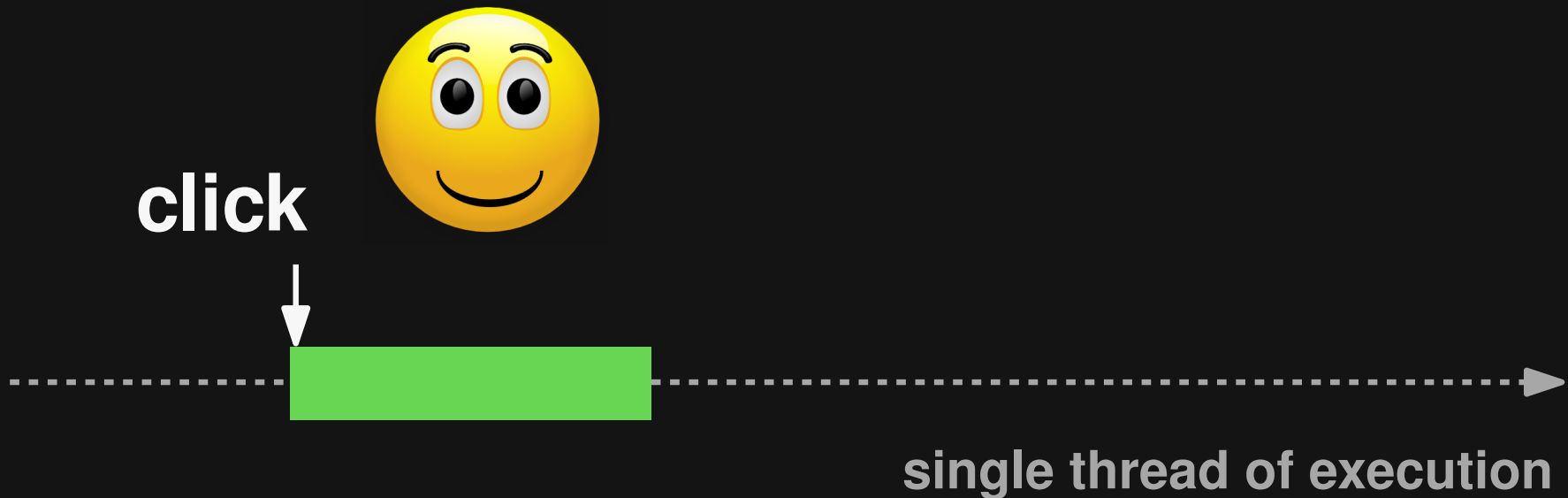
Event-based UI applications should be responsive



single thread of execution

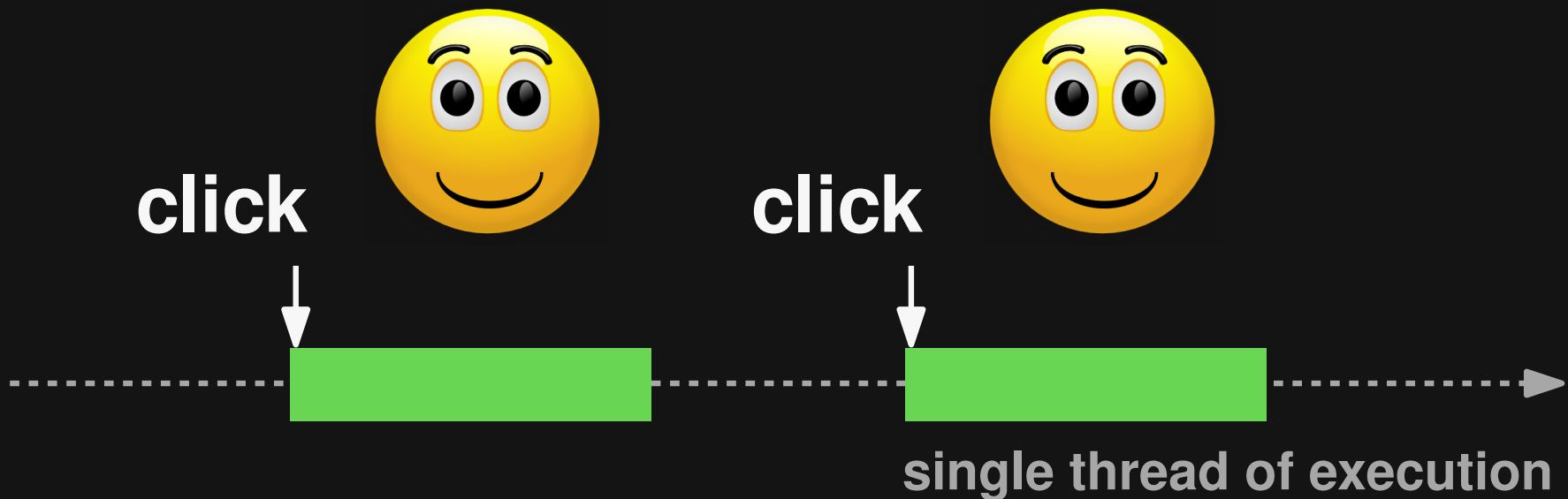
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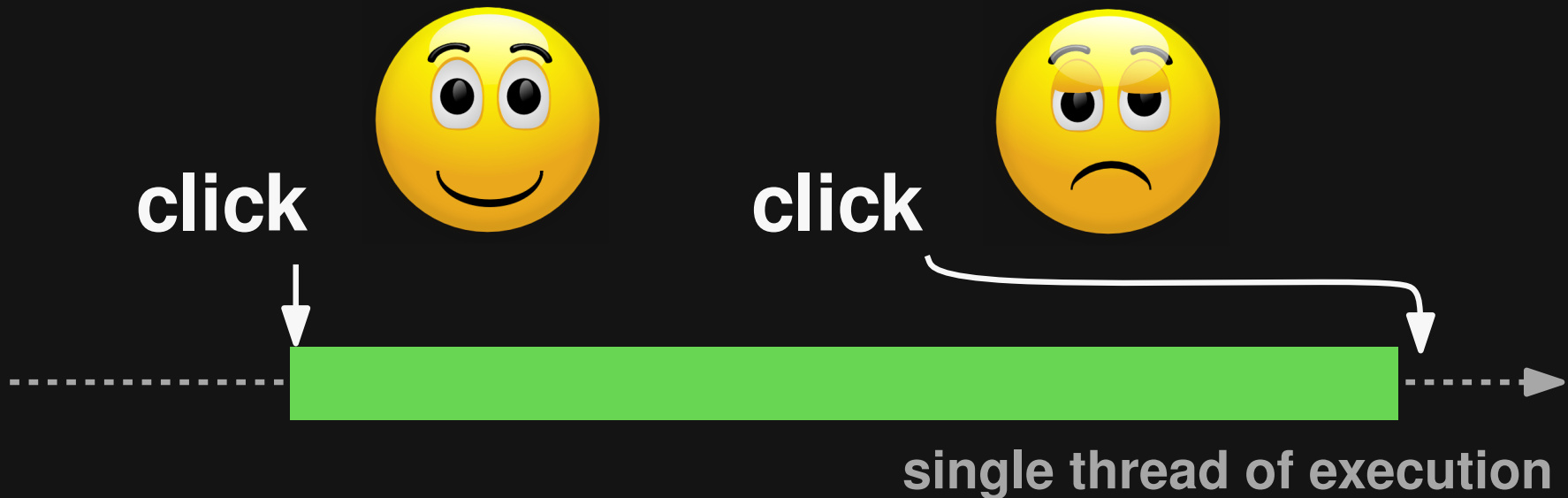
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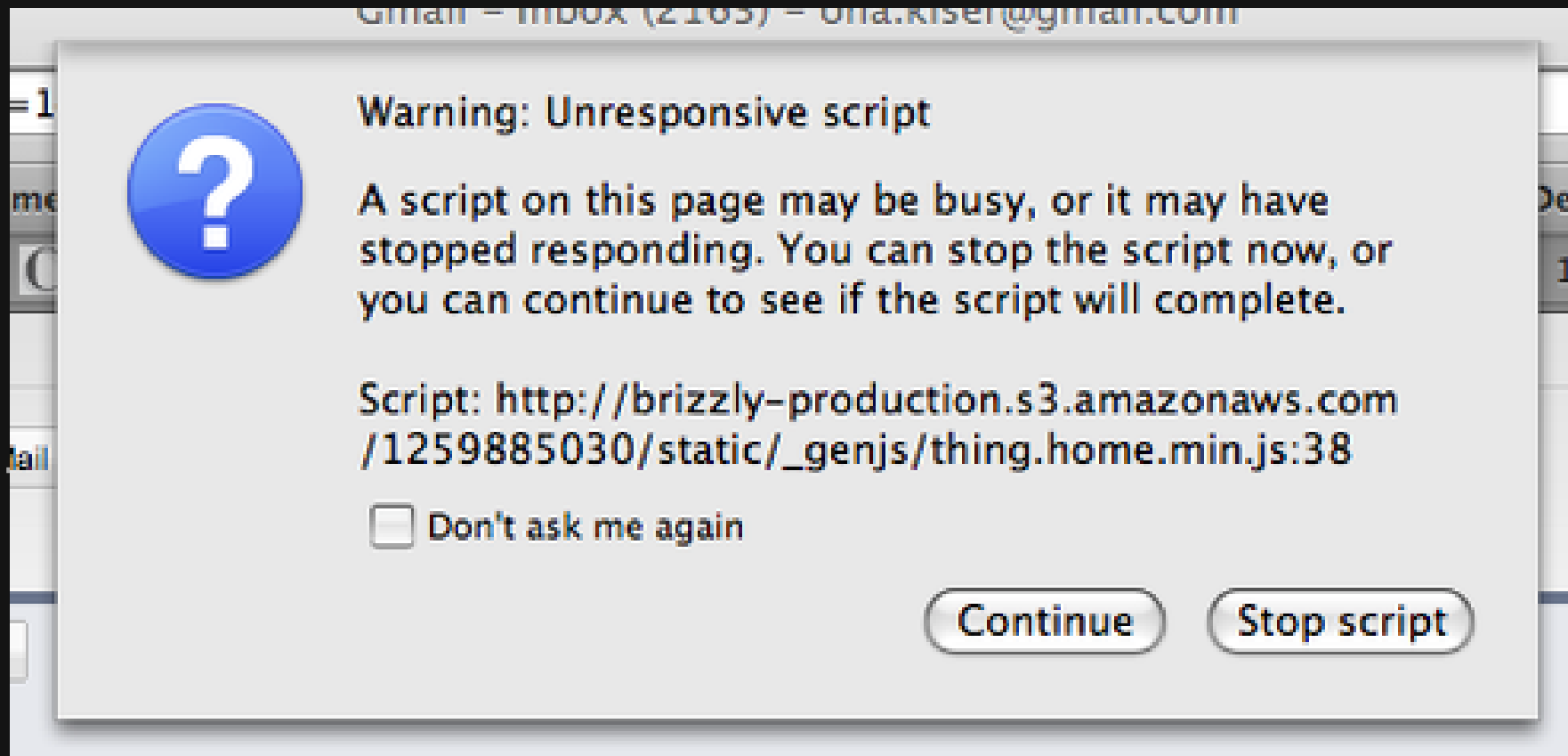
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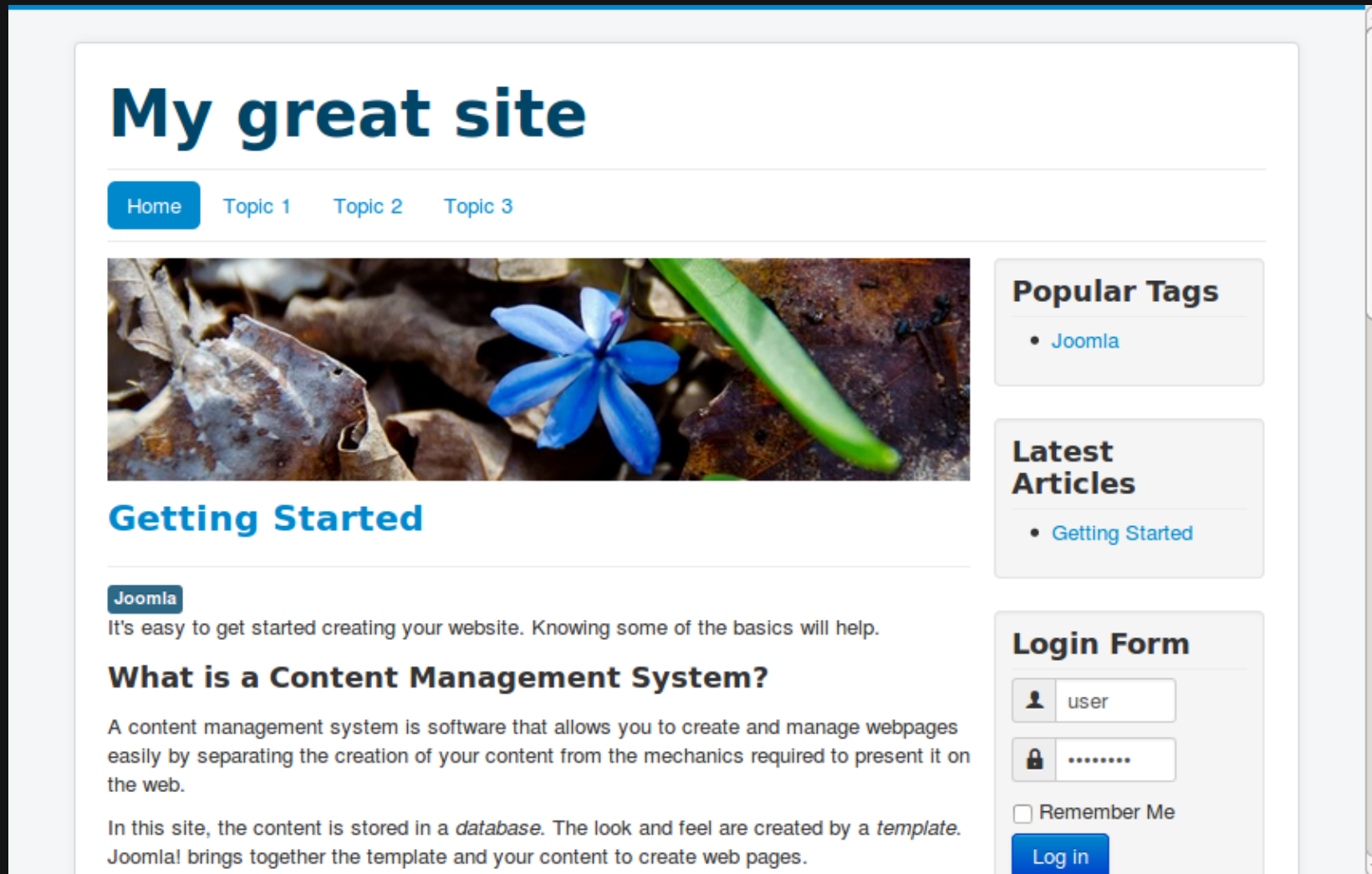


Motivation

Event-based UI applications should be responsive




Real-World Example



My great site

Home Topic 1 Topic 2 Topic 3



Getting Started

Joomla

It's easy to get started creating your website. Knowing some of the basics will help.

What is a Content Management System?

A content management system is software that allows you to create and manage webpages easily by separating the creation of your content from the mechanics required to present it on the web.

In this site, the content is stored in a *database*. The look and feel are created by a *template*. Joomla! brings together the template and your content to create web pages.

Popular Tags

- Joomla

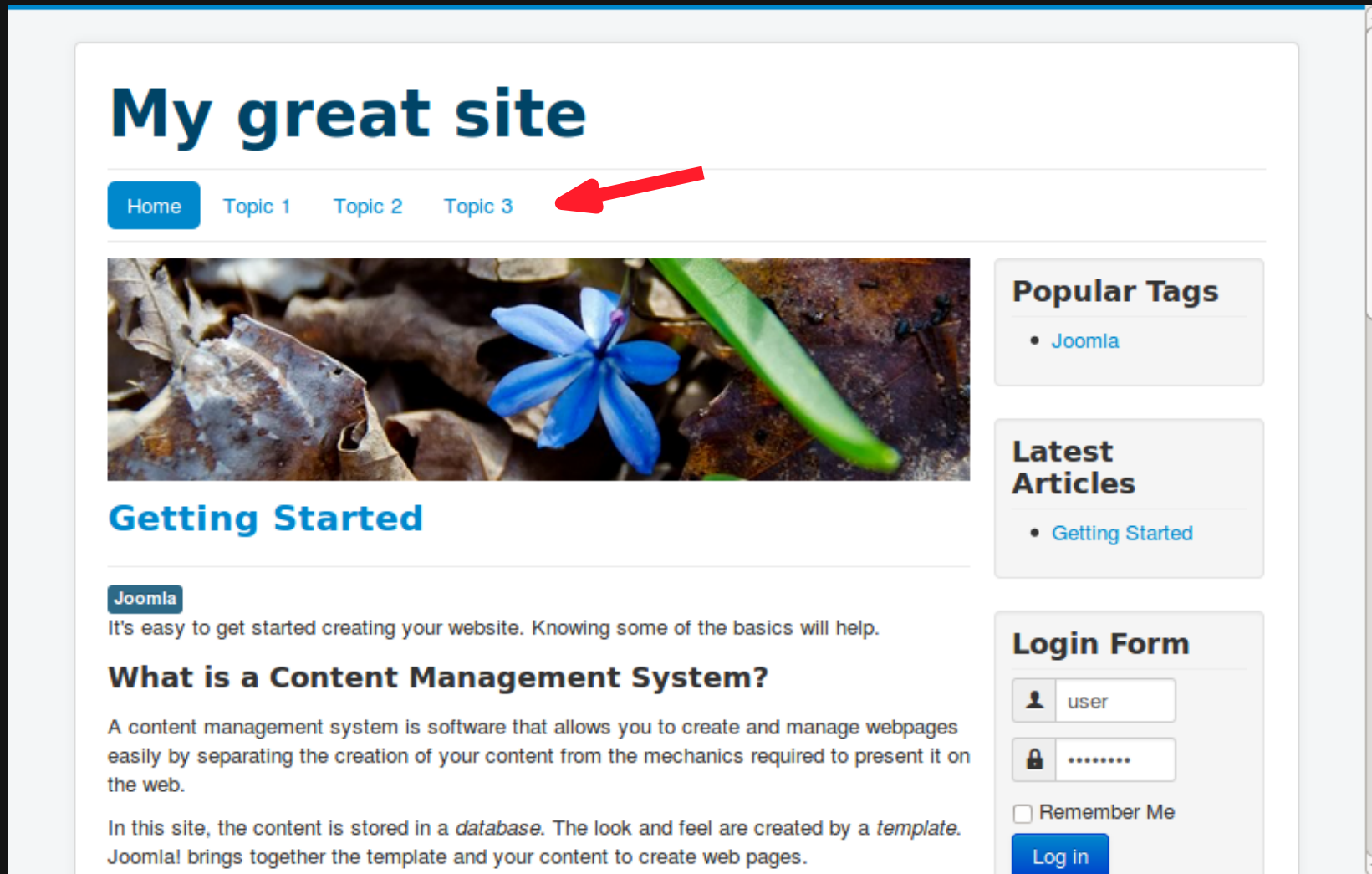
Latest Articles

- Getting Started

Login Form

Remember Me

Real-World Example



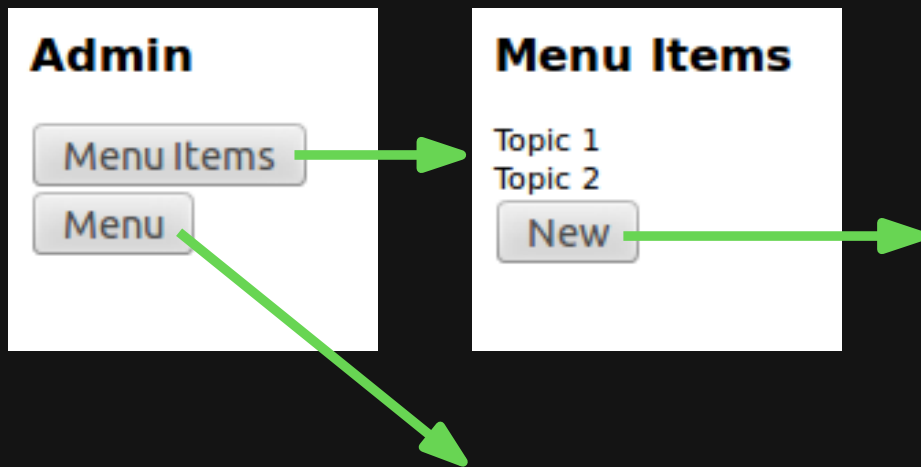
The screenshot shows a Joomla! website with the following elements:

- Page Title:** "My great site"
- Navigation Menu:** "Home", "Topic 1", "Topic 2", "Topic 3". A red arrow points to "Topic 3".
- Main Content Area:**
 - Image:** A blue flower in a field of brown leaves.
 - Section Header:** "Getting Started"
 - Text:** "It's easy to get started creating your website. Knowing some of the basics will help."
 - Section Header:** "What is a Content Management System?"
 - Text:** "A content management system is software that allows you to create and manage webpages easily by separating the creation of your content from the mechanics required to present it on the web."
 - Text:** "In this site, the content is stored in a *database*. The look and feel are created by a *template*. Joomla! brings together the template and your content to create web pages."
- Right Sidebar:**
 - Popular Tags:** "Joomla"
 - Latest Articles:** "Getting Started"
 - Login Form:** Includes fields for "user" and "password", a "Remember Me" checkbox, and a "Log in" button.

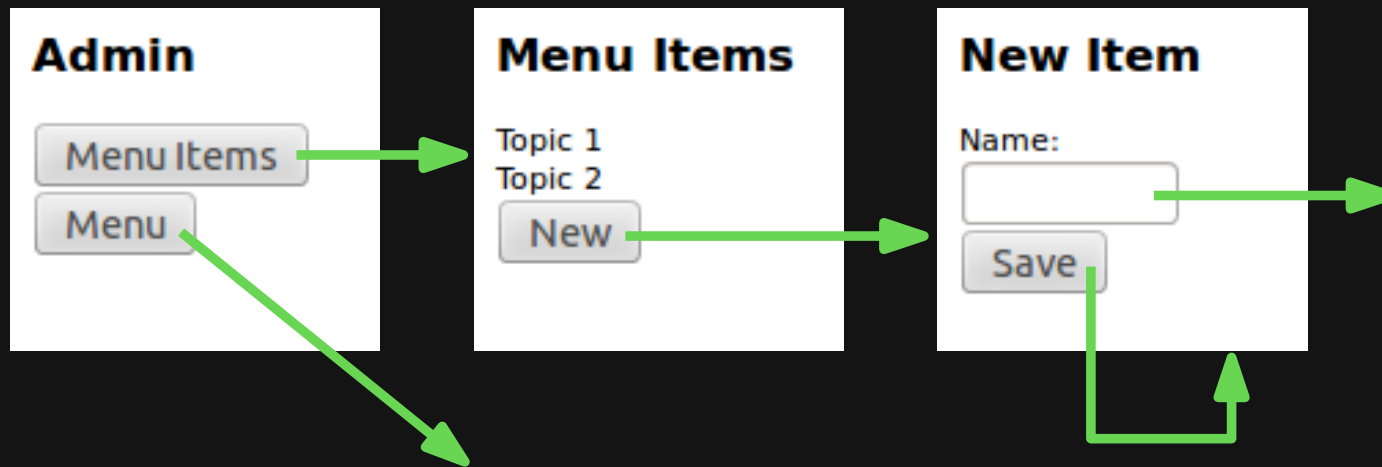
Real-World Example



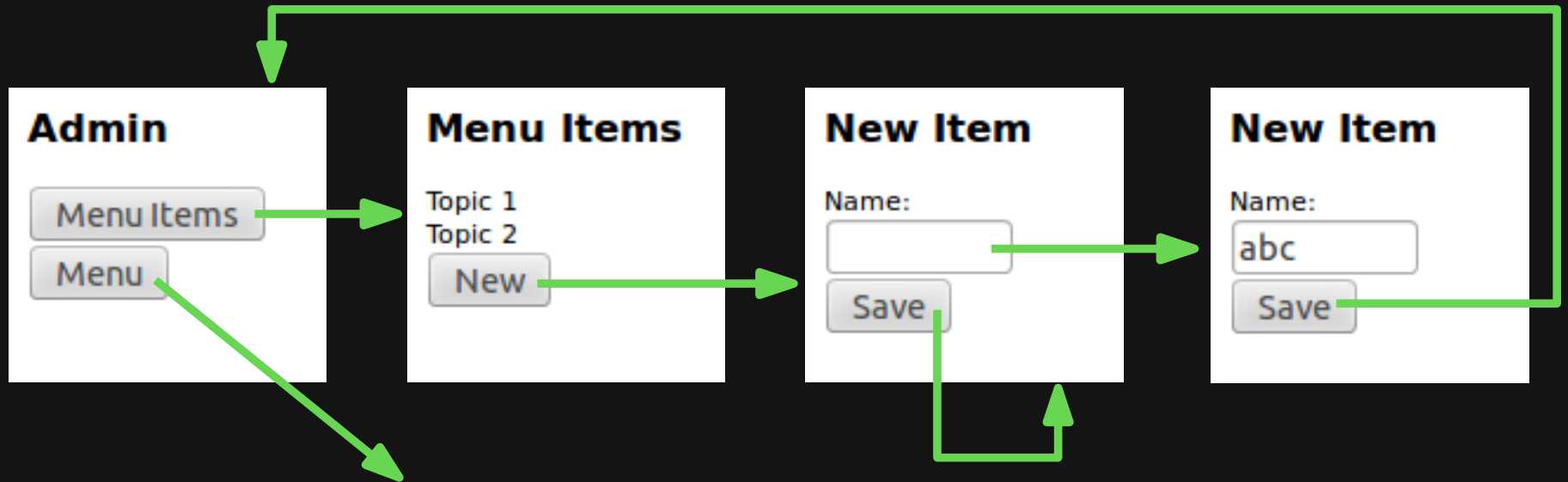
Real-World Example



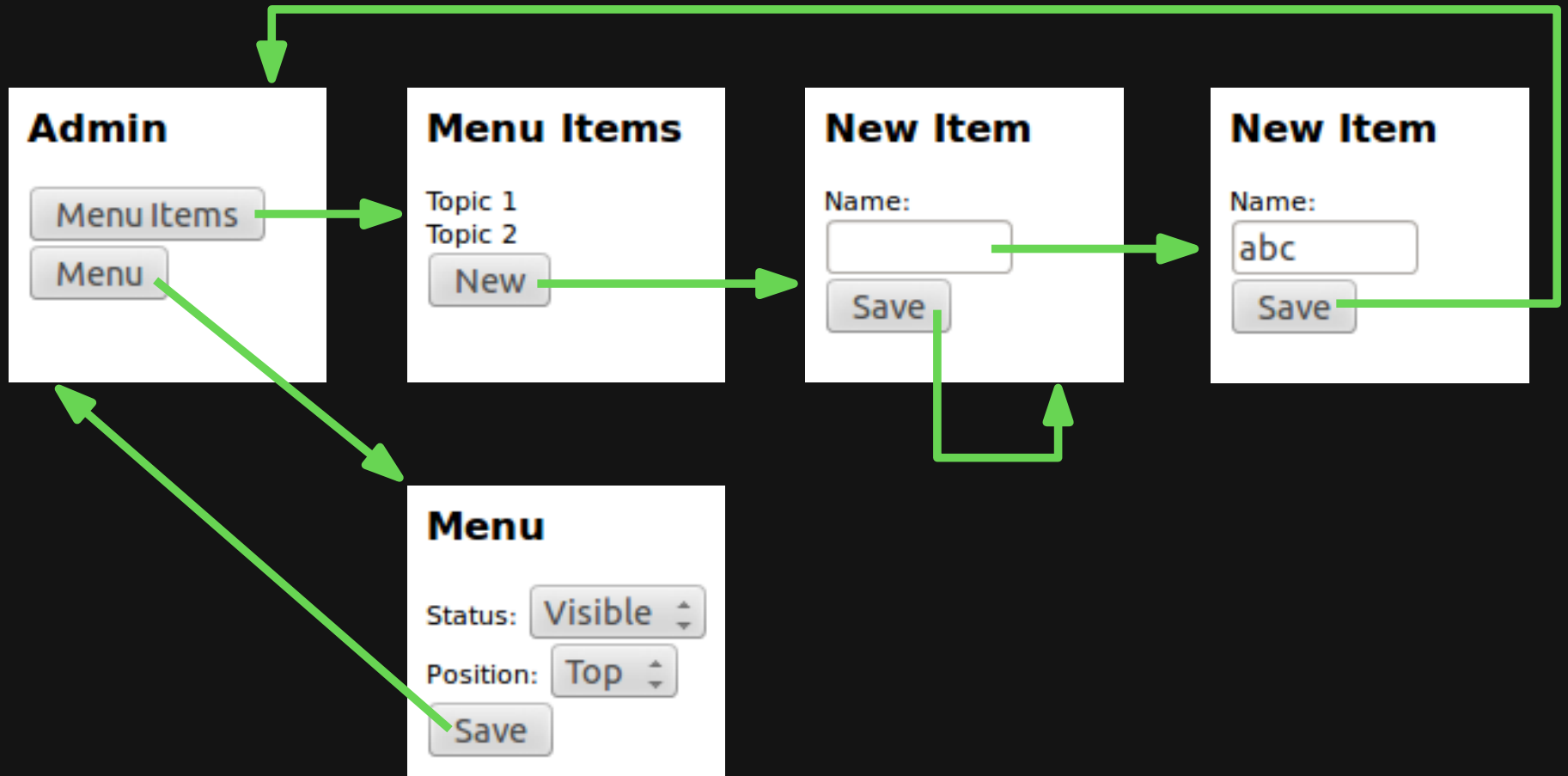
Real-World Example



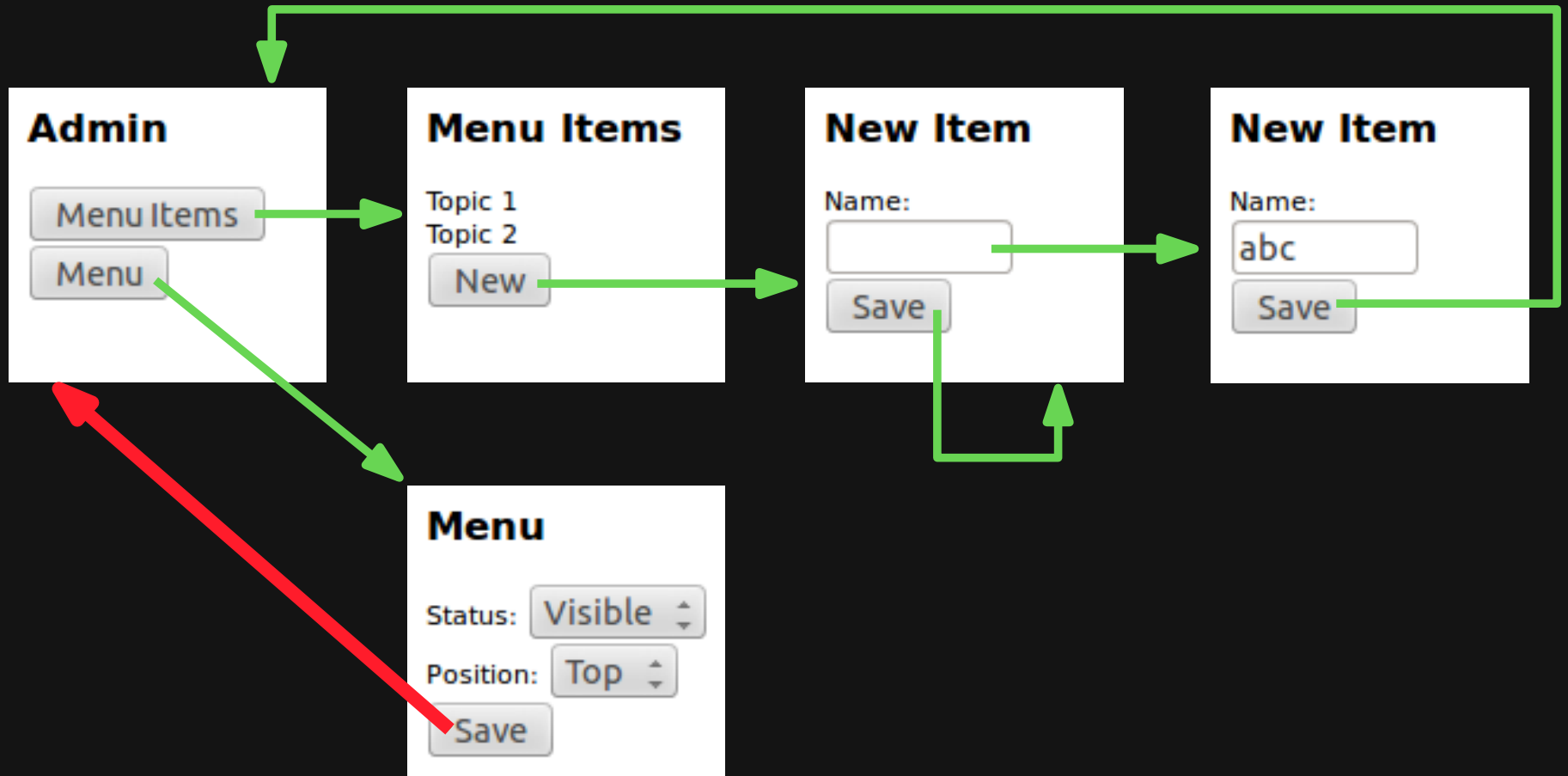
Real-World Example



Real-World Example



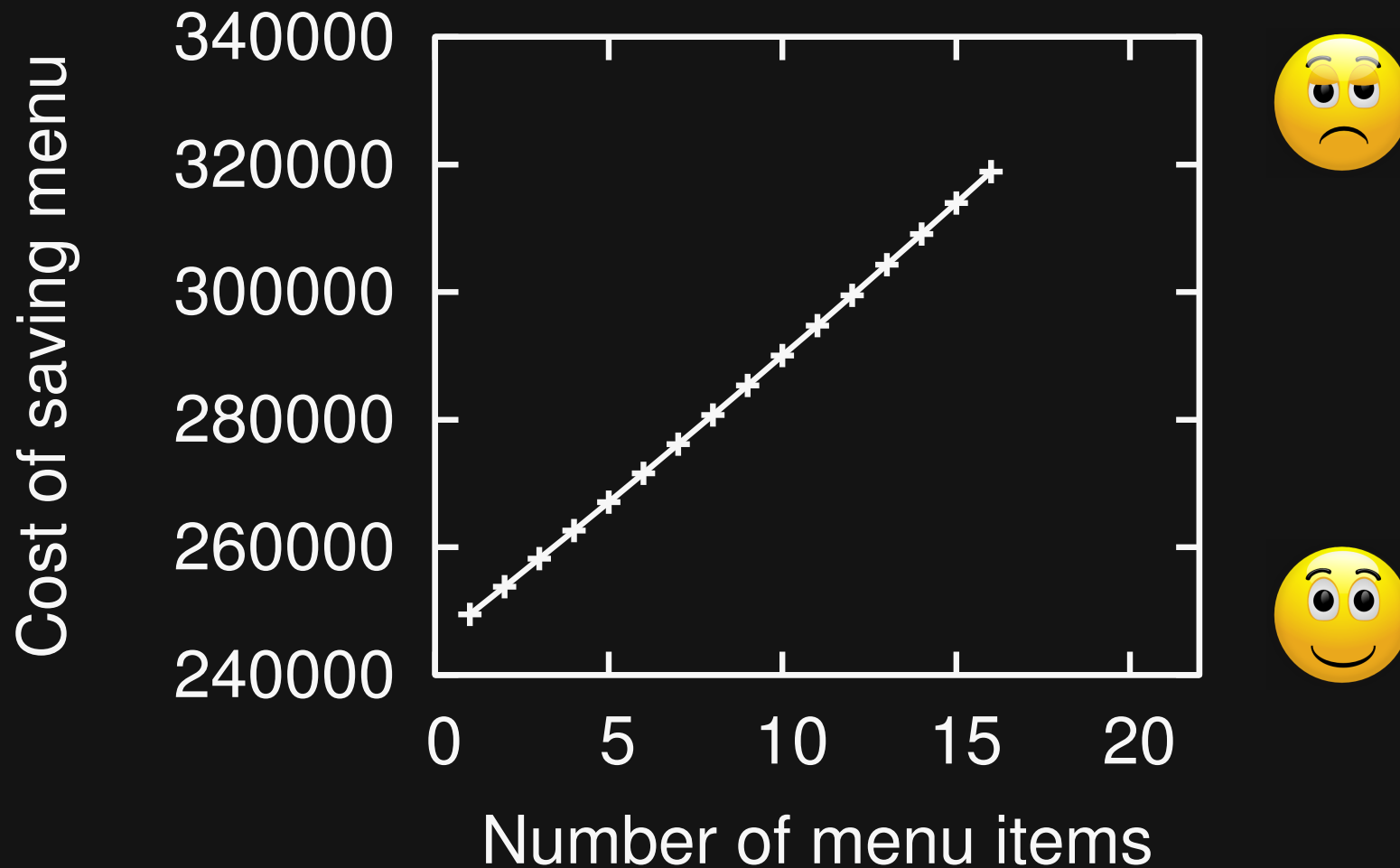
Real-World Example



Unresponsive

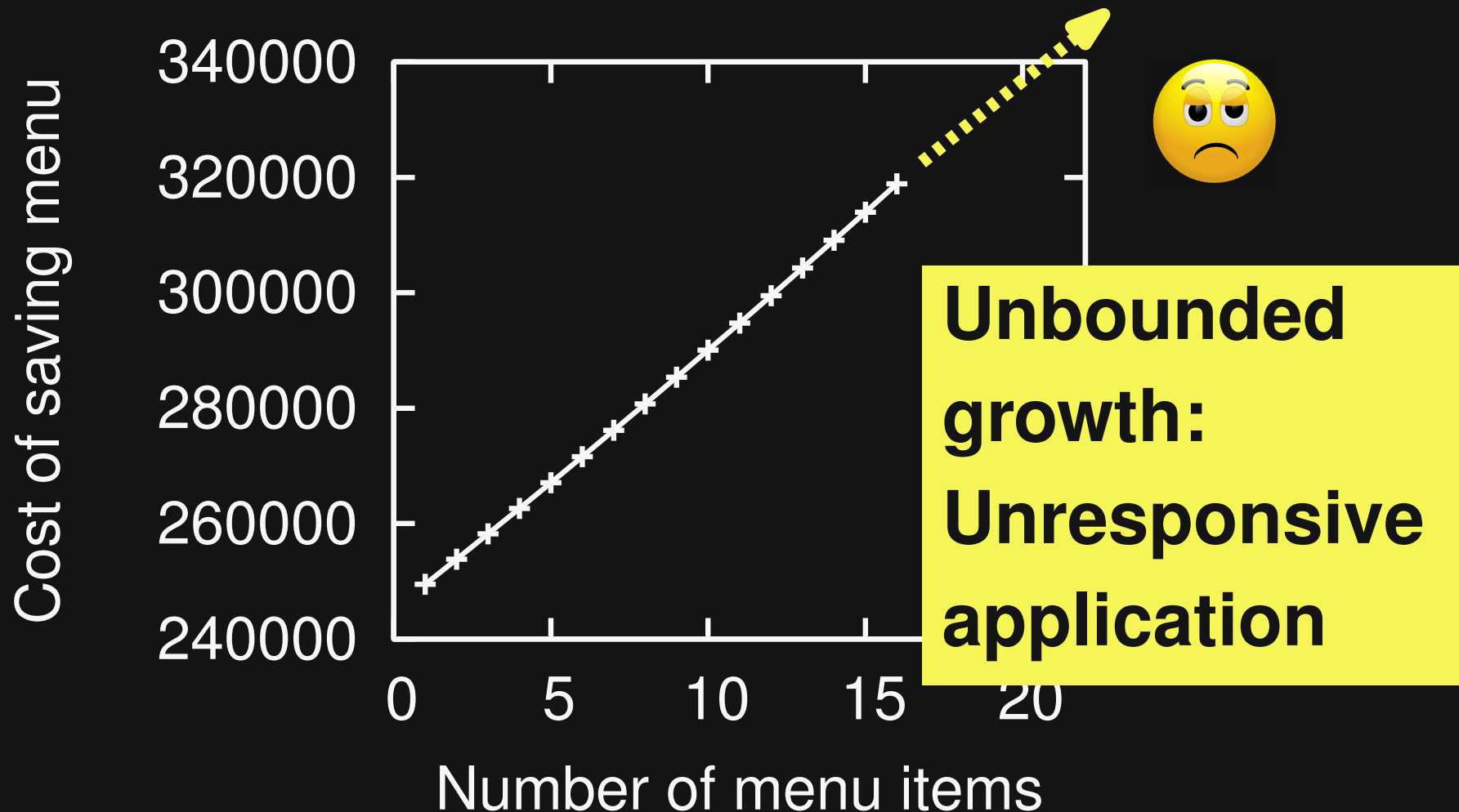
Real-World Example

Cost plot for responsiveness problem



Real-World Example

Cost plot for responsiveness problem



Goal

Analyze **responsiveness** of web applications through **automated testing**

Focus: **Slowdown pairs**

Event E_{cause} increases cost of event E_{effect}

Overview

Dynamic analysis of application

Event-cost history

**Infer potential
slowdown pairs**

**Infer finite state
model of application**

**Targeted test generation:
Verify slowdown pairs**

Slowdown pairs with cost plots

Overview

Dynamic analysis of application

Event-cost history

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**Targeted test generation:
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Slowdown pairs with cost plots

Event-Cost History

Sequence of **event-cost** pairs

- DOM element
- Type of event
- Pre-state
- Post-state

Number of
conditionals evaluated
in event handler

Potential Slowdown Pairs

Does A increase cost of B?

Event	Cost		
B	5]	Supporting evidence S
A	3		
B	10		
B	12]	Refuting evidence R
A	3		
B	12		

$$Supp = |S| = 1 \quad Conf = \frac{|S|}{|S| + |R|} = 33\%$$

Targeted Test Generation

Confirm or reject slowdown pair:

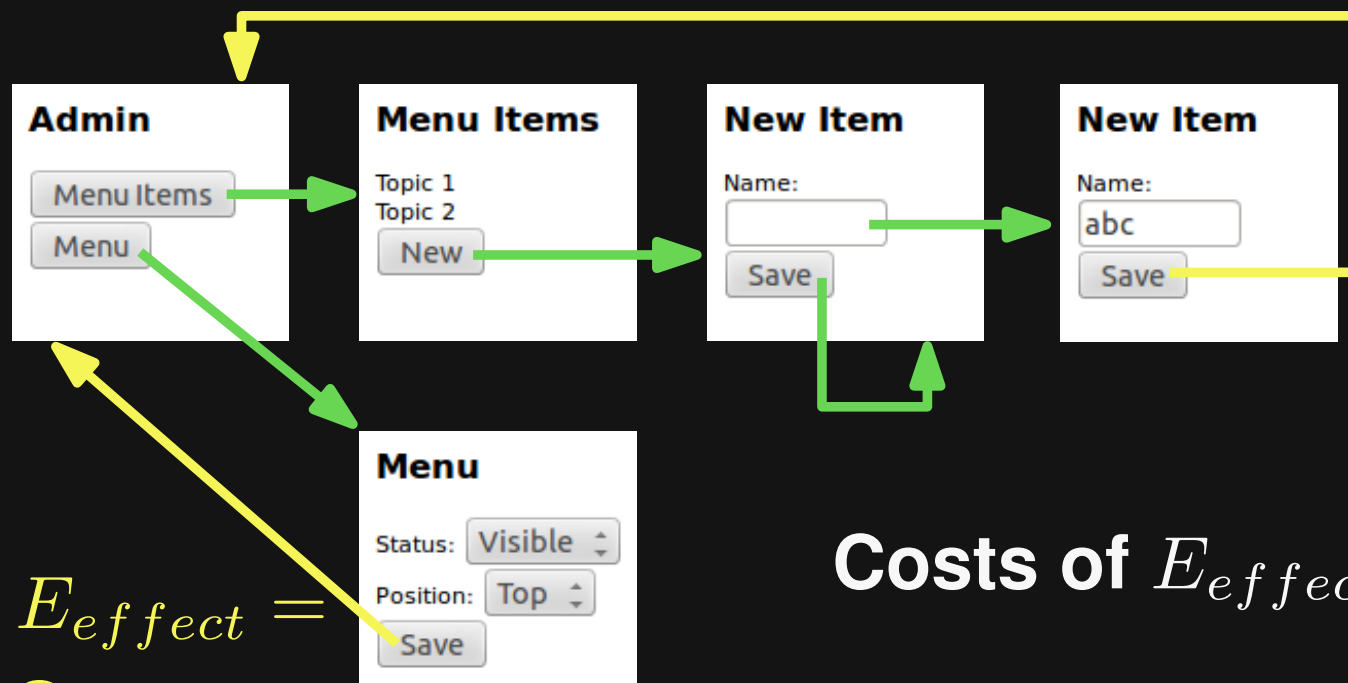
Alternate between E_{effect} and E_{cause}

Targeted Test Generation

Confirm or reject slowdown pair:

Alternate between E_{effect} and E_{cause}

$E_{cause} =$ **Save new item**



$E_{effect} =$
Save menu

Costs of E_{effect} :

current state

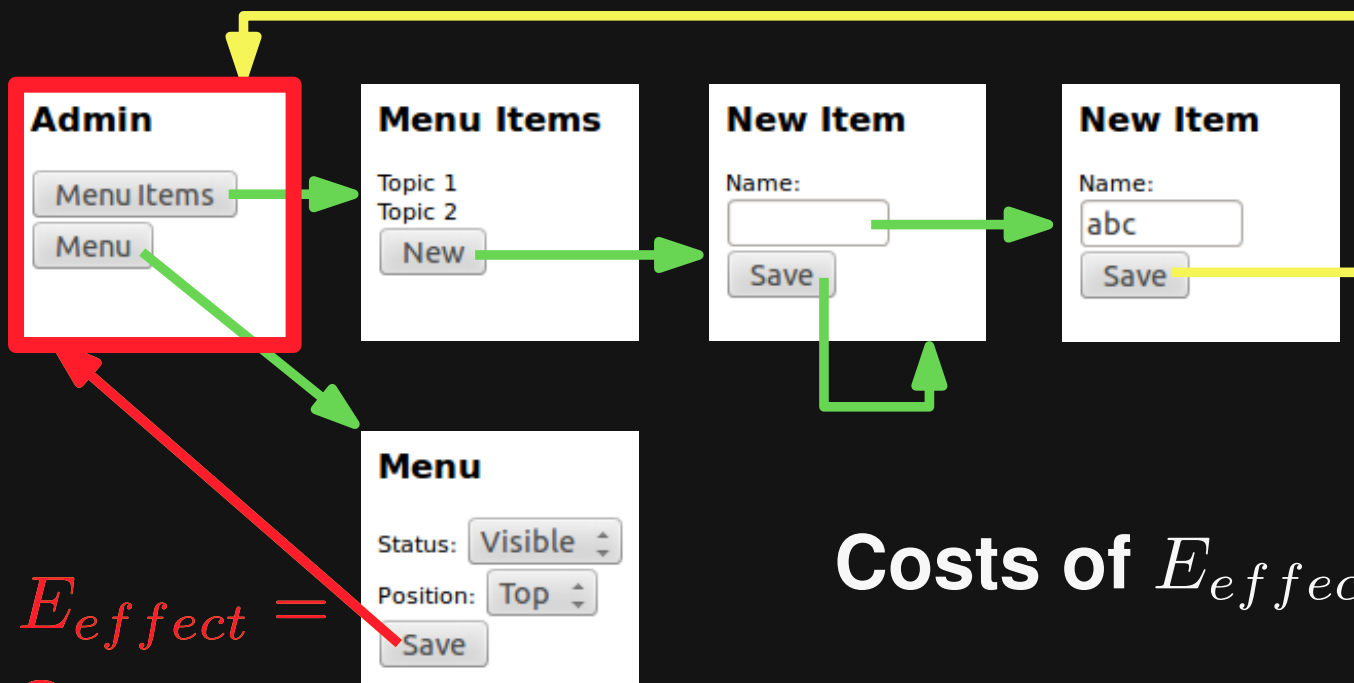
→ target event

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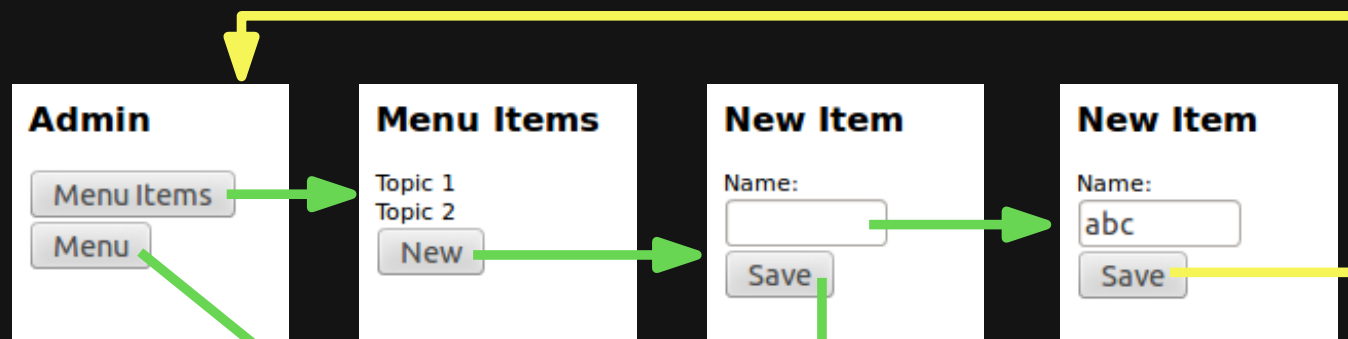
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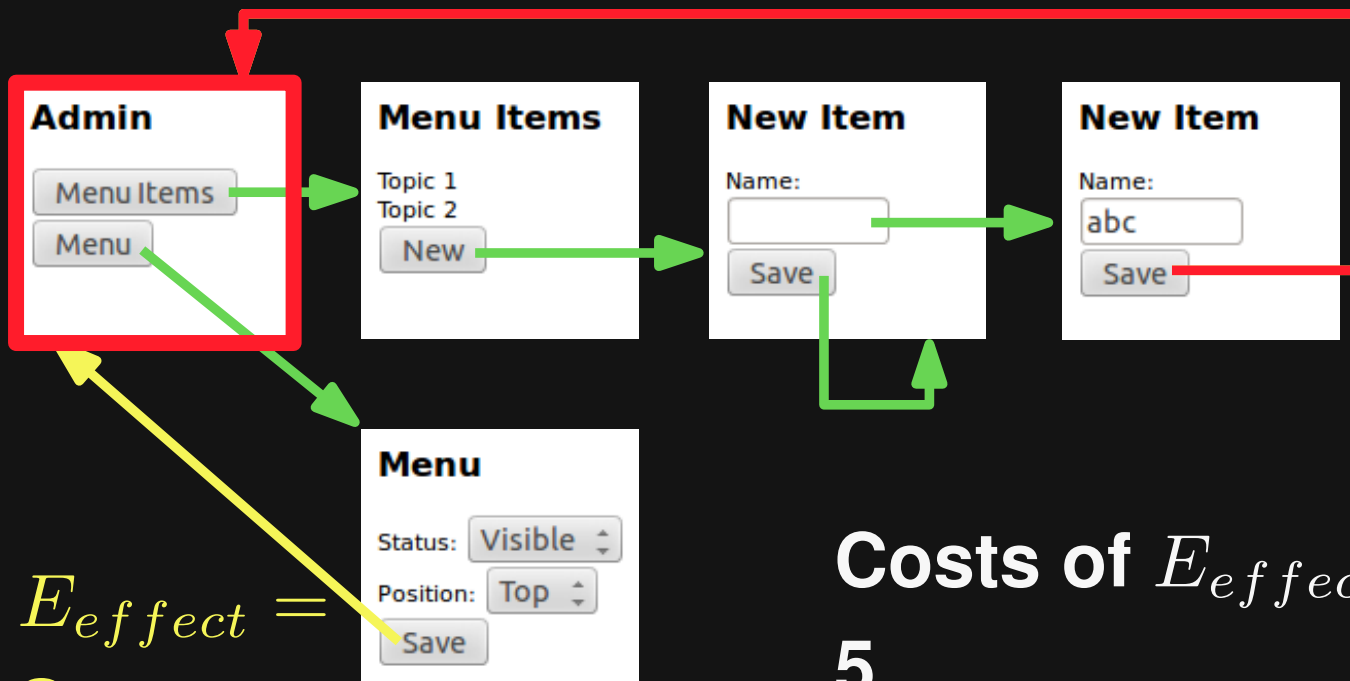
 target event

Targeted Test Generation

Confirm or reject slowdown pair:

Alternate between E_{effect} and E_{cause}

$E_{cause} =$ Save new item



$E_{effect} =$
Save menu

Costs of E_{effect} :
5

 current state

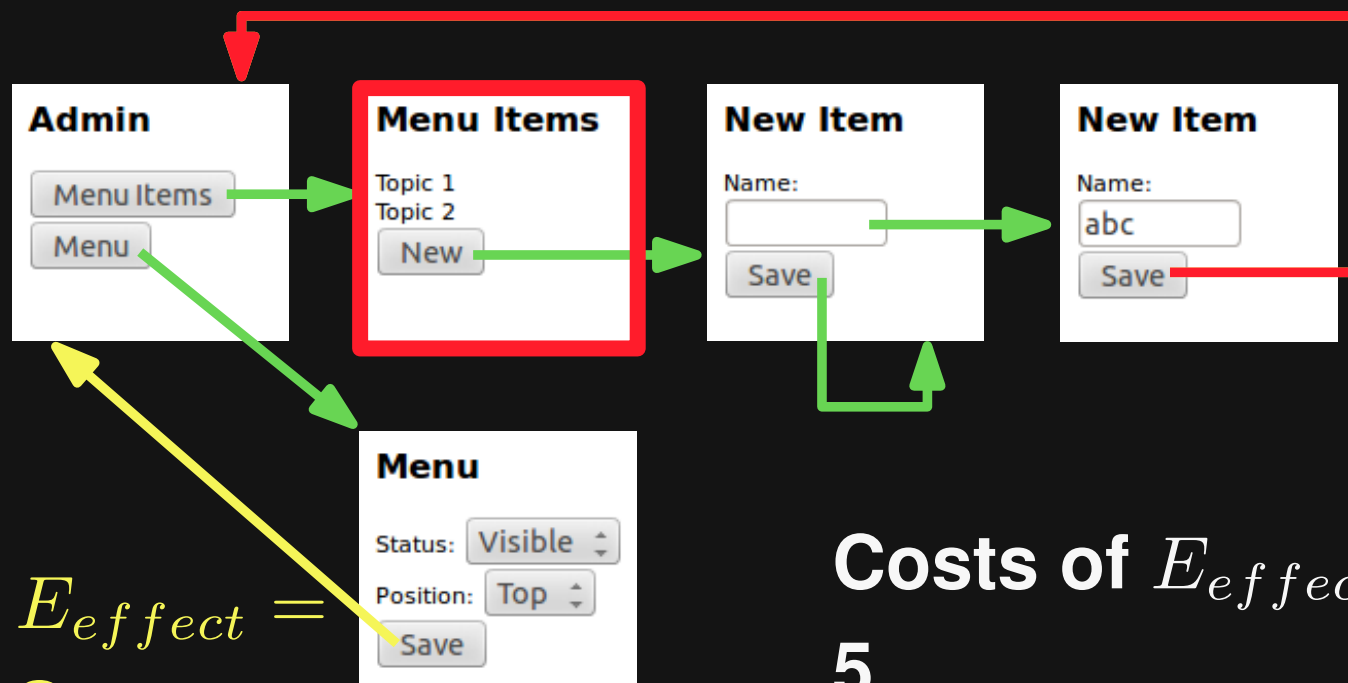
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Costs of E_{effect} :
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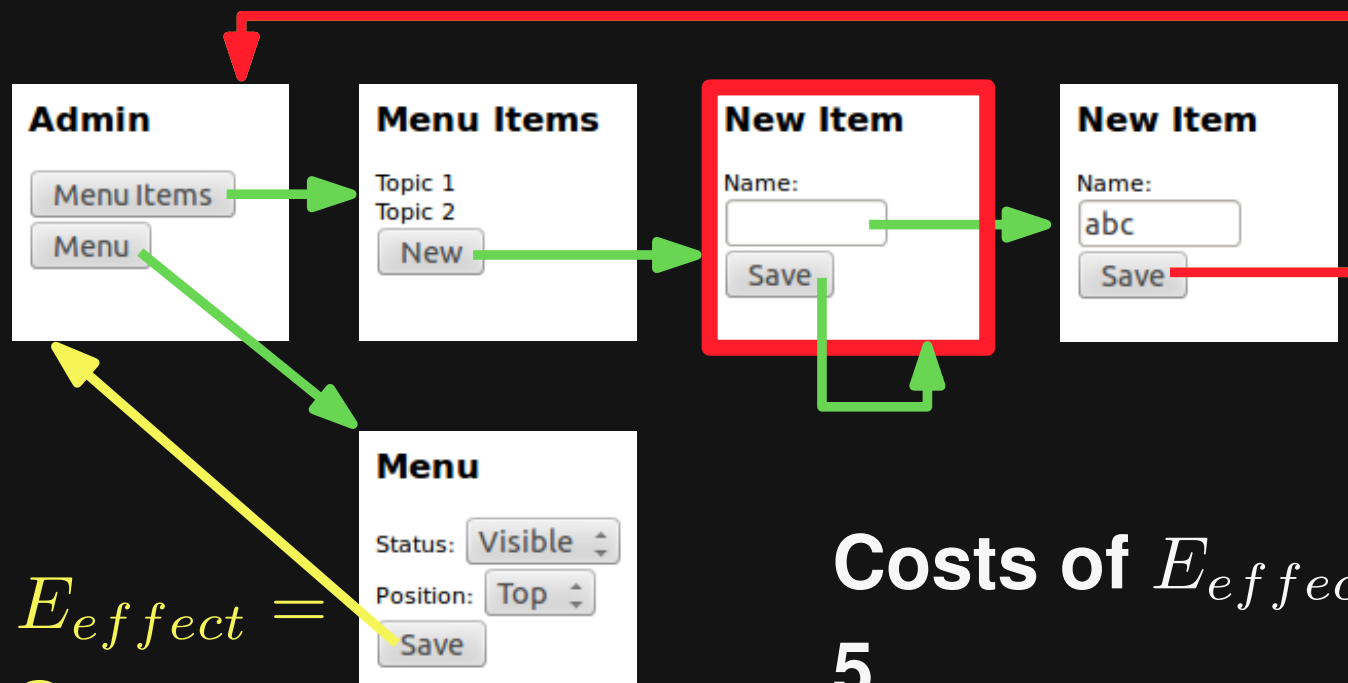
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current state

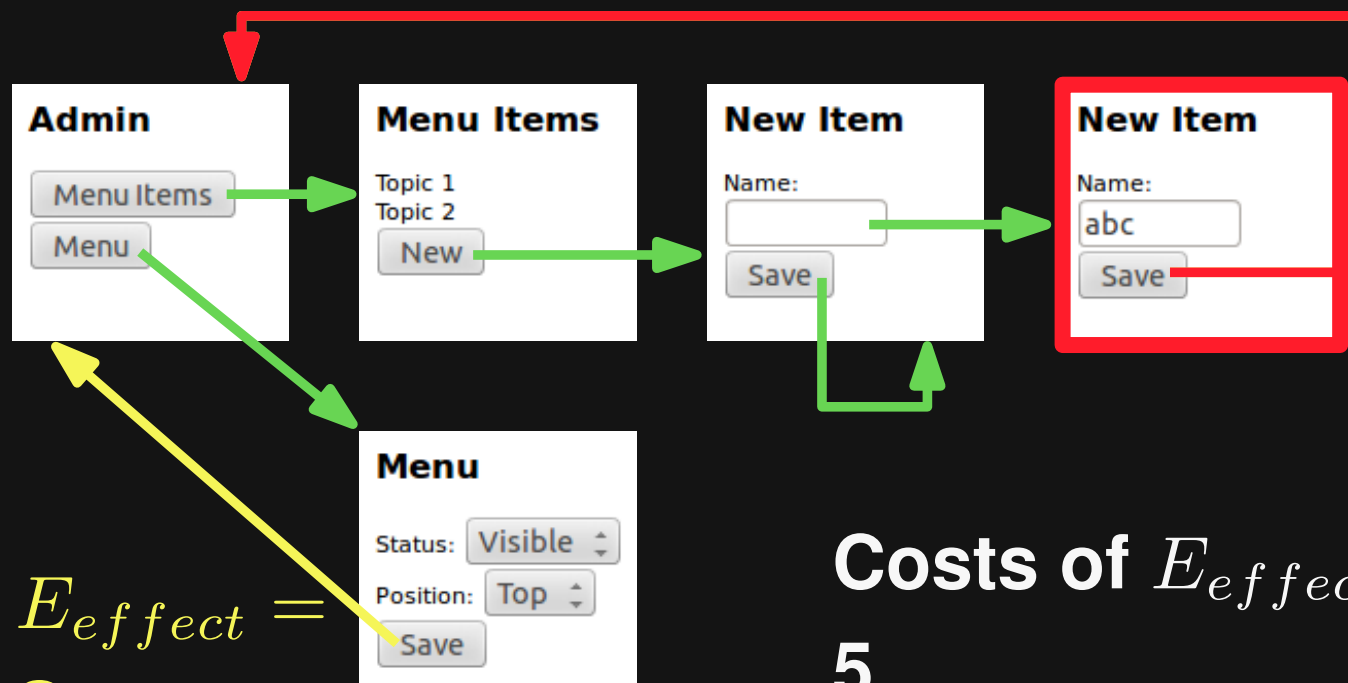
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current state

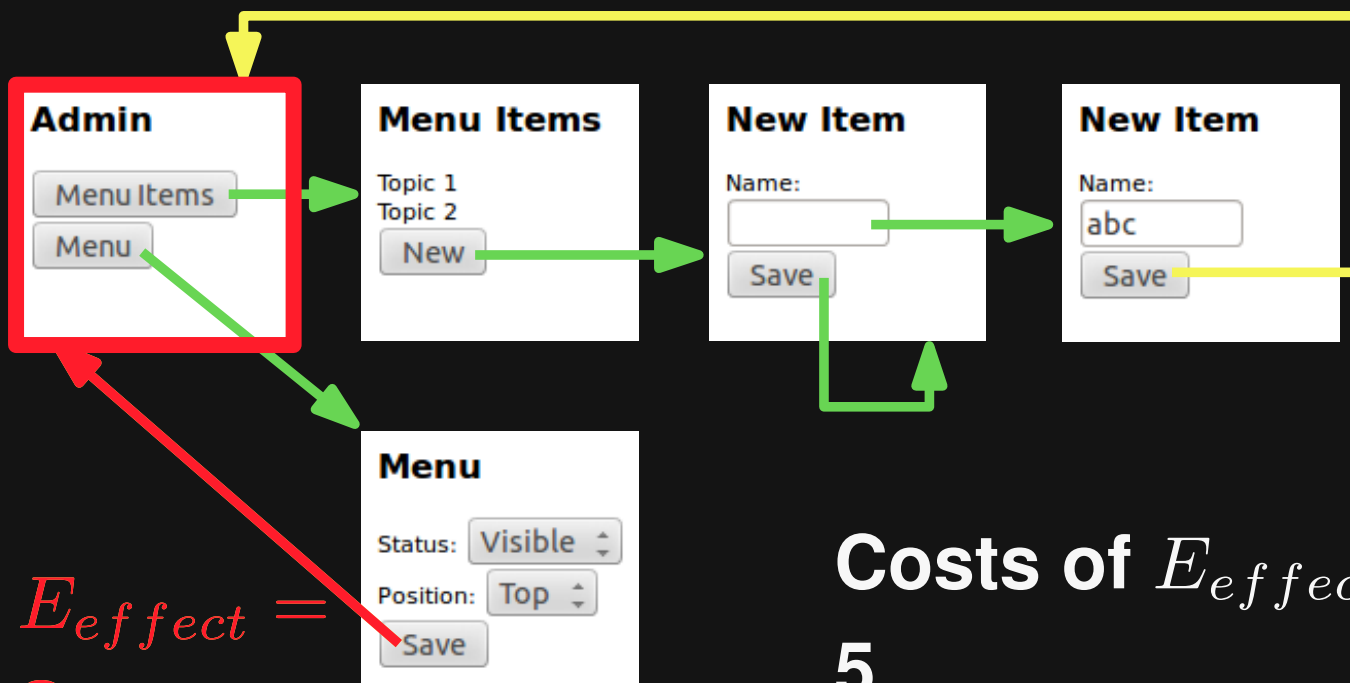
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Costs of E_{effect} :
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 current state

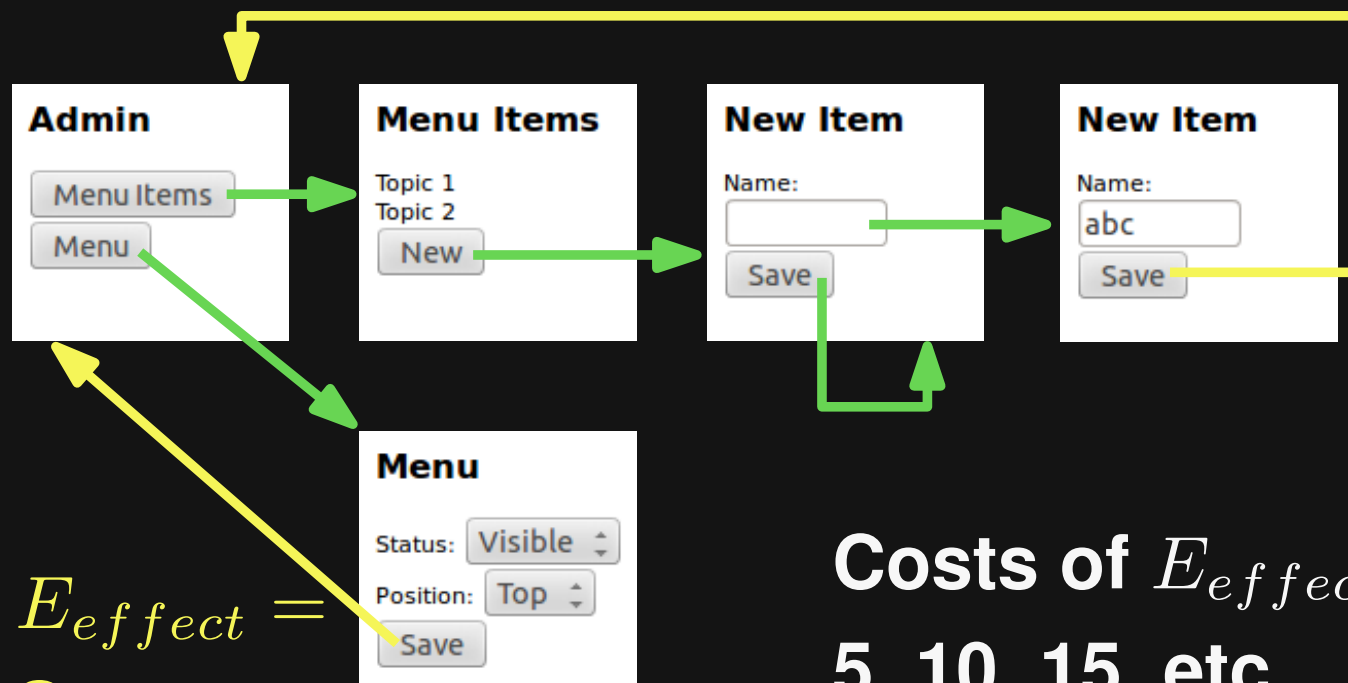
 target event

Targeted Test Generation

Confirm or reject slowdown pair:

Alternate between E_{effect} and E_{cause}

$E_{cause} =$ **Save new item**



Costs of E_{effect} :
5, 10, 15, etc.

current state

→ target event

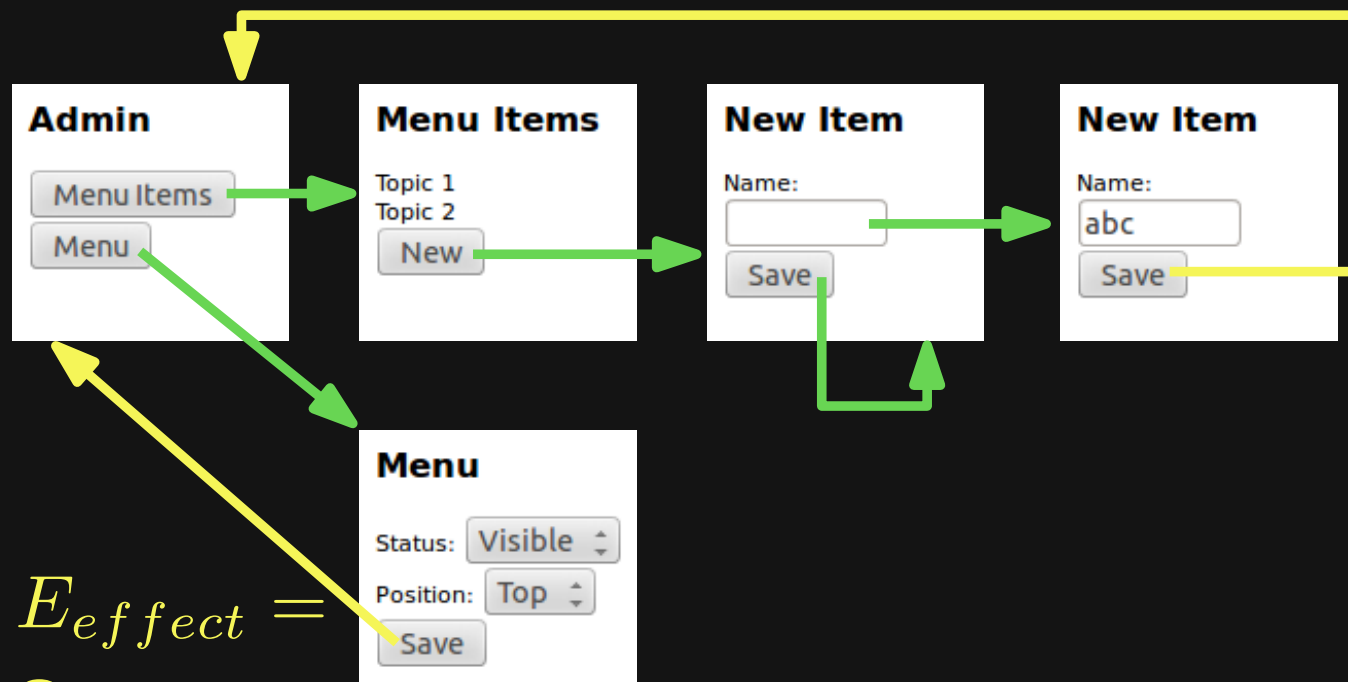
Navigation: Challenge

Shortest event sequence in model may be infeasible in application

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Shortest event sequence in model may be infeasible in application

$E_{cause} =$ Save new item



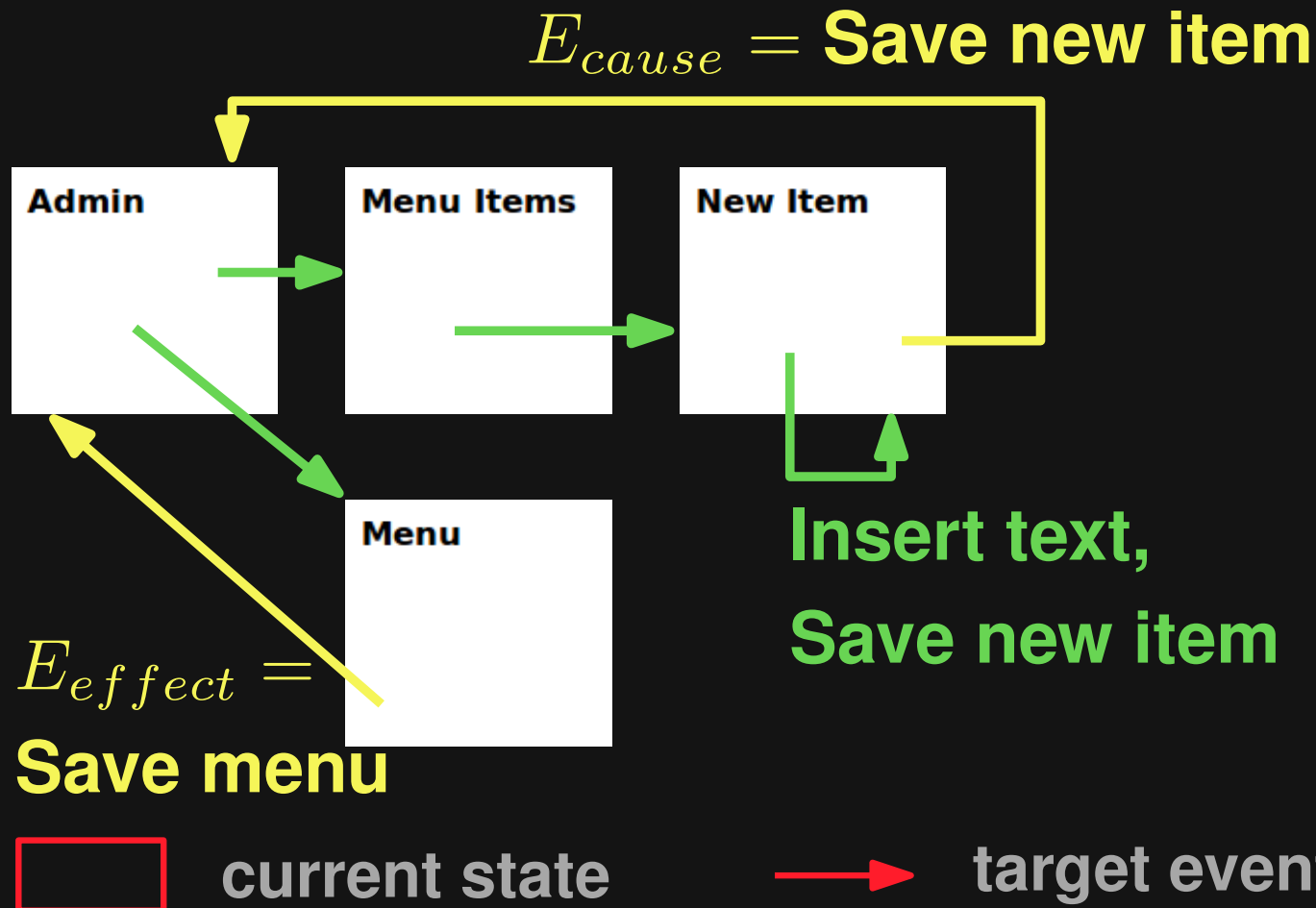
$E_{effect} =$
Save menu

current state

→ target event

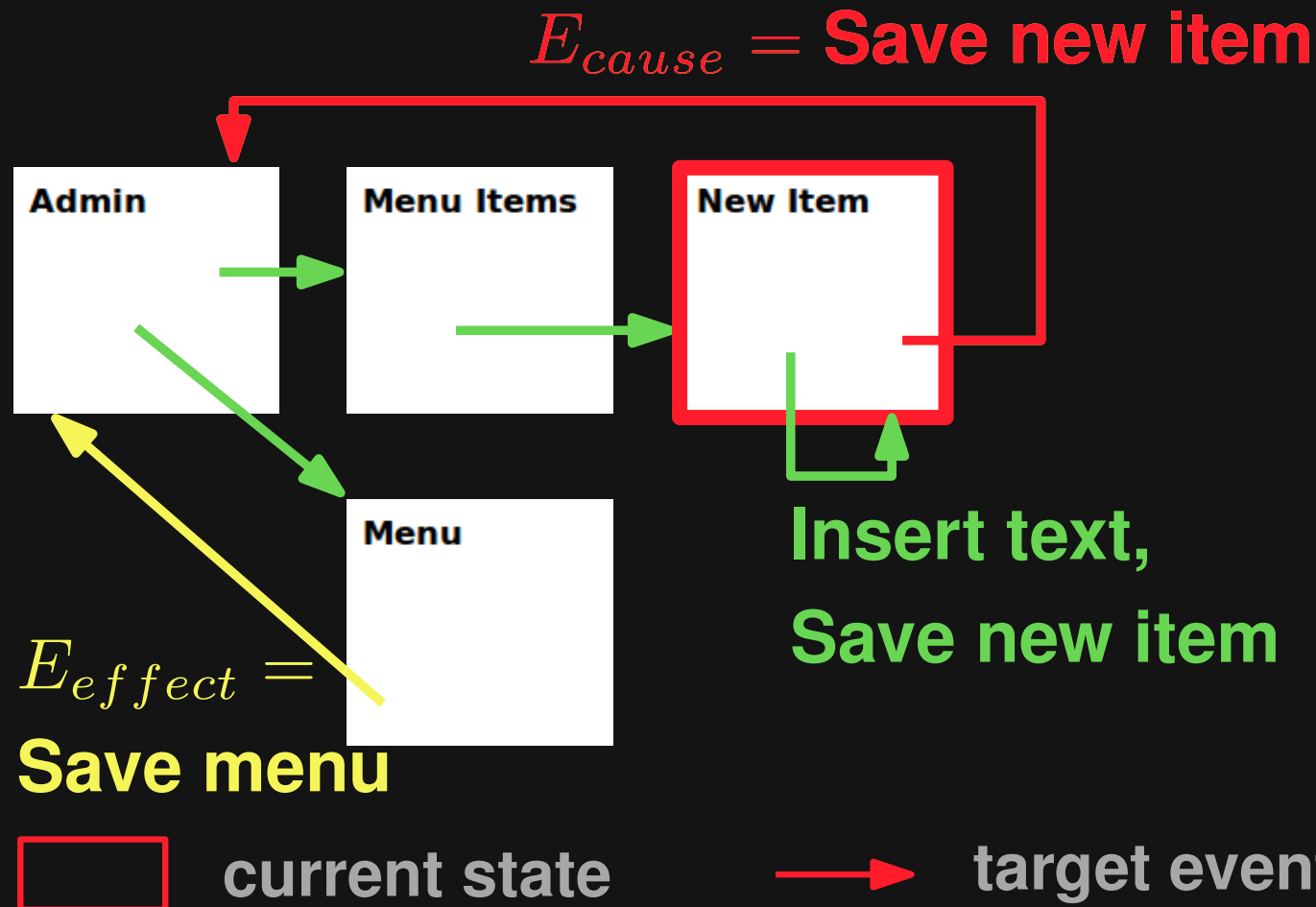
Navigation: Challenge

Shortest event sequence in model may be infeasible in application



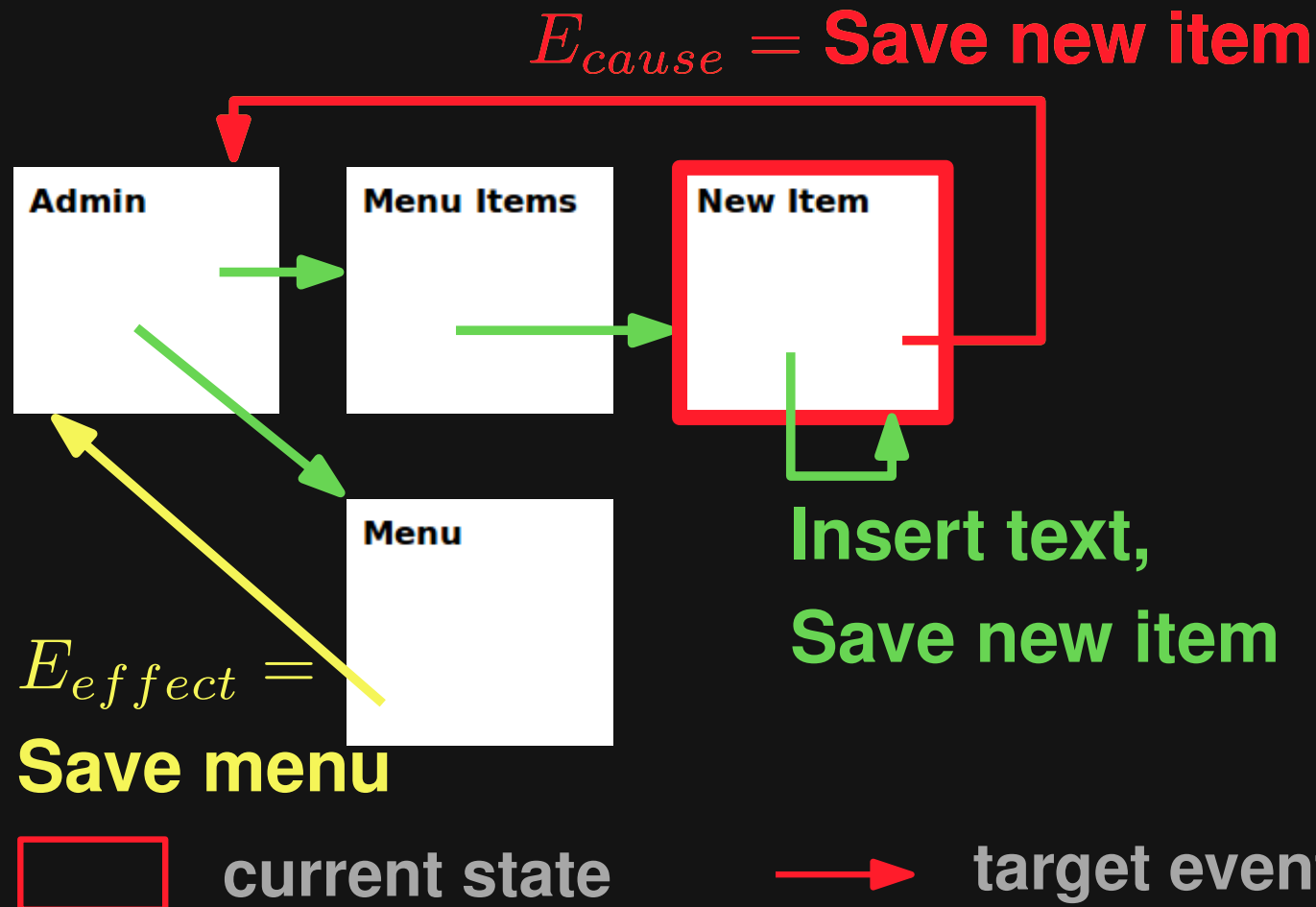
Navigation: Challenge

Shortest event sequence in model may be infeasible in application



Navigation: Approach

- Compute sequences to target event
- Randomly pick from set of first steps



Evaluation

Find responsiveness problems?

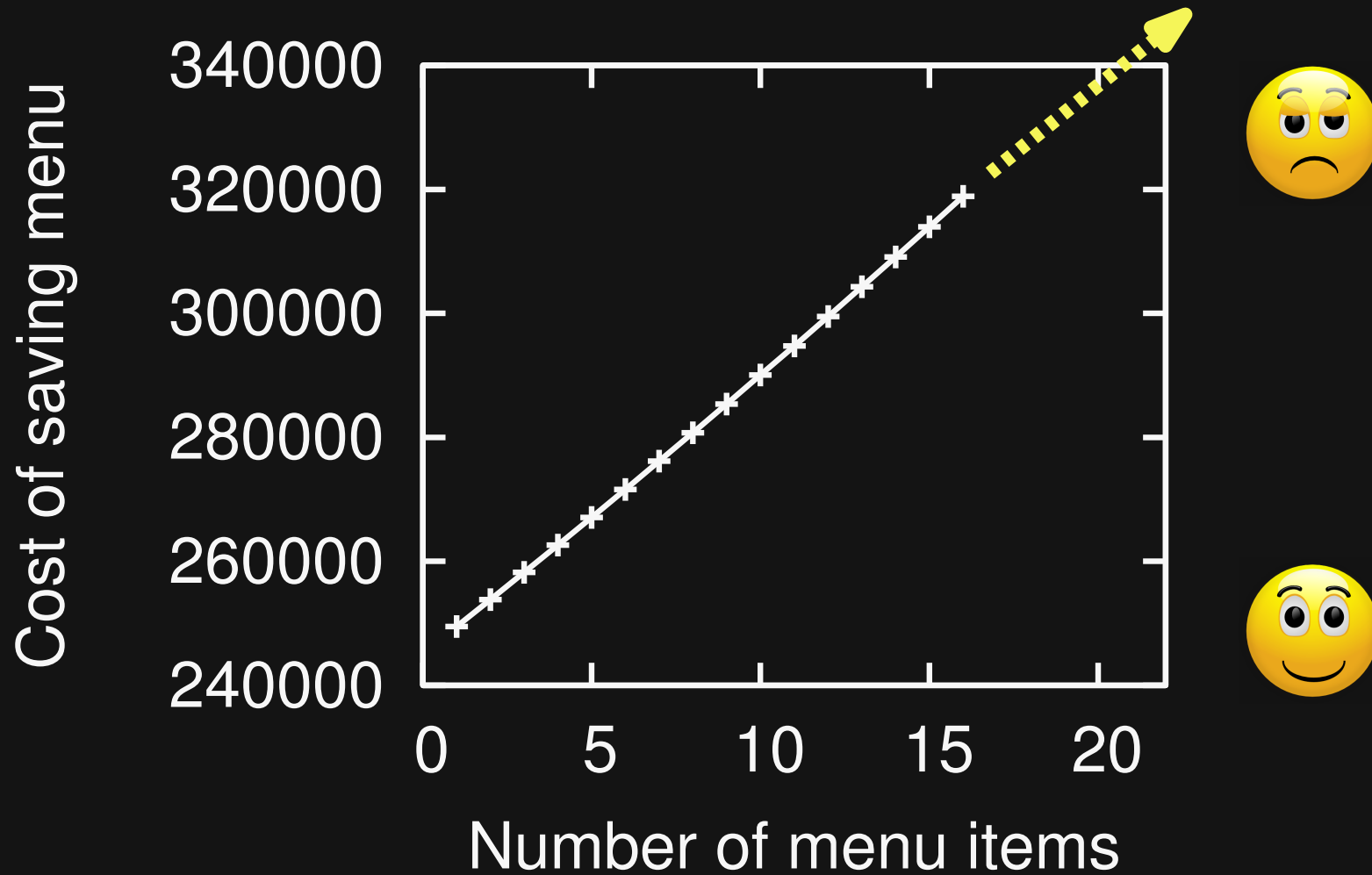
- 2 known + 4 previously unknown

Effectiveness of targeted test generation?

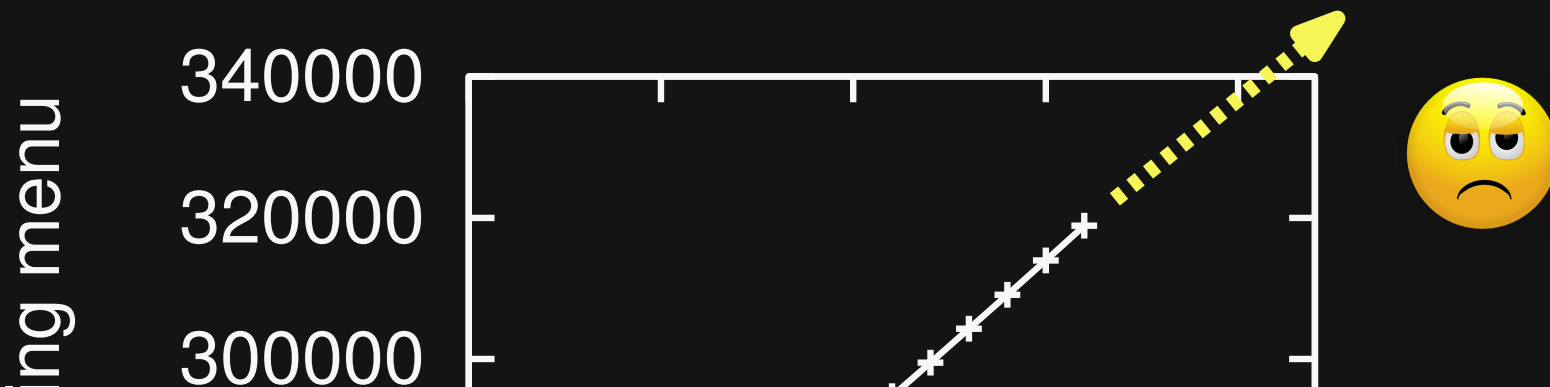
- Reaches 89% of all target events
- Invalidates $> 99\%$ of all potential slowdown pairs



Results: Joomla



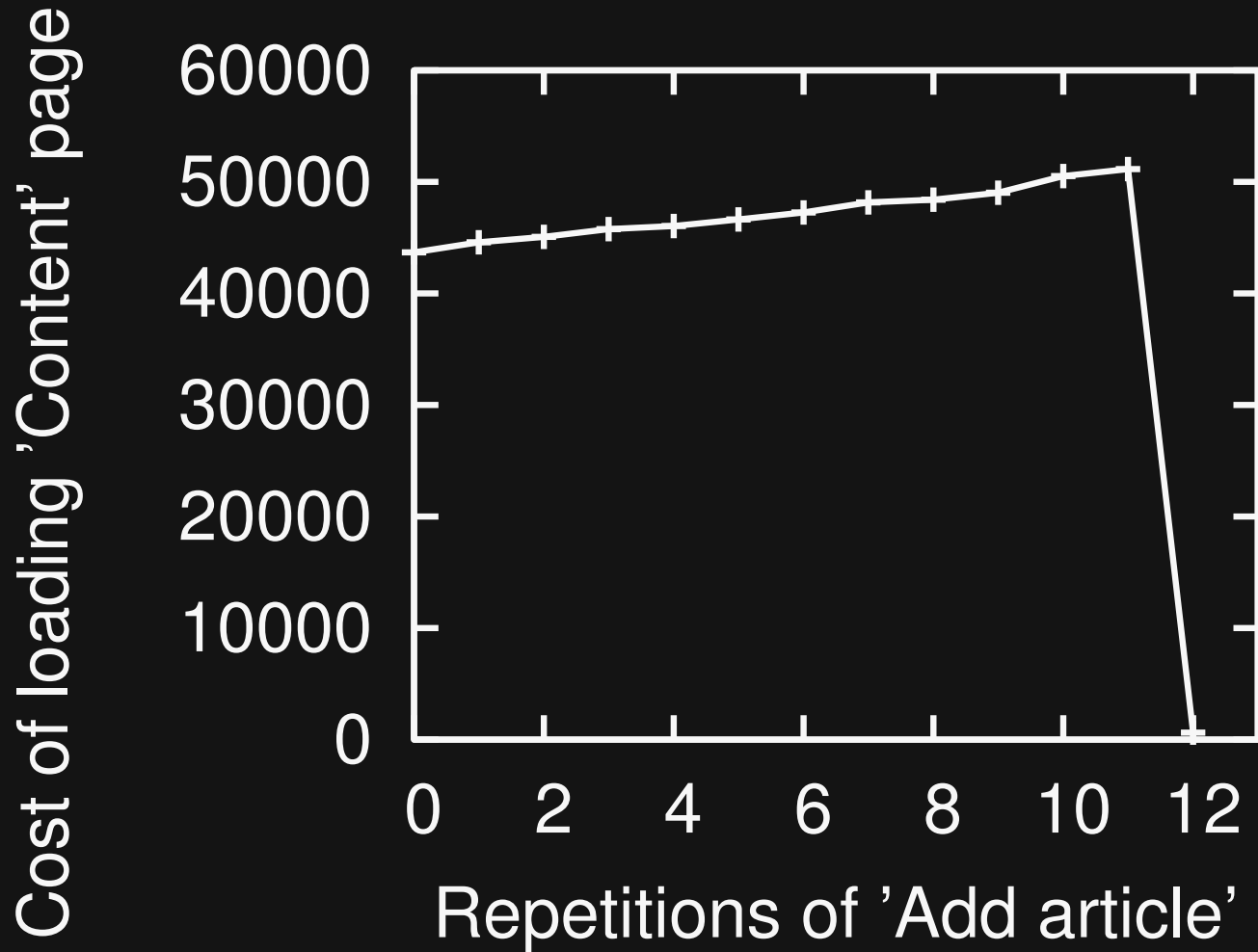
Results: Joomla



Several similar examples:

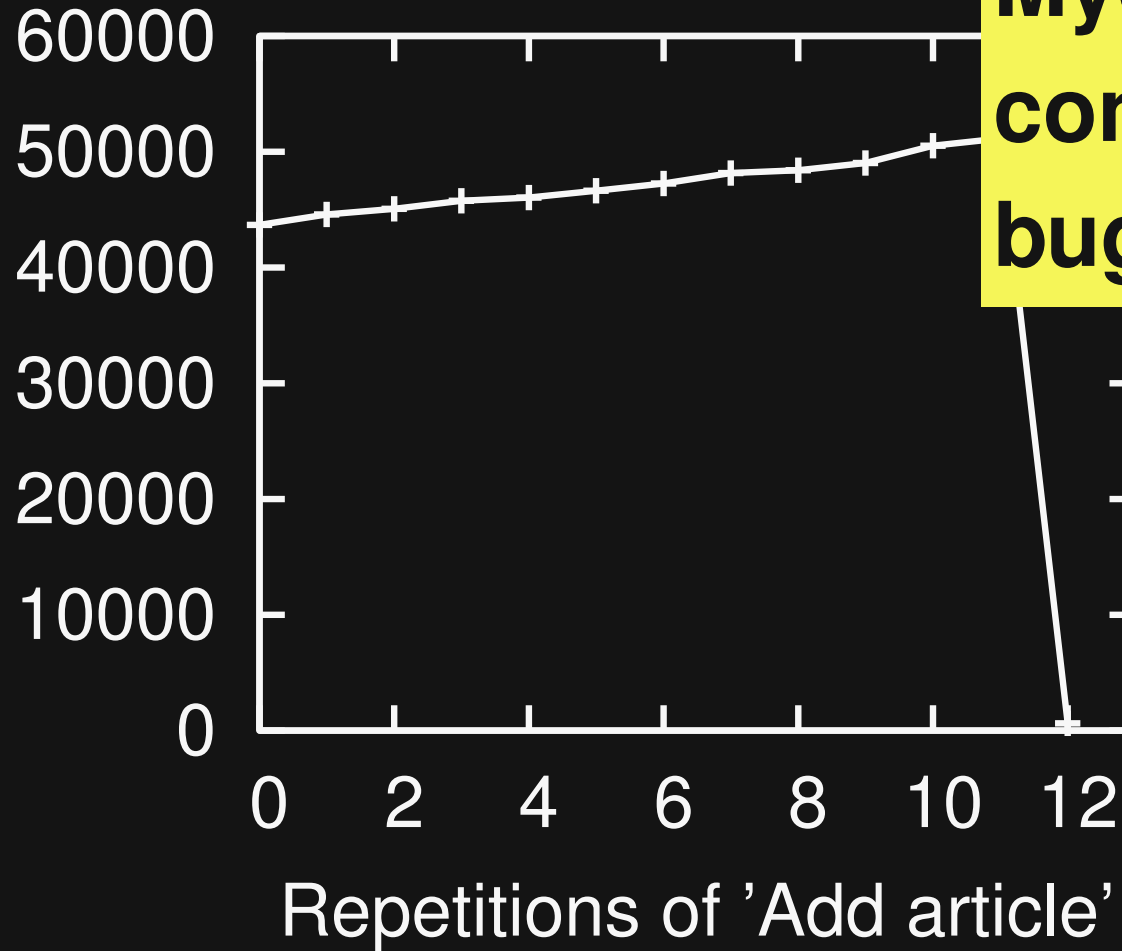
- E_{cause} **accumulates data items**
- E_{effect} **processes all of them and has unbounded cost**

Results: Drupal



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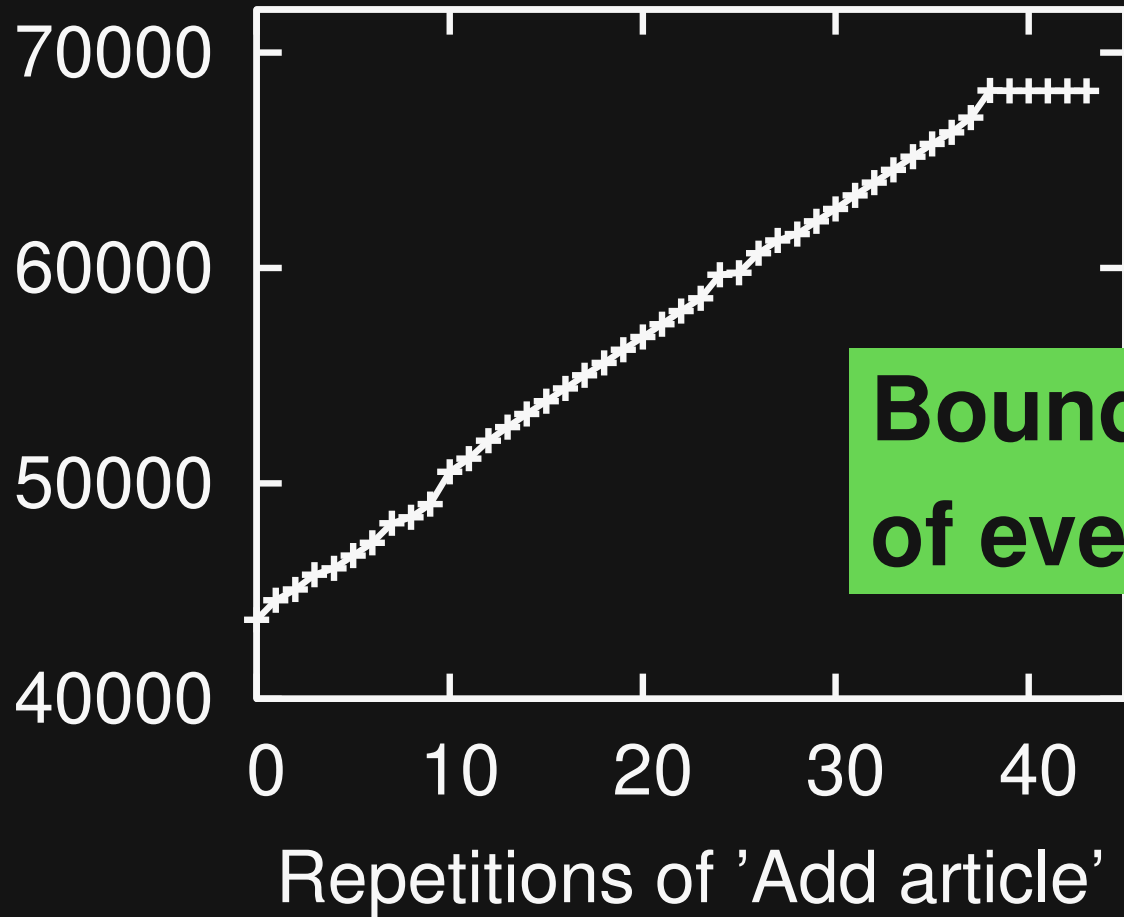
Cost of loading 'Content' page



**MySQL
configuration
bug: Crash**

Results: Drupal (2)

Cost of loading 'Content' page



**Bounded cost
of event handler**

Limitations

- **False negatives**

- Bounded by initial execution
- Focus on pairs of events

But: No false positives

- **Explores event space, ignores input space**

Conclusion

Automated analysis of web application responsiveness

- Slowdown pairs
- Targeted test generation for event-driven applications

EventBreak:

Analyzing the Responsiveness of Web Applications

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George Necula, Koushik Sen**

~~**University of California, Berkeley**~~

**I'm looking for students to join
my group at TU Darmstadt!**