# *Design* with Search

Krishna Dusad & Jinda Han

*CS598RK, Spring 2017*

# A Search Engine for 3D Models

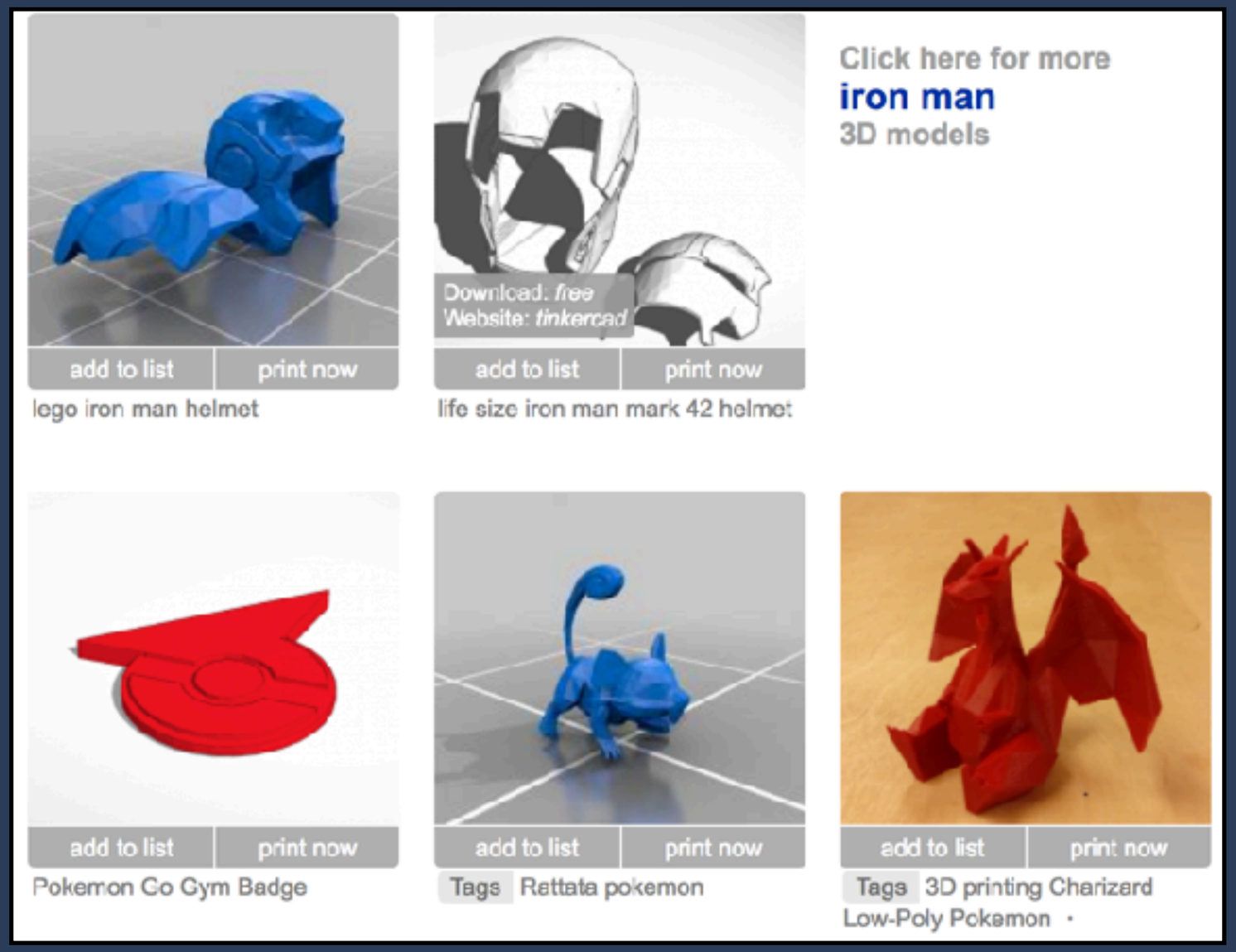
Thomas Funkhouser et al.,
Princeton University

# Inspiration

*'… In the near future, the key question will shift from "How do we construct them?" to "**How do we find them?**" '*

# Why would people search 3D models and how would they use it?

# 3D Printing?




http://www.yeggi.com/

# Objects in a VR environment?

Virtual Reality for Personal Interior Design

*Feng et al.,*

# But ...

# How will people search 3D models?

# *Using text?*

*Badly labeled data*
*Keywords too broad*
*Keywords* ***unknown*** *to the user*

# *Using shapes?*

*How do you compare them?*
*How do you build interfaces for the untrained to be able to search effectively?*
*Will it even be useful?*

# Challenges

1. *Come up with shape descriptors for which indices can be built and similarity queries can be answered efficiently*

2. *Develop a user interface with which untrained users can specify shape-based queries*

1. *Come up with shape descriptors for which indices can be built and similarity queries can be answered efficiently.*

   - *Boundary parameterization can't be extended to 3D.*
   - *High dimensionality of 3D data is expensive.*
   - *Previous methods depended on orientation.*

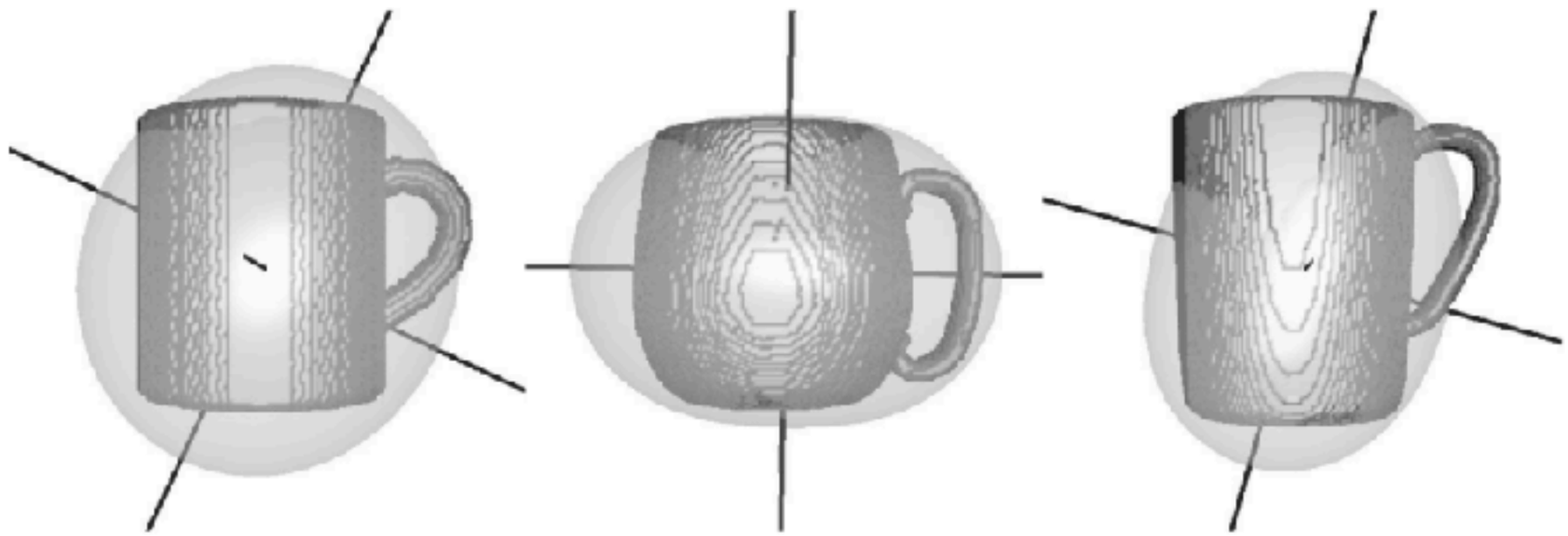


Fig. 3. A collection of mugs drawn with their principal axes. Despite the similarity in the models, the principal axes orient the models in very different ways.

*“ … quick to compute, concise to store, easy to index,* ***invariant under transformations****, insensitive to noise,* ***independent of object representation****, robust to topological degeneracies, and discriminating of shape”*

2. *Develop a user interface with which untrained users can specify shape-based queries*

- *What tool could people use to create shapes*
- *Accommodate both advanced and novice users.*
- *Should be easy to learn for first-time visitors*

*“Our goal is to allow novice users to specify 3D shapes quickly. The interface should be easy to learn for first-time visitors to a Web site. ”*

# Solutions

1.

→ *Use spherical harmonics to compute discriminating similarity measures without requiring repair of model degeneracies or alignment of orientations.*

*"The main idea is to decompose a 3D model into functions on* ***concentric spheres*** *and use spherical harmonics to* ***discard orientation information*** *(phase) for each one yielding a shape descriptor that is both* ***orientation invariant and descriptive.****"*

# 3D

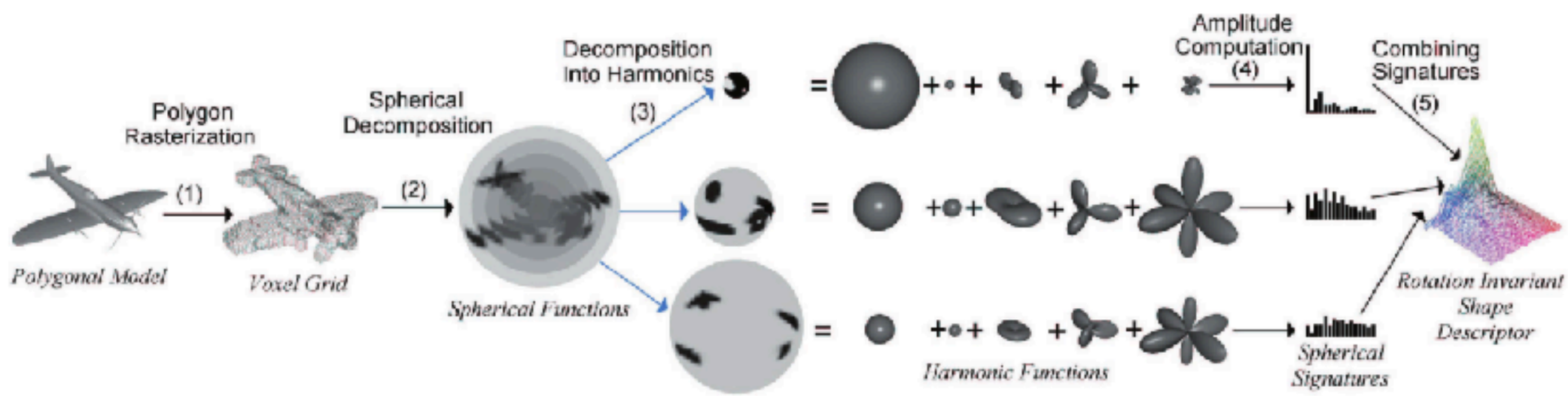



Fig. 4. Computing our spherical harmonics shape descriptor.

# 2D sketches

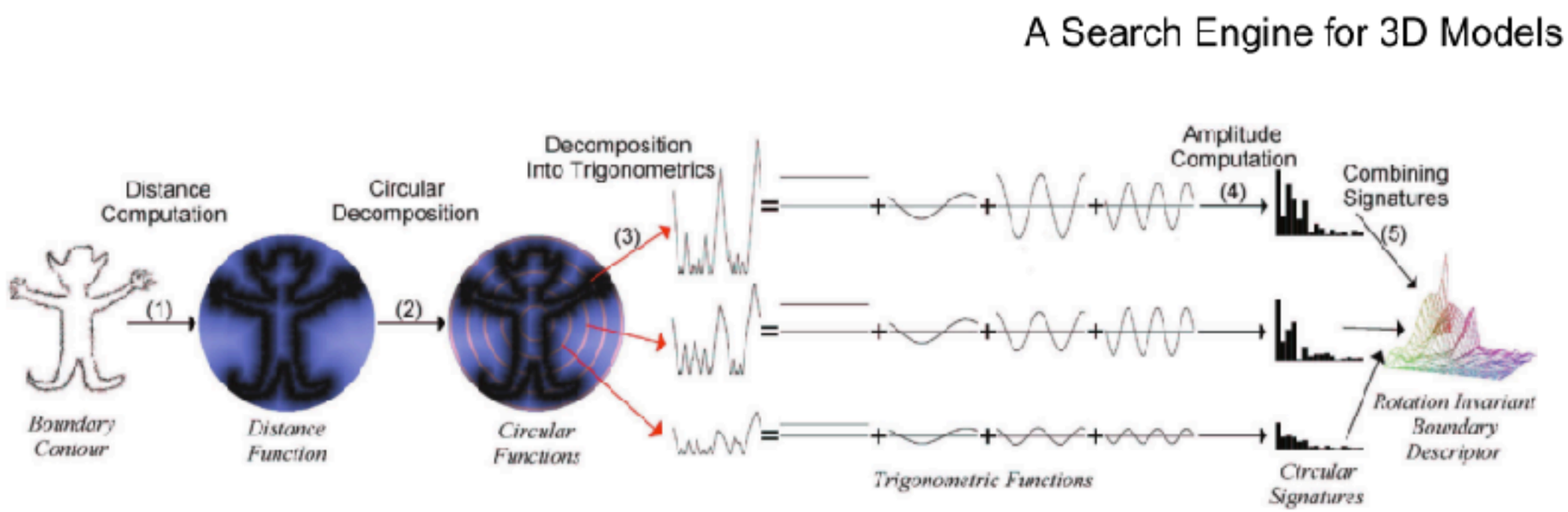
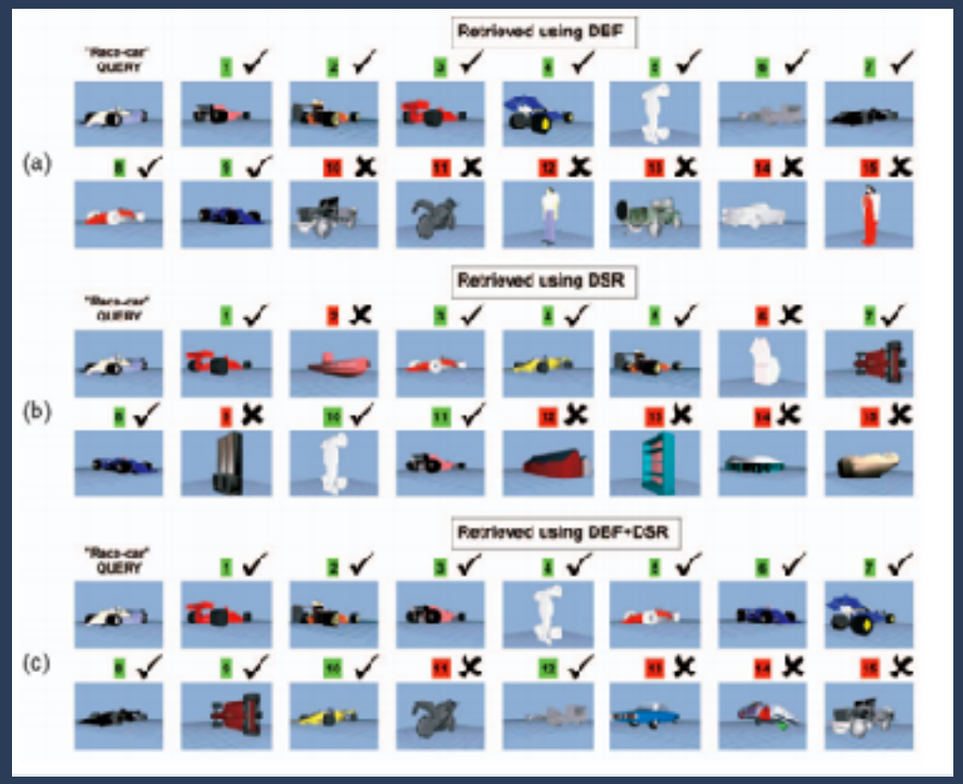



Fig. 9. Computing our shape descriptor for boundary contours.

# What other techniques could be used?




# 3D Model Retrieval Using Probability Density-Based Shape Descriptors

*Ceyhun Burak Akgu¨l et al,*

# SVM-based Semantic Clustering and Retrieval of A 3D Model Database

*Suyu Hou, Kuiyang Lou and Karthik Ramani*

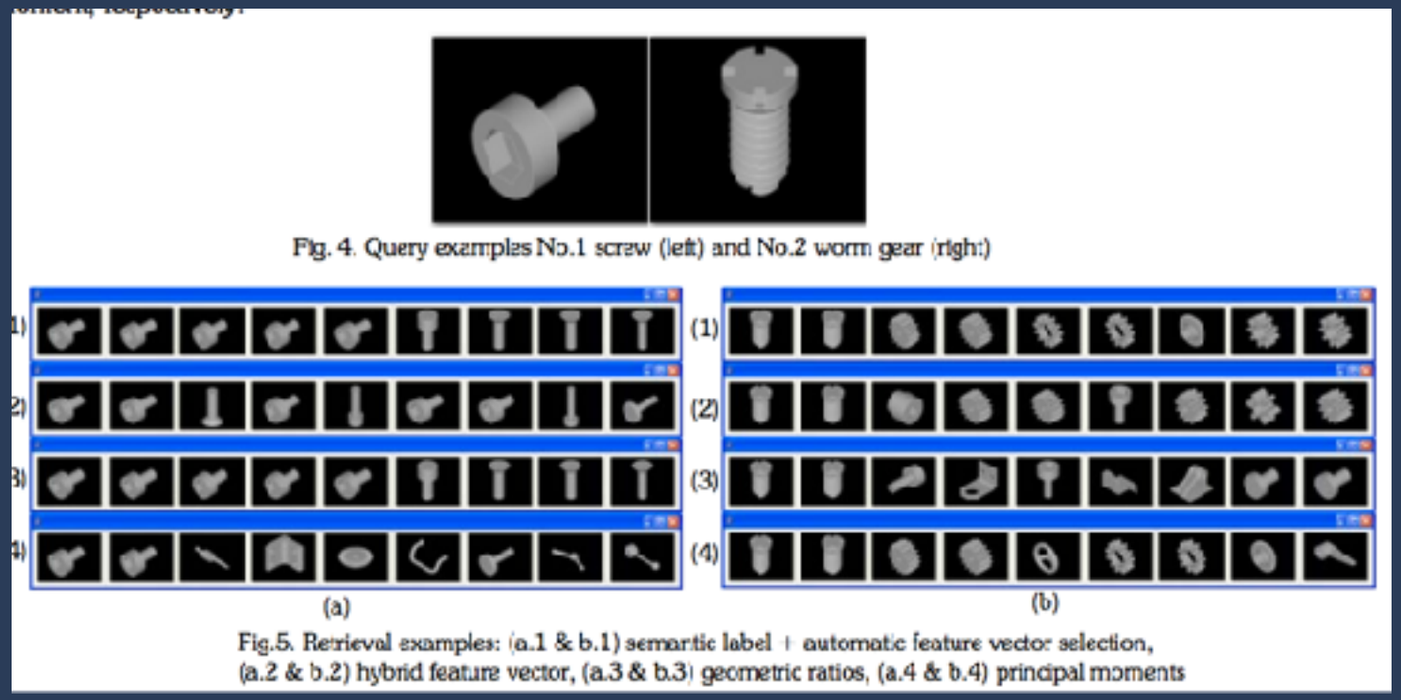
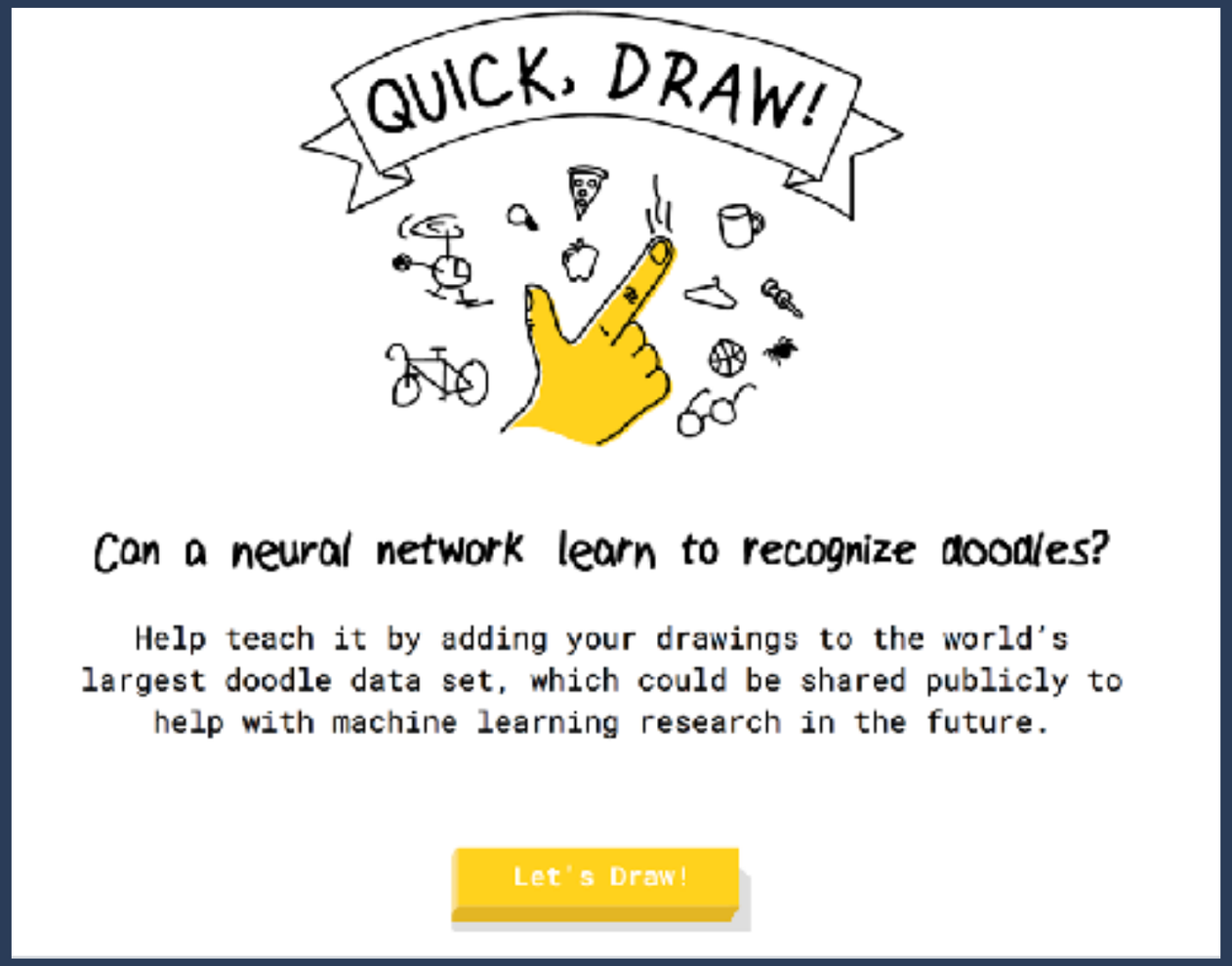


Fig. 4. Query examples No.1 screw (left) and No.2 worm gear (right)

Fig.5. Retrieval examples: (a.1 & b.1) semantic label + automatic feature vector selection, (a.2 & b.2) hybrid feature vector, (a.3 & b.3) geometric ratios, (a.4 & b.4) principal moments

Discussion

# Google Quickdraw




https://quickdraw.withgoogle.com/

2.

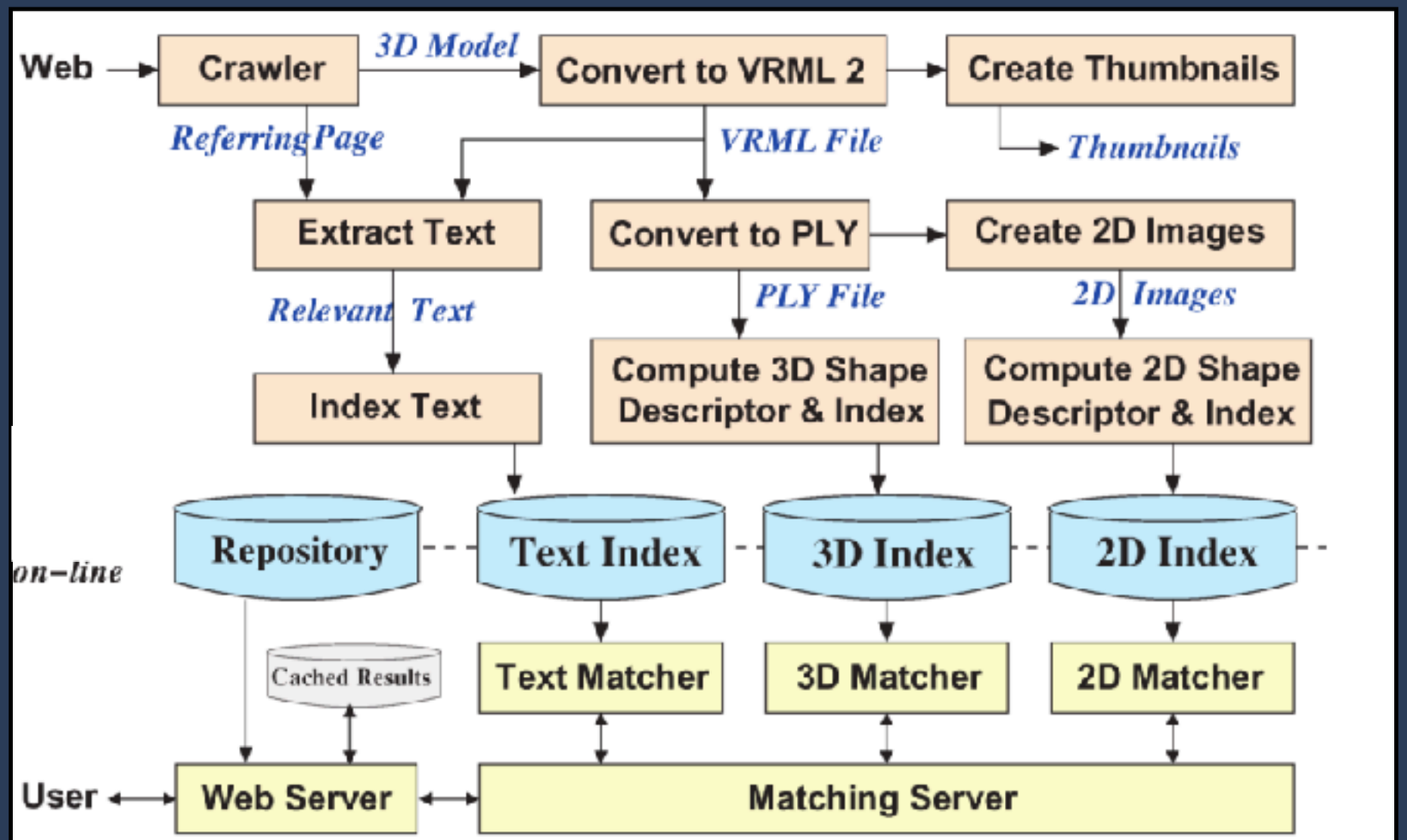
→ *Allow for multimodal queries in the form of text, 3D models, and 2D sketches.*

→ *Create a pixel-paint platform for people to be able to do draw.**

*Also figure out the math for this

*“The advantage of this approach is that the interface is easy to learn. Most novice computer users* ***have used a paint program before.****The disadvantage is that 2D images generally have lesser shape information.”*

# Overview




1. Flow of data through the search engine. The data shown in blue text are stored in the repository.

# Website

Text & 2D Sketch
Searc...
All Models
Keywords:
View 1
Undo
Clear
View 2
Left mouse button = draw
Right mouse button = erase
Undo
Clear
View 3
Undo
Clear
Princeton Shape Retrieval and Analysis Group
3D Model Search Engine
Text & 2D Sketch Text & 3D Sketch File Compare Research Contact Us Links FAQ Main
Available search types:
Text & 2D Sketch
one or more keywords and/or 1/2/3 simple outline sketches
Text & 3D Sketch
one or more keywords and/or a single 3D sketch
File Compare
upload your own 3D model file
Find Similar Shape
click the link below a search result
Available datasets:
Free Models
~ 31000 models downloaded from the Web
Viewpoint Models
~ 2000 commercial models
De Espona Models
~ 1000 commercial models
Cacheforce Models
~ 2000 commercial models
All Models
All of the above
Online since November 2001
This site should work with Netscape 4.0 or up, or equivalent, with Java and Javascript enabled. If you are running a version of Java older than 1.2, then get the latest version of the Java Runtime Environment at this page. If something does not work, please let us know by clicking here.

# What other interfaces could be built?

# Natural Language Queries?

**Figure 1:** This paper presents a data-driven fashion model that learns correspondences between high-level styles (like "beach," "flowy," and "wedding") and low-level design elements such as color, material, and silhouette. The model powers a number of fashion applications, such as an automated personal stylist that recommends fashion outfits (right) based on natural language specifications (left).

## The Elements of Fashion Style

Kristen Vaccaro, Sunaya Shivakumar, Ziqiao Ding, Karrie Karahalios, and Ranjitha Kumar

# Image Queries?

# Context Based?

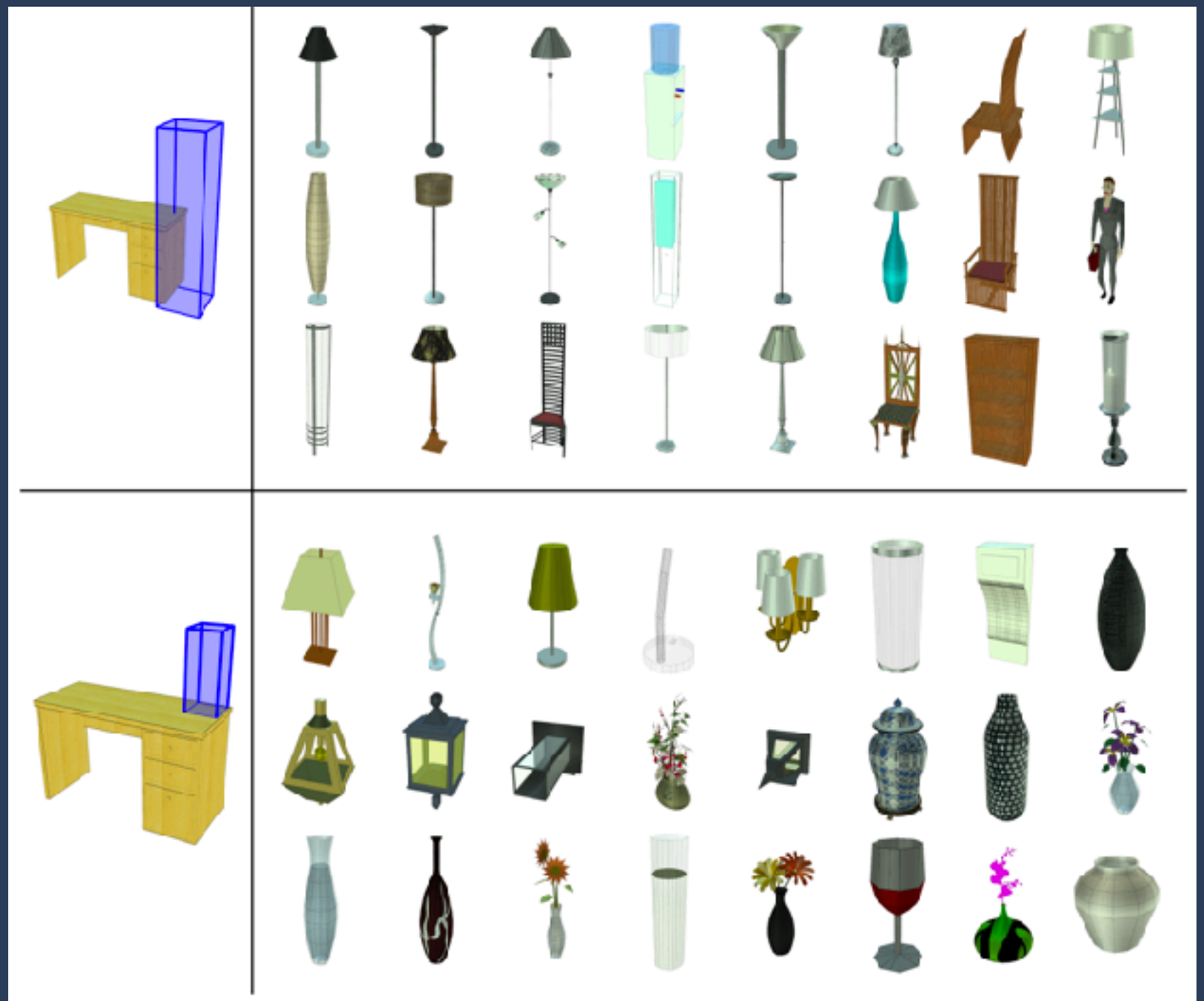


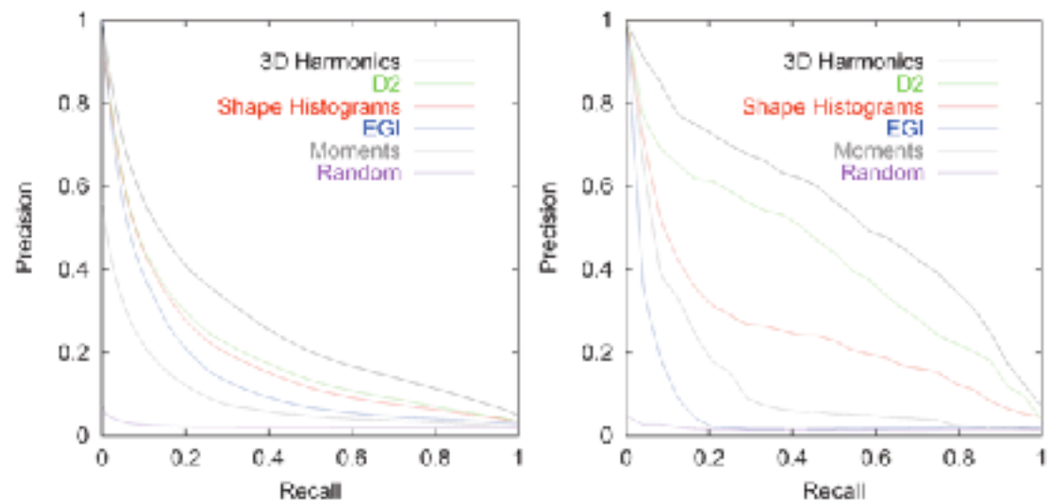
**Figure 5:** *Context query results with a desk as the only supporting object. Left: The user places a query box in the vicinity of the desk. Right: The top 24 search results for each query. When models with identical geometry but different textures occur, only the first result is shown.*

Context-Based Search for 3D Models
Matthew Fisher

# Results

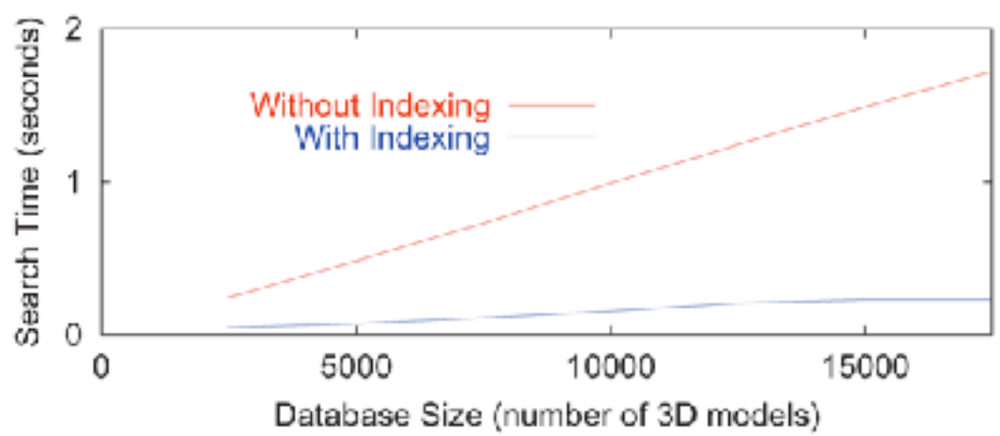
# Recall vs Precision

- T. Funkhouser et al.




(a) All classes (b) Living room chairs

Fig. 13. Plots of precision versus recall of our spherical harmonics descriptor versus other shape matching methods.




"Recall" represents the ratio of models in class C returned within the top K matches, and "Precision" indicates the ratio of the top K matches that are members of class C.

*On average, Recall & Precision were **higher** than of previous methods.*

*Since the method describes objects up to rotations of multiple independent components, it achieves a **nice combination of rotational invariance and discriminating power**.*

*The search time grows **sub-linearly**, and the total search time for a database of 17,500 models is less than 0.25 seconds.*

# Single vs Multimodal Queries

Table II. Comparison of Retrieval Results with Queries Comprising Only Text, Only 2D Sketches, and Both Combined

| Target Object Name | Median Rank (out of 1890) | | | % in Top 16 | | |
|---|---|---|---|---|---|---|
| | Only Text | Only Sketch | Both Combined | Only Text | Only Sketch | Both Combined |
| Chair | 216 | 17 | 28 | 0.0 | 46.2 | 25.6 |
| Elf | 10 | 12 | 2 | 89.7 | 53.8 | 97.4 |
| Table | 100 | 571 | 252 | 5.1 | 5.1 | 10.3 |
| Cannon | 7 | 40 | 2 | 82.1 | 33.3 | 89.7 |
| Bunkbed | 3 | 64 | 2 | 89.7 | 20.5 | 89.7 |

*Text was effective at identifying classes of objects, and the sketches were helpful at selecting the best matches from within a class.*

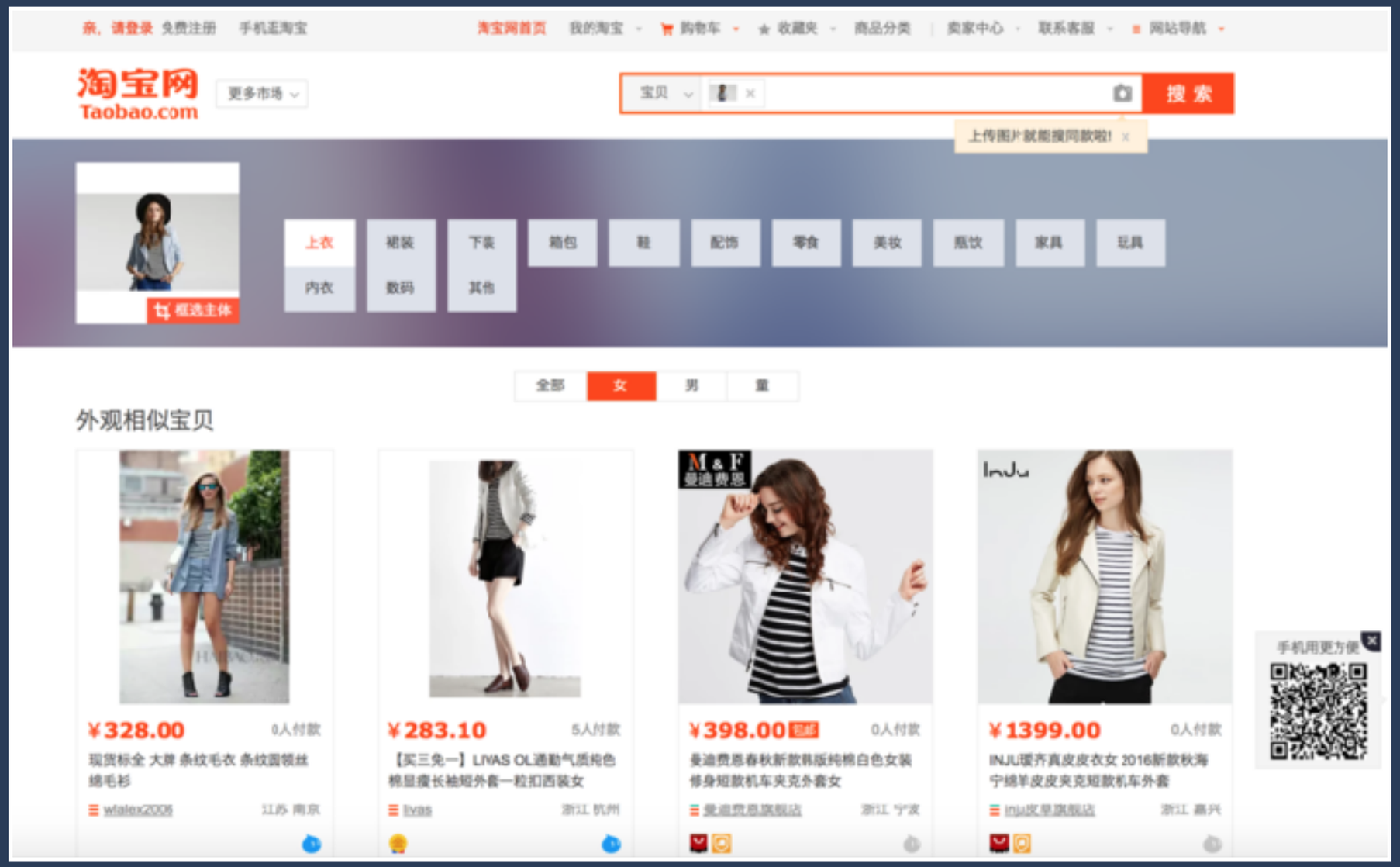
*The net result was that the combination of sketches and text usually produced a better match than either one alone.*

*People that used a combination of show similar, text and sketches were faster than those who did not.*

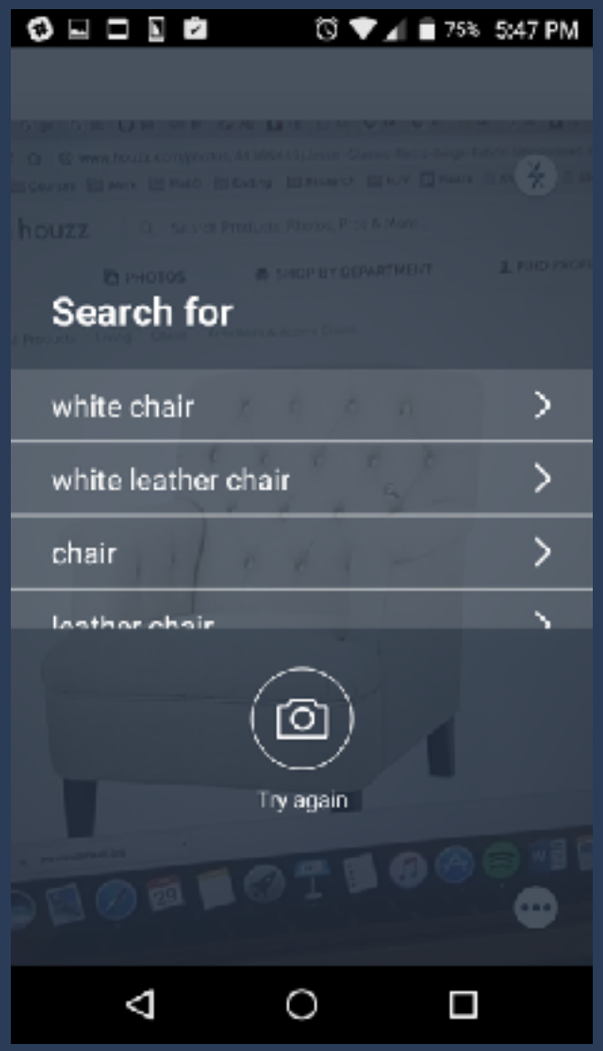
# What other contexts is search used in/ should be used in?

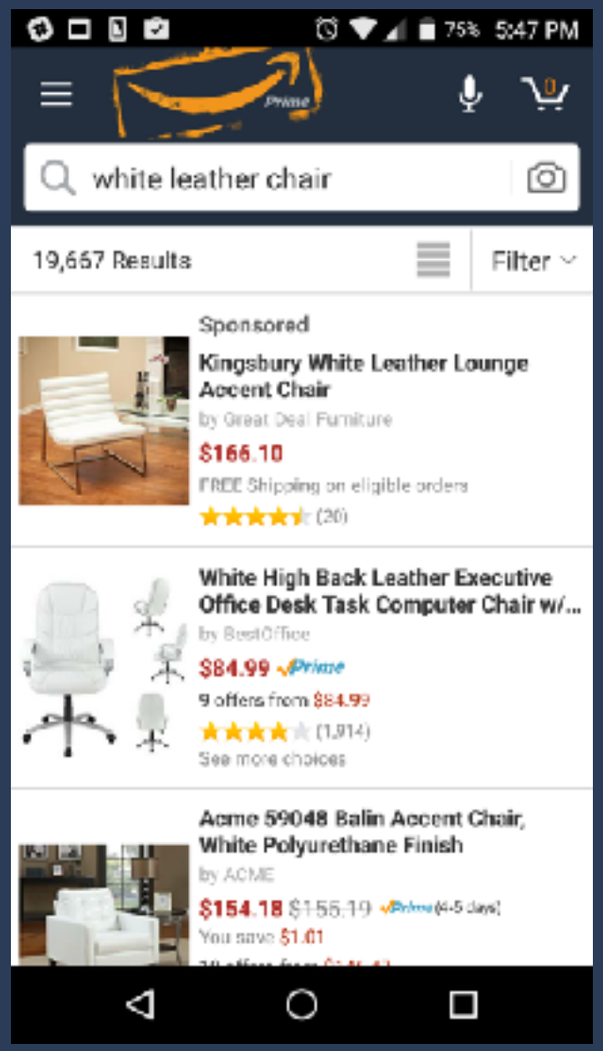
Discussion

# Shopping?


淘宝网
Taobao.com
搜索
上衣
裙装
下装
箱包
鞋
配饰
零食
美妆
瓶饮
家具
玩具
内衣
数码
其他
外观相似宝贝
¥328.00
¥283.10
¥398.00
¥1399.00

# Shopping?


75% 5:47 PM
houzz
Search for
white chair
white leather chair
chair
Try again


75% 5:47 PM
white leather chair
19,667 Results
Filter
Sponsored
Kingsbury White Leather Lounge Accent Chair
by Great Deal Furniture
$166.10
FREE Shipping on eligible orders
White High Back Leather Executive Office Desk Task Computer Chair w/...
by BestOffice
$84.99
9 offers from $84.99
See more choices
Acme 59048 Balin Accent Chair, White Polyurethane Finish
by ACME
$154.18 $155.19
You save $1.01

# A Search Engine for HTML Snippets

Jinda

# Example-Centric Programming: Integrating Web Search into the Development Environment

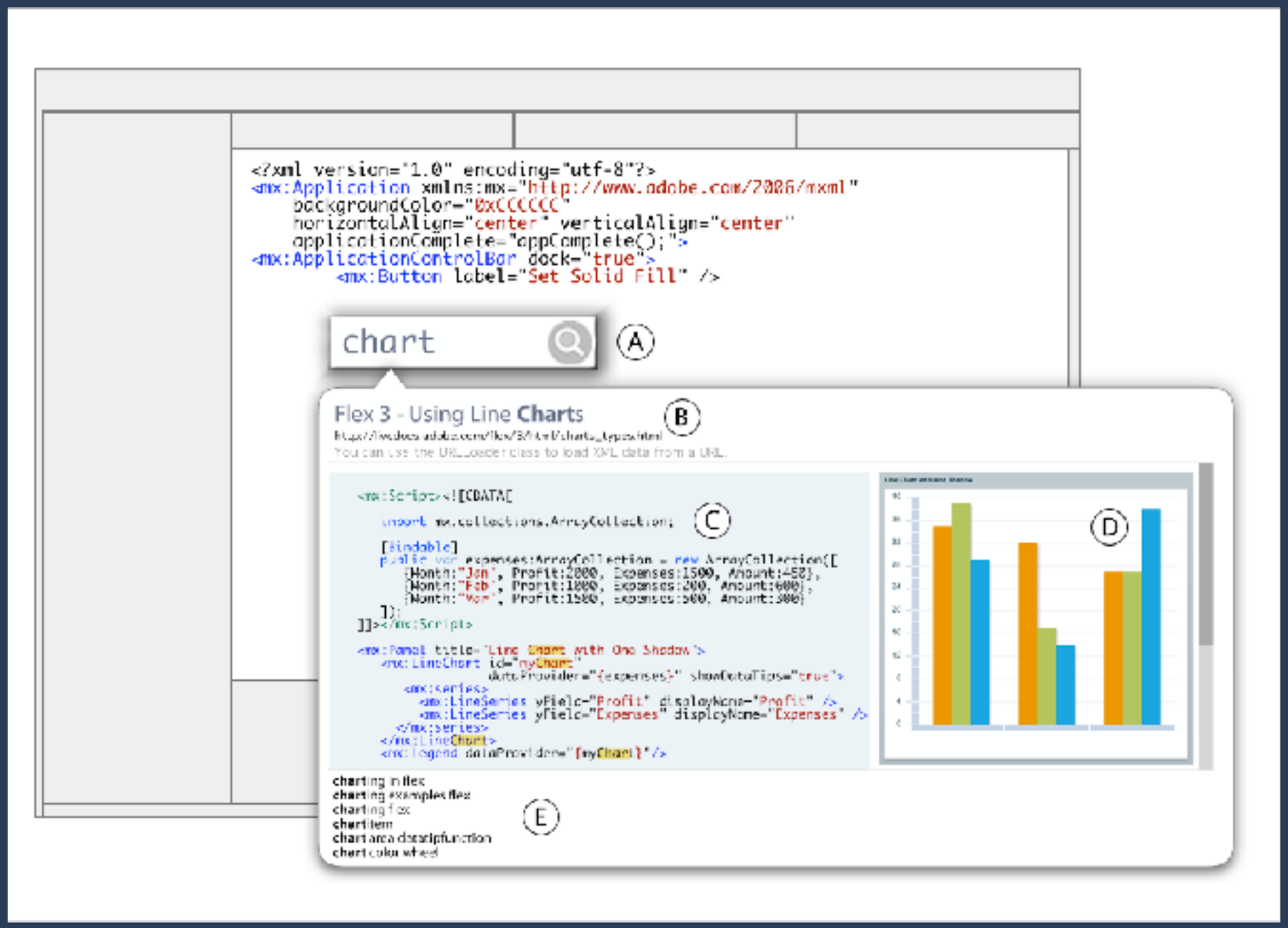
*Joel Brandt, Mira Dontcheva, Marcos Weskamp, Scott R. Klemmer*

*CHI 2010*

"creating a new and effective way for programmers to interact with computers."

# Insights from Joel's Prior Works in 2009

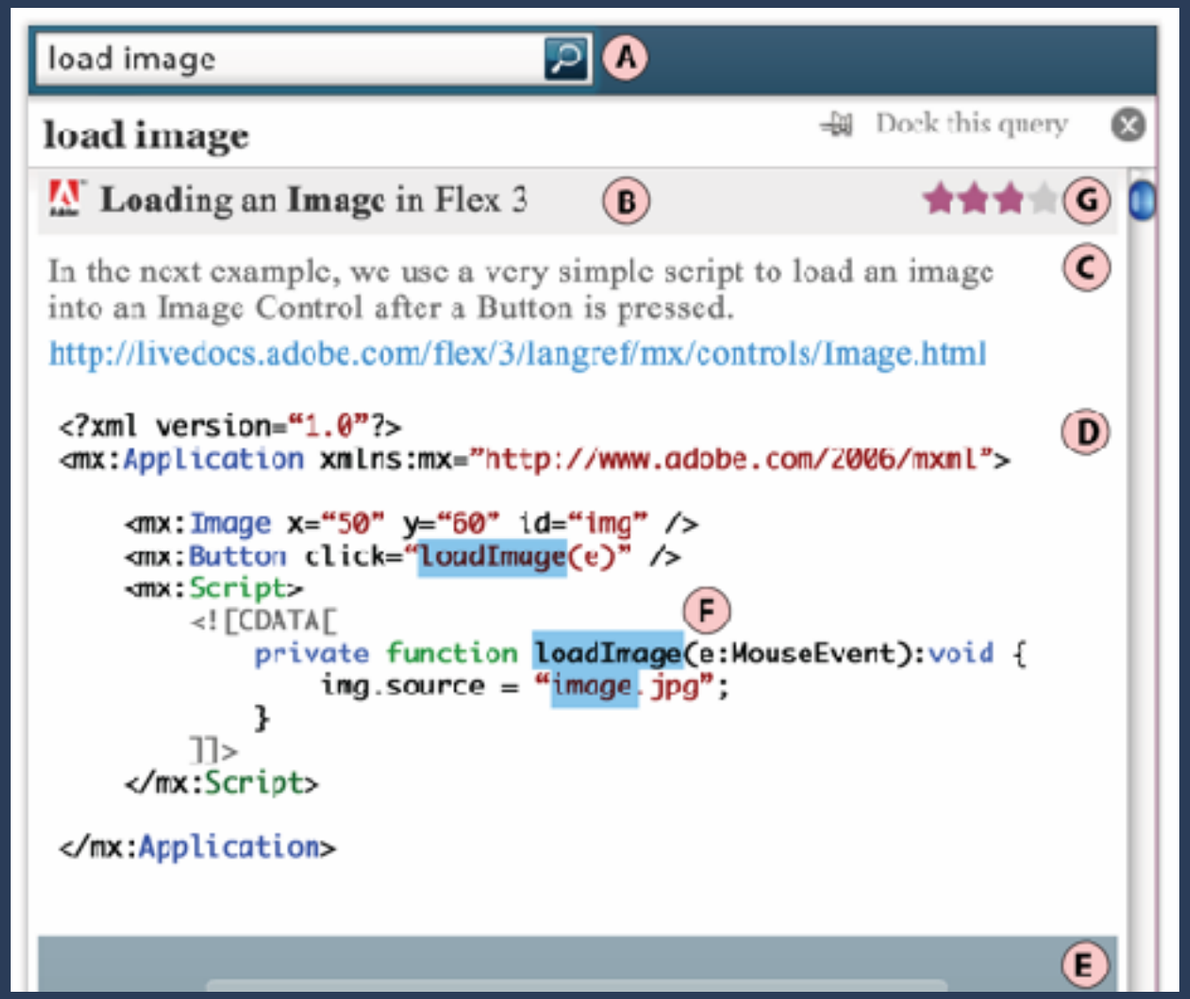
*http://hci.stanford.edu/cstr/reports/2009-01.pdf*



# Joel’s Summer internship @ Adobe

# A Plug-in for Adobe Flash Builder

Embeds a domain-specific search engine within the IDE



# Why they built it?

At that time (in 2010),

Search tools are not designed
to assist with programming task

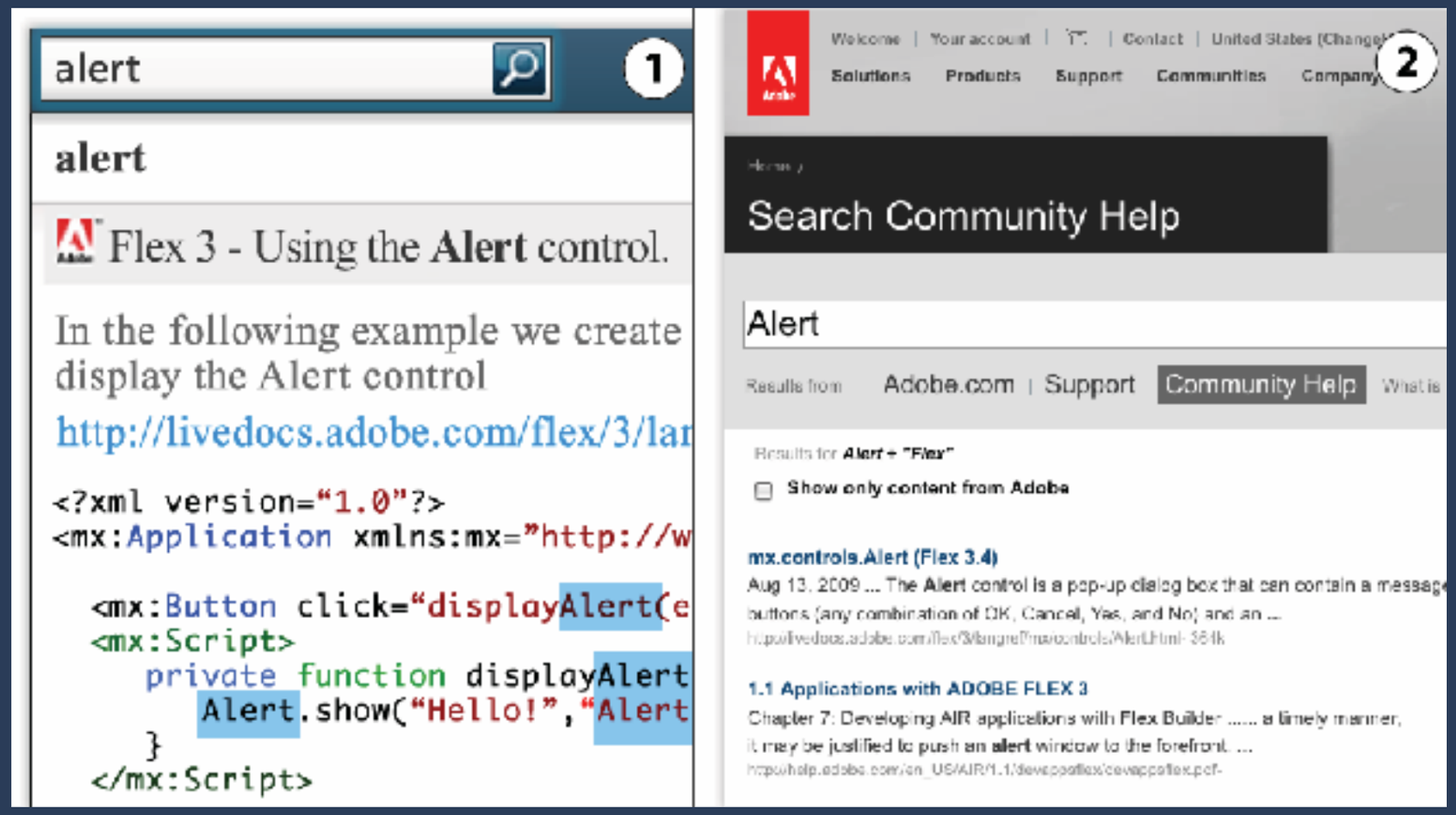
Separate from the editing tools

# Why they built it?

Some part of code even not working

Is this tool **legal** to using and tracking code online?

# Adobe Blueprint System




Combines an IDE plugin + custom search engine

*a new kinds of user interactions*

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
<mx:Script>

    urlLoader
```

# 1.

# Instant Web search

## without leaving the IDE’s code editor

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
<mx:Script>
```

urlLoader

Flex 3 - Using the **URLLoader** class

http://livedocs.adobe.com/flex/3/net/URLLoader.html

You can use the URLLoader class to load XML data from a URL.

```
var loader:URLLoader = new URLLoader();
loader.addEventListener(function(e:Event){
    trace("loaded");
};
loader.load(new URLRequest("example.com"));
```

2.

Browsing through automatically "code-centric" format results

More useful to programmers than web

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
<mx:Script>
```

urlLoader

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loader.addEventListener(function(e:Event){
    trace("loaded");
};
loader.load(new URLRequest("example.com"));
```

3.

fast copy-and-paste of retrieved example of code snippets into user's code

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
```

urlLoader

Flex 3 - Using the **URLLoader** class

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loader.load(new URLRequest("example.com"));
```

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
<mx:Script>

// @url http://livedocs.adobe.com/flex/3/net/URLLoader.html
// @pasted Tue Mar 24 13:24:06 PDT 2009
// @query: urlloader


var loader:URLLoader = new URLLoader();
loader.addEventListener(function(e:Event){
    trace("loaded");
};
loader.load(new URLRequest("example.com"));
```

4.

Provides links between the copied code and its source

notifications when source gets update

# Example

```
<?xml version="1.0" encoding="utf-8"?>
<mx:Application xmlns:mx="http://www.adobe.com/2006/mxml">
```

urlLoader

Flex 3 - Using the **URLLoader** class

http://livedocs.adobe.com/flex/3/net/URLLoader.html

You can use the URLLoader class to load XML data from a URL.

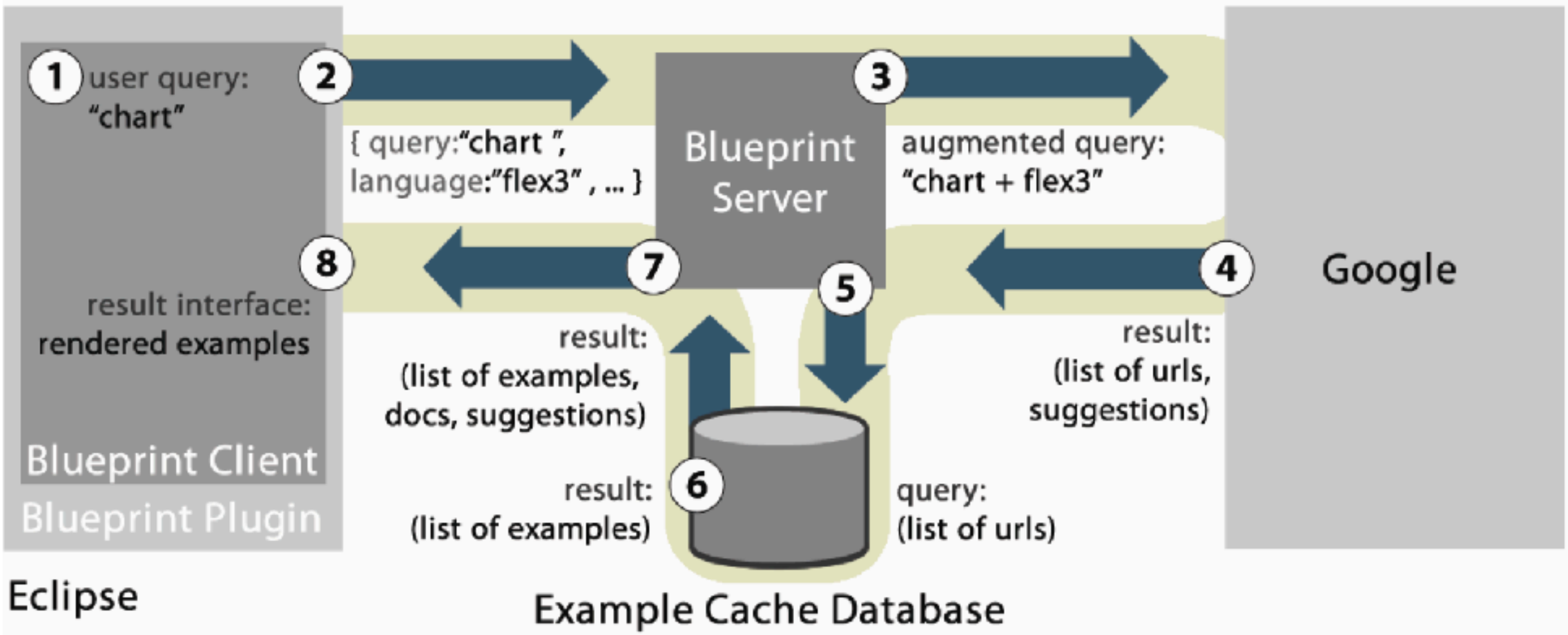
```
var loader:URLLoader = new URLLoader();
loader.addEventListener(function(e:Event){
    trace("loaded");
};
loader.load(new URLRequest("example.com"));
```

Are there any similar function built-in any other IDEs or as a plug-in for code editors?

e.g. *Sublime text*, *Eclipse*, *PyCharm*, etc.?

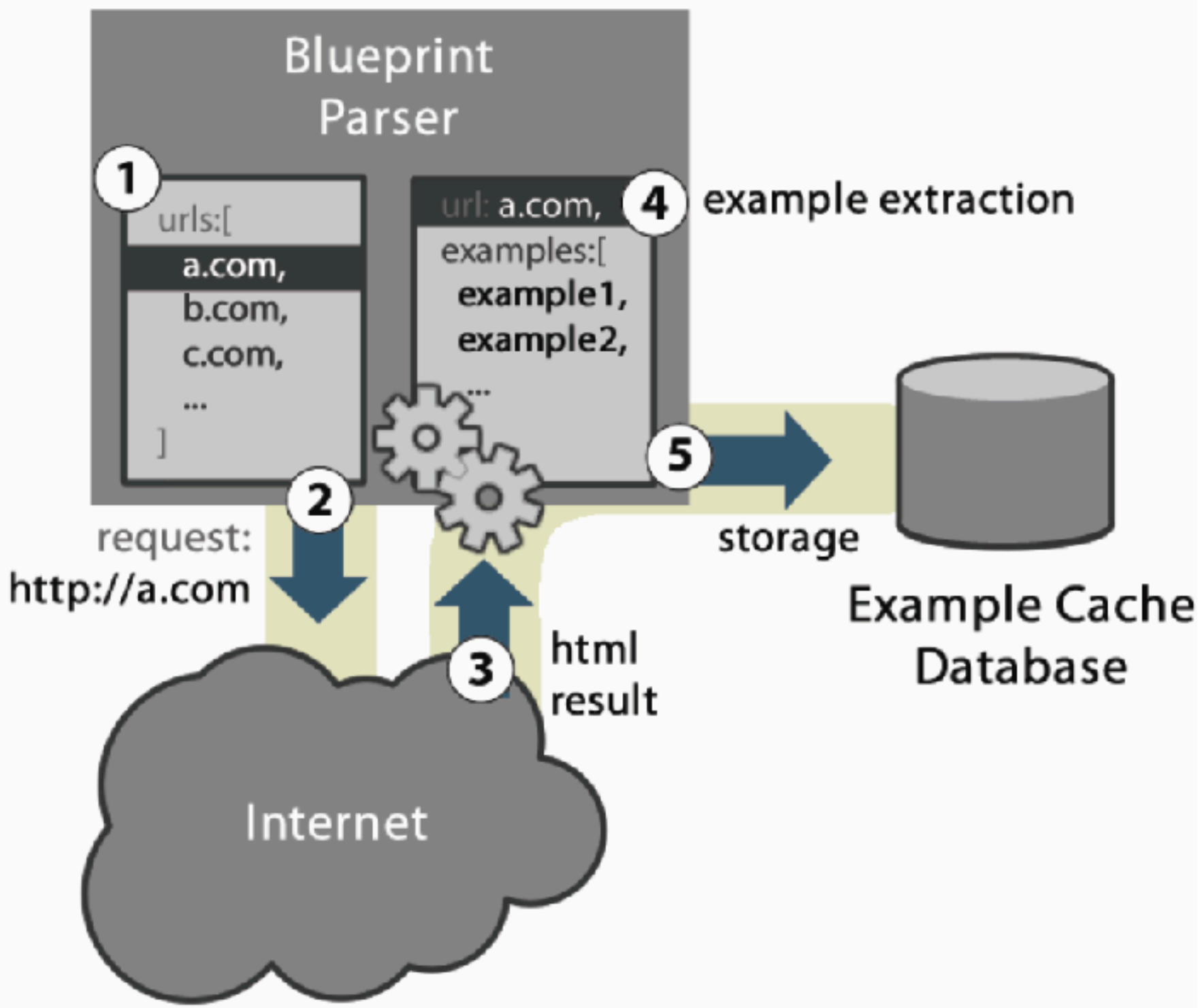
# Blueprint Server Query Process

## Blueprint Server Query Process



# Blueprint Parsing Process

# Blueprint Parsing Process



# Initial User Study

20 Professional programmers at Adobe
Performed a series of programming tasks

50% participants used Blueprint system

50% participants used regular Web browser

compared the performance in both groups such as *completion time*, *code quality*, etc.

# Results of Initial User Study

9/10 Participants finished task

("See Figure 4", however no figure 4 in paper)

Using Blueprint finished in average 346s
Traditional finished in average 479s
38.4% improvement

# Longitudinal Study

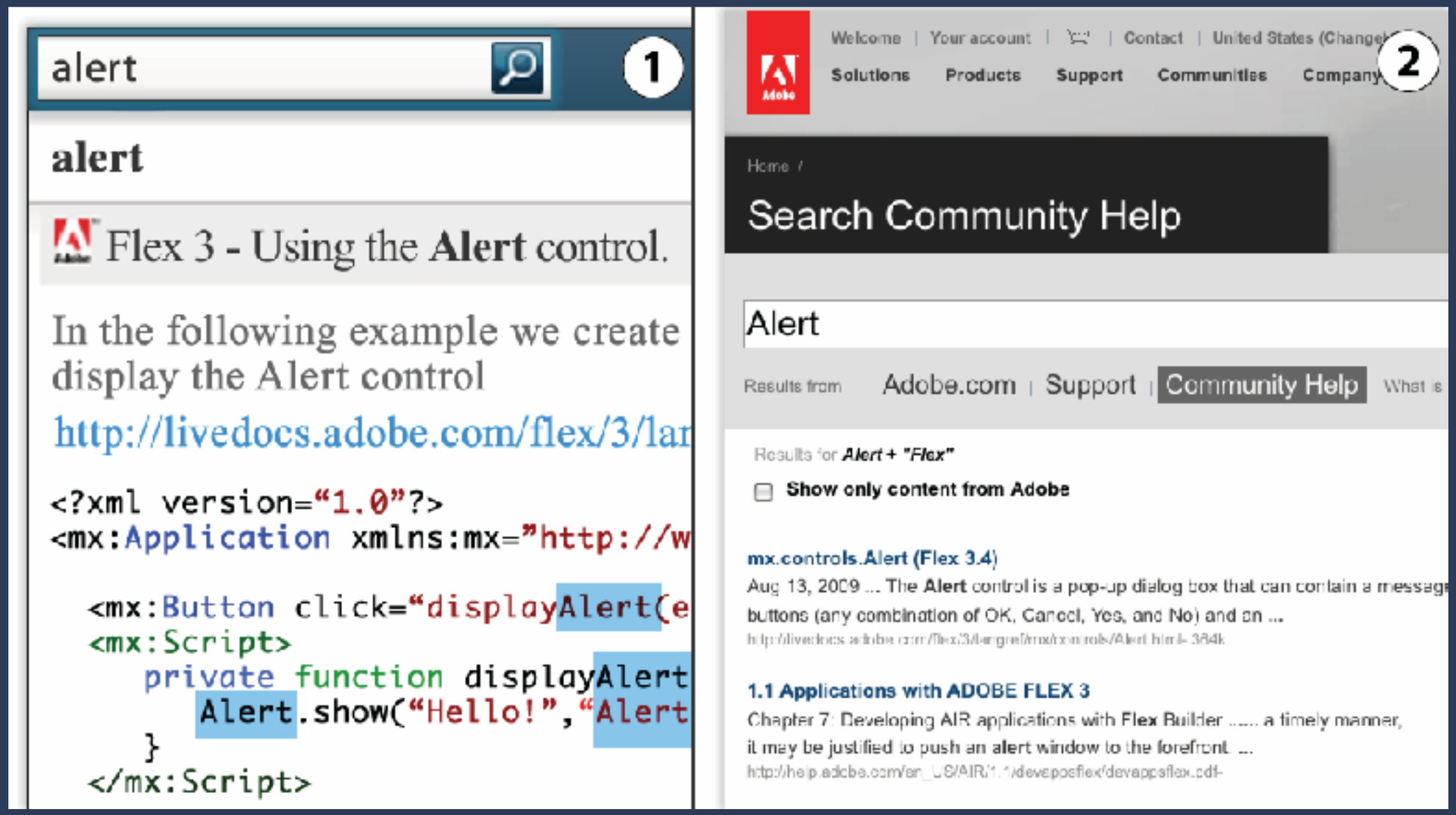
2024 users in 82 days

25 new installations per days

recorded 17,012 queries (8.4/per.u)

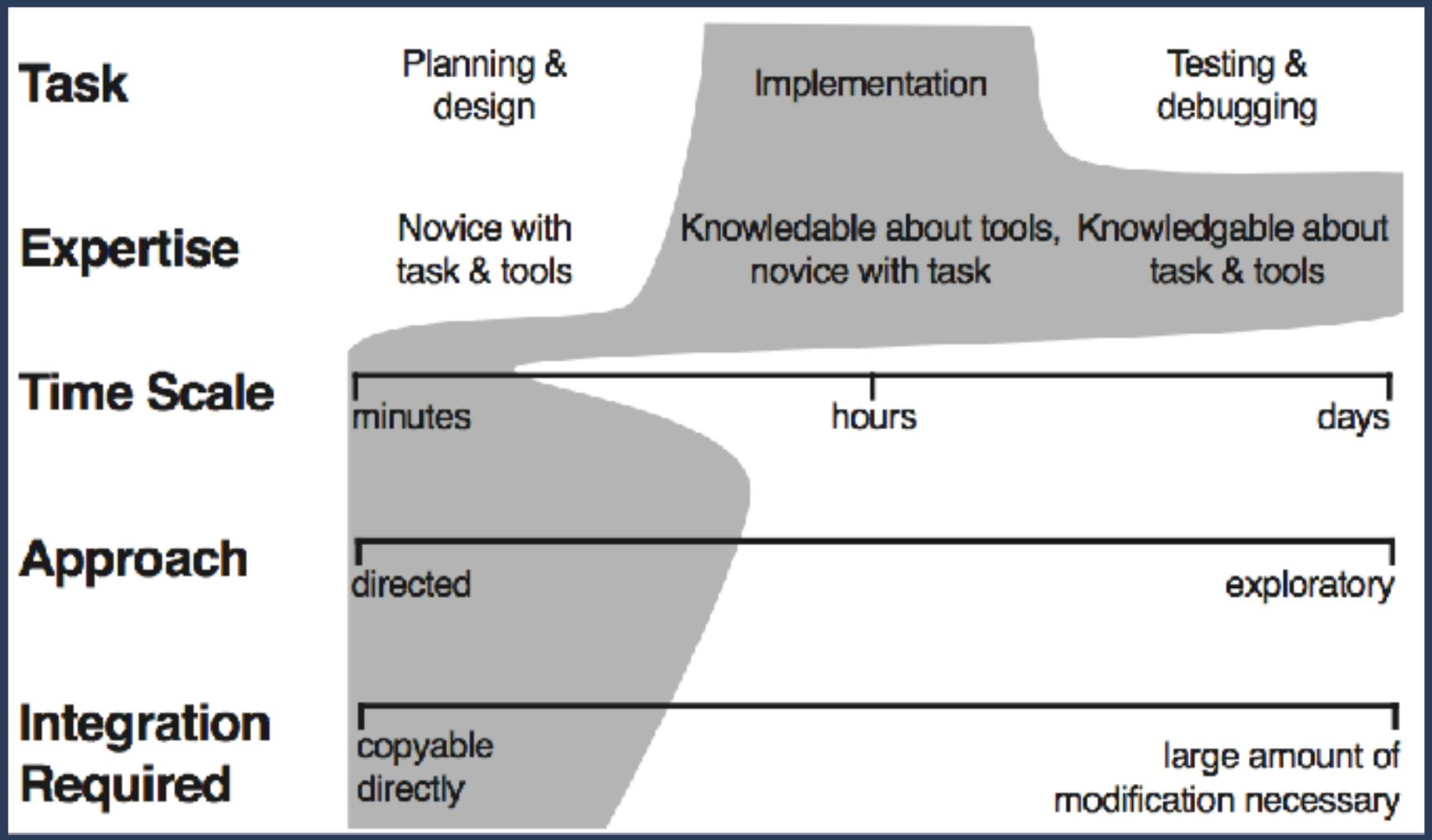
analyzed the contents of those queries to discover *insights*

# Results of Longitudinal Study




***Both interface modalities are important***

# Results of Longitudinal Study




***Blueprint's limitation in the context of this design suggest directions for future work***

# Conclusion

introduced a *example-centric* plug-in for the development environment

with a *code-specific* search engine

improve programmers efficiency

widely future extension

# Other related & extended future works?

# Search the Similar Web Style

## Webzeitgeist: Design Mining the Web

*Ranjitha Kumar, Arvind Satyanarayan, Cesar Torres, Maxine Lim, Salman Ahmad, Scott R. Klemmer, and Jerry O. Talton*

Proceedings of CHI '13

# Learning Web Design Patterns using Machine Learning

**Learning Design Patterns with Bayesian Grammar Induction**

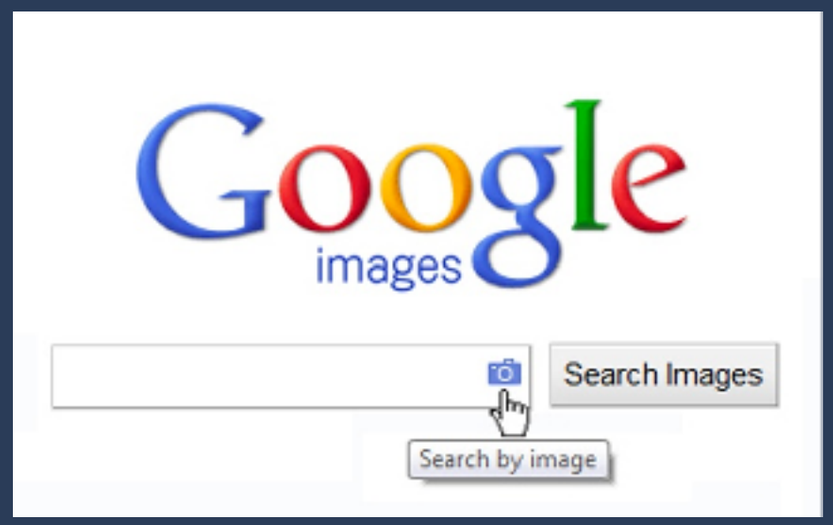
*Jerry O. Talton, Lingfeng Yang, Ranjitha Kumar, Maxine Lim, Noah D.*
Stanford University CSTR 2012-03

**Learning Structural Semantics for the Web**

*Maxine Lim, Ranjitha Kumar, Arvind Satyanarayan, Cesar Torres, Jerry O. Talton, and Scott R. Klemmer*
Proceedings of UIST '12

# Common points in these two papers?

# What kind of other types to search?



# Where do you seek help when you programming?

Google

GitHub

stackoverflow

w3 schools

# Reference


1. Some Images from http://www.google.com
2. Joel Brandt, M. Dontcheva, etc. Example-Centric Programming: Integrating Web Search into the Development Environment. Processing of CHI 2010.
3. P. Goo. Two Examples of HCI Research. Communications of the ACM. 2013.