

# Looking through Camera Lenses: Computer Vision and its Applications in Etsy

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# Overview

What is computer vision?

Why should we care?

Application examples @ Etsy

Lessons learned in productizing the technologies

What's possible next?

Etsy

Etsy is an online marketplace where people connect to buy and sell **unique** goods: Handmade, vintage, craft supplies

**21M**

Active Users  
(buyer &  
sellers)

**1M**

Shops

**26M**

Listings

**9**

Languages

**200**

Countries

90M  
Images

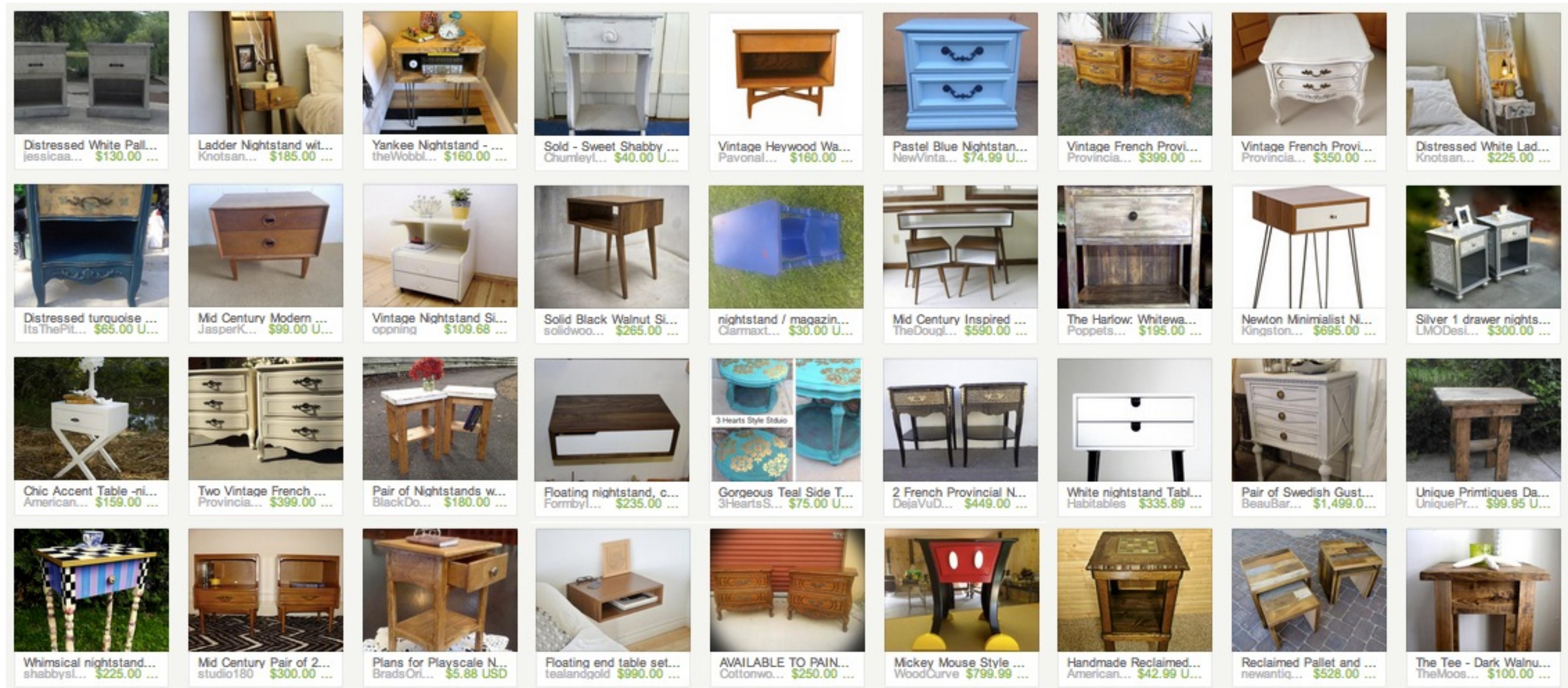
Almost 44 days video at 24 frames/s

Why should we care?!

Etsy is a visual experience

# How do people decide what to buy?

Example: search results for “nightstand” - 100+ pages



Images provide an alternate data modality

## Example: Tag Suggestion

theredbri... Favorite Shop

13 items

Wooden Tree Mobile - \*RESERVED FOR  
Stephanie Stevens\*

\$60.00 USD Ask a Question

Only 1 available

Overview

- Handmade item
- Materials: pine, birch plywood
- Made to order
- Feedback: 26 reviews
- Ships worldwide from United States

Add to Cart

Favorite 831 Add to Embed

Tweet Pin It Like 0

Meet the owner of theredbri...  
Learn more about the shop and process.

Mike

tags

Related to this item

Children Housewares Mobile tree mobile wood mobile handmade handcrafted woodland mobile nursery decor

cabin decor baby gift pine trees forest woodsy christmas gift lumberjack triangle fall autumn

Listed on Aug 13, 2014 2931 views 831 Favorites 74 Treasury lists Add item to treasury Report this item to Etsy

Meet *the owner of theredbirdshop.*  
[Learn more about the shop and process.](#)



Mike

## tags



### Related to this Item

- [Children](#)
- [Housewares](#)
- [Mobile](#)
- [tree mobile](#)
- [wood mobile](#)
- [handmade handcrafted](#)
- [woodland mobile](#)
- [nursery decor](#)
- [cabin decor](#)
- [baby gift](#)
- [pine trees forest](#)
- [woosy](#)
- [christmas gift](#)
- [lumberjack](#)
- [triangle](#)
- [fall autumn](#)

Listed on Aug 13, 2014 2931 views 831 Favorites 74 Treasury lists [Add item to treasury](#)

[Report this item to Etsy](#)

# Tag selection and Solution

1

Learn similar listings tags through images



2

Use existing listings tags as recommendation

**What will buyers type into search to find your item?**

Tags help buyers find your item when they search on Etsy. Add 13 tags to reach as many Etsy buyers as possible.

Tags [Get ideas](#) | [From image](#) | [From title and description](#)

[geometric](#) | [lighting](#) | [outdoor](#) | [hanging](#) | [votive](#) | [hurricane](#) | [under 25](#) | [lantern](#) | [candle](#) | [green](#)

 Add

Add 13 tags.

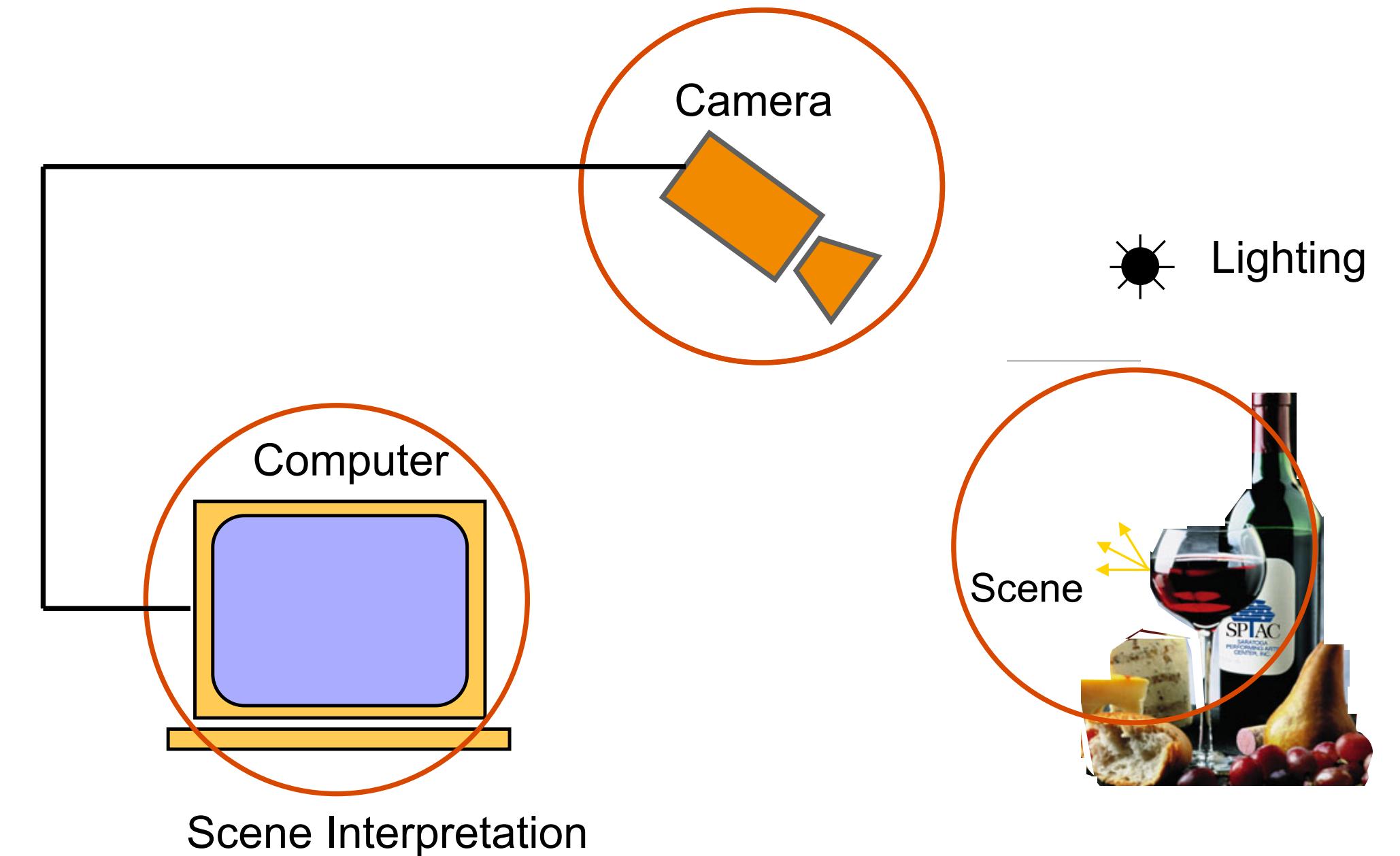
Cameras are becoming more accessible

# What is Computer Vision?

- Inverse Optics
- Intelligent interpretation of Images
- Building a Visual Cortex
- ...

## Components of a Computer Vision System

---

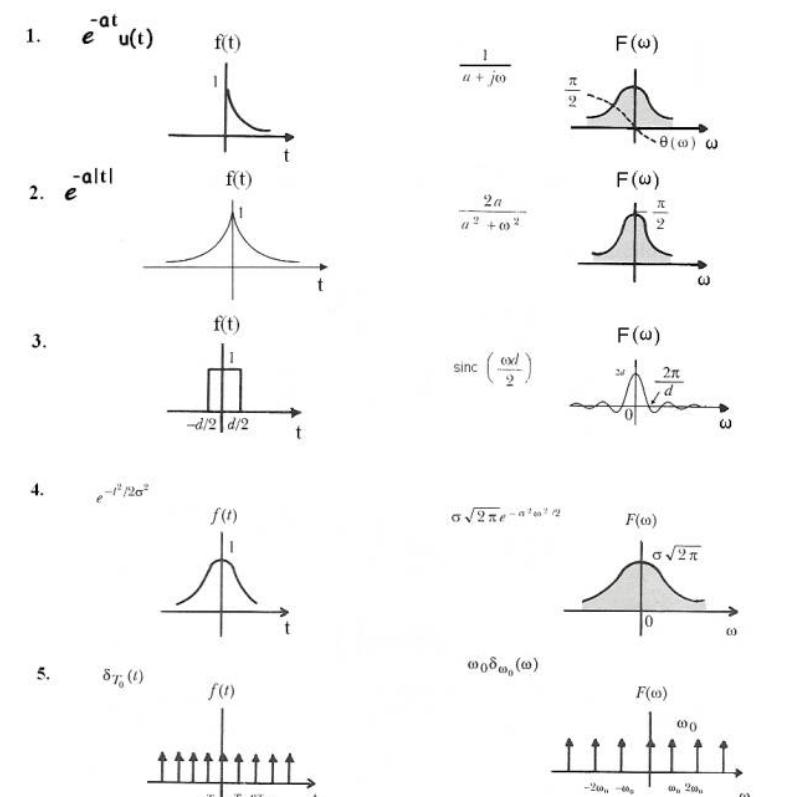


# Computer Vision Applications

# OVERVIEW

## Example : Applications

### Image Processing

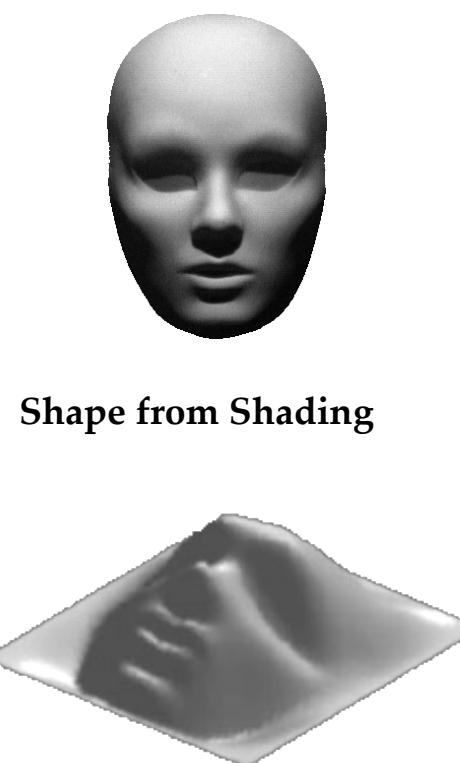


Fourier Transform  
Sampling, Convolution



Image enhancement  
Feature detection

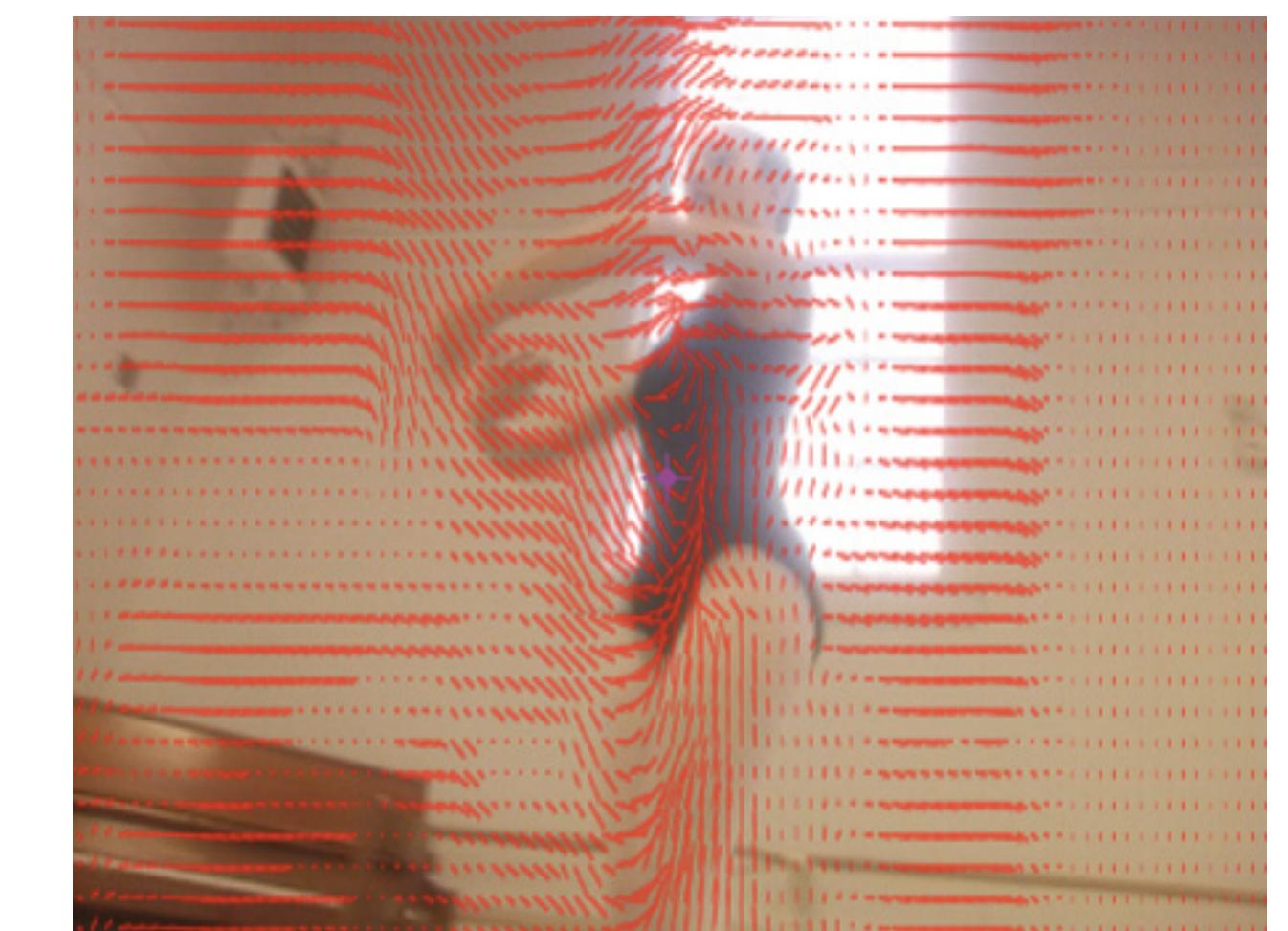
### 3D from Shading



Shape from Shading



Photometric Stereo



### Optical Flow

### Tracking



### Binocular Stereo



### Face Recognition



- Principle Components Analysis (PCA)
- Face Recognition

# Application Examples @ Etsy

- **Search**
  - Filter search result by color
- **Quality Control**
  - Visible watermark detection
- **Fraud Analysis**
  - Image fingerprint
- **Machine Learning**
  - Combine image attributes with other data points to form a model

# Application - Search by Color

Show results for: Bags & Purses > Sports Bags (199 Results)

Sort By: Relevancy

Only 1 items

Refine your search

Item Type:  All Items  Handmade  Vintage

Price: \$ Low to \$ High

Filter by Color: 

Ordering Options:  In Your Favorites  Accepts Etsy Gift Cards  Customizable

**Personalized Small Terry Cloth Zipper Bag** (Ad)   
CreativeCuddles \$15.00 USD

**Rosie 1505E Bright Large Dandelion Bag** (Ad)   
3greensisters \$36.00 USD

**Mountain Custom Rock Climbing Chalk Bag** (Ad)   
DynoClimbing \$32.00 USD

**Large Bicycle Handlebar Bag with Teal Stripes**   
SavvySacs \$36.00 USD

**Personalized GYMNASTICS GRIP Bag**   
GYMNASTICSGripBAGS \$12.90 USD

**Rainbow Chakra Yoga Mat Bag**   
TheYogaCloset \$40.61 USD

**Chicago Cubs Hipster Purse Cross Body Bag**   
HandCraftsbyKaren \$36.00 USD

**Vintage Bowling Bag - Rockabilly Aquamarine**   
DollFood \$36.95 USD

**Monogrammed Duffle With Sports M...**   
trndesigns \$21.95 USD

## Edges and Corners



- Gaussian filter  
 $G(x, y)$
- Find the intensity gradients

$$G = \sqrt{G_x^2 + G_y^2}$$

$$\theta = \arctan(G_y, G_x)$$

- Apply double threshold to determine potential edges

## Edges and Corners



## Example

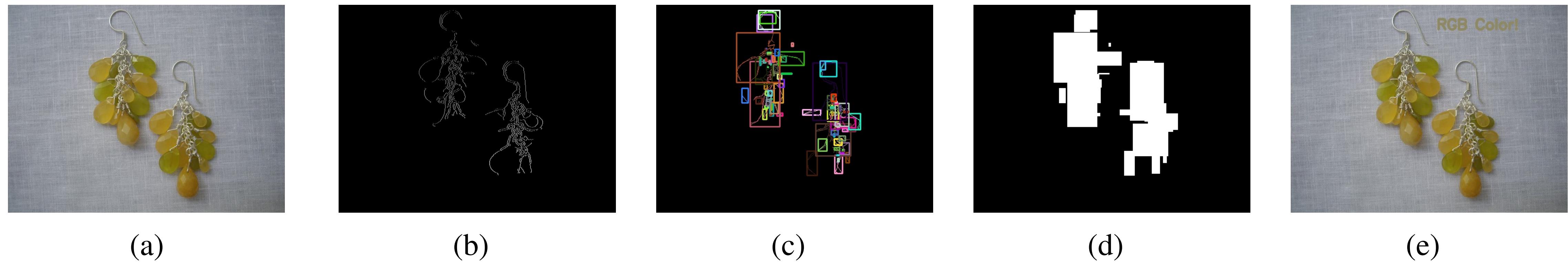
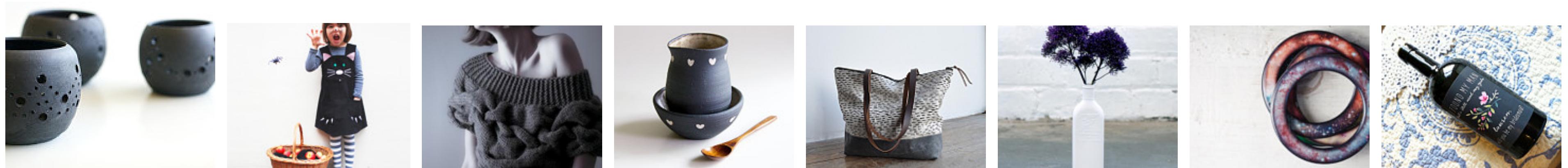


Fig. 1: (a) source image, (b) estimated edges, (c) contours, (d) final mask and (e) dominant color illustrated.

Example



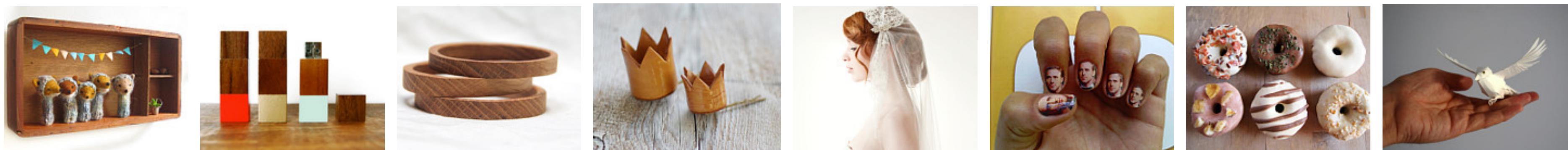
# Application - Search by Color



(a)



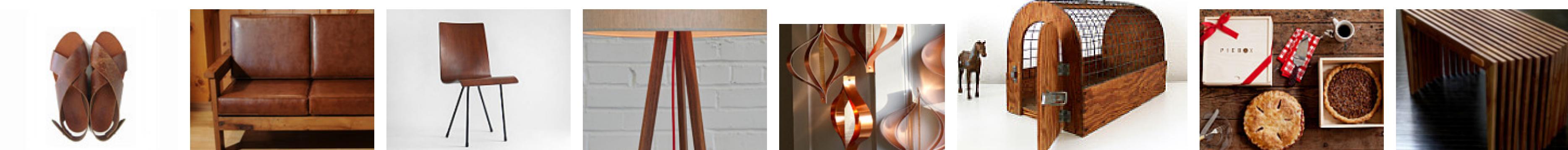
(b)



(c)



(d)



(e)

# Application - Search by Color



(a)



(b)

Classification method	Average accuracy rate	AUC
logistic regression	0.5512	0.5694
perceptron	<b>0.5600</b>	<b>0.5906</b>
passive aggressive	0.5329	0.5240
MIRA	0.5232	0.5240

TABLE I: Average classification accuracy rate and AUC are reported for favorite listing classification using text and color features.

- Identify image with undesirable element
- Google Product Listing Ads (GPLA)
- Rules to ensure high quality product data
  - No water marks allowed in image

## Google Product List Ads (GPLA) Policy

### Images



#### What's the policy?

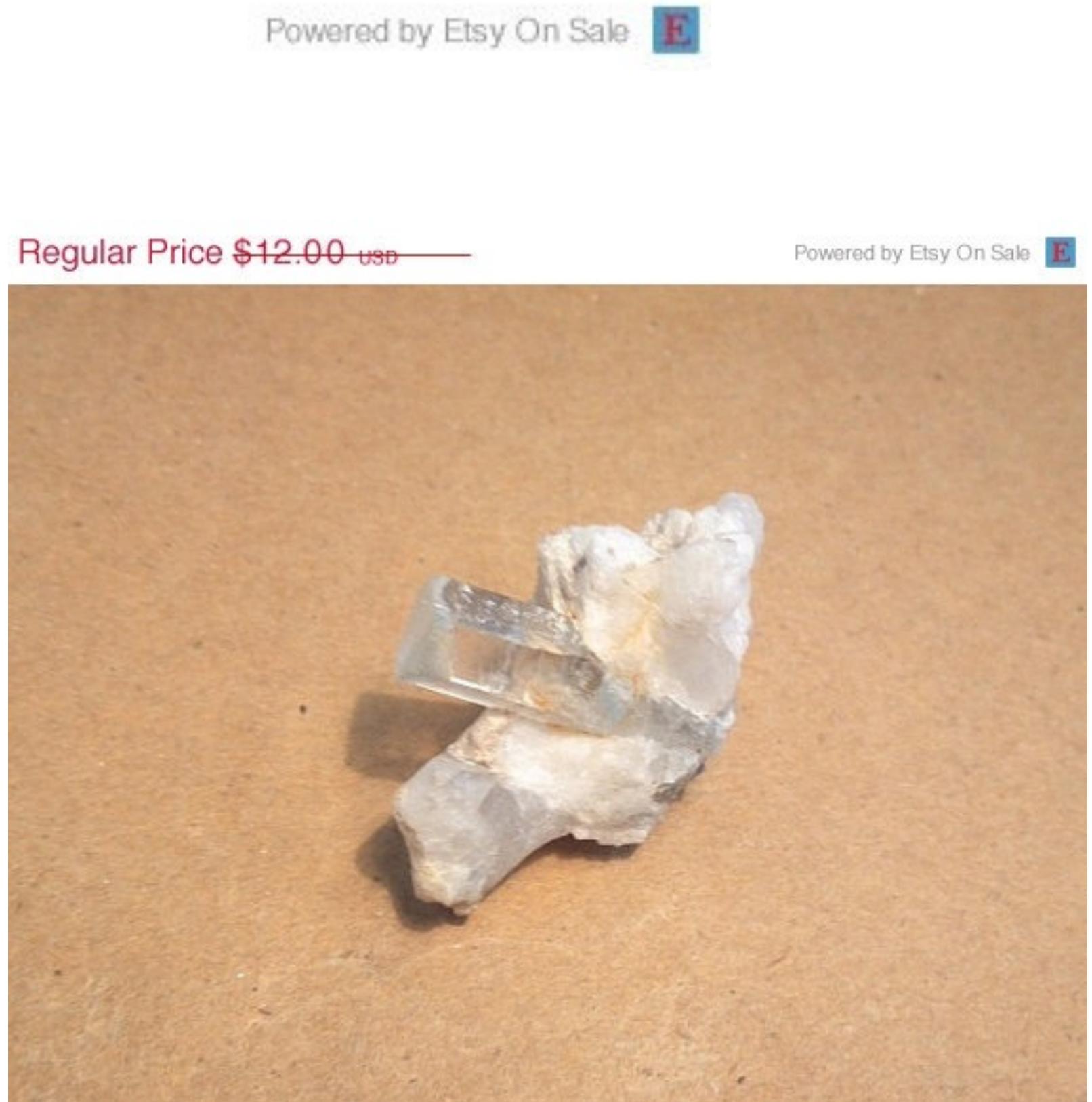
Google Shopping doesn't allow product listings with the following images:

- Placeholder or incorrect product images
- Generic images, graphics, or illustrations that are not the actual product images, except for products in the 'Hardware' or 'Vehicles and parts' categories
- Images containing promotional elements (e.g. calls to action such as "buy"; service-related information such as extended warranty; free shipping; promotional adjectives such as "best, cheap"; condition or compatibility such as new, 2-piece, adaptable) or names and/or logos of merchants regardless if the above mentioned elements overlay the product. This also applies to watermarks with promotional elements or names and/or logos of merchants.
- Images containing obstructing content (e.g. watermarks, brand names and/or logos) that overlay the product being sold
- Images that include borders

# Template Matching

- Input :  $(x, y, I(x, y)) \quad (x, y, T(x, y))$
- sliding T( template) over I ( input )
- For each location of T over I, you store the metric in the result matrix (R). Each location  $(x, y)$  in R contains the match metric.
- Distance metrics:
  - square diff
  - normalized correlation
  - etc

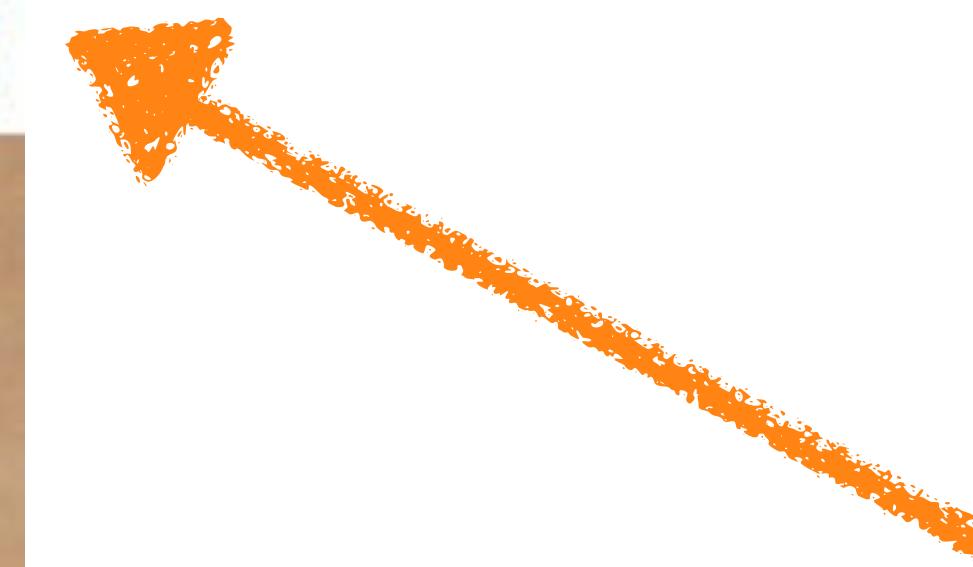
$$R(x, y) = \sum_{x', y'} (T(x', y') - I(x + x', y + y'))^2$$



## Template Matching - Raw image

Regular Price ~~\$12.00~~ USD

Powered by Etsy On Sale 

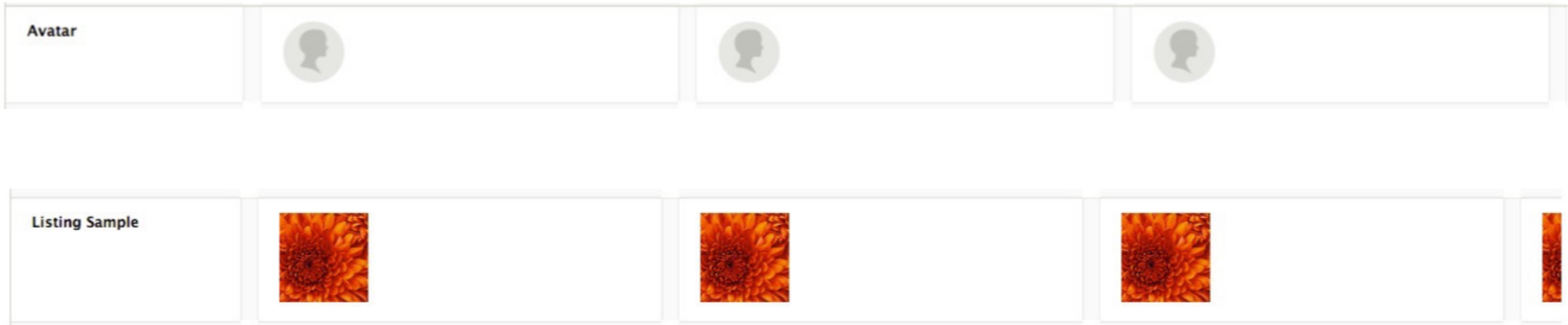


Powered by Etsy On Sale



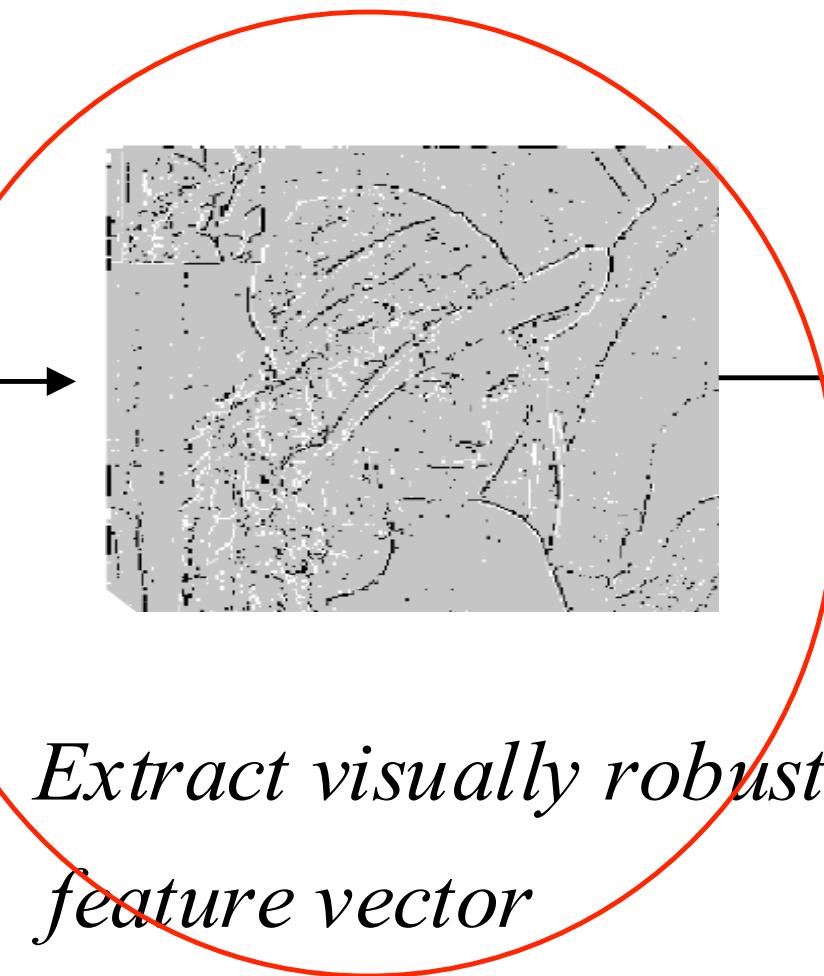
# Application - Fraud Analysis

## Compare Users

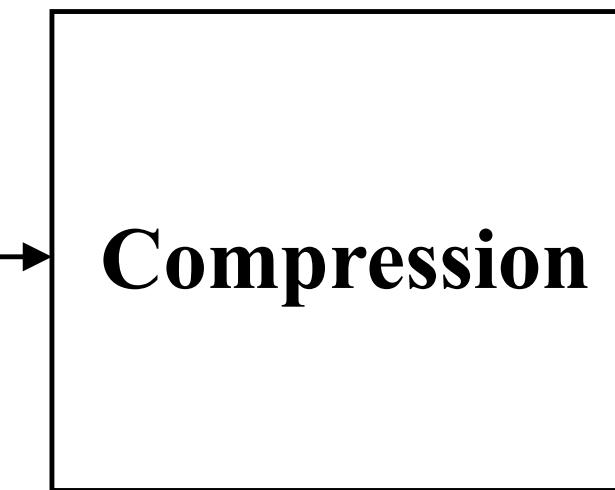


- Two-stage hash algorithm

**Input Image  $I$**



*Extract visually robust  
feature vector*



**Final Hash**

*Clustering of similar  
feature vectors*

- Feature vectors extracted from “perceptually identical” images must be close in distance metric



## Perceptual Hashing



- Features for Machine Learning Models
  - EXIF (exchangeable image file format)
    - Make, model, software, etc...
  - Tampered image
    - based on image quality analysis
    - how much an image is tampered from the original

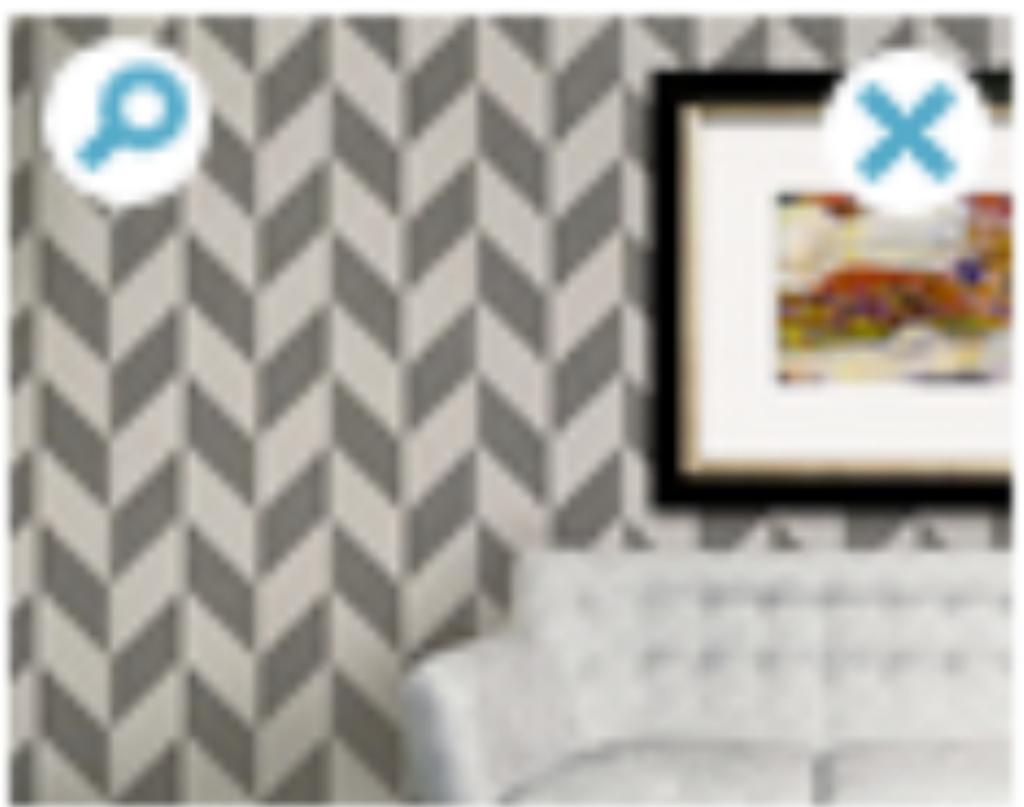
# Application - Tag Suggestion

Wall art  
Geometric  
decor  
DIY home  
Wall sticker

The screenshot shows a user interface for tagging an item. At the top, there is a section for "Photos" where a user has uploaded an image of a geometric wall decal. A pink arrow points to this image with the text "uploaded image". Below the photos, there is a note: "Convey the shape, size, color, and texture. Try to use natural light and include a great close up." Underneath this, there is a message: "We're going to use these new attributes soon to help buyers find your item. If you currently use tags for recipient, occasion, or style you should continue to add those tags." There are fields for "Recipient" (with a dropdown menu "Select a recipient...") and "Occasion" (with a dropdown menu "Select an occasion..."). Below these fields, a product listing is shown for "Free Shipping - Geometric decal wall art - Ornament wall decal - Abstract wall decal - home decor 064" by "awesomeDecals". The listing includes a small image of the decal, the brand name, category information ("housewares > wall\_decal > abstract"), a description of the item's use and size, and a price of "\$44.90". At the bottom of the listing, there is a list of suggested tags: "geometric | triangle | gift wrap | wrapping paper | egift | wall sticker | geometric wall art | DIY home decor | colorful wall art | wood". A pink arrow points from the text "Tags from image" to this list of suggested tags.

K

## Application - Tag Suggestion

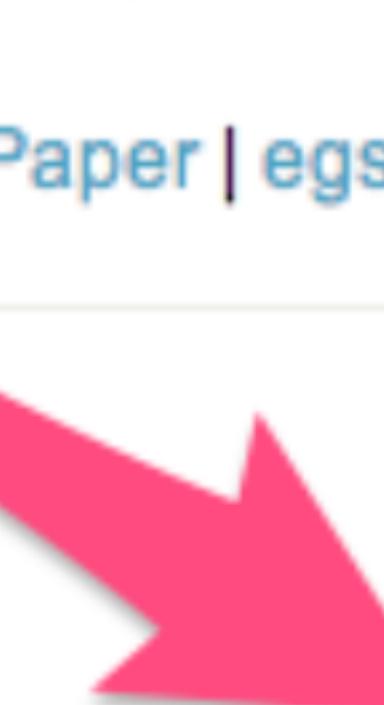


**What will buyers type into search to find your item?**

Tags help buyers find your item when they search on Etsy. Add 13 tags to reach as many Etsy buyers as possible.

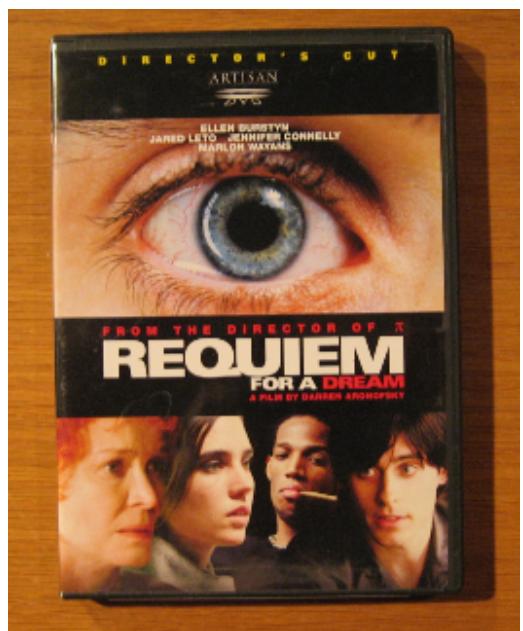
**Tags** [Get ideas](#) | [From image](#) | [From title and description](#)

[geometric](#) | [triangle](#) | [Gift Wrap](#) | [Wrapping Paper](#) | [egst](#) | [wall sticker](#) | [geometric wall art](#) | [DIY home decor](#) | [colorful wall art](#) | [wood](#)

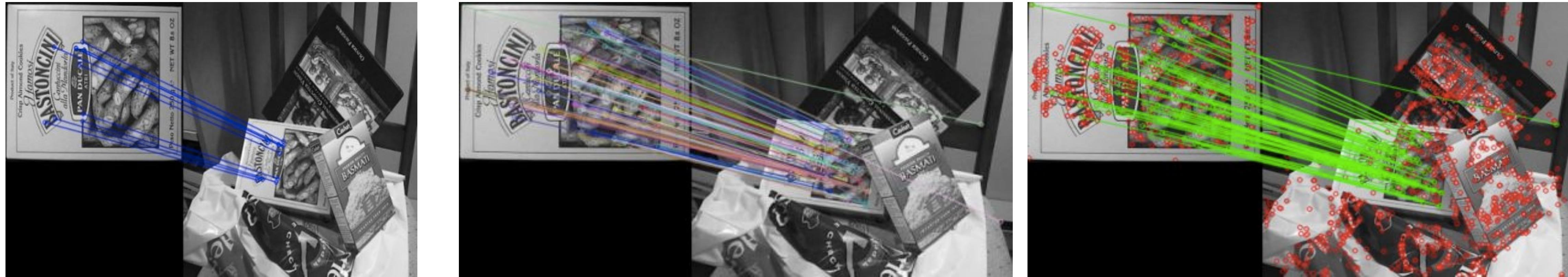


**tags from image**

# Why Features?

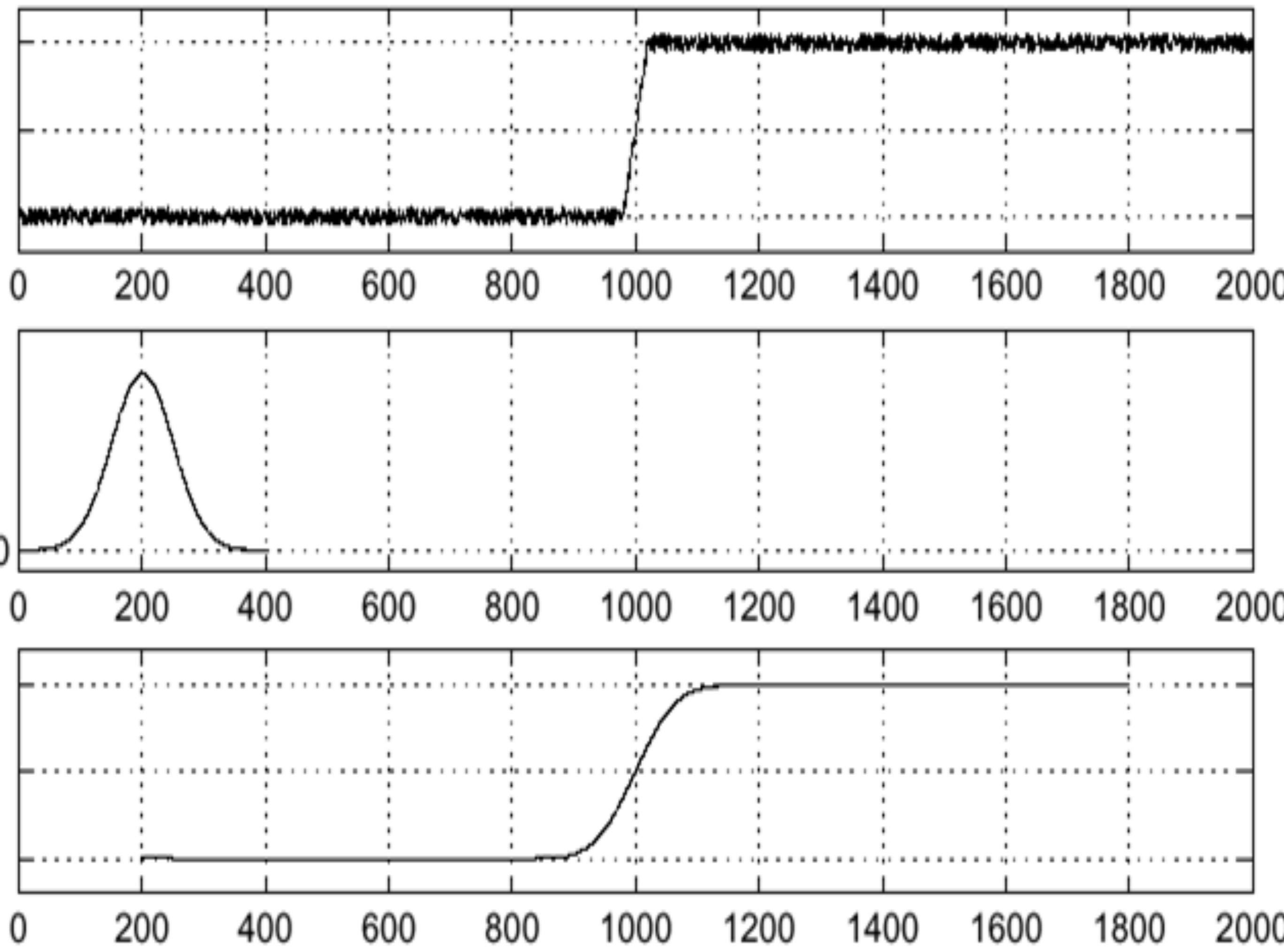


## Features



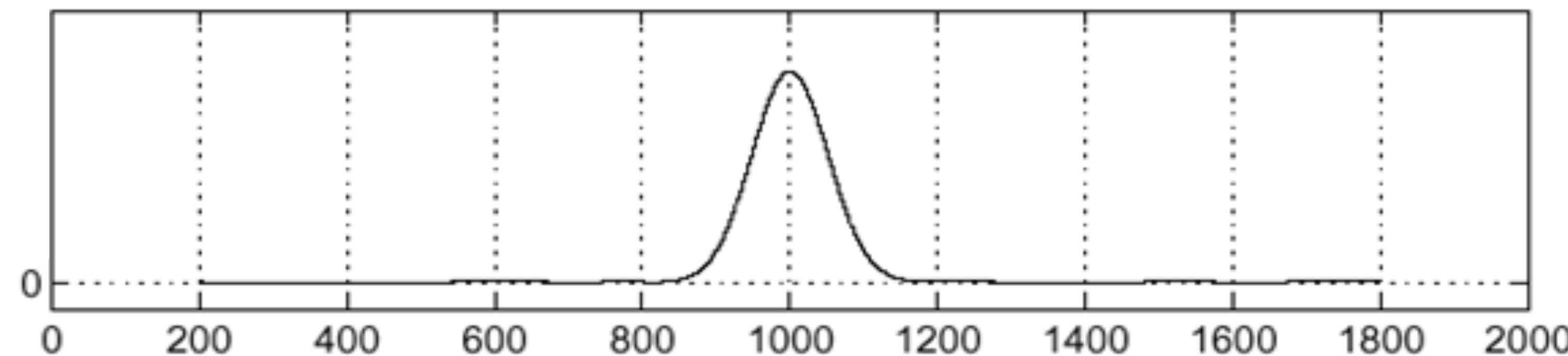
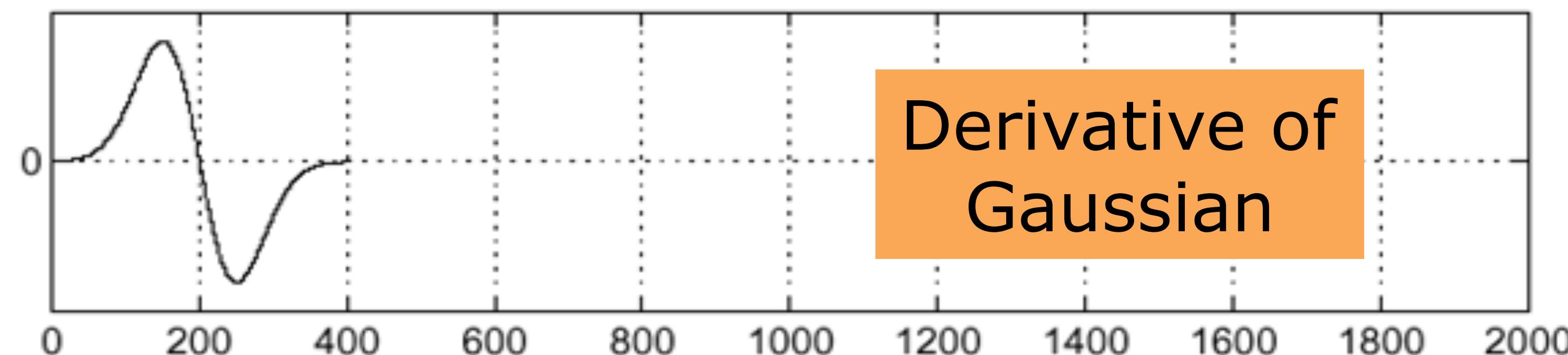
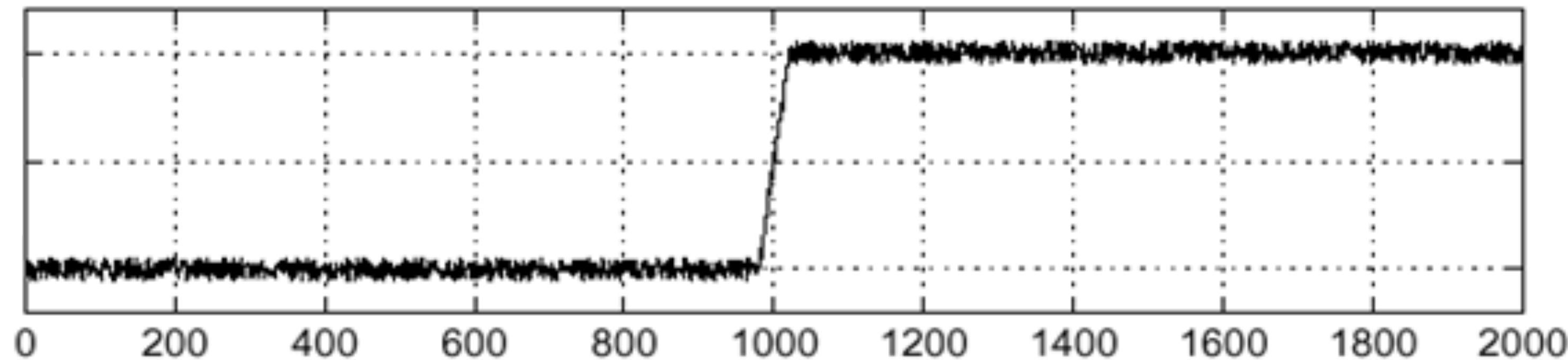
- Rich image content within the local window
- Well-defined signature and position
- Invariant to rotation, scaling, tolerant of lighting changes

## SIFT - Smoothing

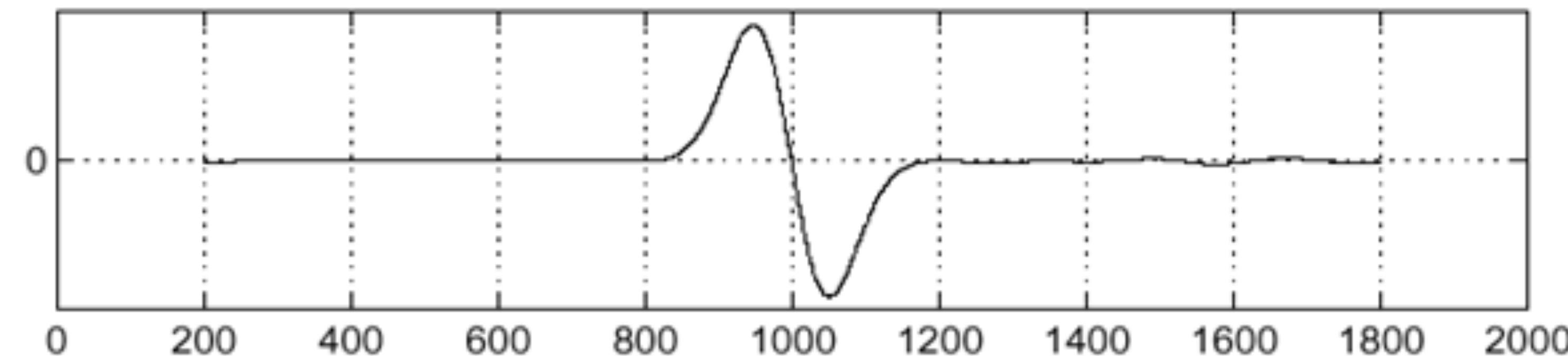
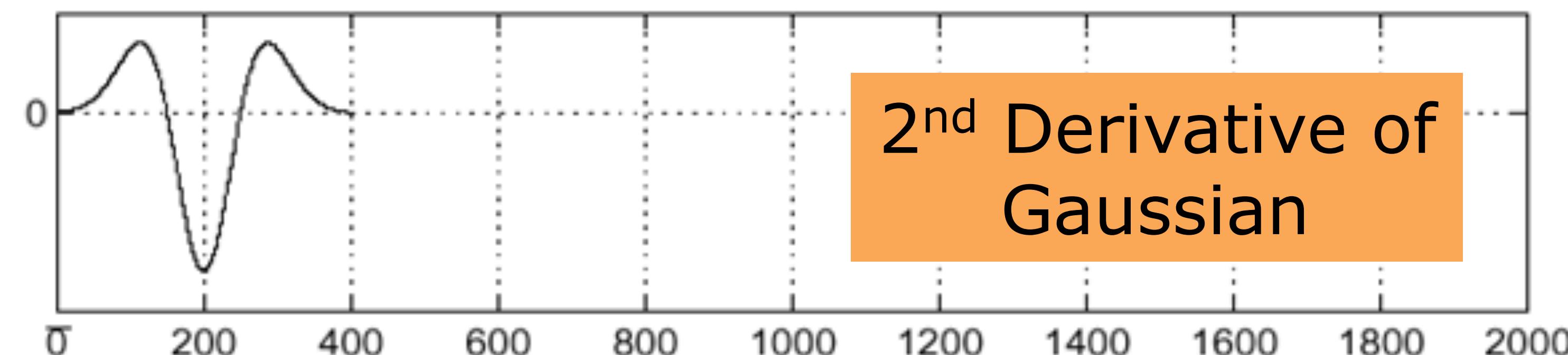
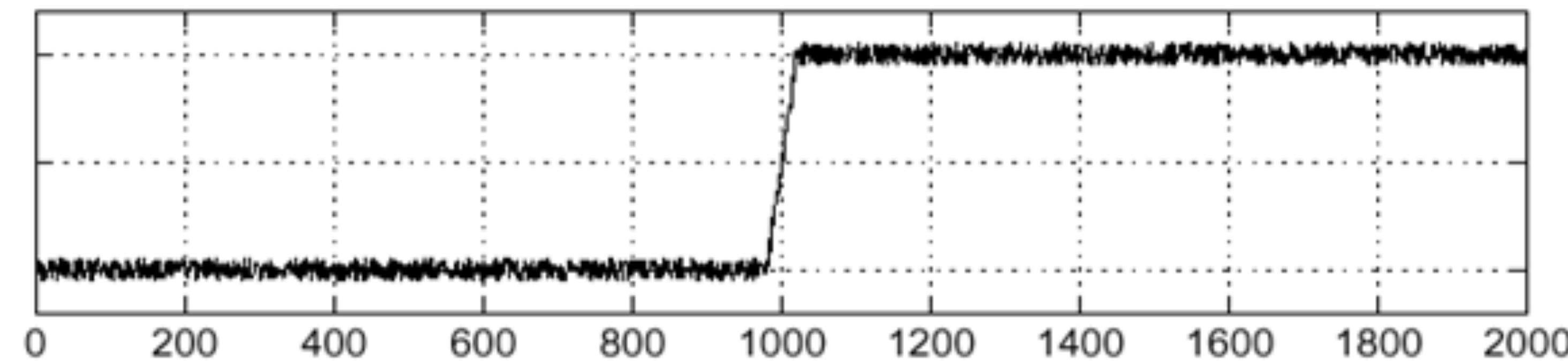


Gaussian

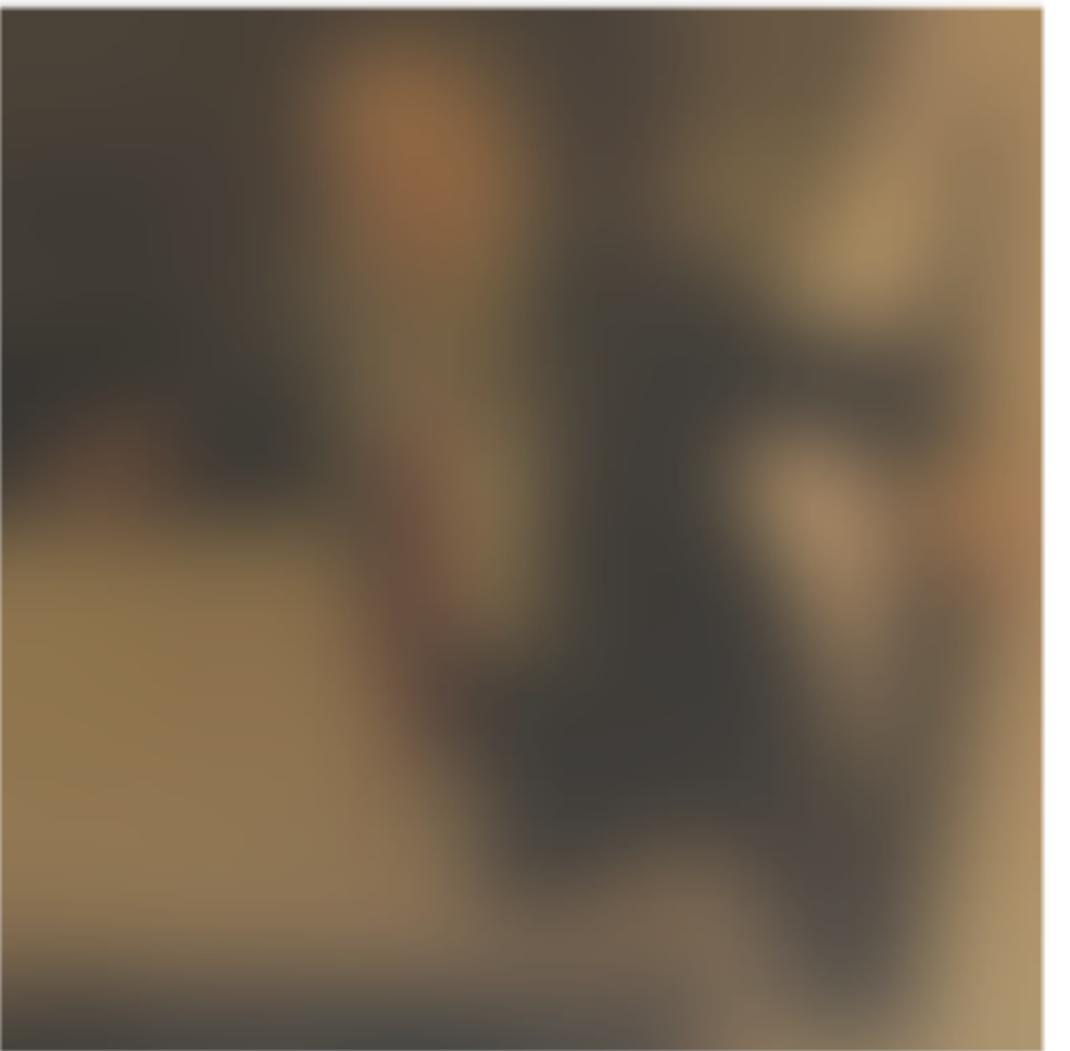
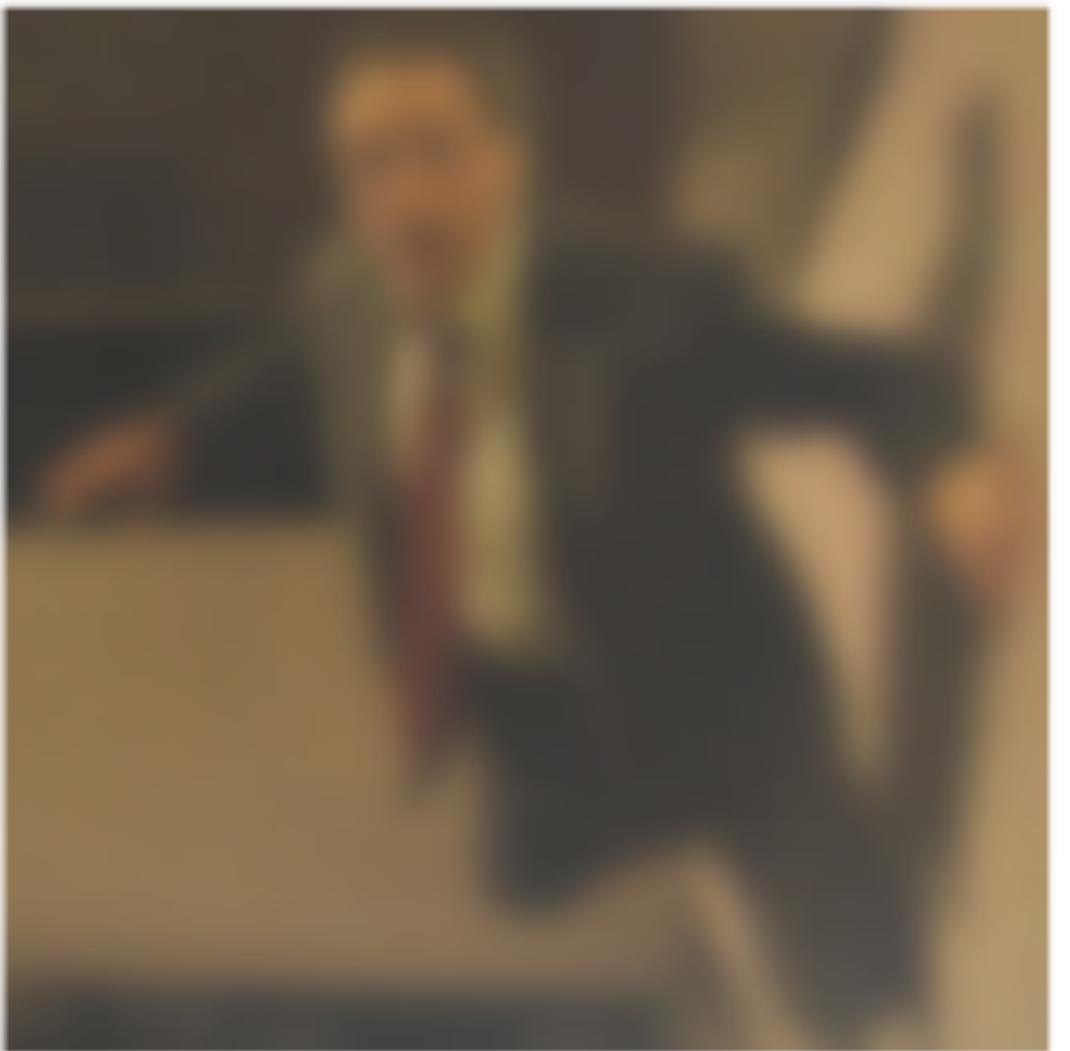
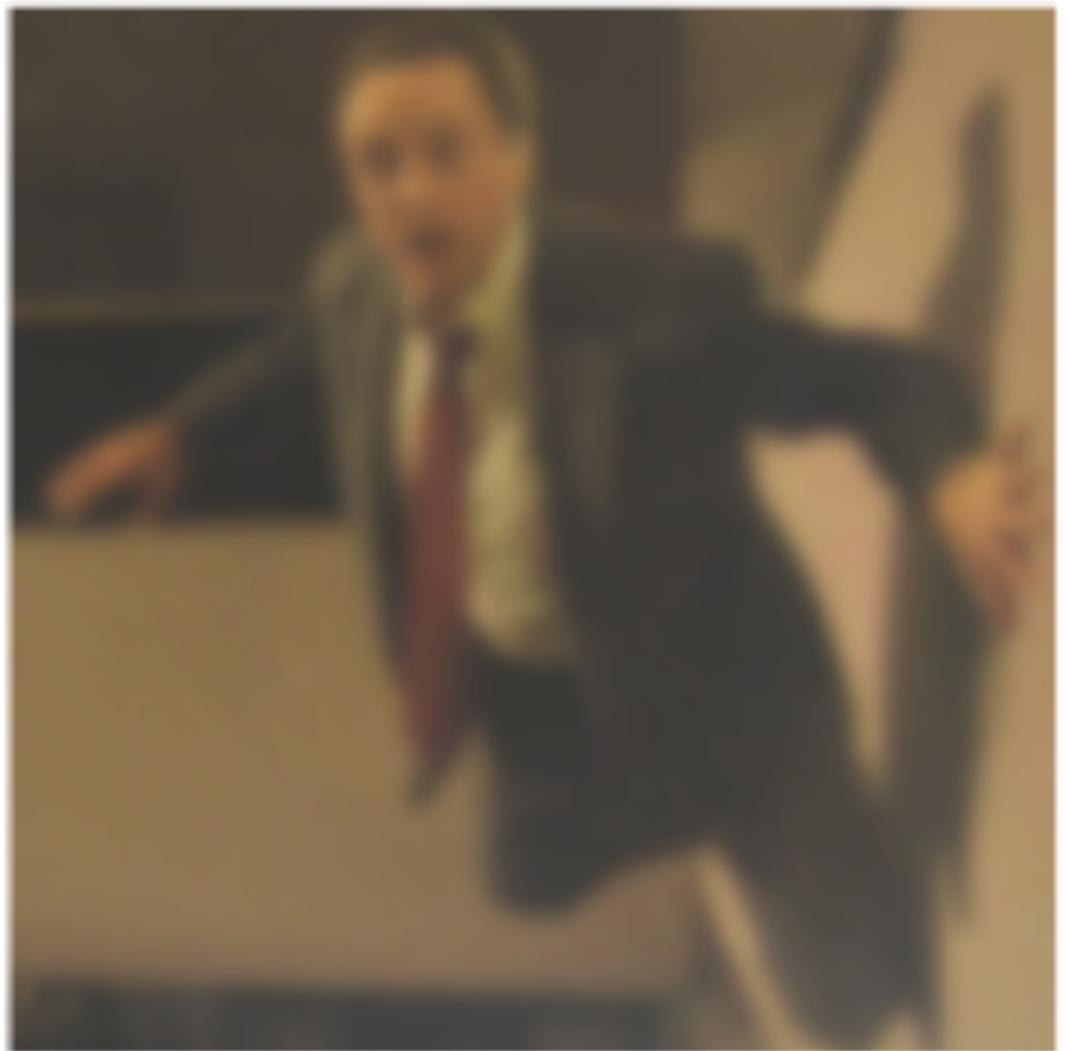
## SIFT - Edges?



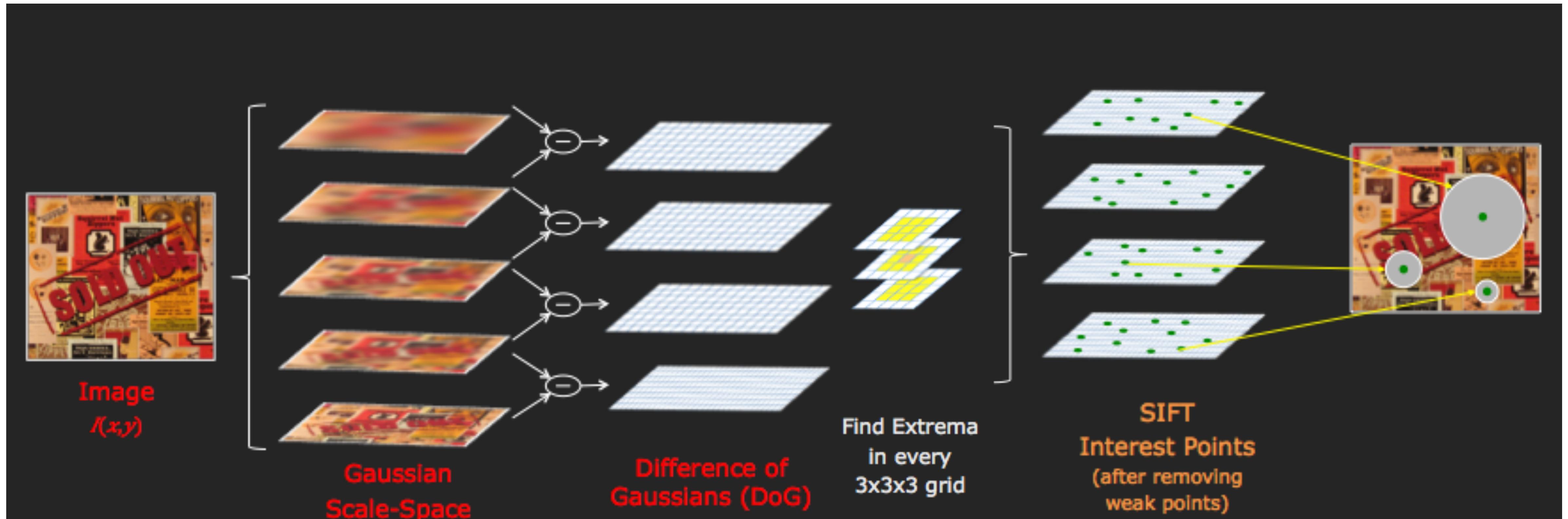
## SIFT - ZRC Edge



## SIFT - Scale Space



# SIFT : Overview

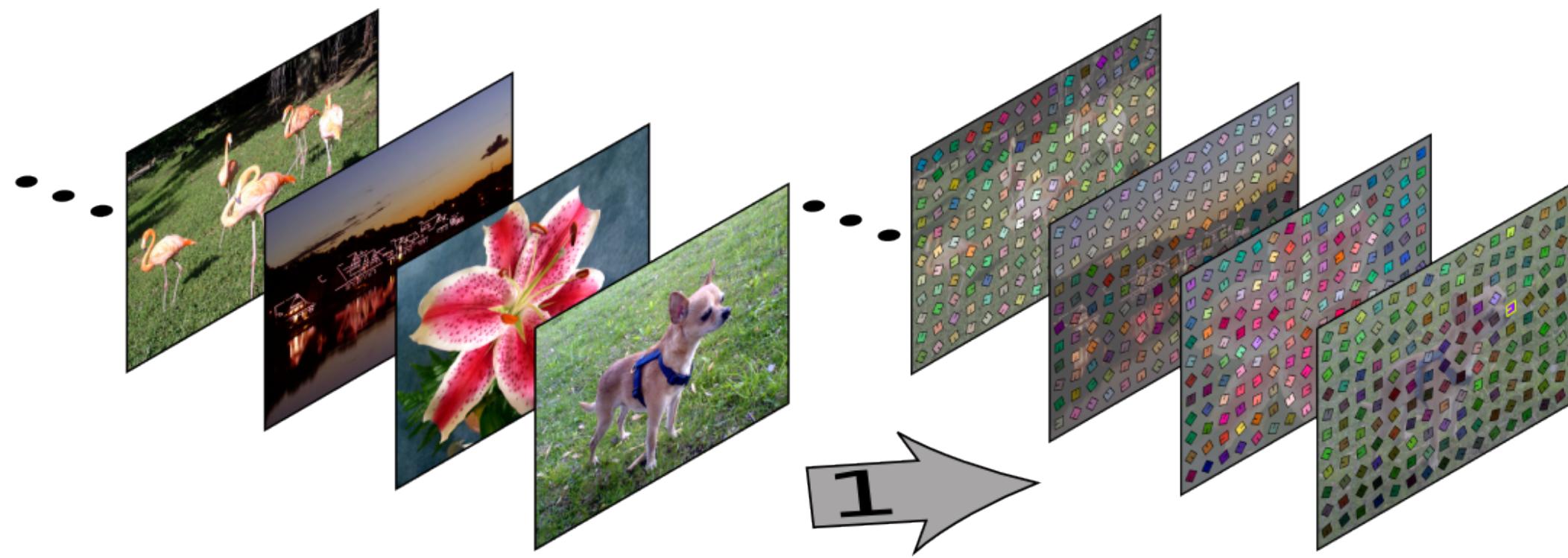


- Many different features: SURF, GIST, HOG, ...

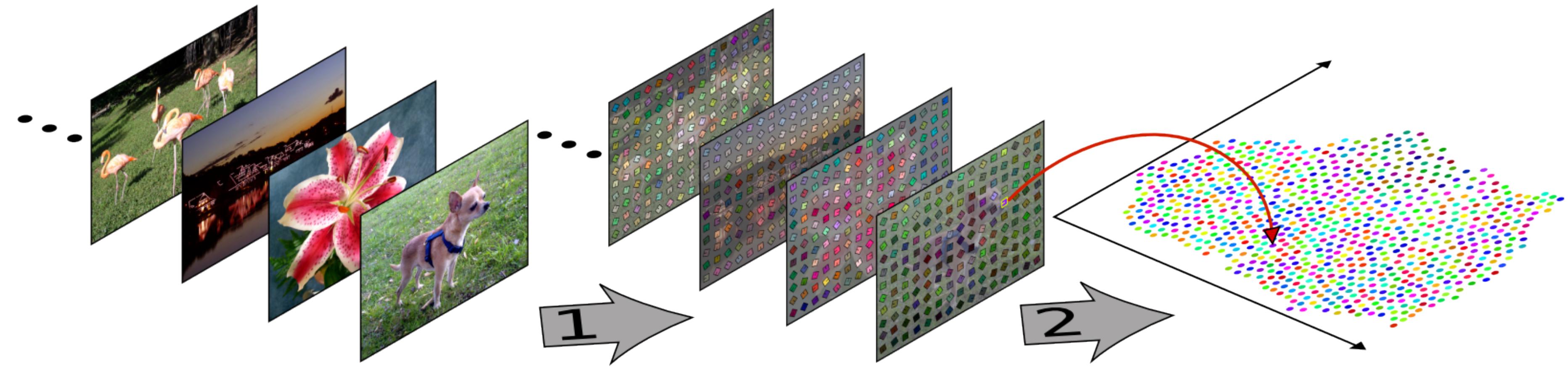
## Codebook ( Visual vocabulary)



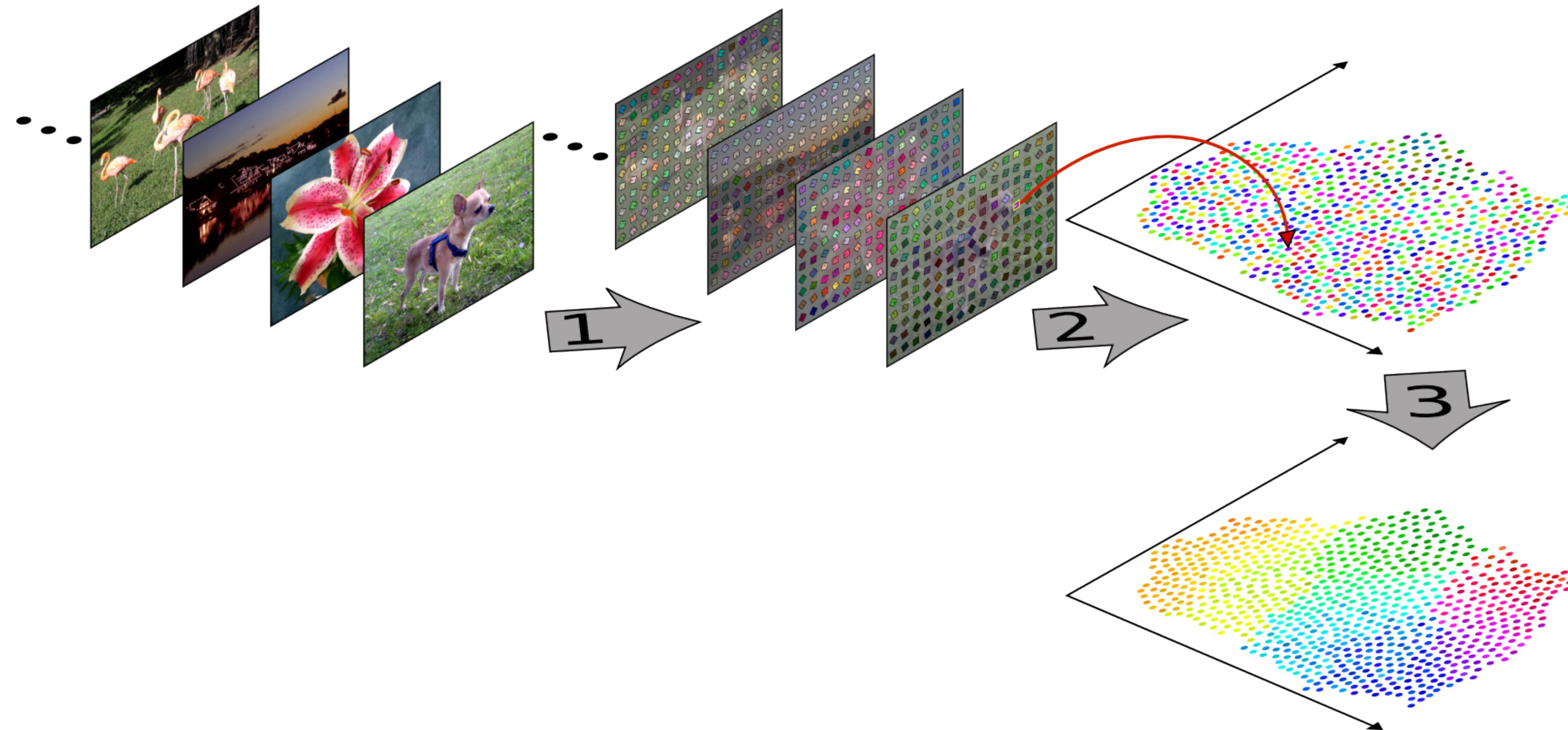
## Codebook ( Visual vocabulary)



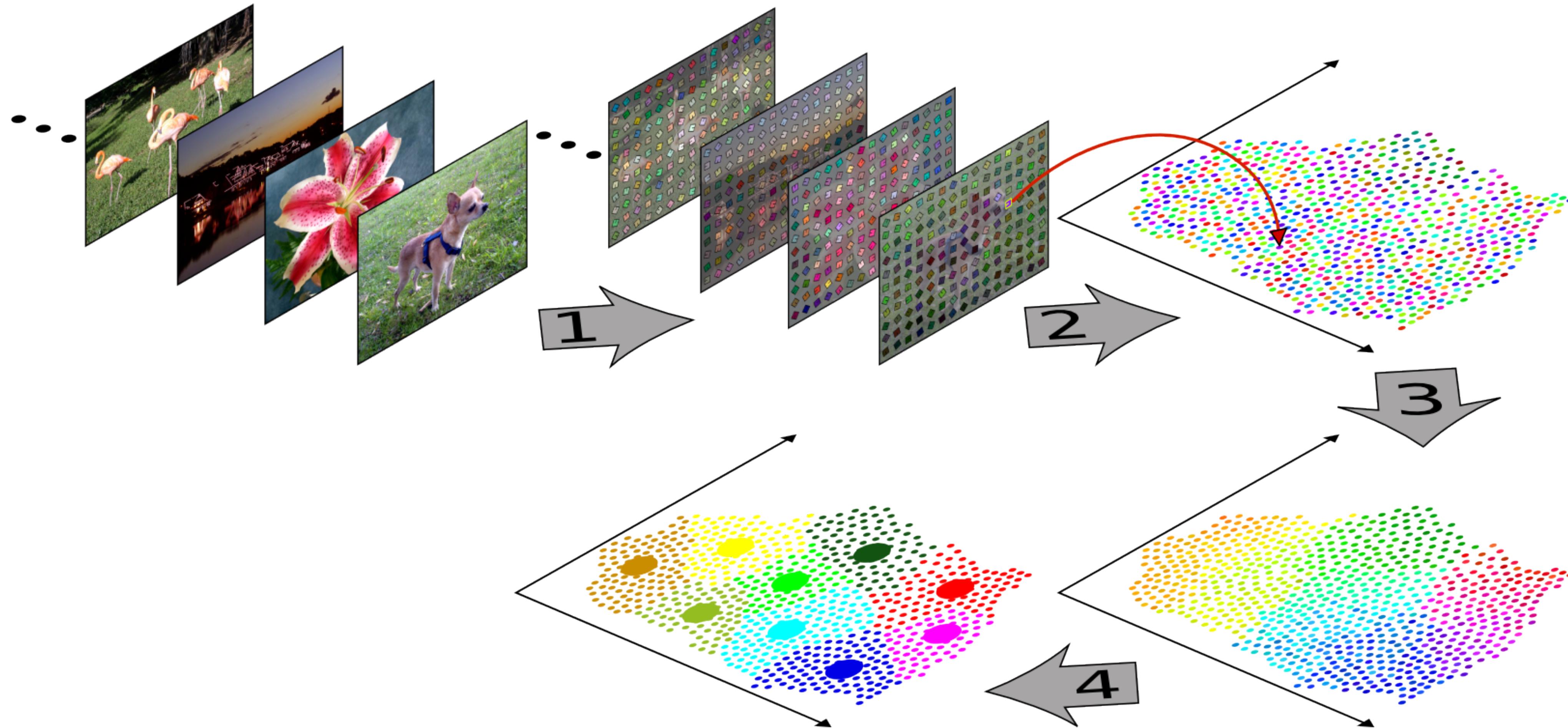
## Codebook ( Visual vocabulary)



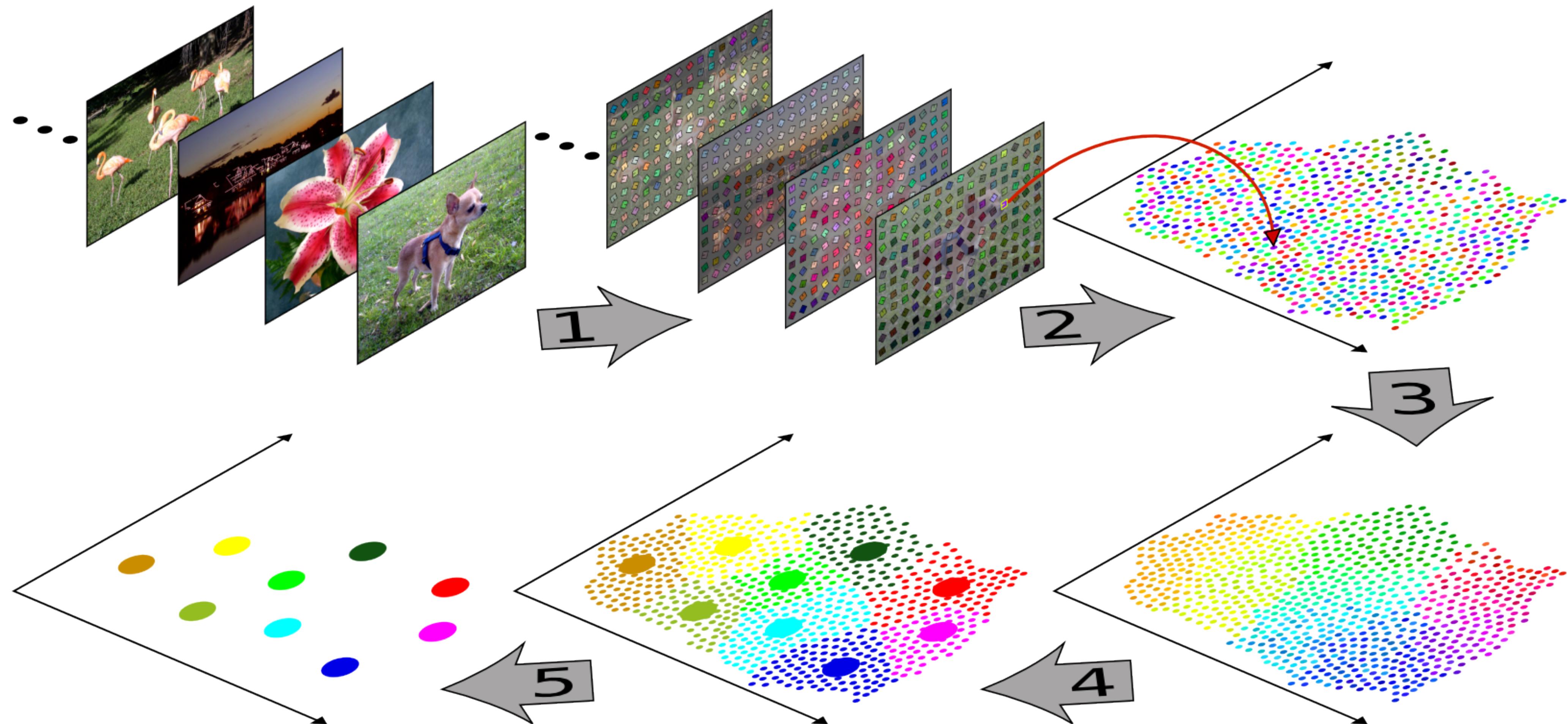
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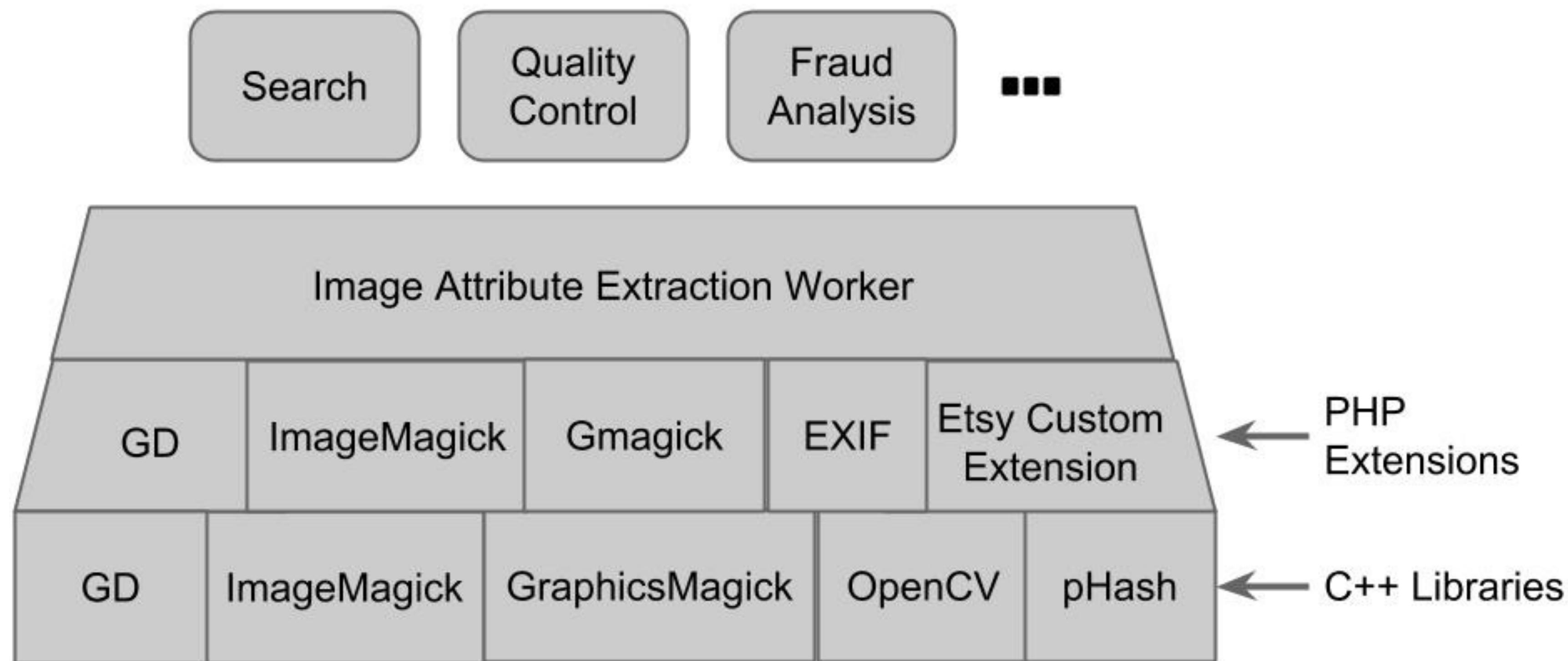


## Codebook ( Visual vocabulary)



# Lessons Learned in Production

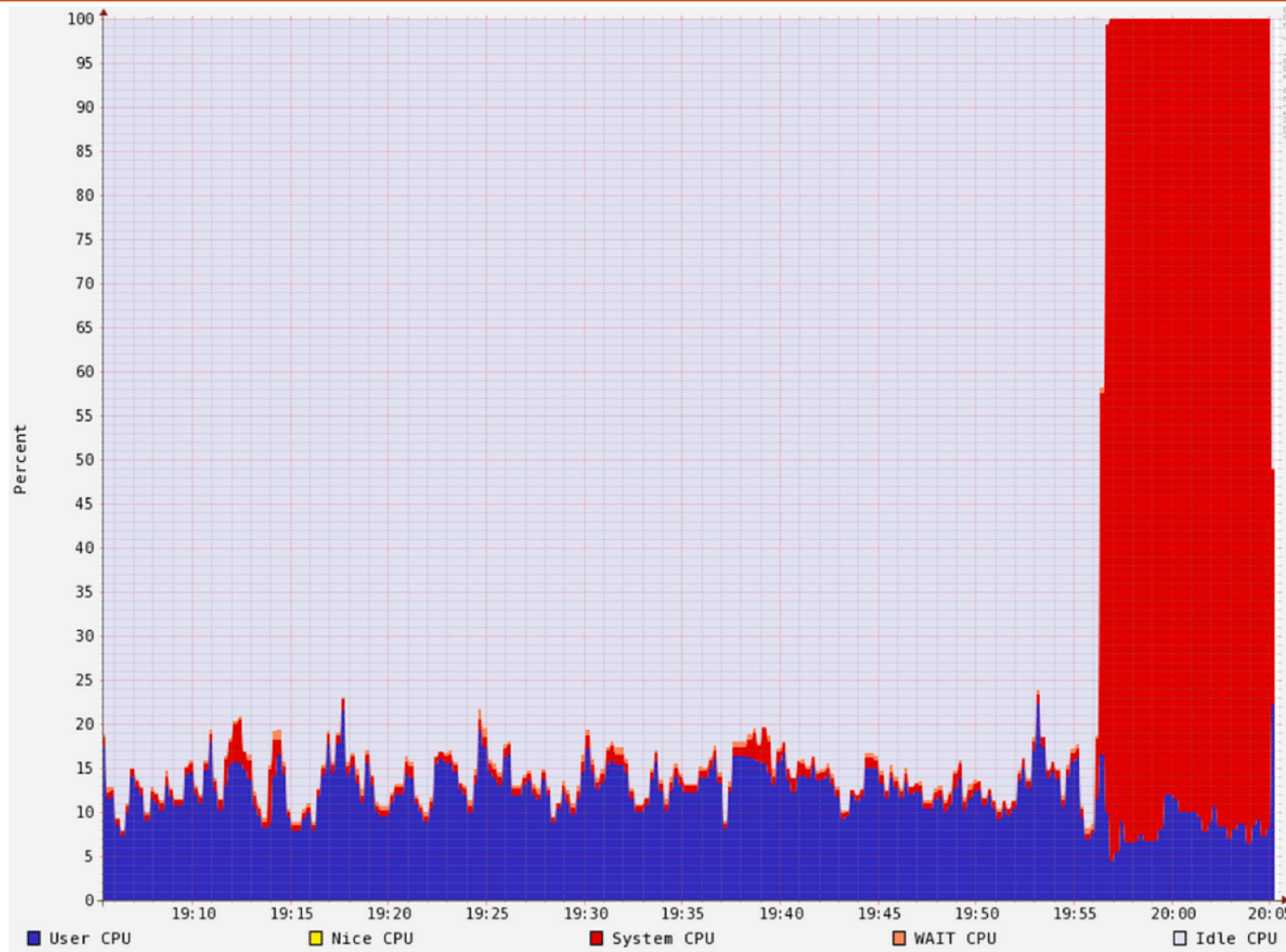
# Software Stack



- Anticipate problems
  - Small iteration
  - Feature flag
  - Ramp up
- Control problems
  - Test automation
  - Sophisticated log monitoring tools
  - Measure and graph everything

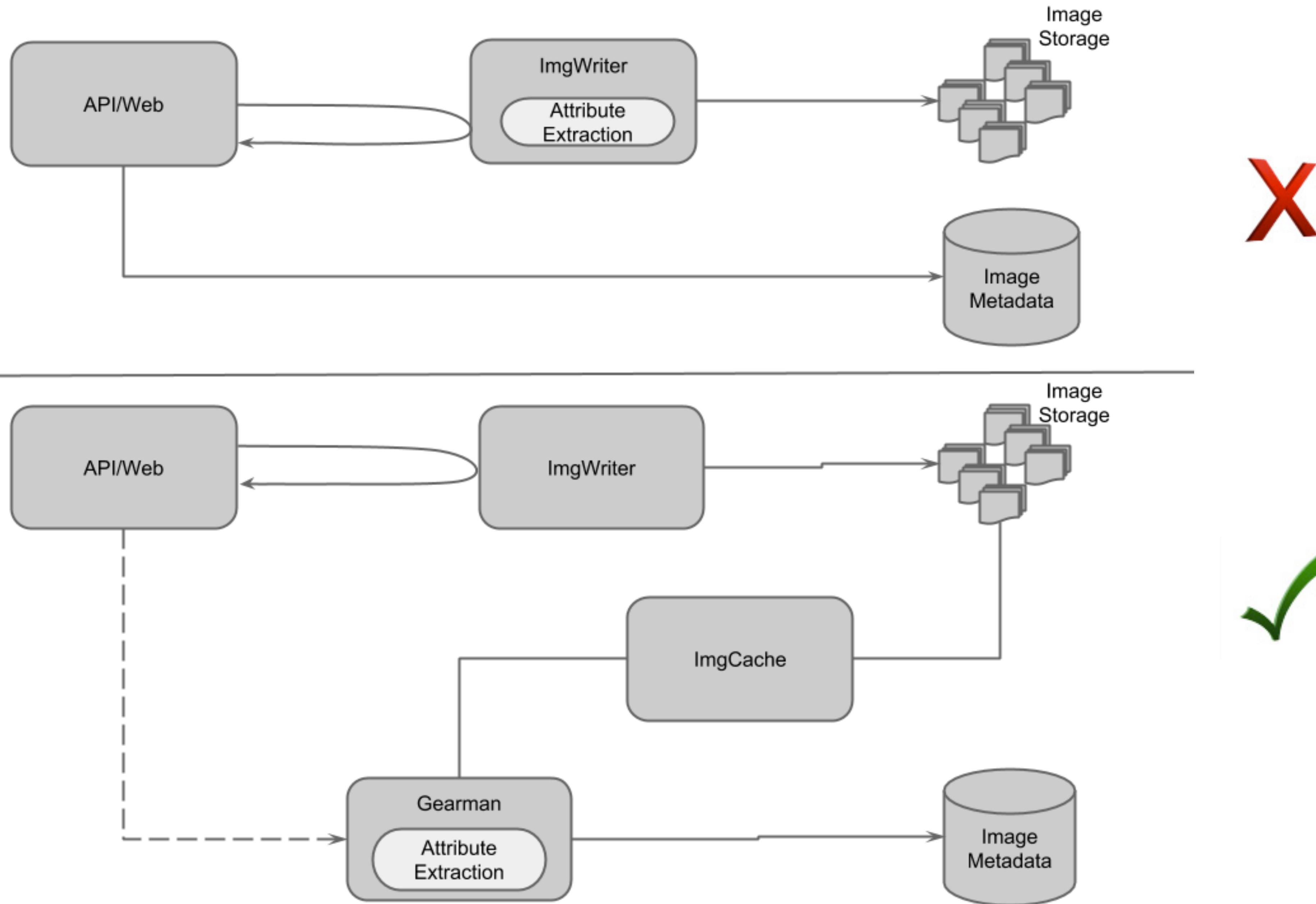
- Unsanitized user data
  - corrupted image file
  - small dimension breaks watermark detection
- Apache child fails to unload extension cleanly
  - Problem does not occur until child processes were recycled

# Delivery - Graph Everything



- Apache configuration tuning
  - E.g., memory configuration
- Storage server runs out of file handles
  - Read file directly from storage server
  - Tie up the file handle too long
  - Small increase of load pushes over capacity

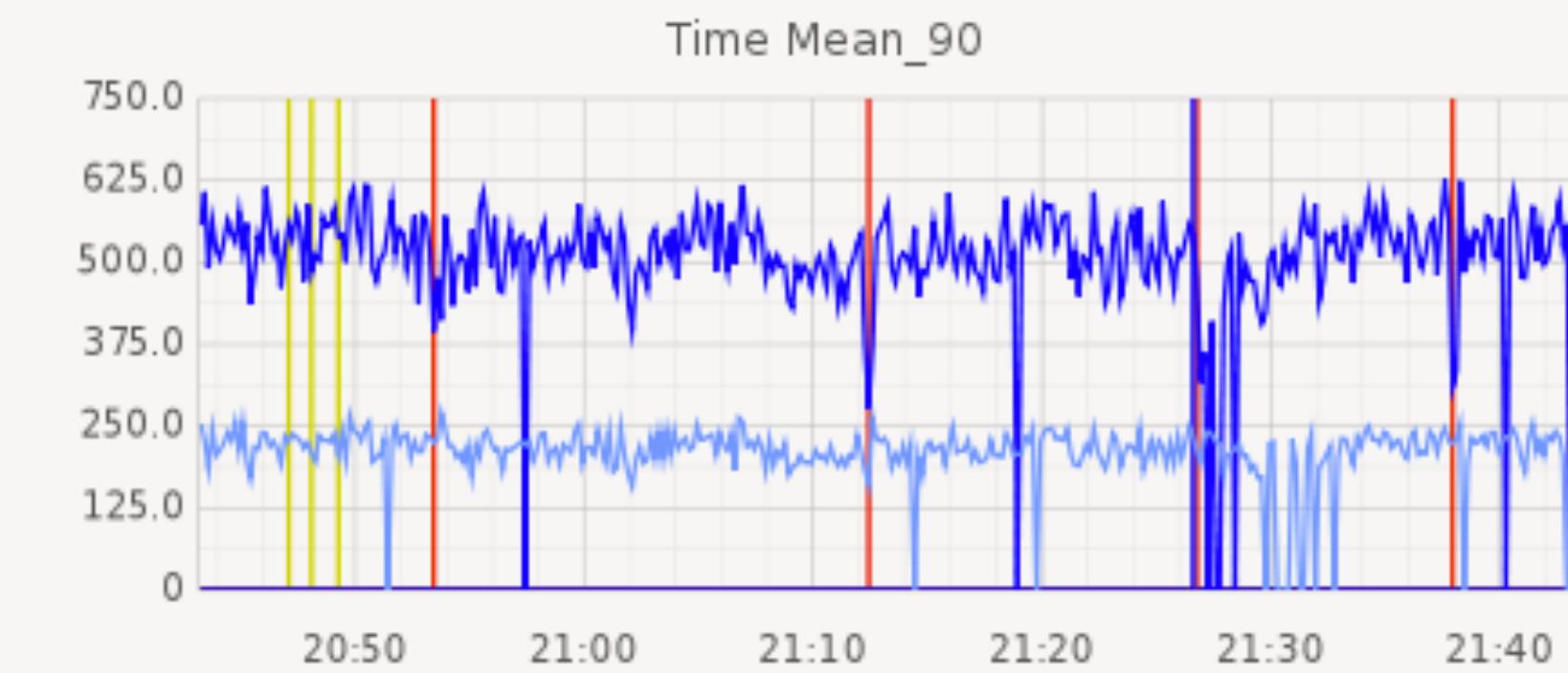
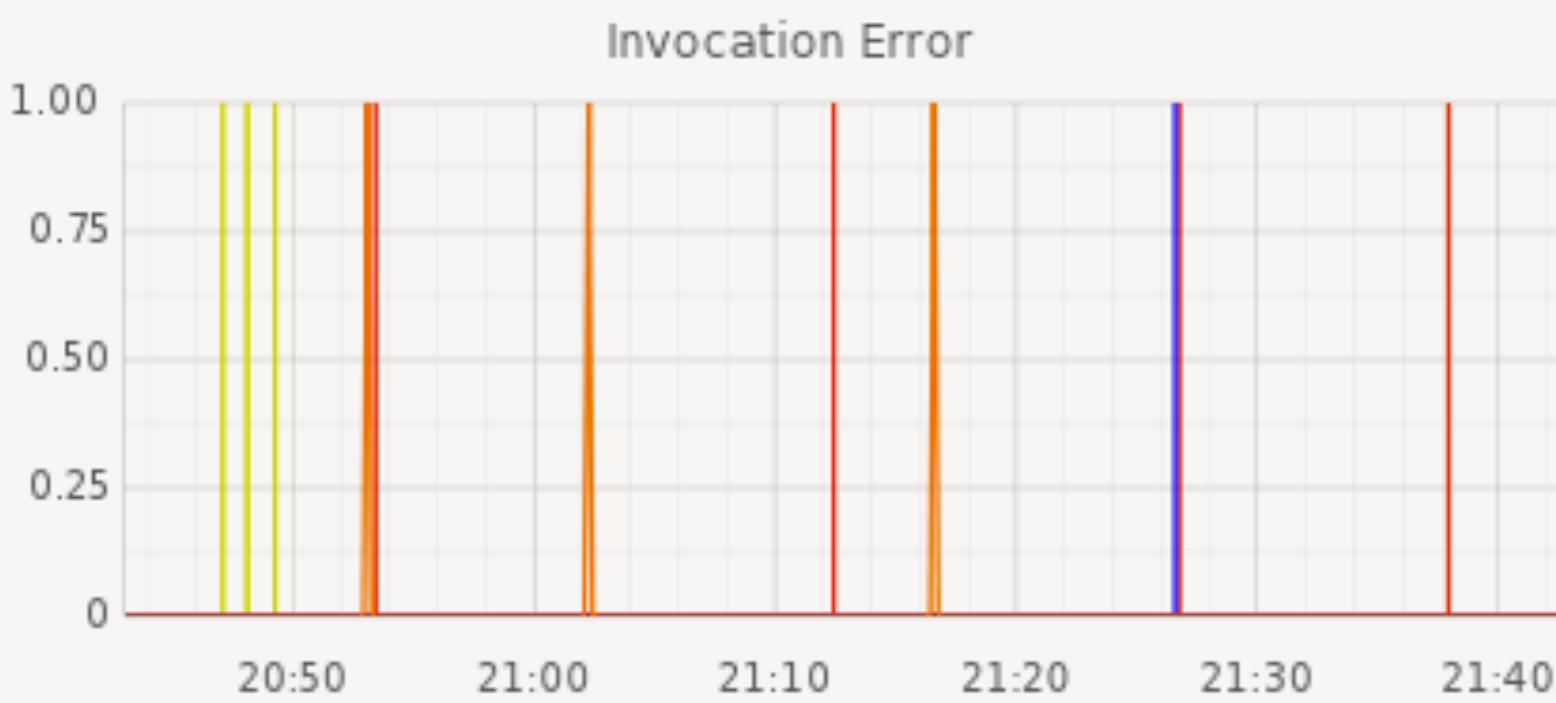
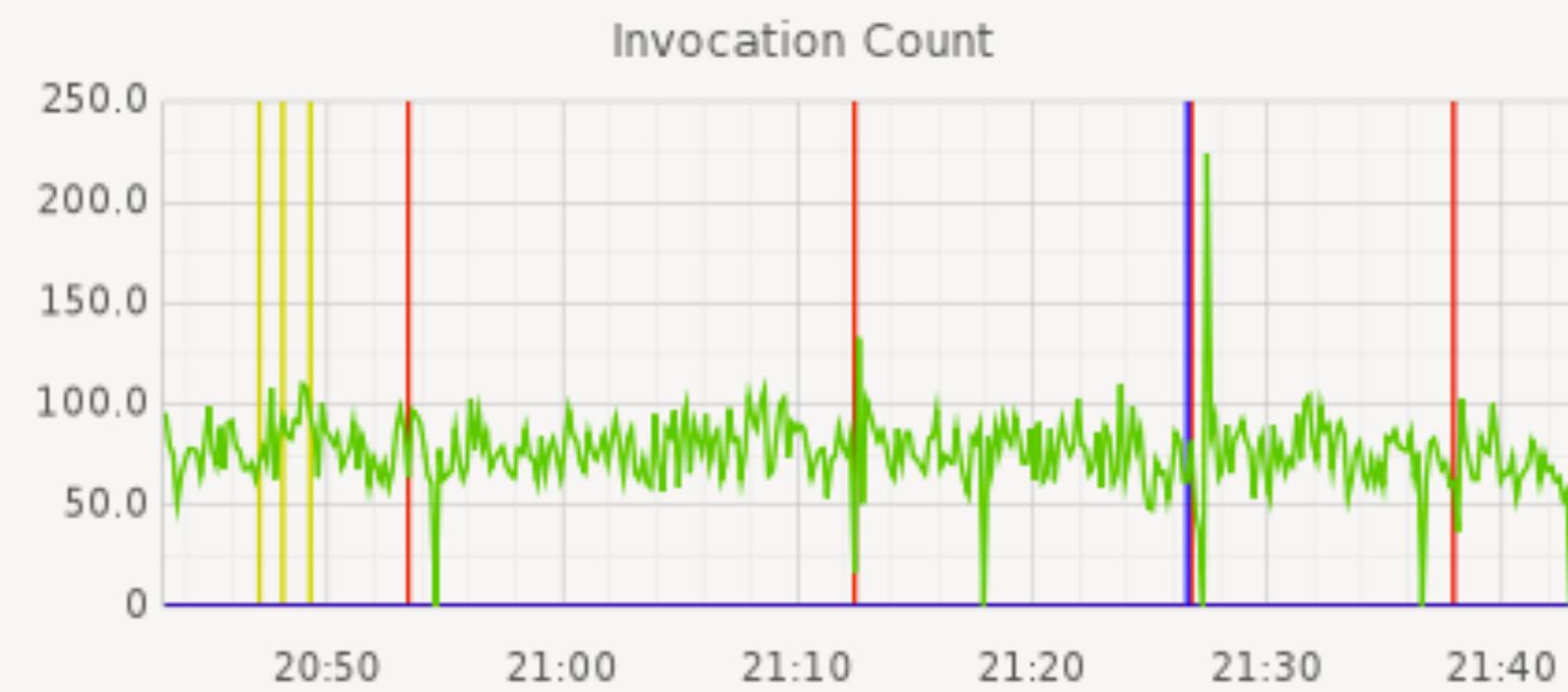
# Image Processing Integration



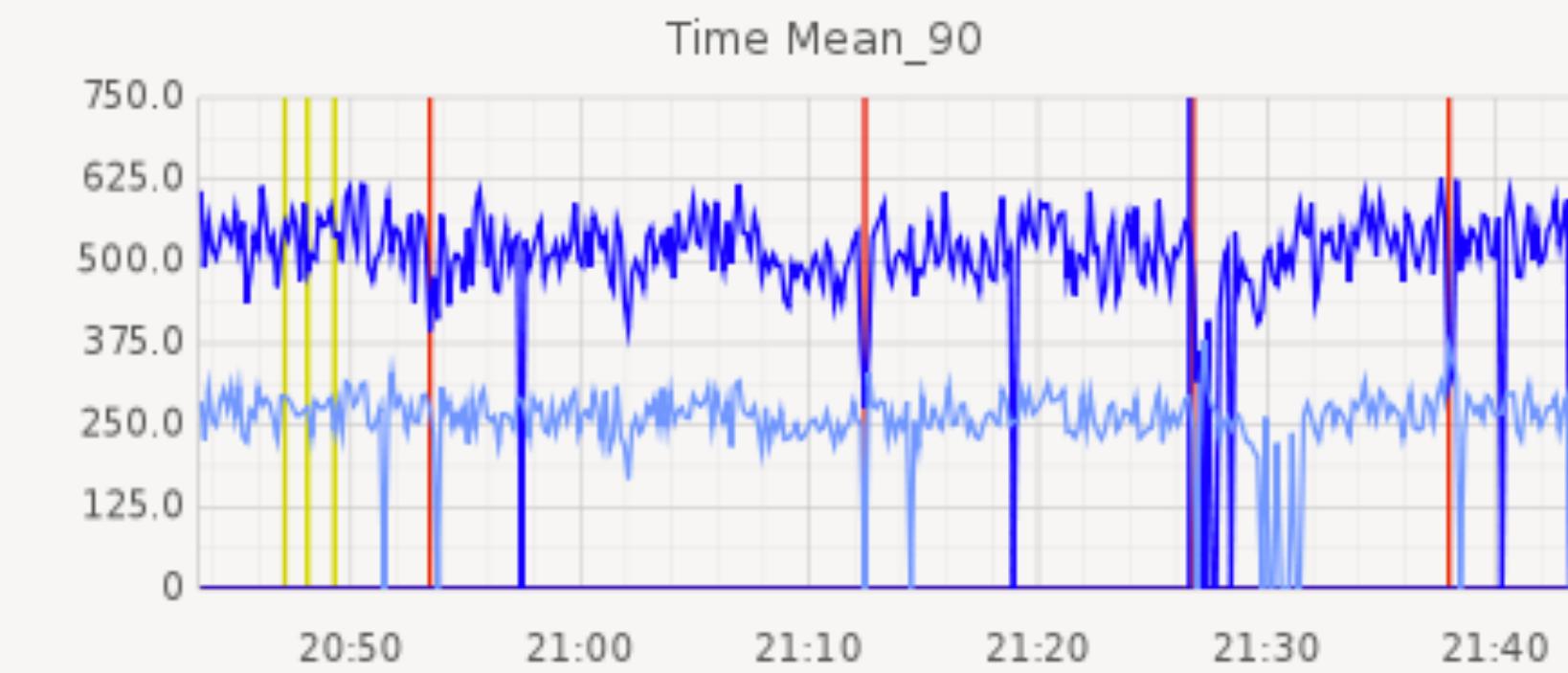
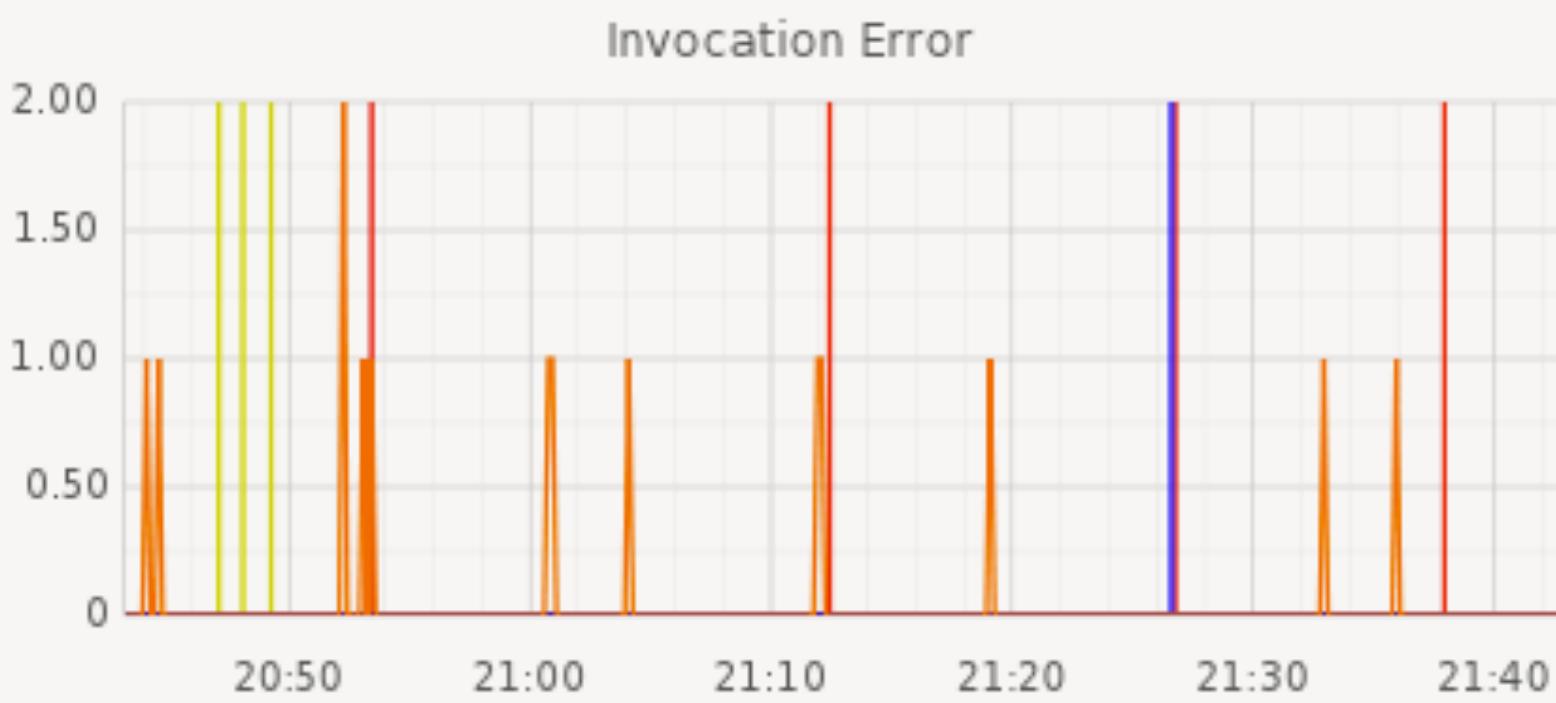
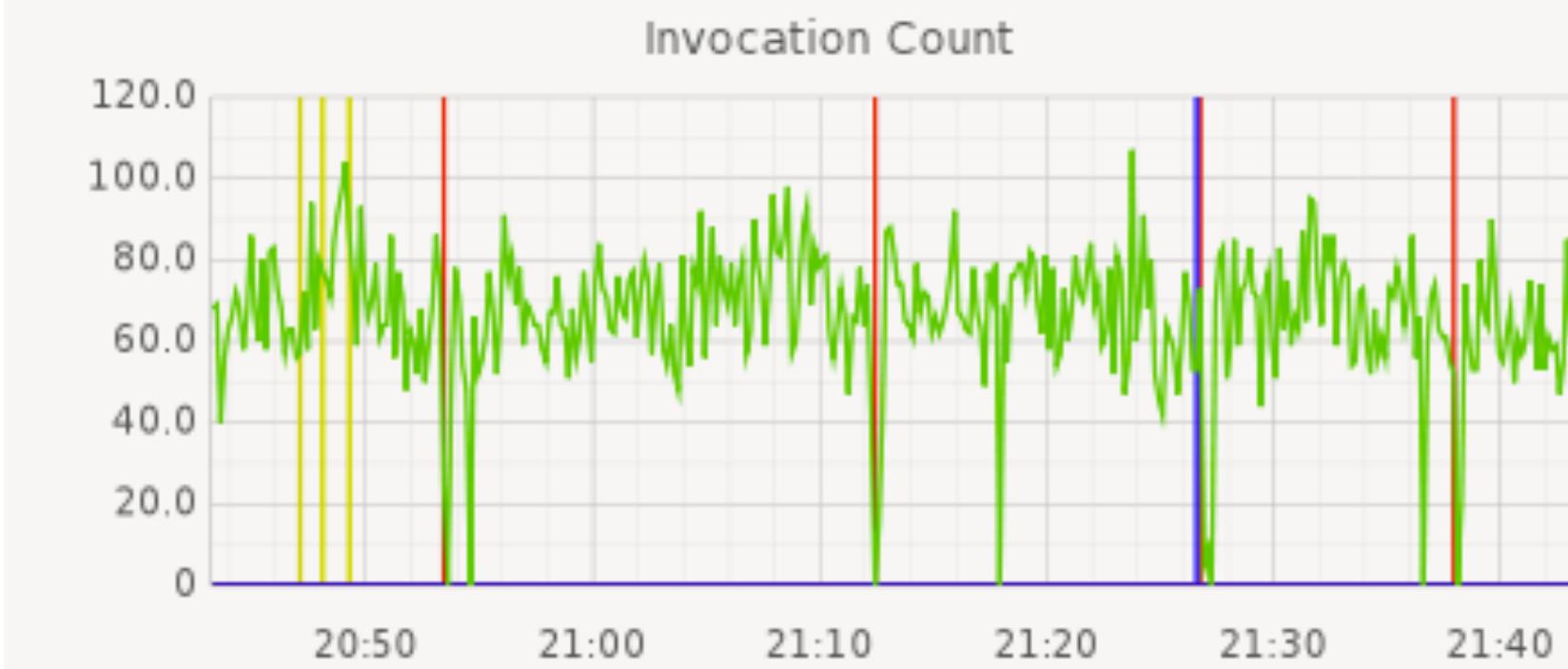
# System Monitoring

## Image Attribute Extraction (1 hour)

### pHash



### Watermark



What's Next?

## Future Plans

- Extract more image attributes
  - Visual vocabulary - to productize our tag suggestion hack week project
- Fuzzy fingerprint
  - More resilient to alteration

- Ride on big data and search infrastructure
  - Similarity search
  - Finding hamming distant search effectively is hard
    - high dimension vectors – 576-bit bitmap
    - large data set – 100 of millions of images
  - Data science team's novel approach: Neural networks

Questions?

Thank You!

<http://et.sy/anpvxiv>