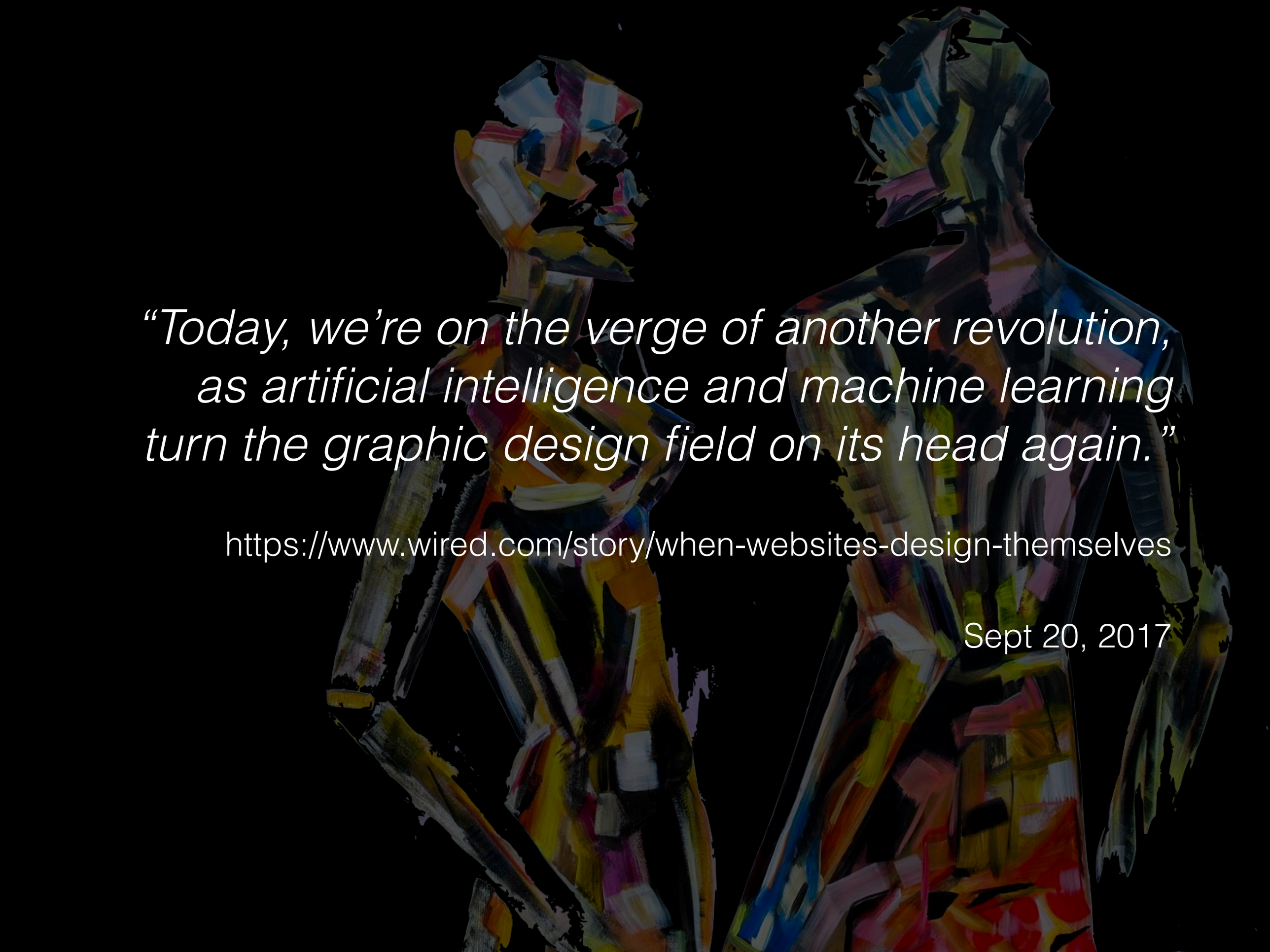
Learning Visual Importance for Graphic Designs and Data Visualizations

Zoya Bylinskii, Nam Wook Kim, Peter O'Donovan, Sami Alsheikh, Spandan Madan, Hanspeter Pfister, Fredo Durand, Bryan Russell, Aaron Hertzmann



“Today, we’re on the verge of another revolution,
as artificial intelligence and machine learning
turn the graphic design field on its head again.”

https://www.wired.com/story/when-websites-design-themselves

Sept 20, 2017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RUNNING PLANET
25
endurance tips to
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the next level
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Our experts discuss all
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Get set for
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OCTOBER 2016


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Learning Visual Importance

- bottom-up pop-out

  fonts, colors, styles

- bottom-up pop-out

  fonts, colors, styles

- bottom-up pop-out

  fonts, colors, styles

- bottom-up pop-out

  fonts, colors, styles

- design elements

  title, annotation, visual

- bottom-up pop-out

  fonts, colors, styles

- design elements

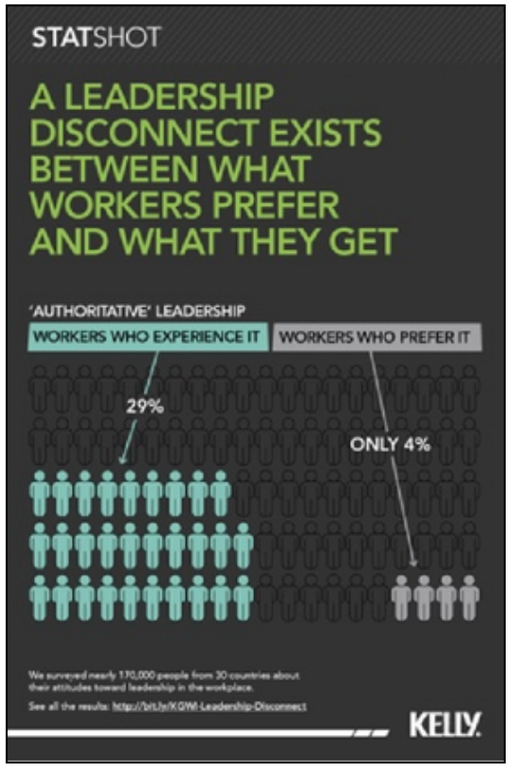
  title, annotation, visual

- element locations

  layout priors

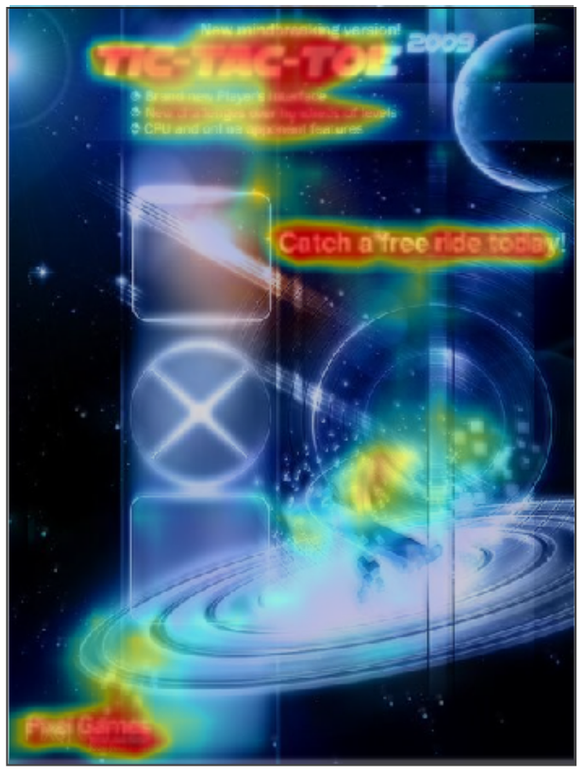
Retargeting

Thumbnailing

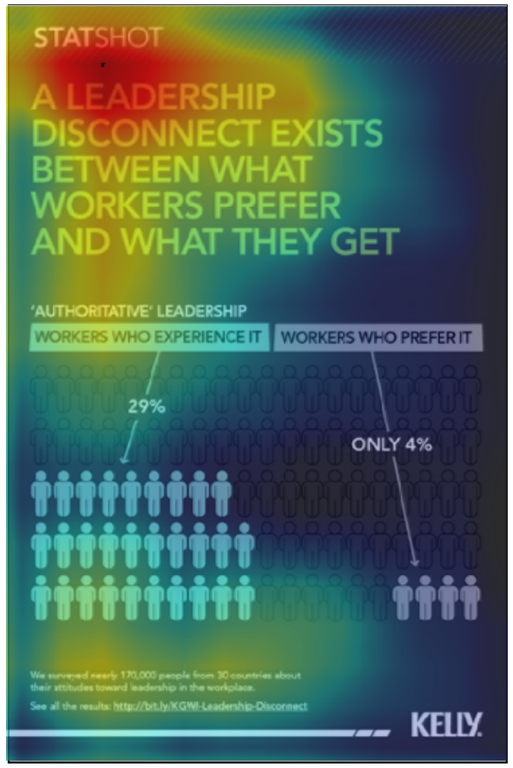


Design feedback

Retargeting

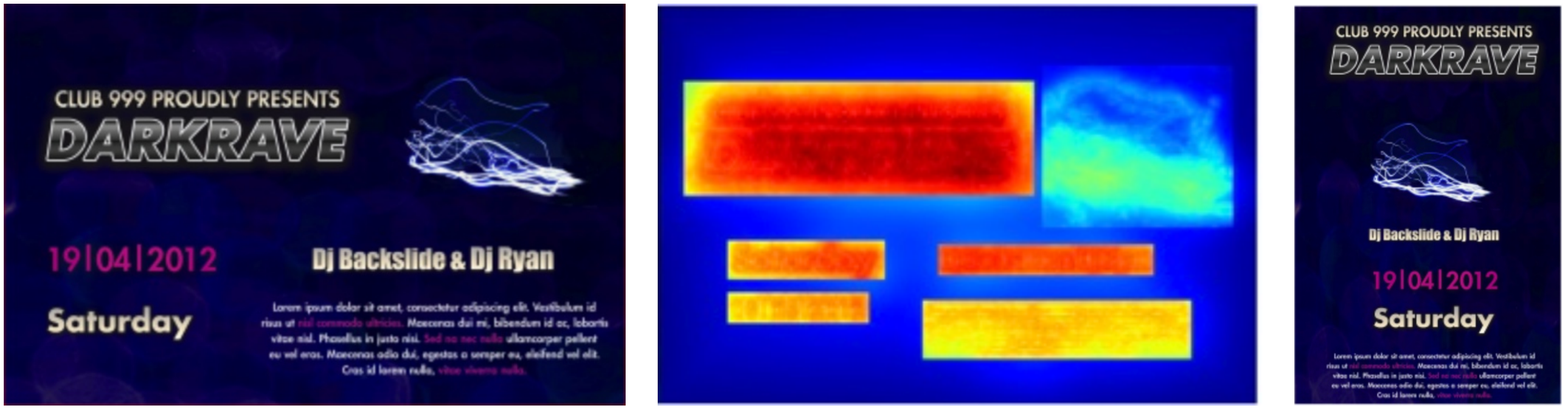


Thumbnailing



Design feedback

related work

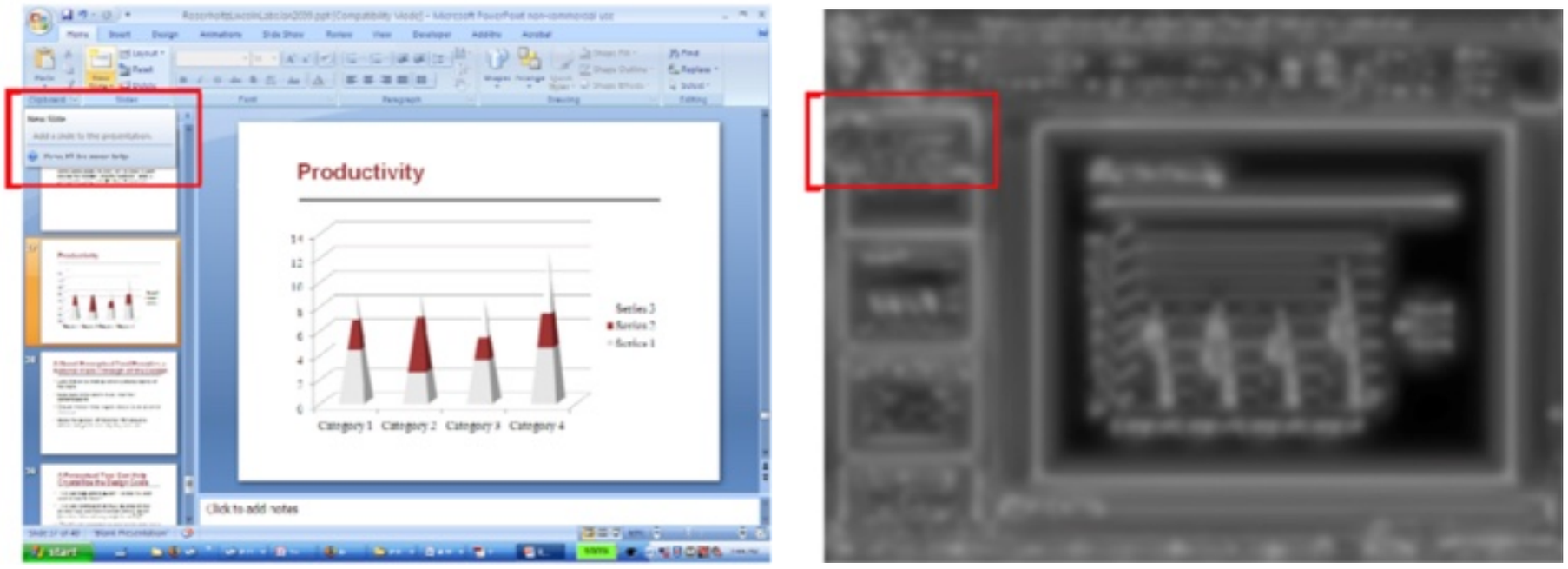


O’Donovan, Agarwala, Hertzmann [TVCG’14]

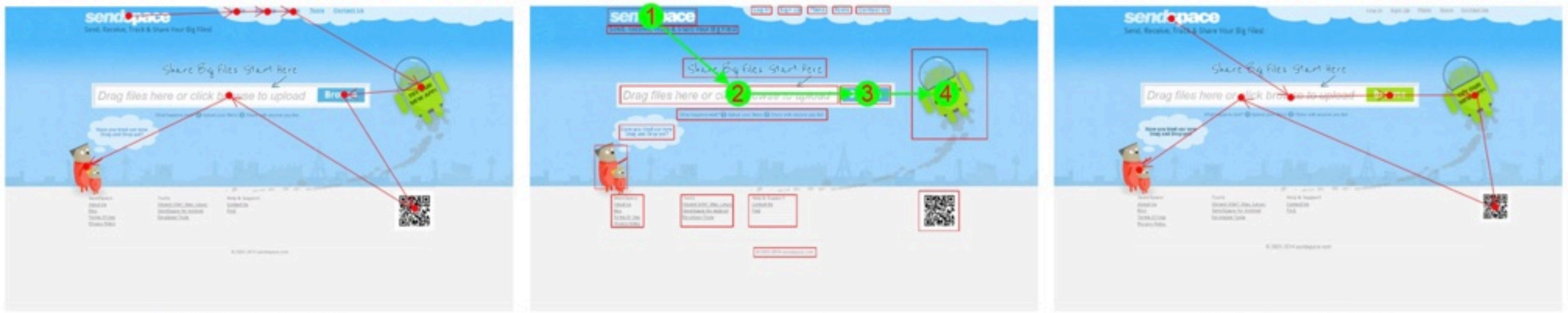
O’Donovan, Agarwala, Hertzmann [CHI’15]

Graphic Design Importance (GDI) dataset

related work



Rosenholtz, Dorai, Freeman [ACM 2011]



Pang, Cao, Lau, Chan [Siggraph Asia'16]

How to define and measure **importance**?

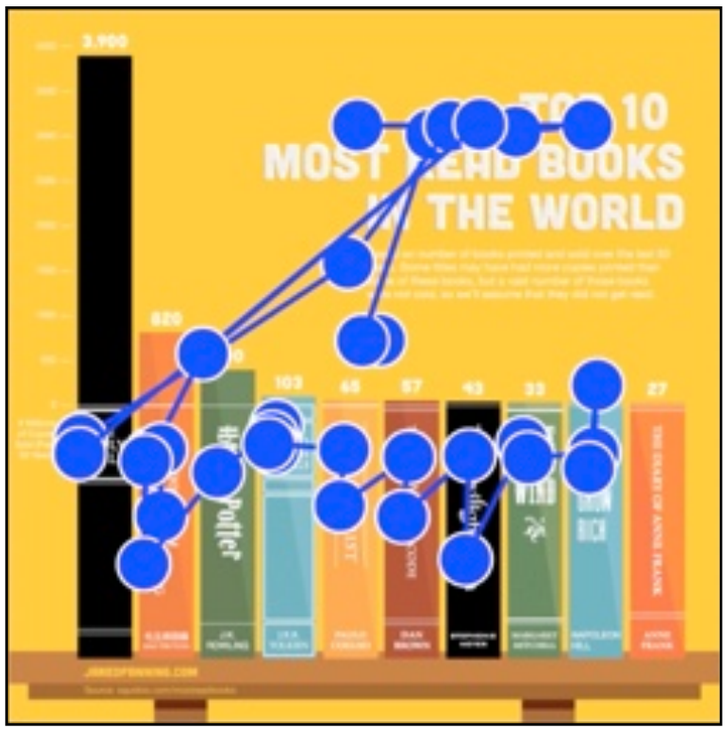
- Eye fixations

- Mouse clicks

- Explicit importance annotations

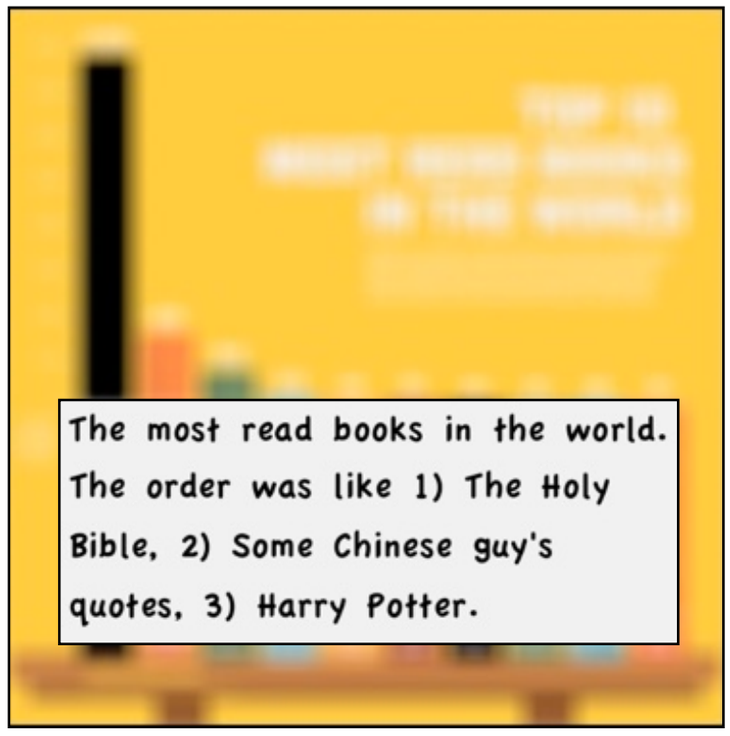
data collection → eye fixations

Eye-tracking



Memory

Comprehension



massvis.mit.edu

What Makes a Visualization Memorable?[InfoVis 2013]
Beyond Memorability: Visualization Recognition and Recall [InfoVis 2015]

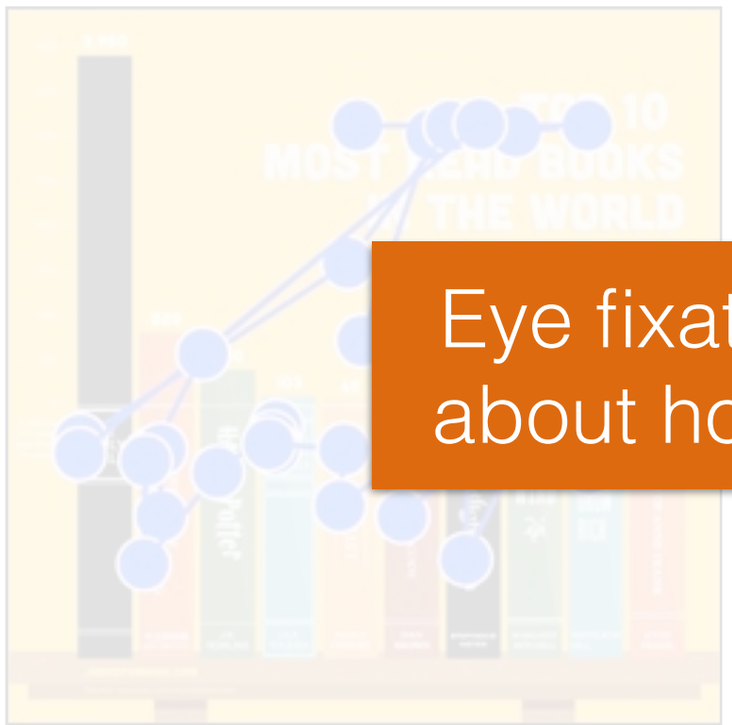
data collection

eye fixations

Eye-tracking

Memory

Comprehension



Eye fixations can give us important clues about how people perceive visualizations

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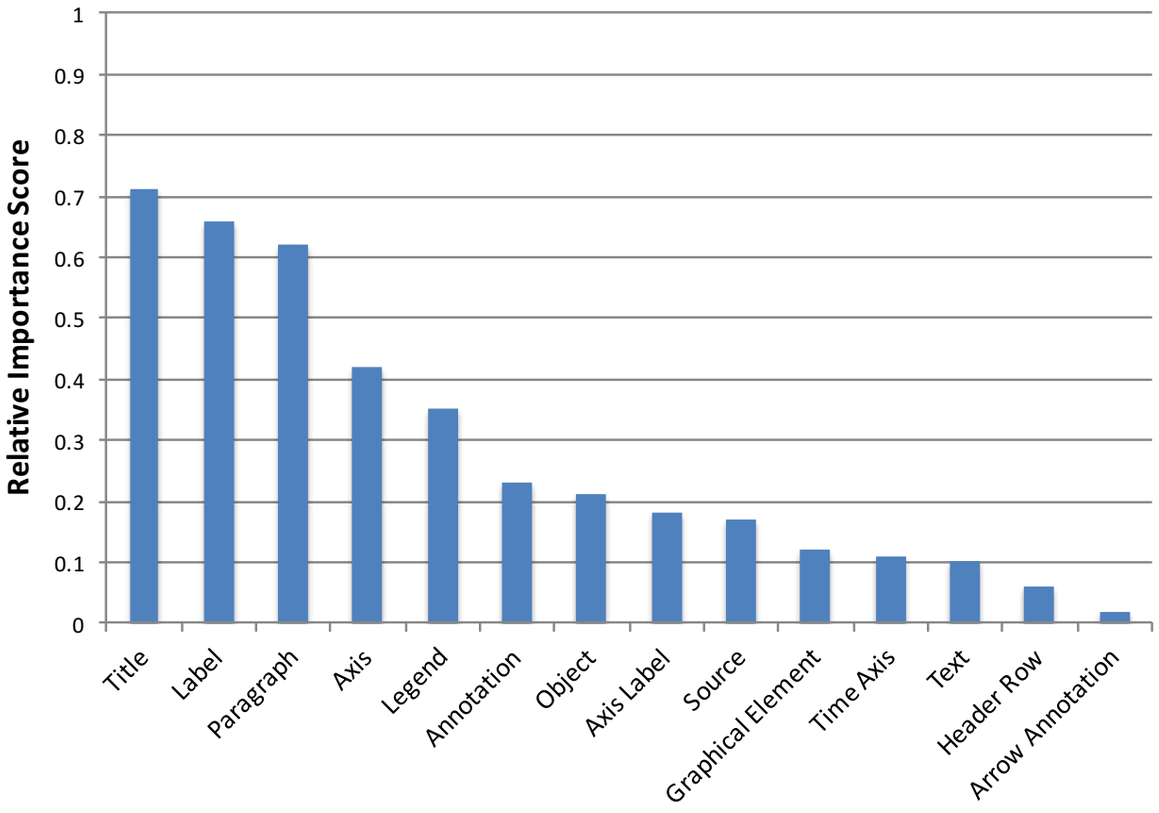
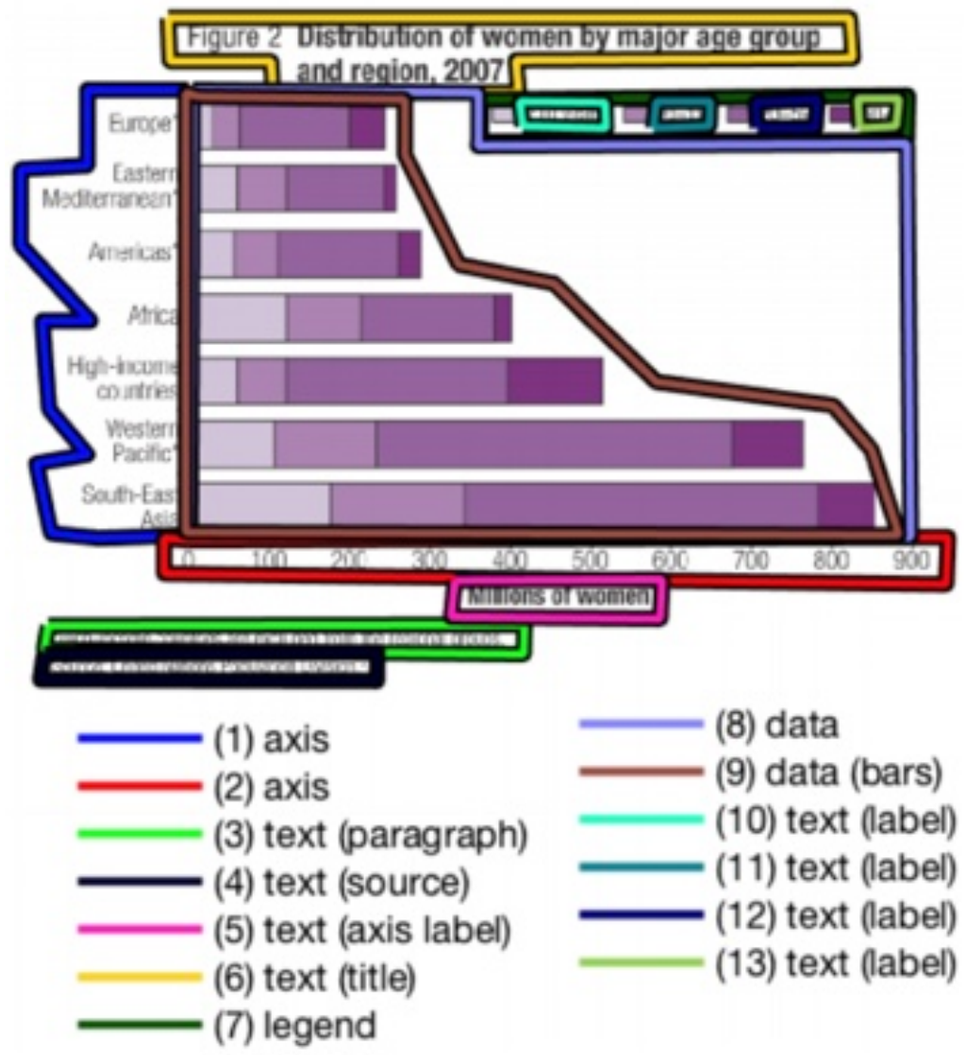
What design elements are most important?





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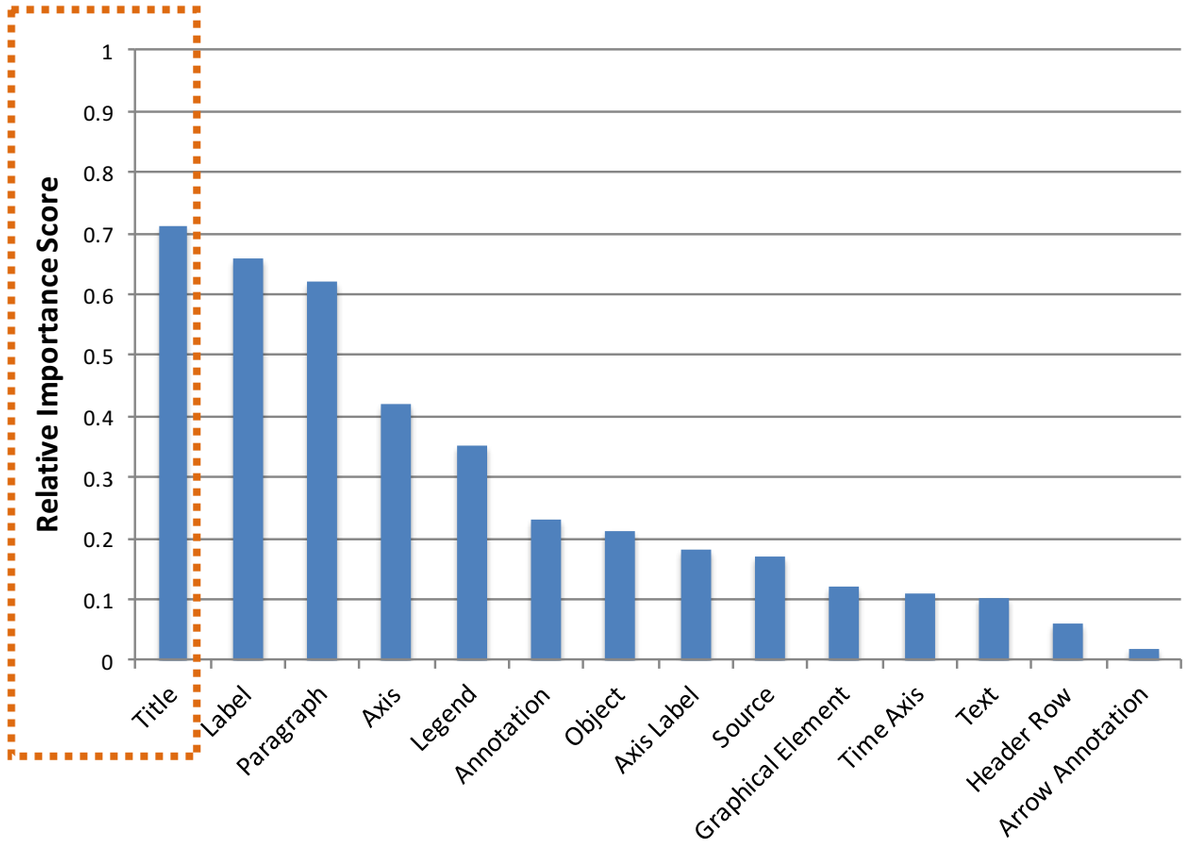

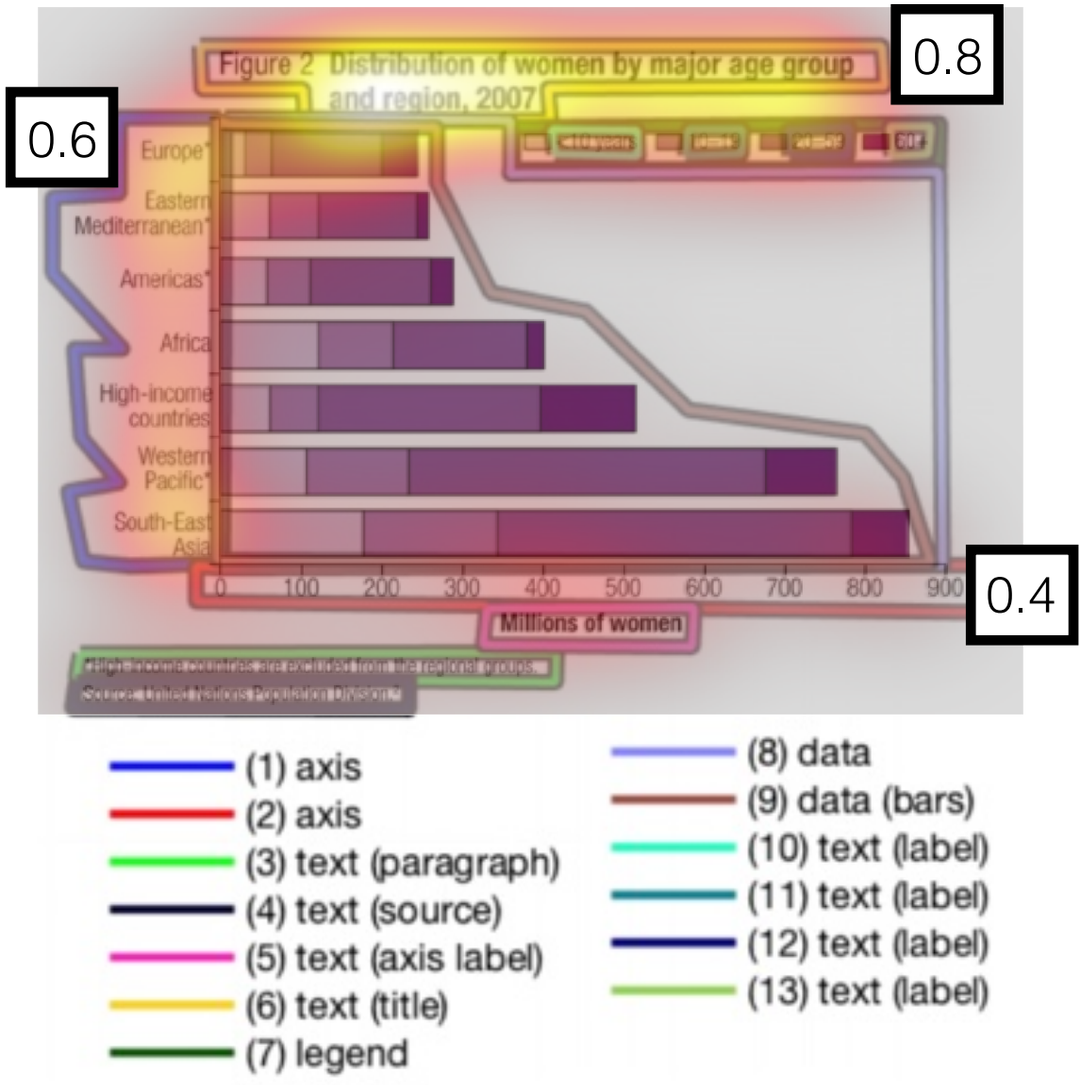

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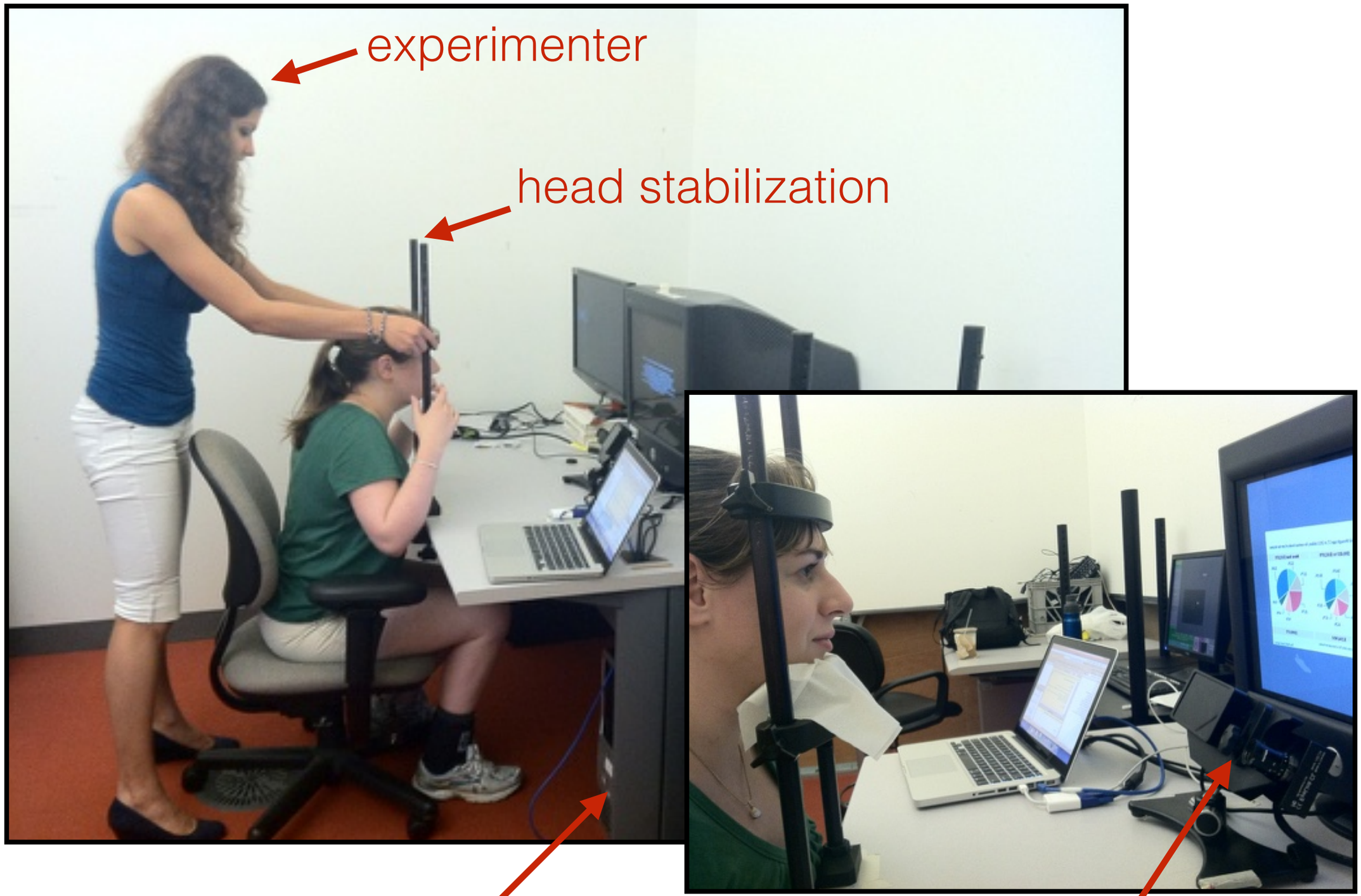
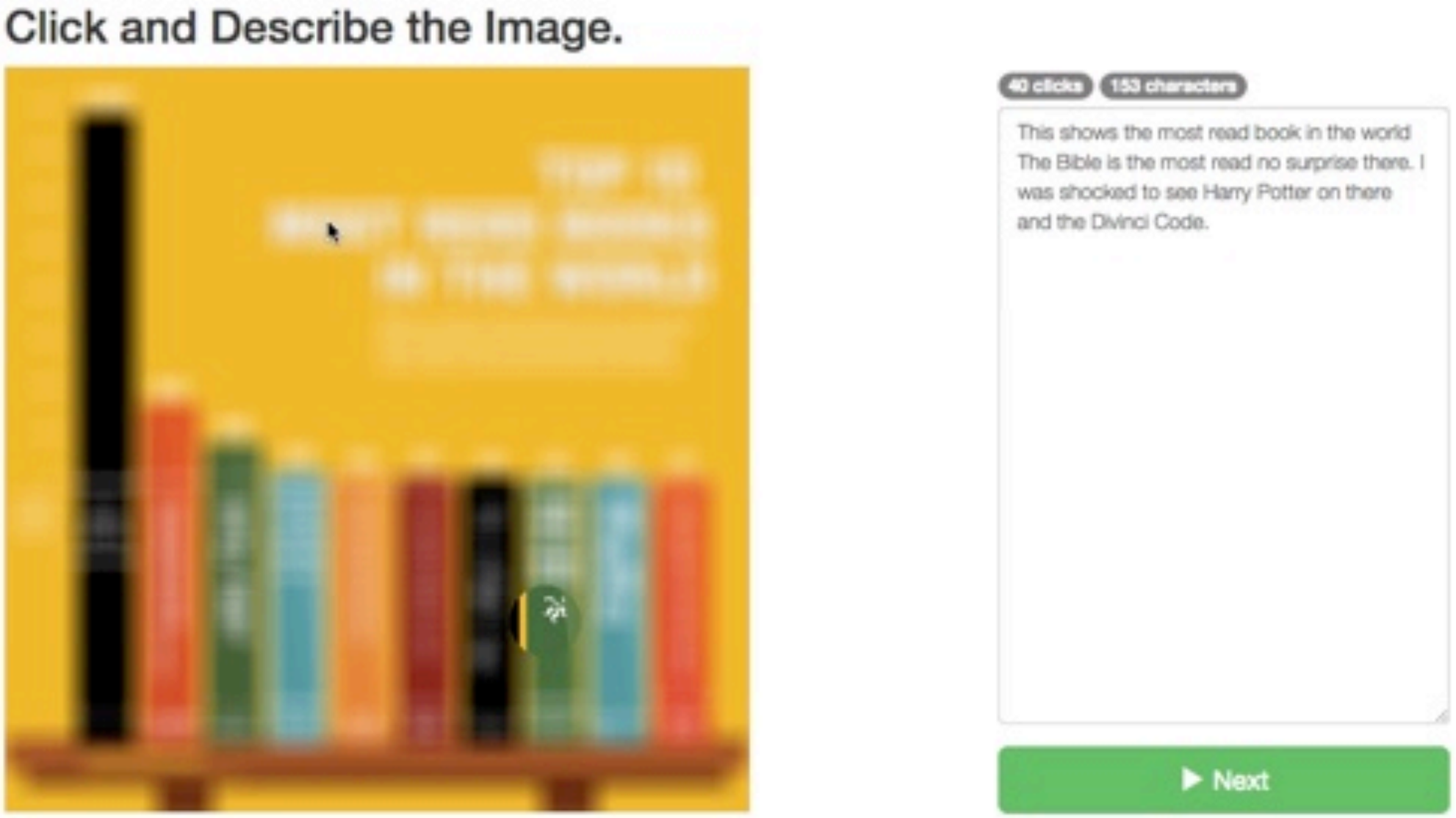

experimenter
head stabilization
specialized hardware
infrared camera

data collection | bubble clicks



BubbleView: an interface for crowdsourcing image importance maps and tracking visual attention. [TOCHI, in press]

Computing **importance maps**

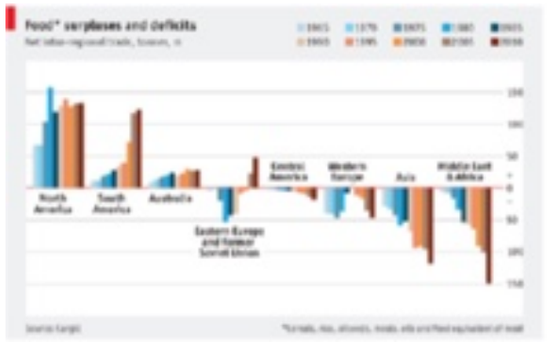
BubbleView: an interface for crowdsourcing image importance maps and tracking visual attention. [TOCHI, in press]

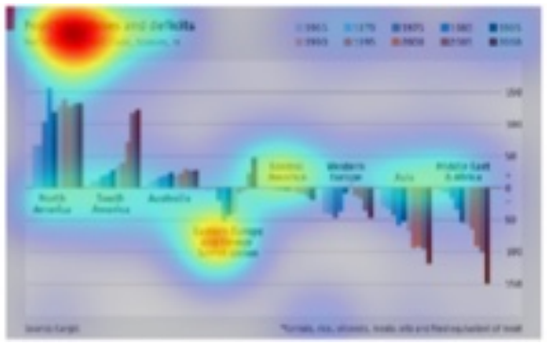
data collection

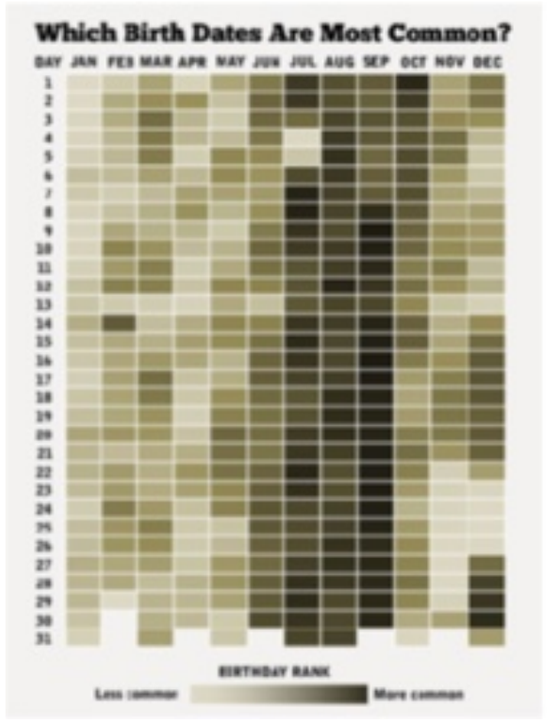
bubble clicks

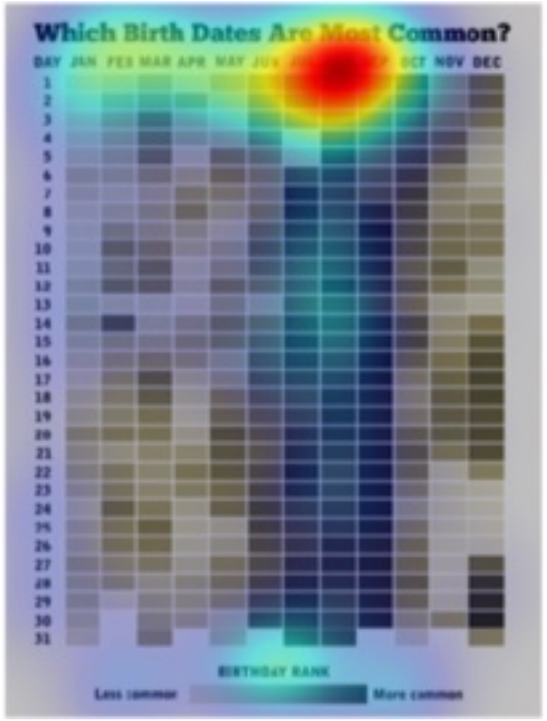
Fixations

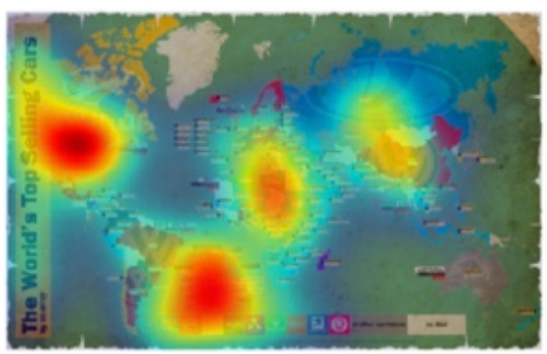
Clicks





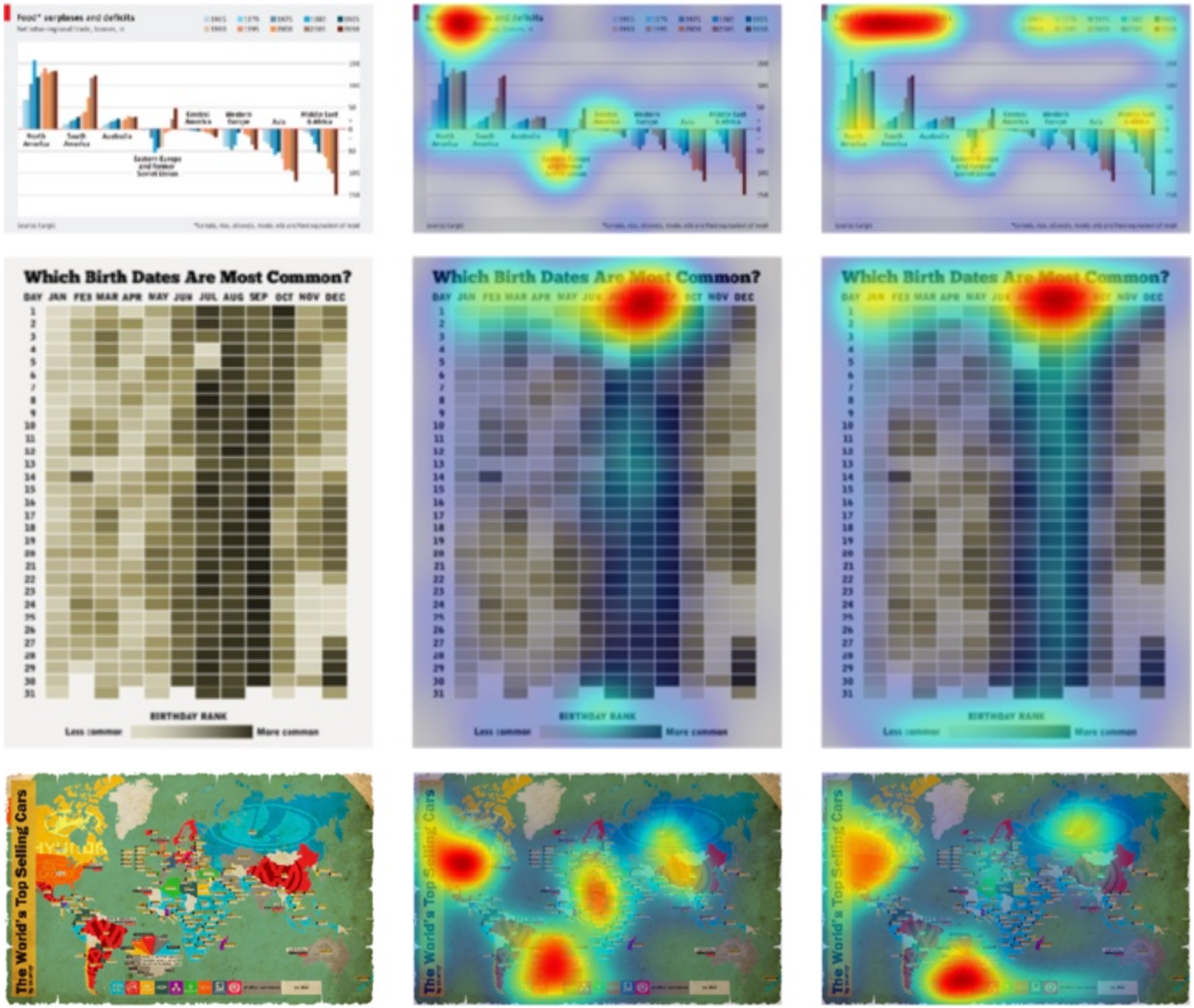


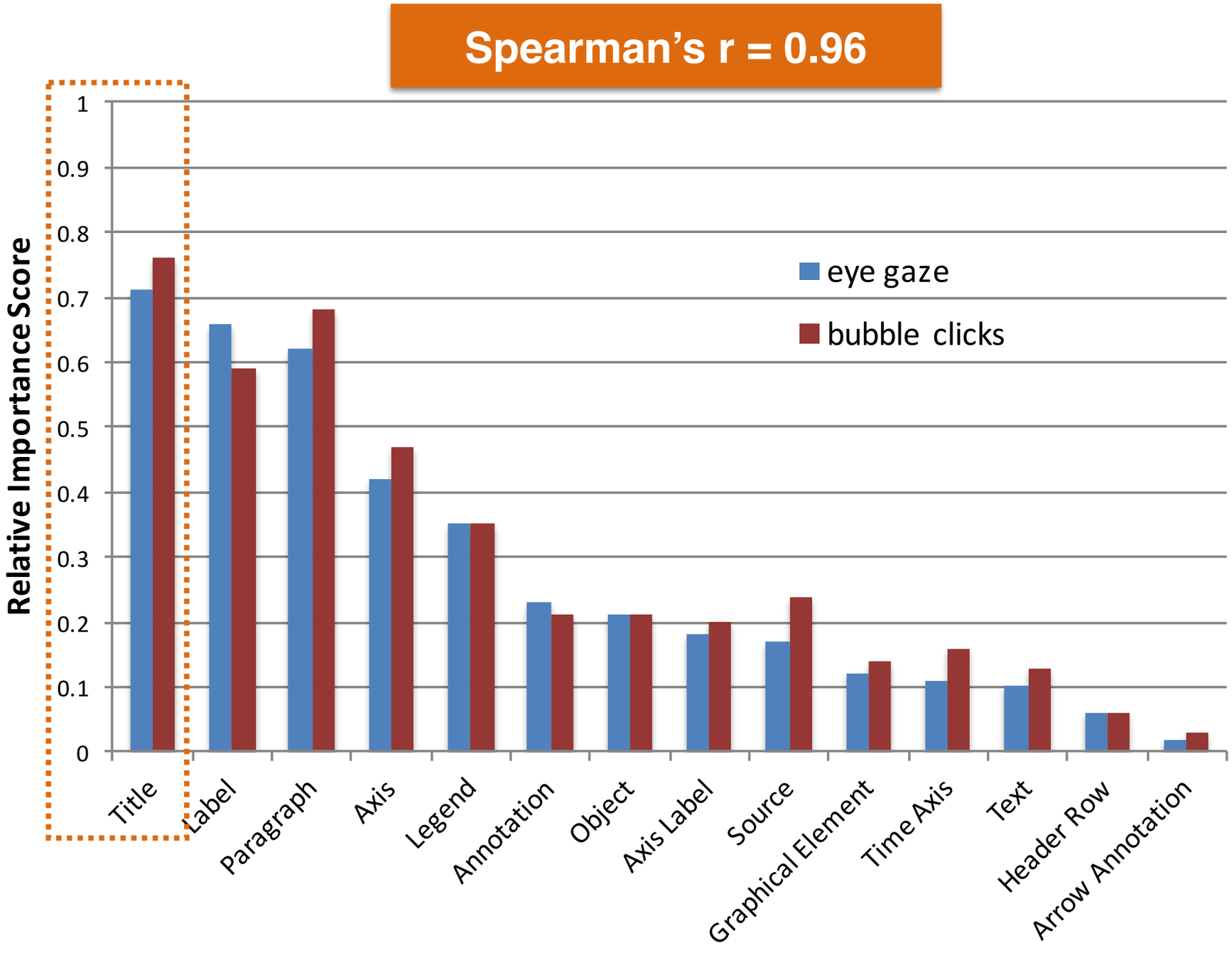




data collection → bubble clicks

Fixations | Clicks



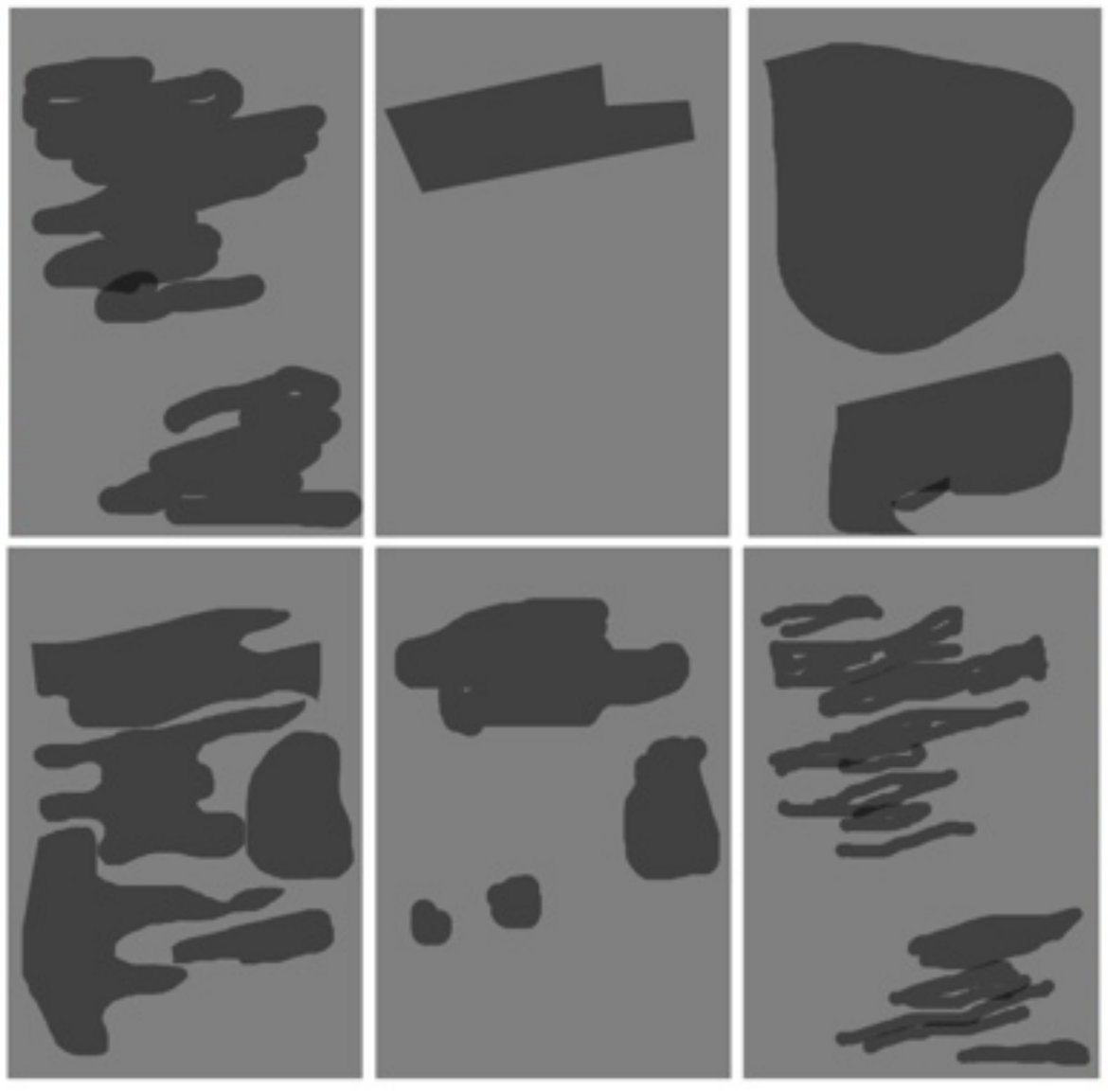

Spearman's r = 0.96
Relative Importance Score
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
eye gaze
bubble clicks
Title
Label
Paragraph
Axis
Legend
Annotation
Object
Axis Label
Source
Graphical Element
Time Axis
Text
Header Row
Arrow Annotation

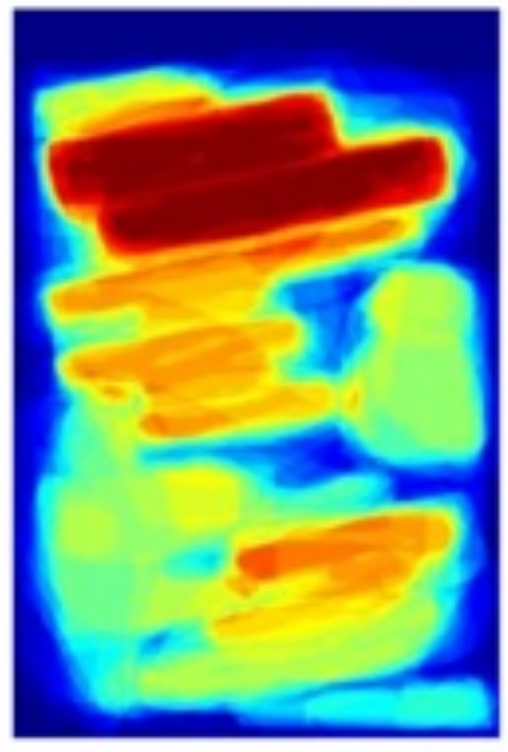
data collection | annotations

Input

Crowd Annotations

Average Annotation

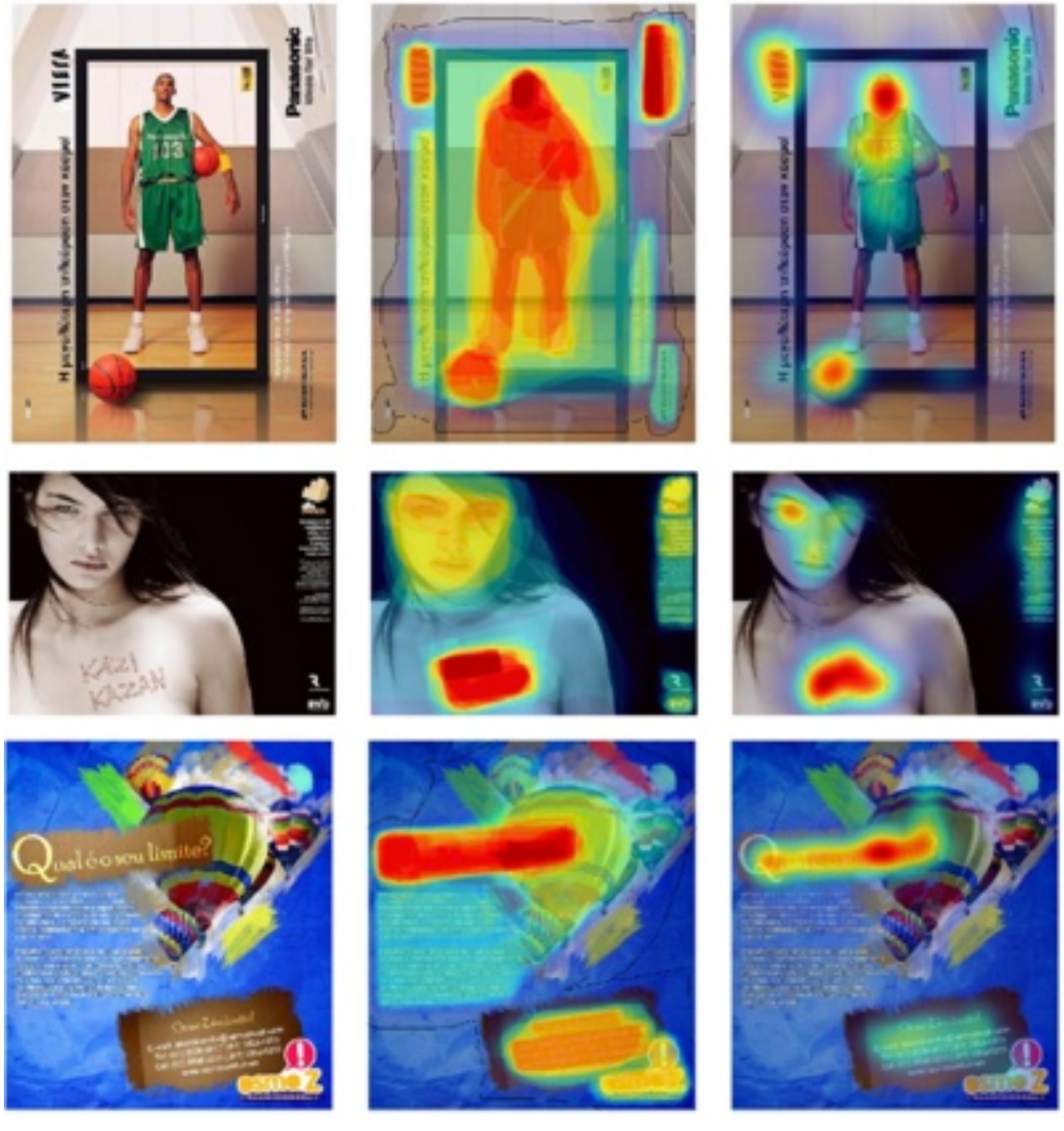




Graphic Design Importance (GDI) dataset

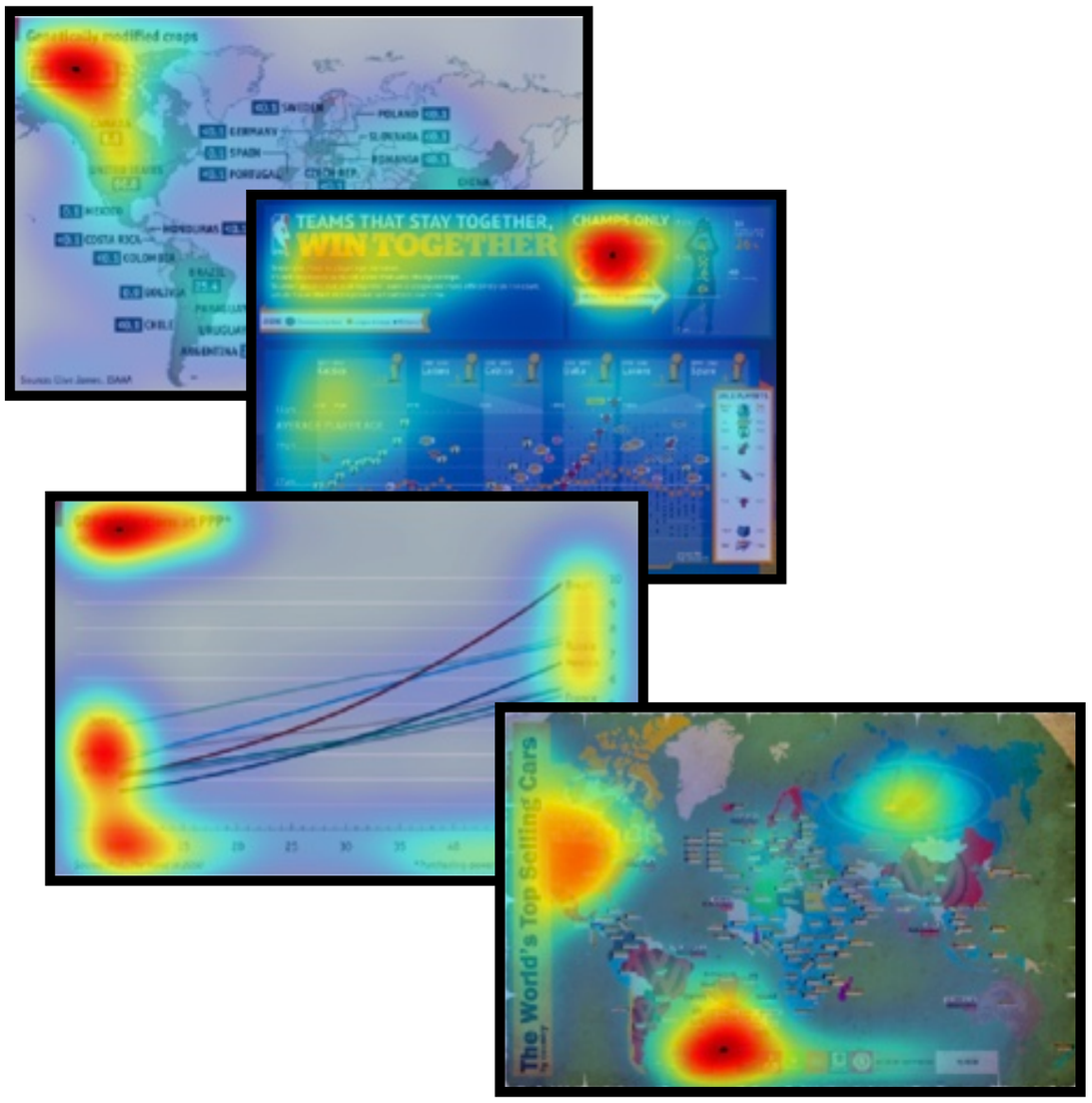
Choosing an importance representation

Annotations Clicks

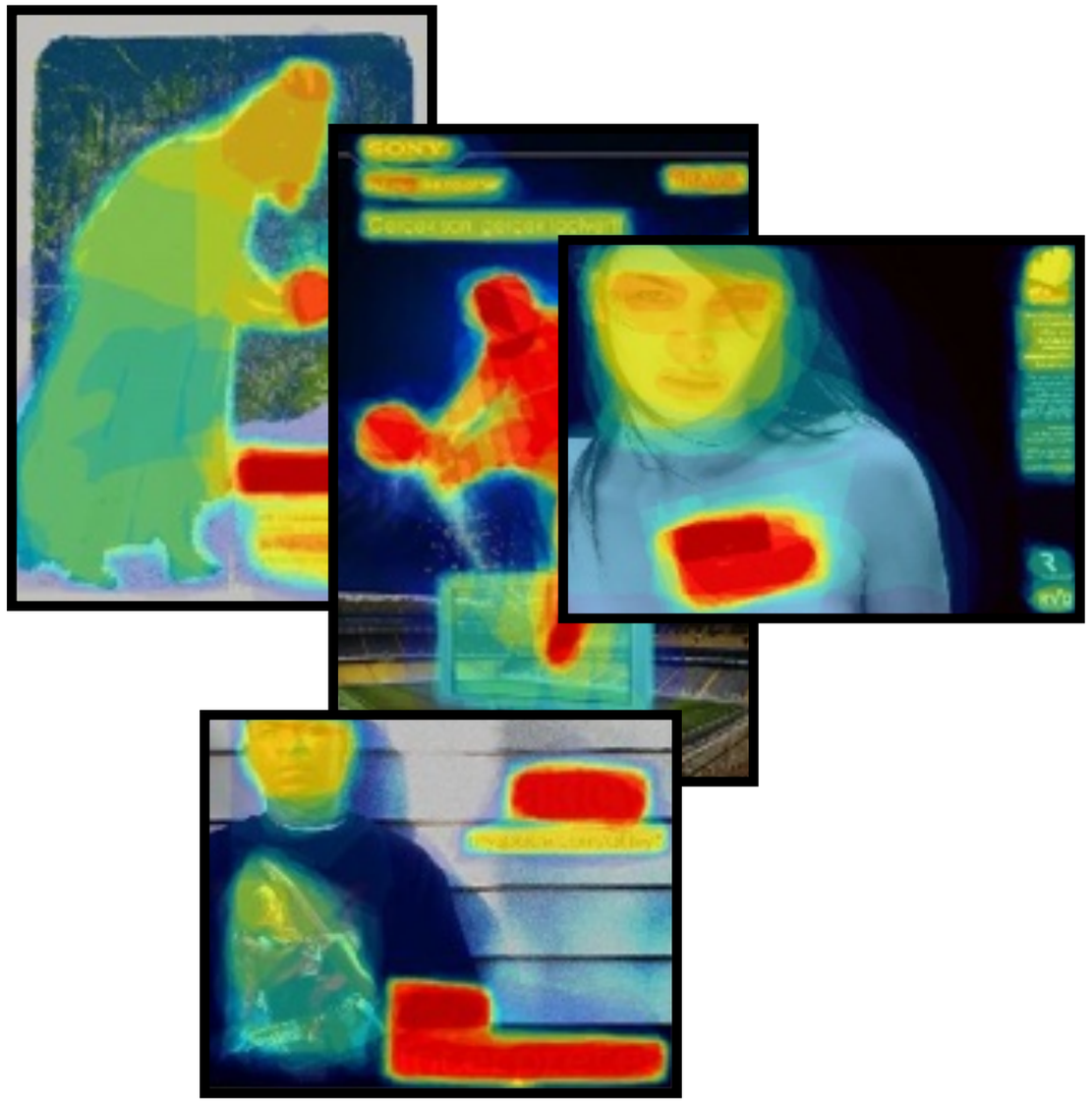


We create importance models for:

data visualizations



graphic designs



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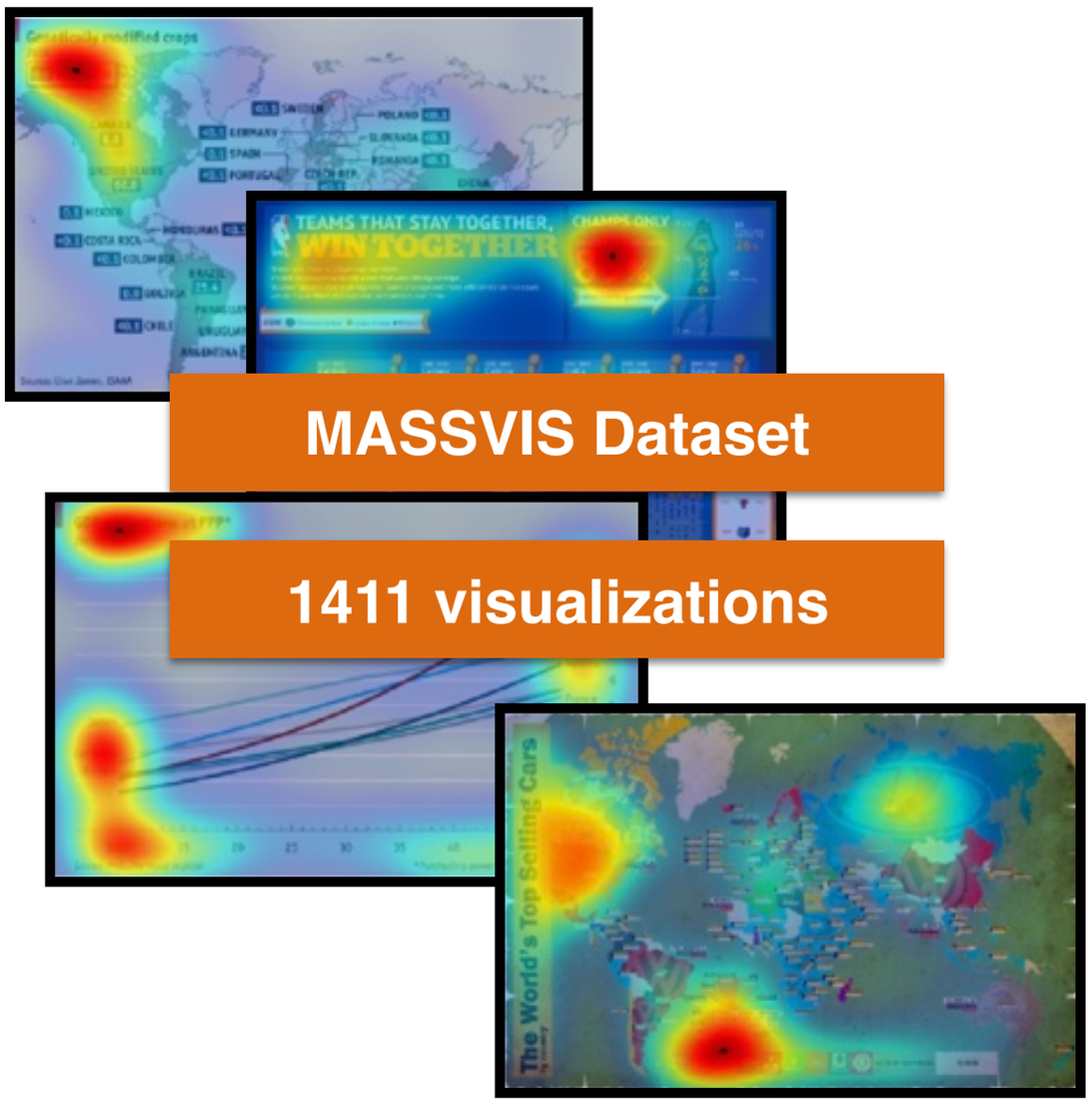
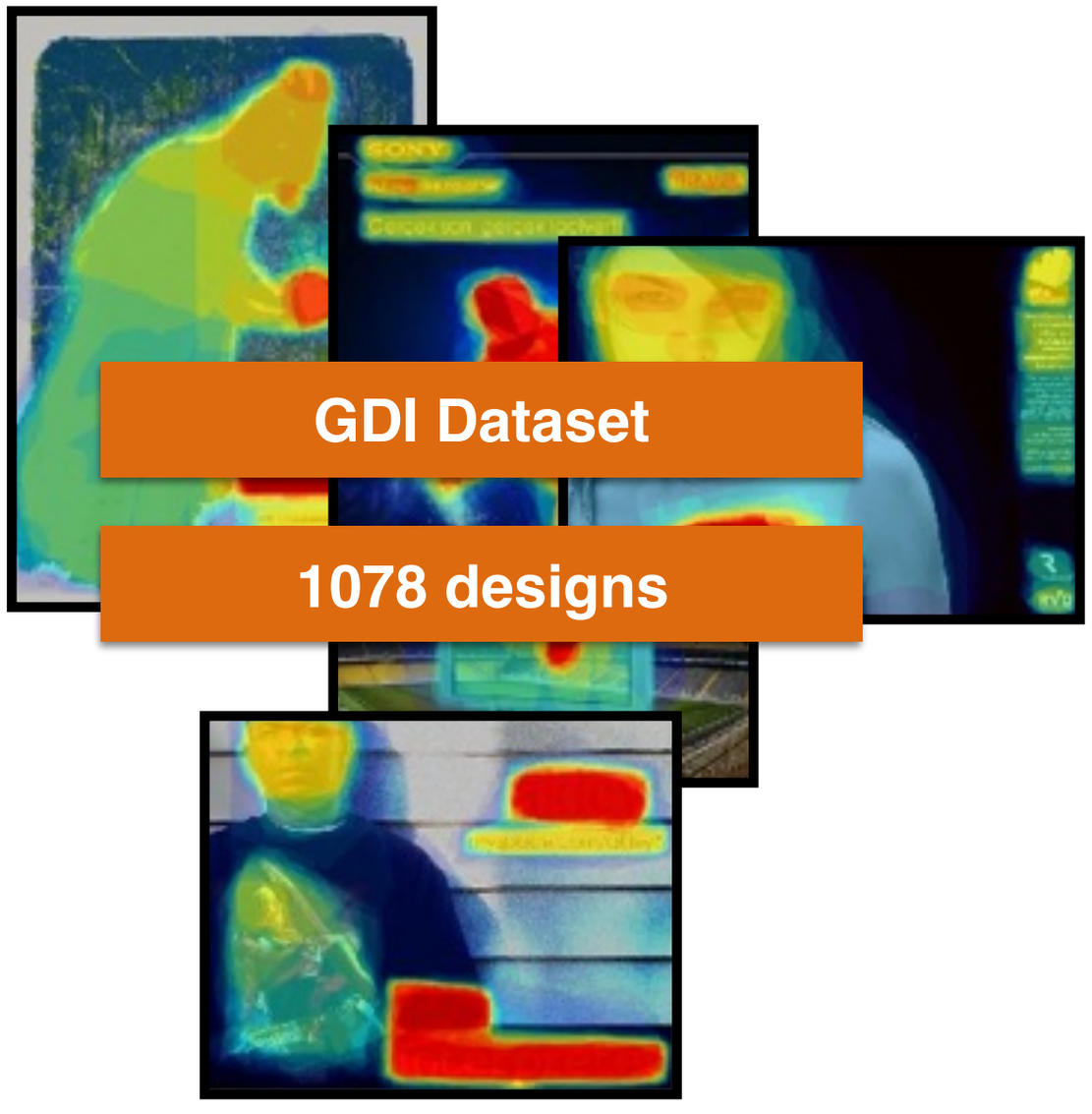


MASSVIS Dataset

1411 visualizations

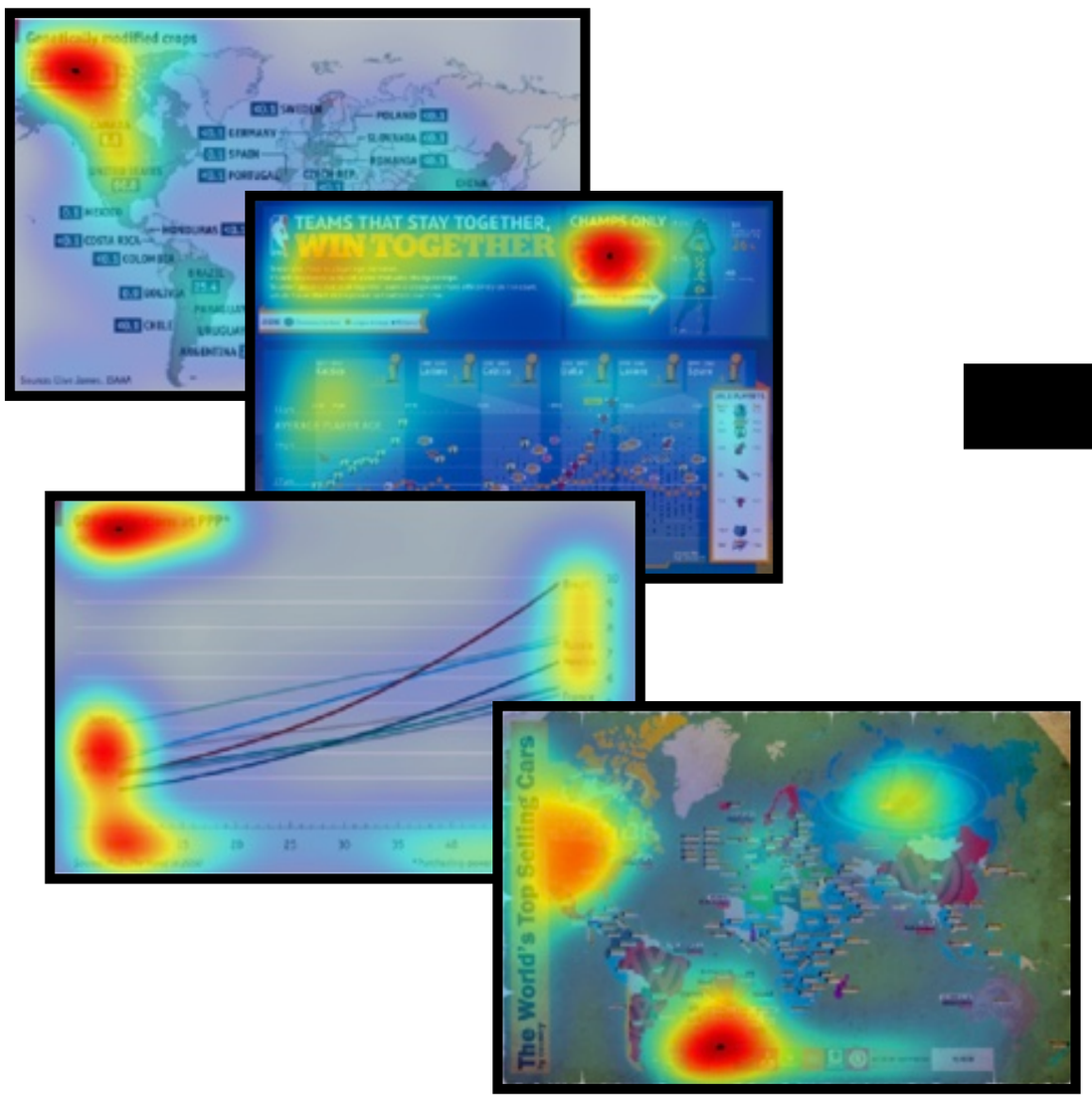
graphic designs

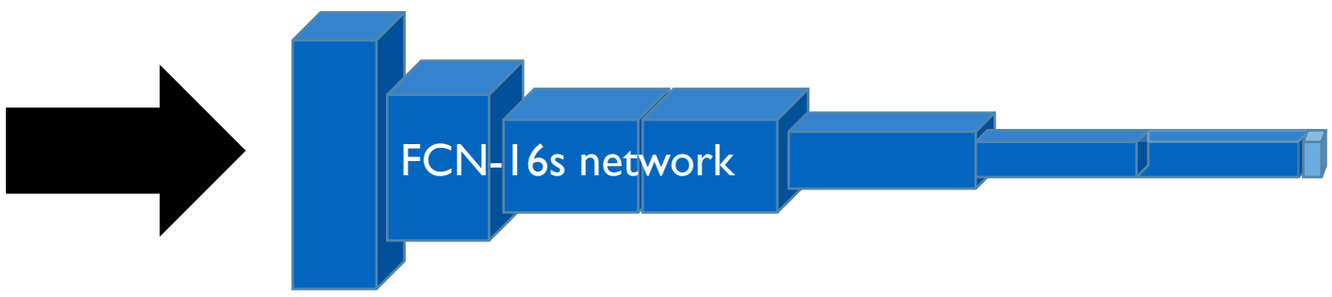


GDI Dataset

1078 designs

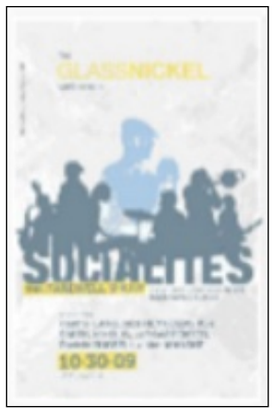
Training our importance model

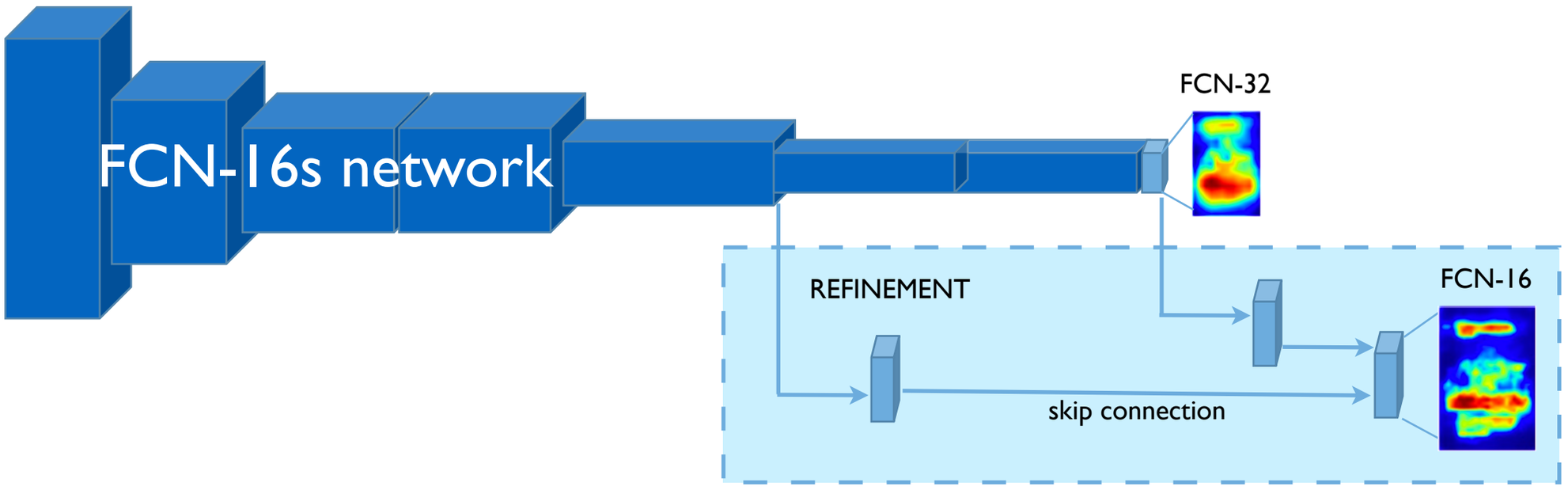




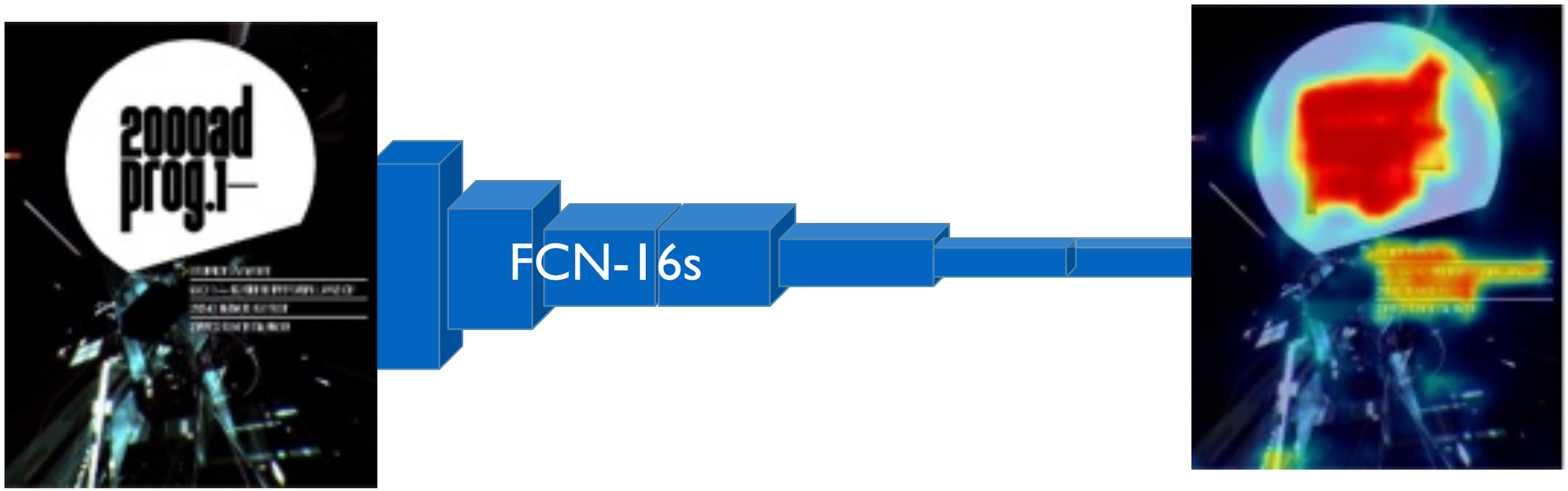
- fully-automatic prediction
- real-time performance

FCN adapted from semantic segmentation





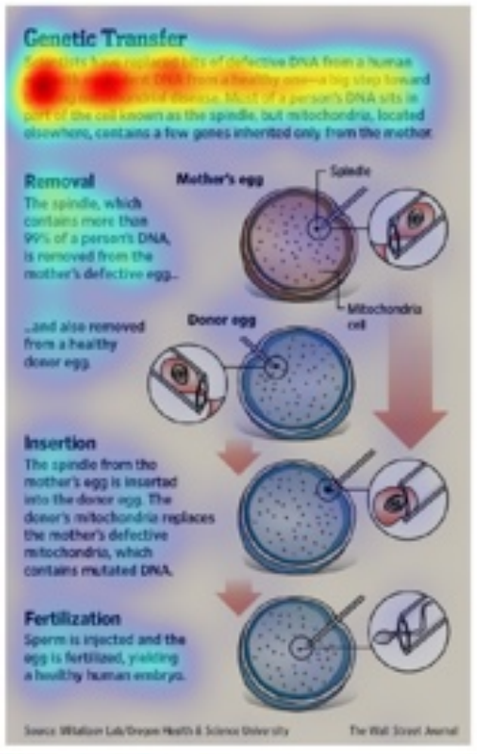
Bitmap design in, importance out

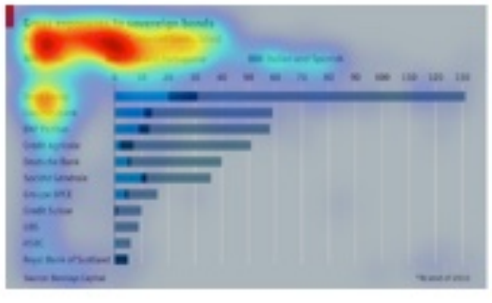


We make importance predictions for:

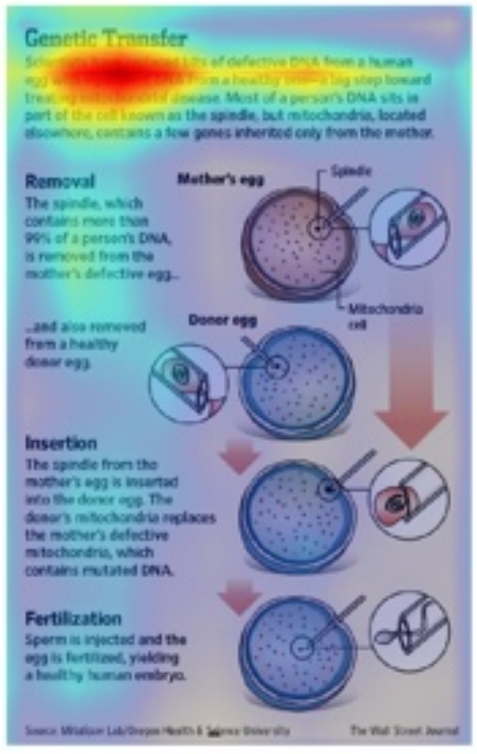
data visualizations

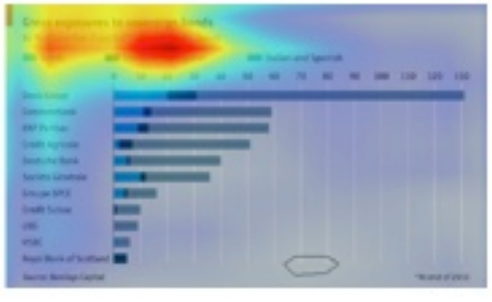
Ground truth





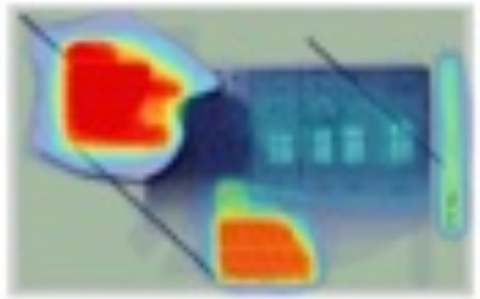
Prediction

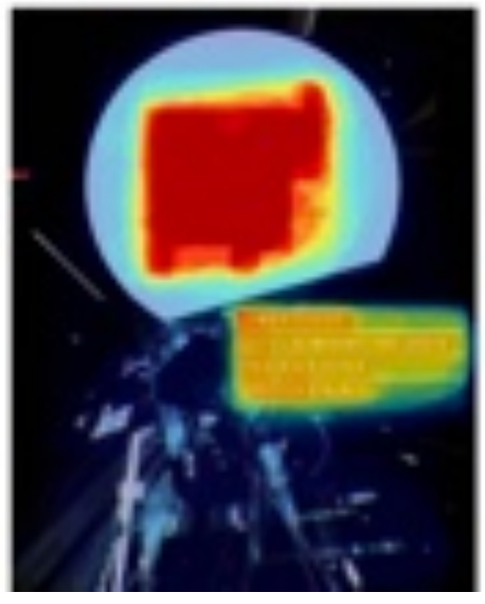




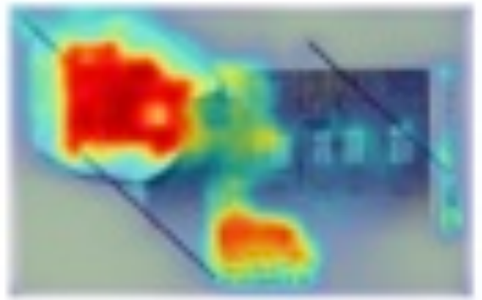
graphic designs

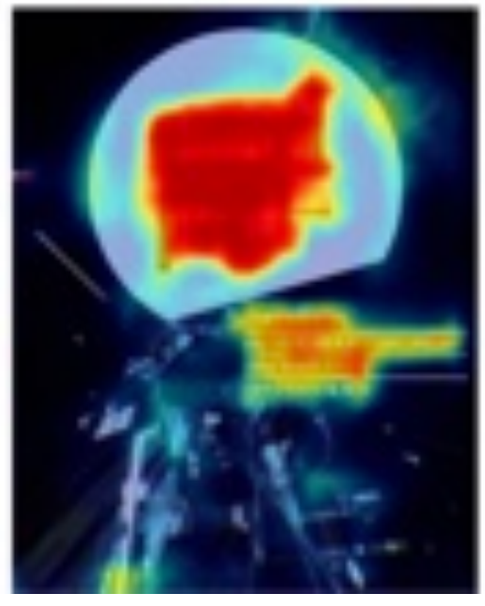
Ground truth





Prediction

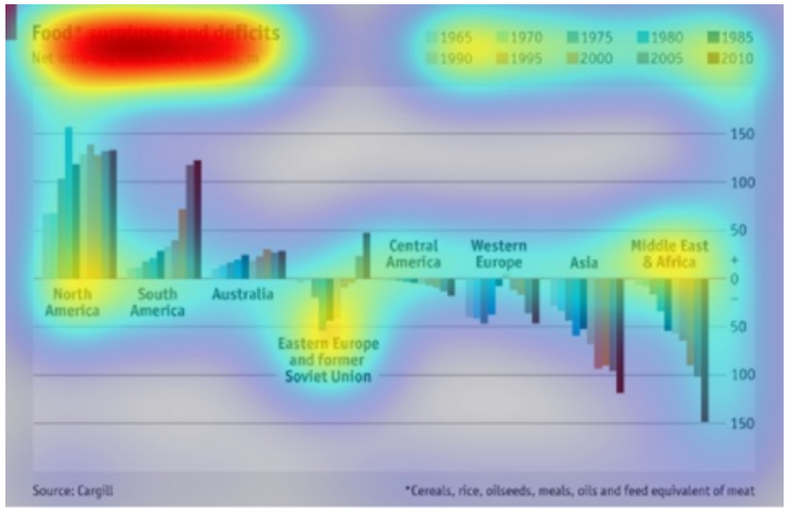




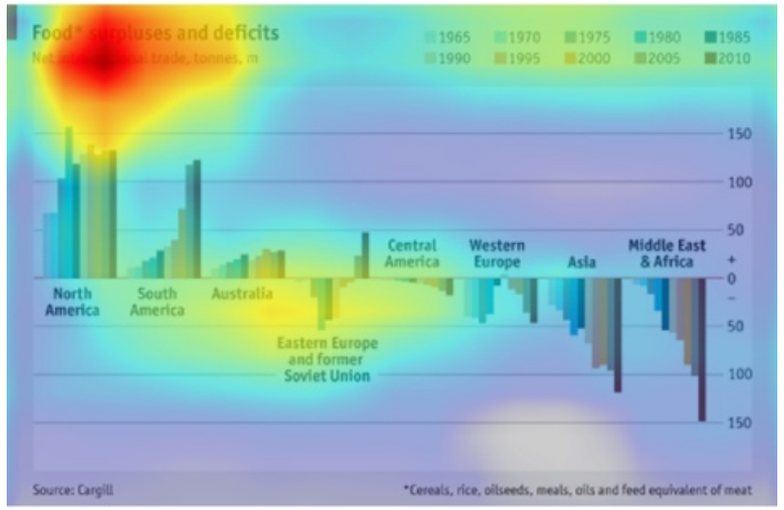
results

visualizations

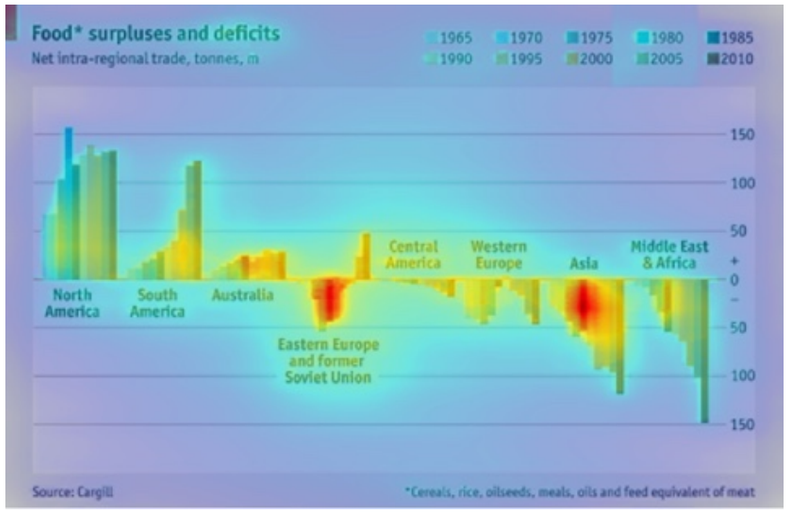
Ground truth



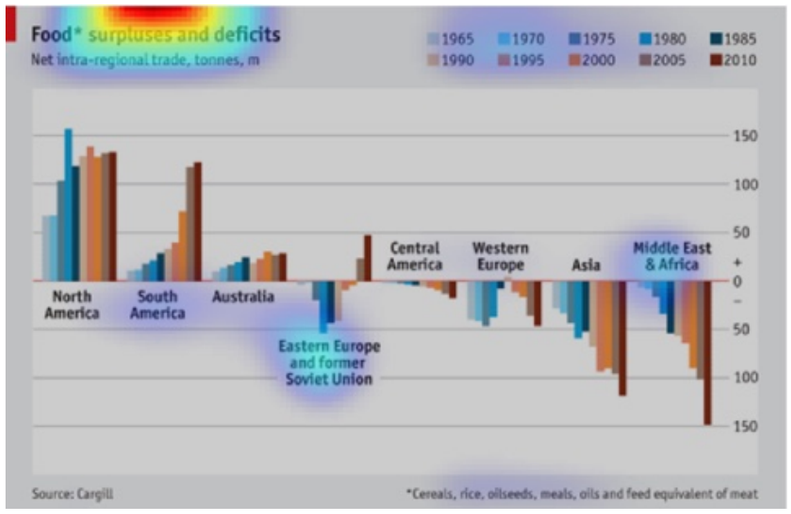
Our model



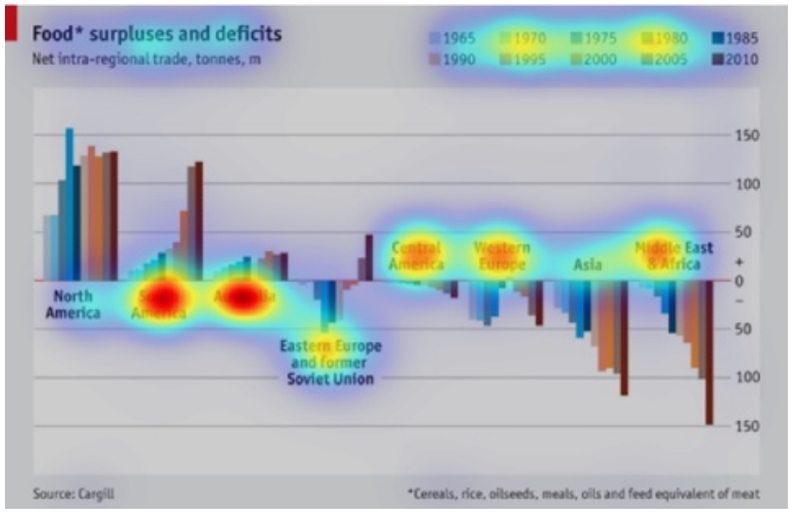
Judd



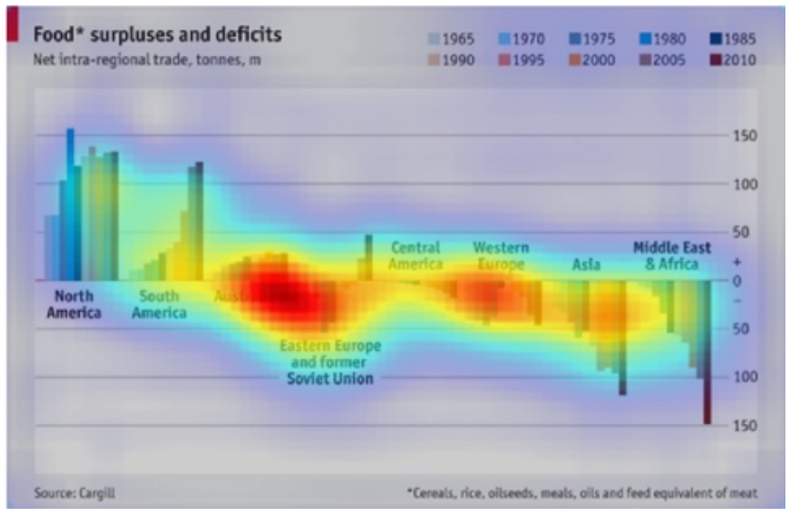
DeepGaze



SalNet



SALICON



Ground truth

Our model

Judd

DeepGaze

SALICON

	CC↑	KL↓
Judd	0.11	0.49
SalNet	0.24	0.77
SALICON	0.54	0.76
DeepGaze2	0.54	0.47
DeepGaze	0.57	3.48
Our model	**0.69**	**0.33**

results

visualizations

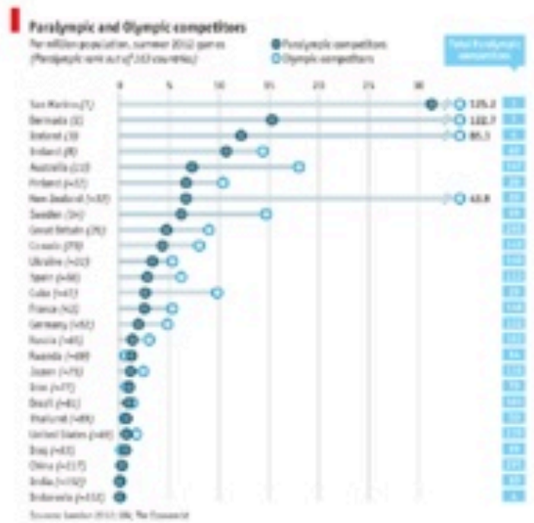
Input visualization

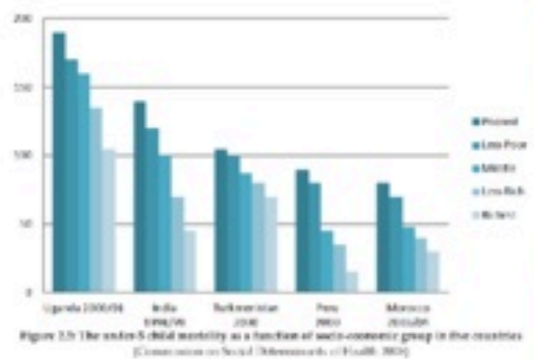
Ground truth

Predicted importance
(CC=0.89, KL=0.12)

(CC=0.79, KL=0.24)

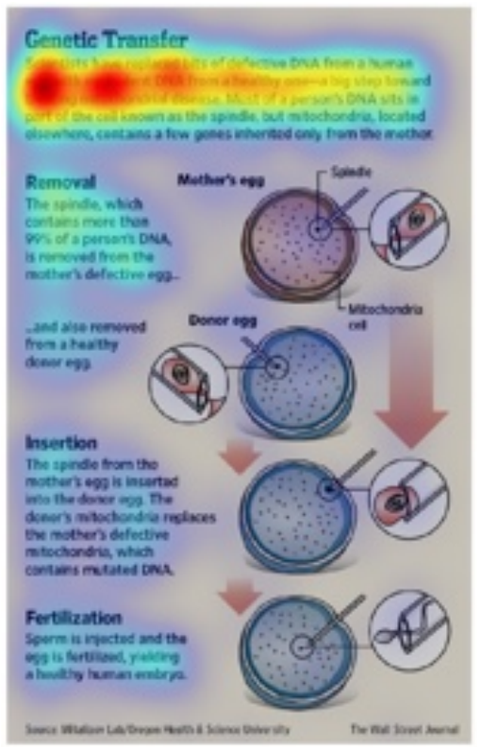
(CC=0.39, KL=0.83)

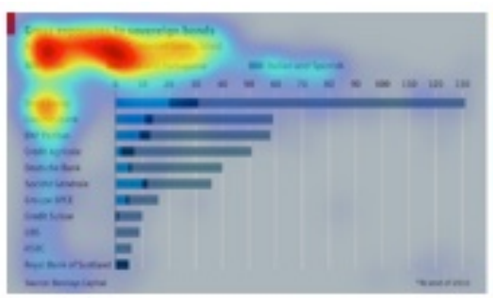




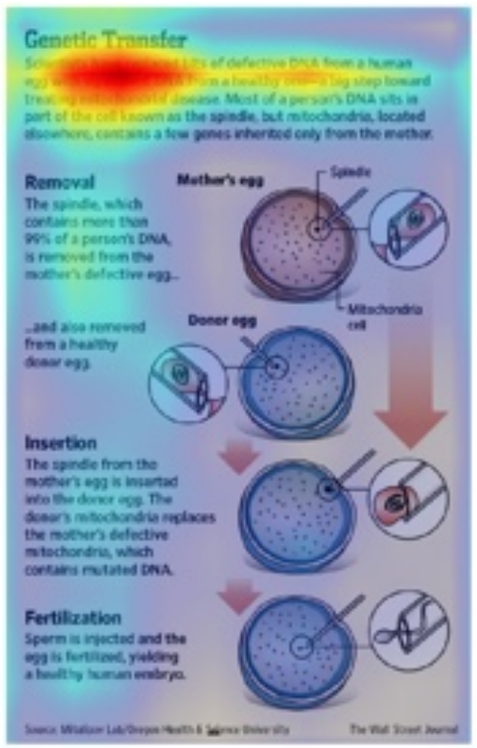
Is element importance preserved?

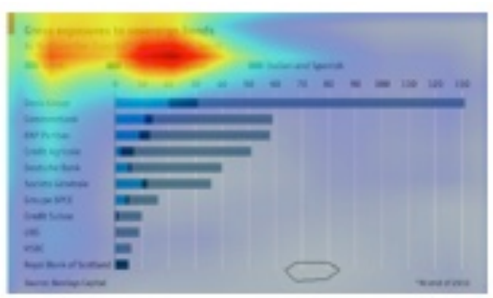
Ground truth



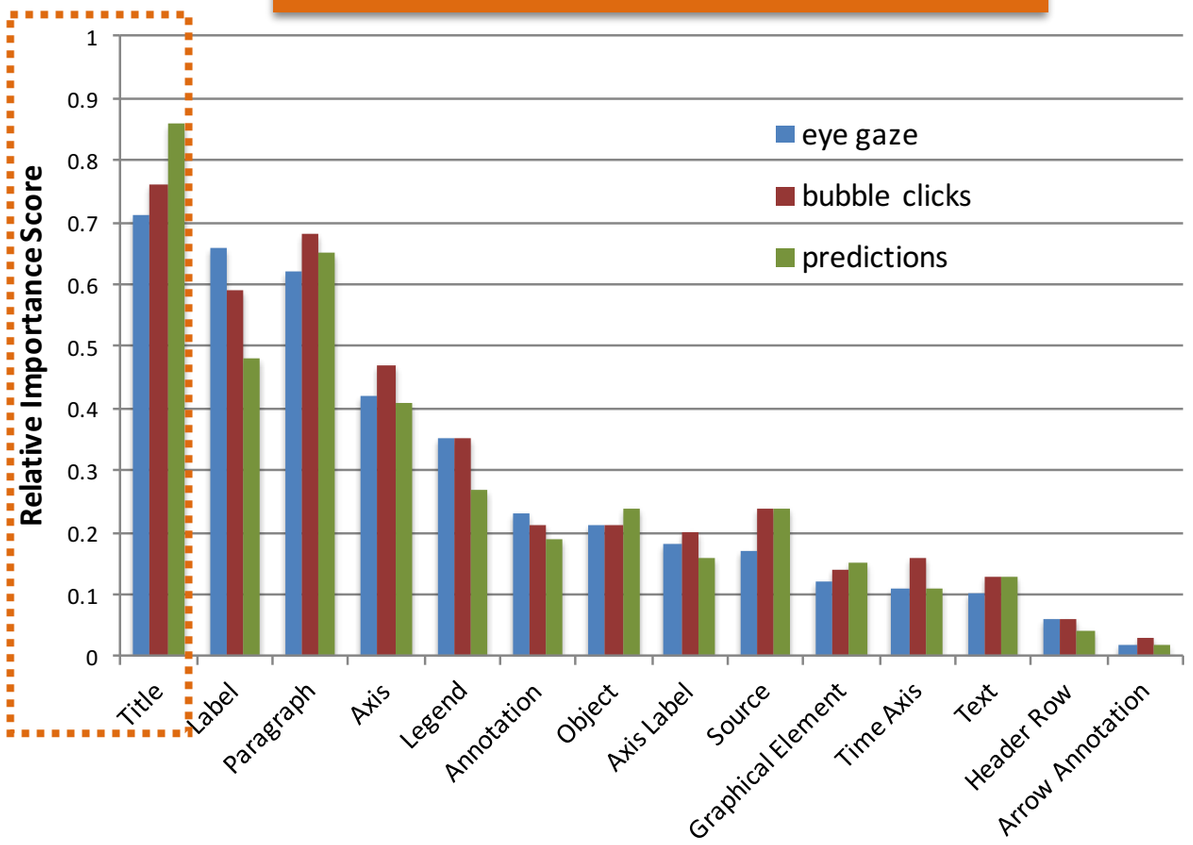


Prediction



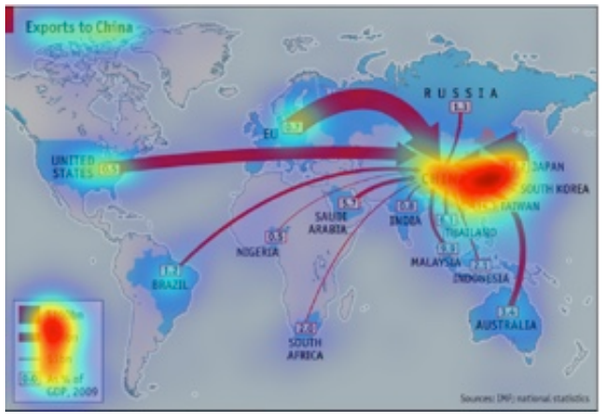


Spearman's r = 0.96

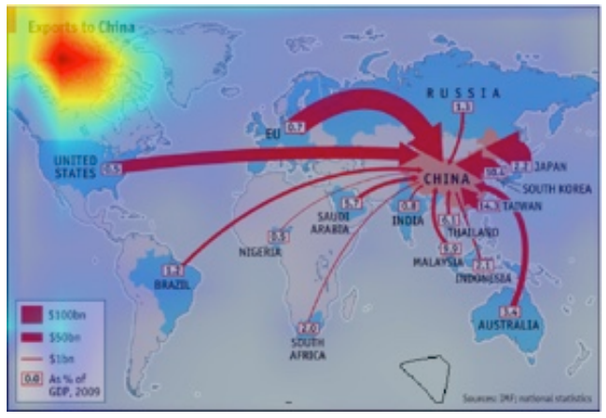


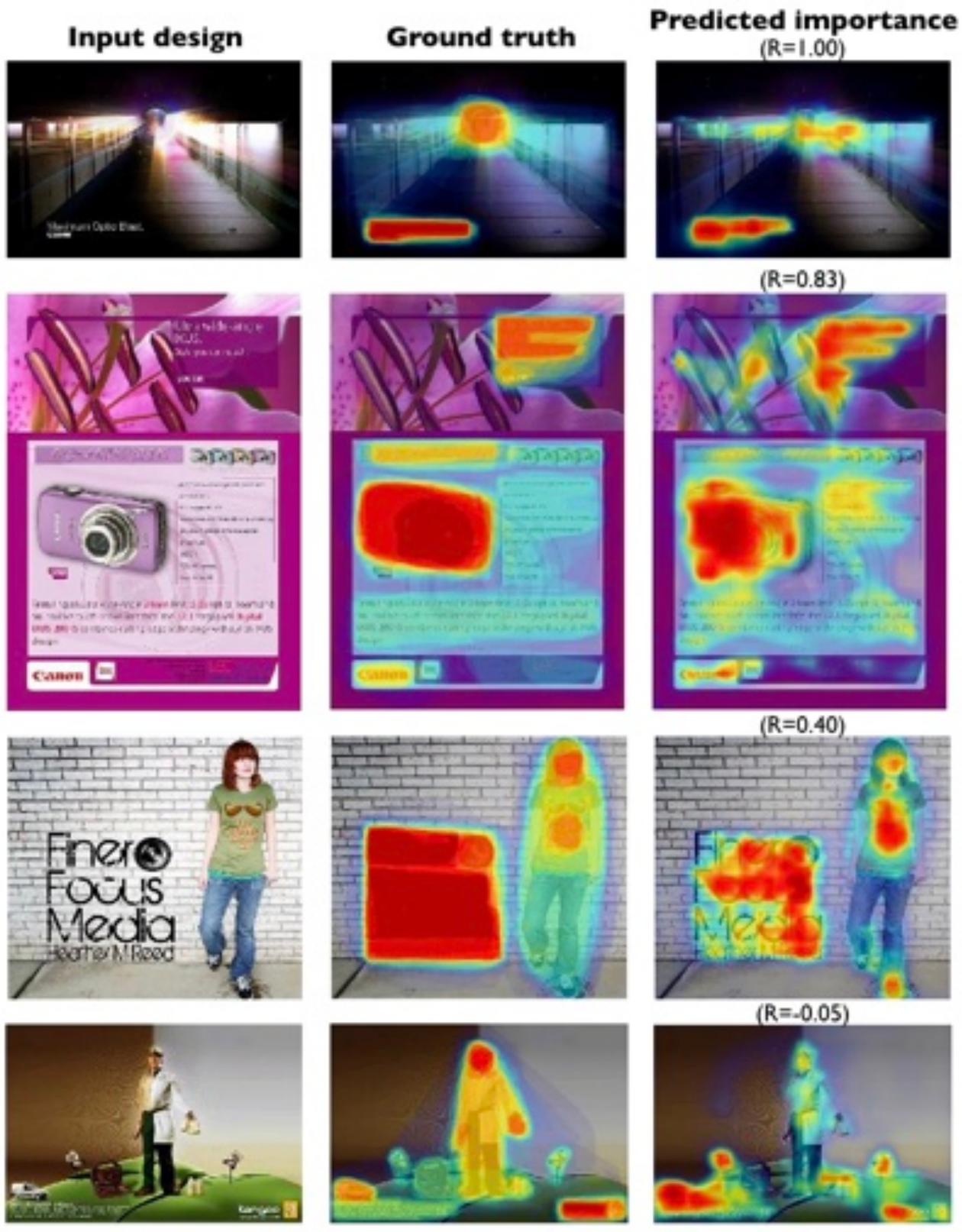
Limitations

Ground truth



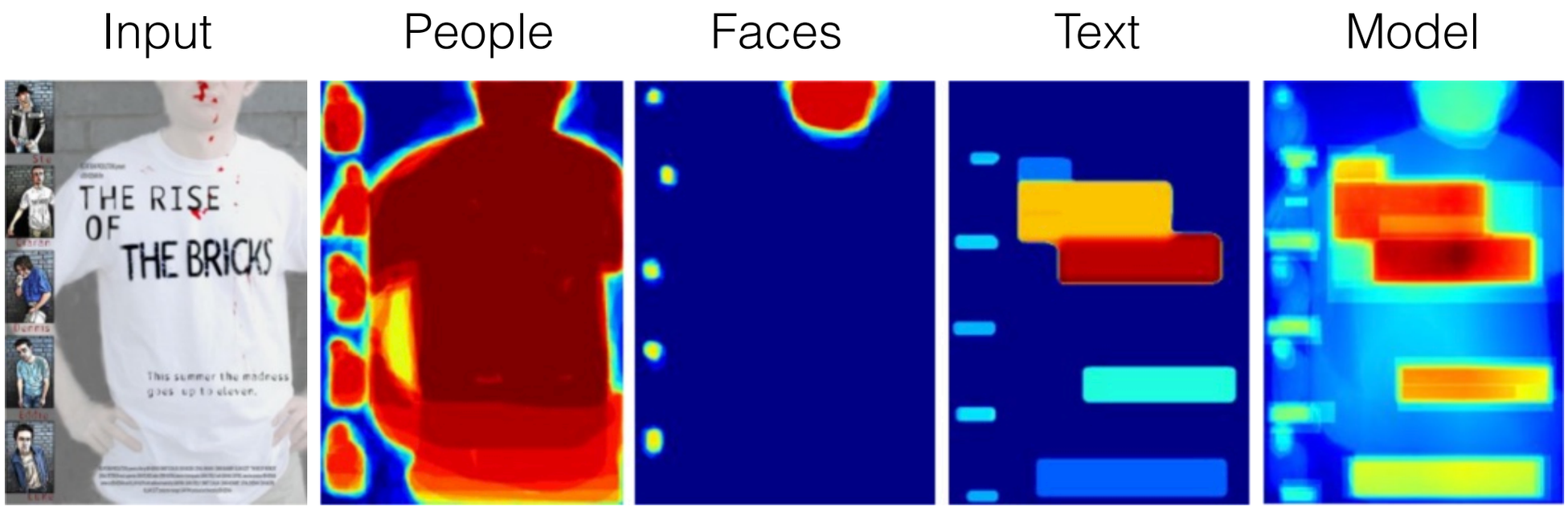
Prediction




Input design
Ground truth
Predicted importance
(R=1.00)
(R=0.83)
(R=0.40)
(R=-0.05)

Input Model


THE RISE
OF
THE BRICKS
This summer the madness
goes up to eleven.



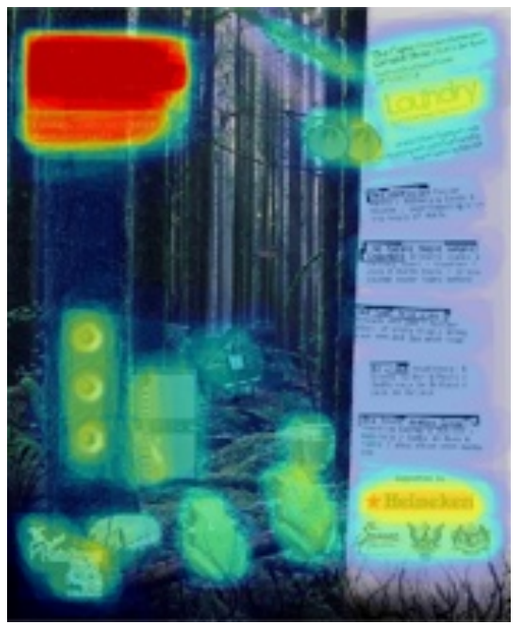
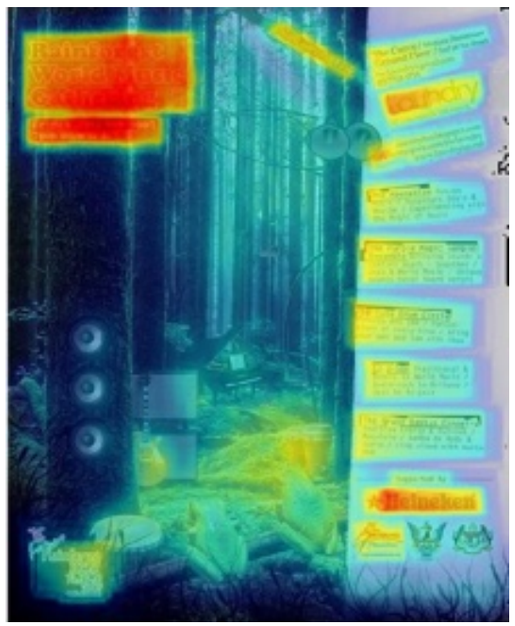
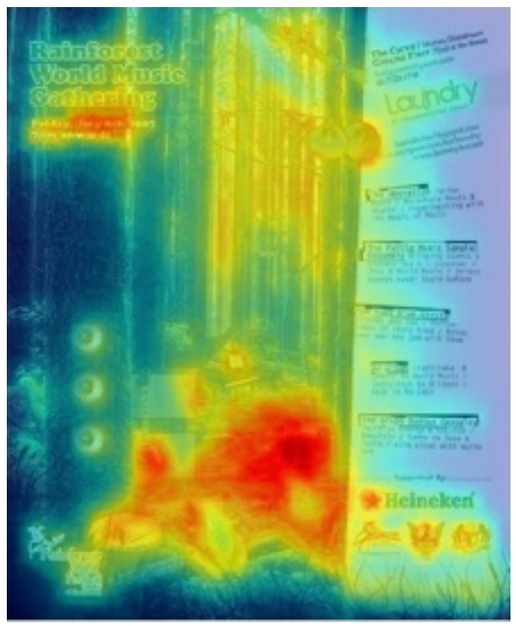
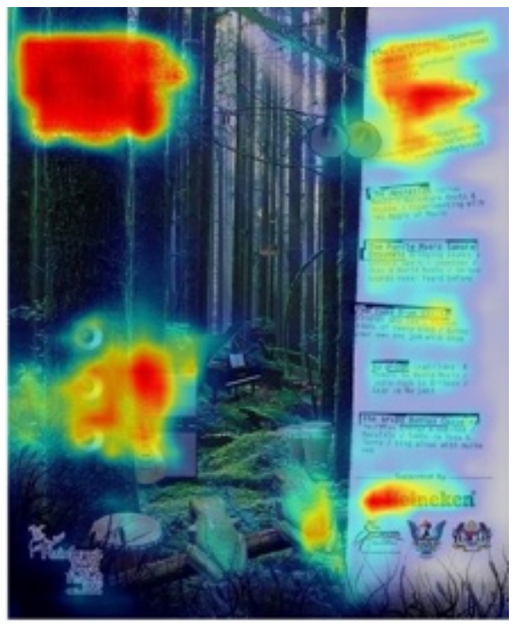
O’Donovan, Agarwala, Hertzmann [TVCG’14]

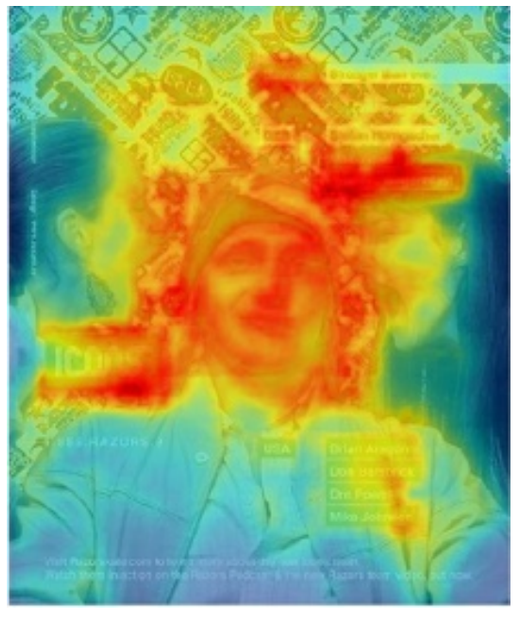
Ground truth

OD-Full

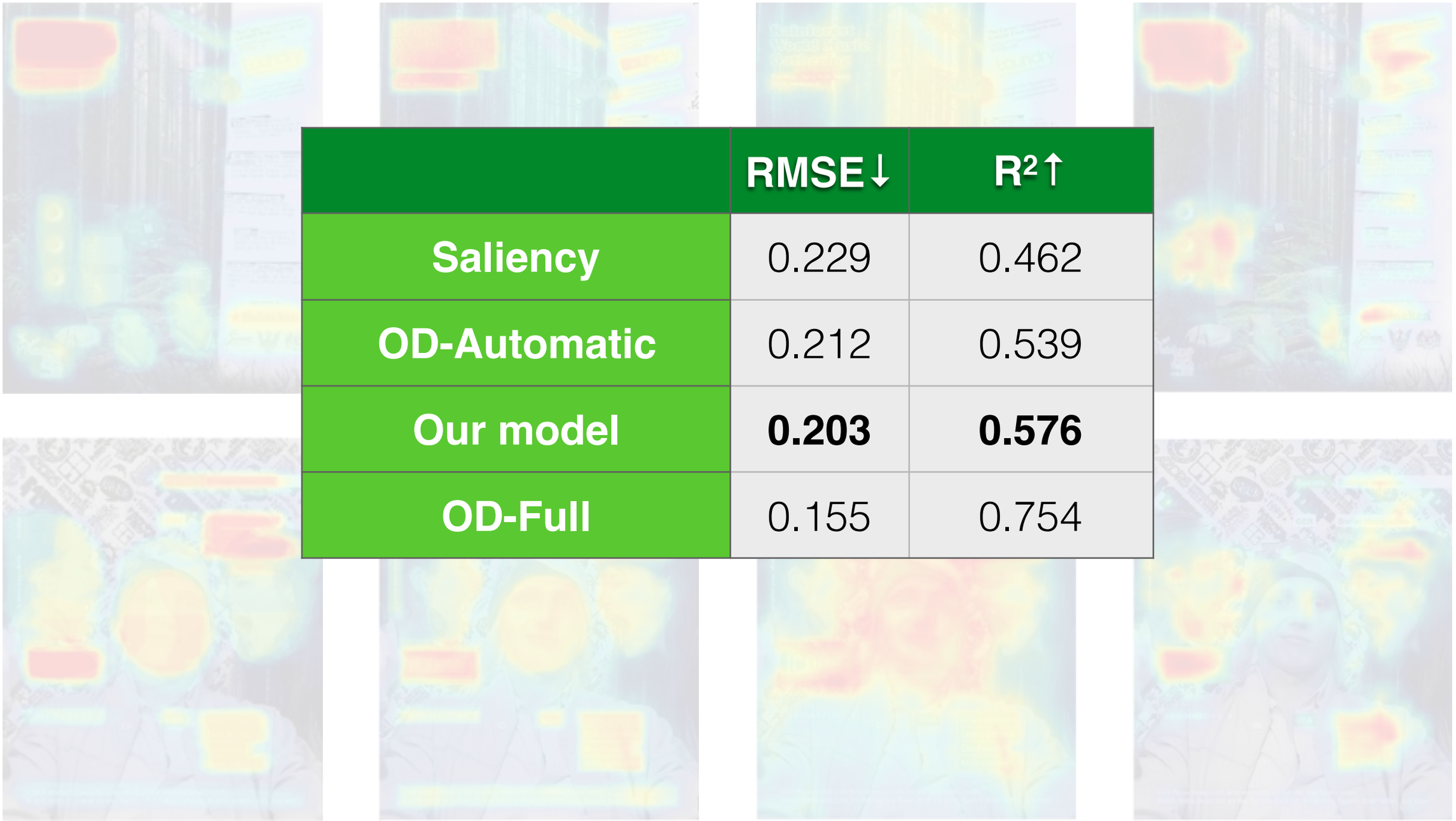
OD-Automatic

Our model


Ground truth OD-Full OD-Automatic Our model

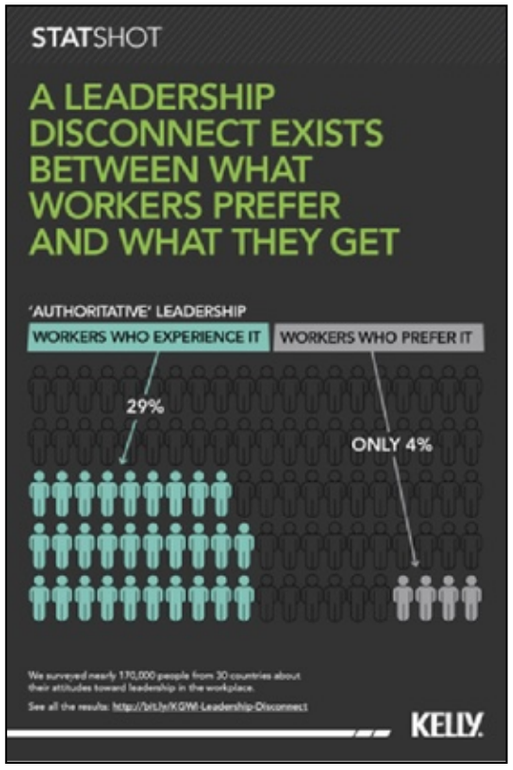


	RMSE↓	R^2↑
Saliency	0.229	0.462
OD-Automatic	0.212	0.539
Our model	**0.203**	**0.576**
OD-Full	0.155	0.754

applications

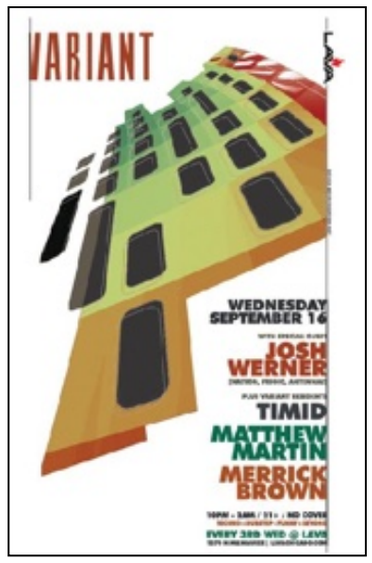
Retargeting

Thumbnailing

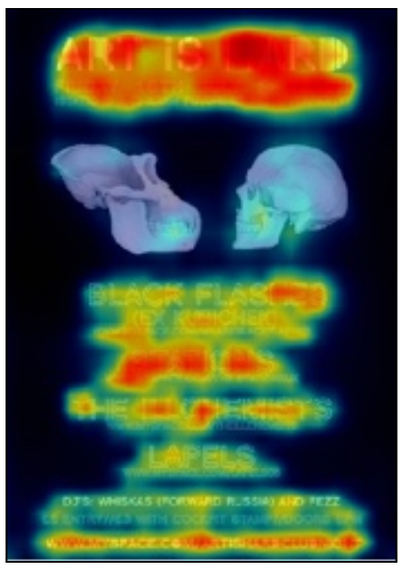


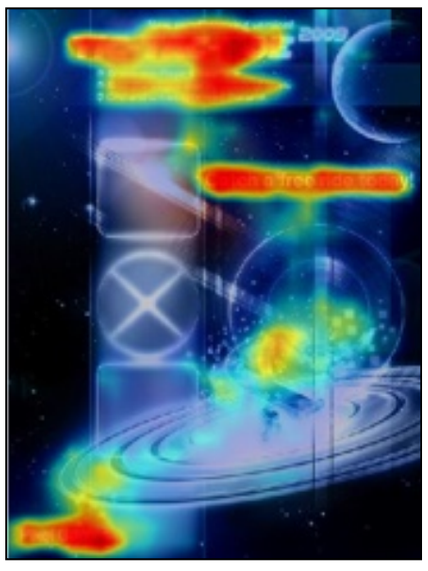
Design feedback

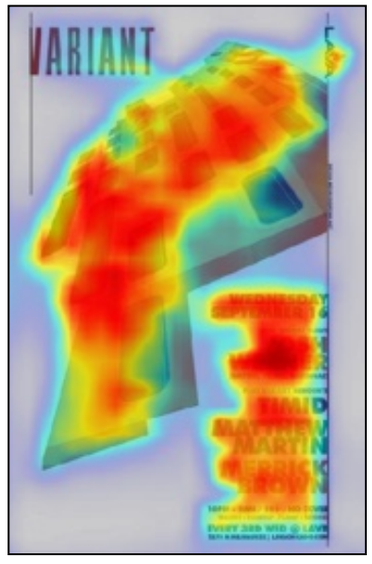
Original design



Importance heatmap





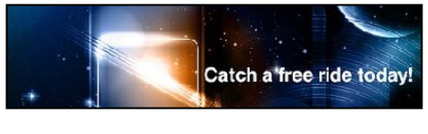


Our model

Edge-energy

Judd

DeepGaze

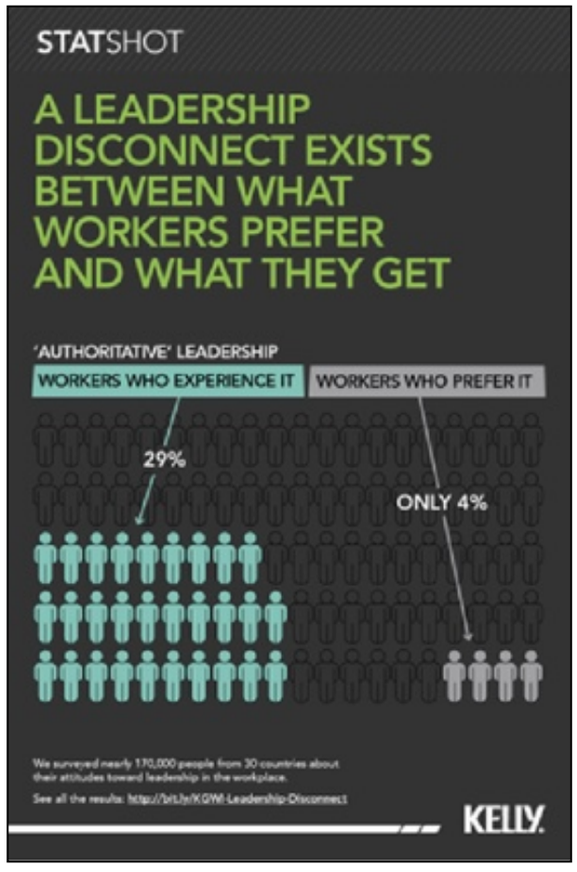


MTurk evaluation

Predicted importance performed:

- better than: edge energy ✓ Judd saliency ✓ random crops ✓
- similar to: DeepGaze (deep natural image saliency) ≈

Input

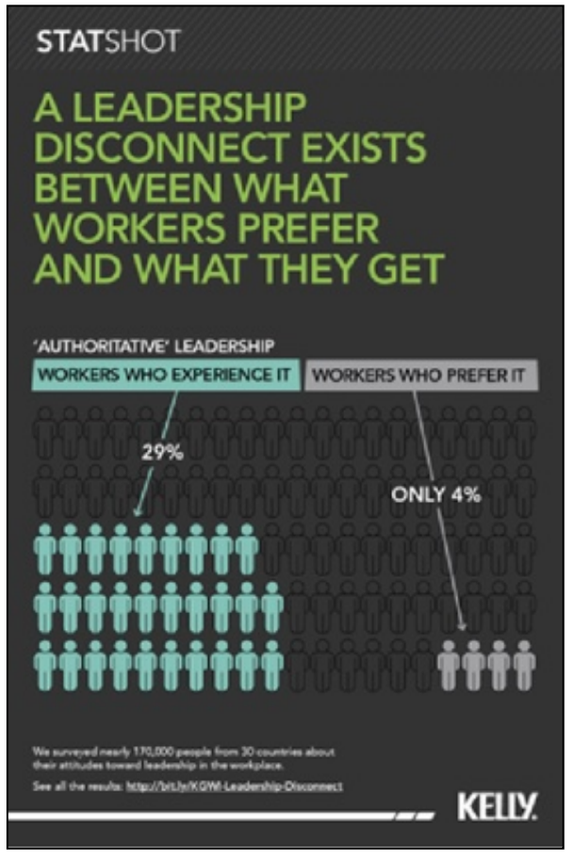


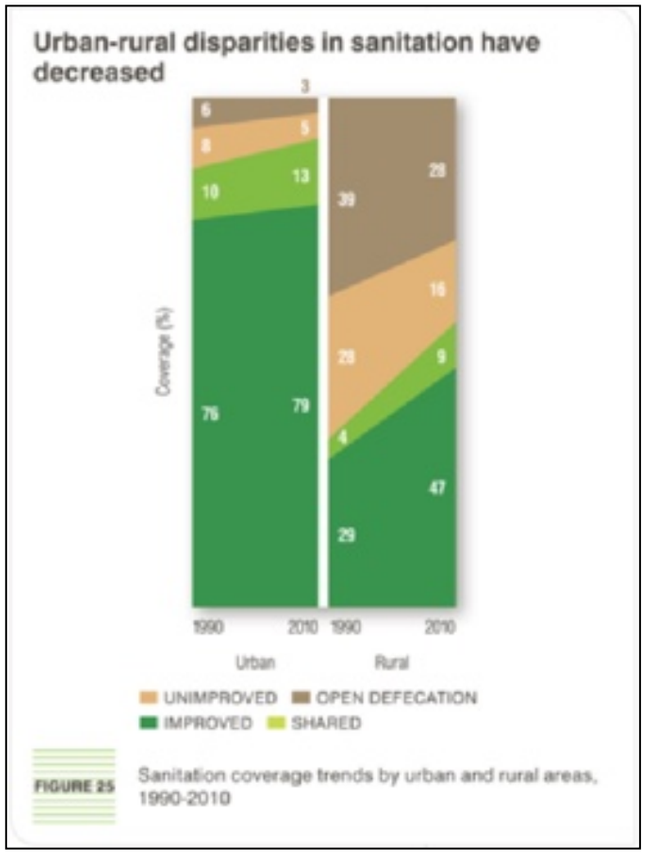
Importance heatmap

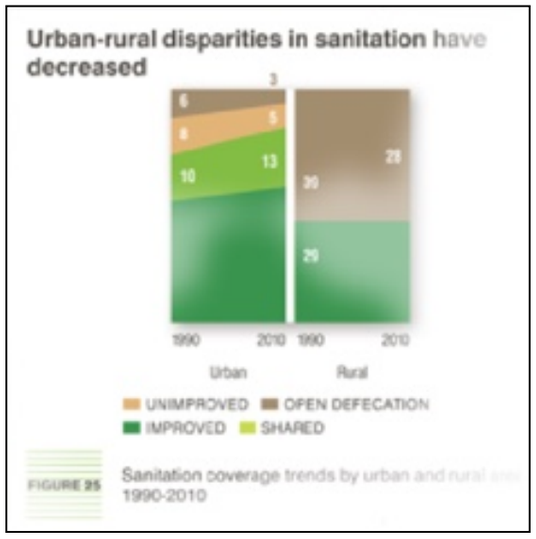
Thumbnail

applications

thumbnailing







applications

thumbnailing

Find an image with a given caption.

Instructions

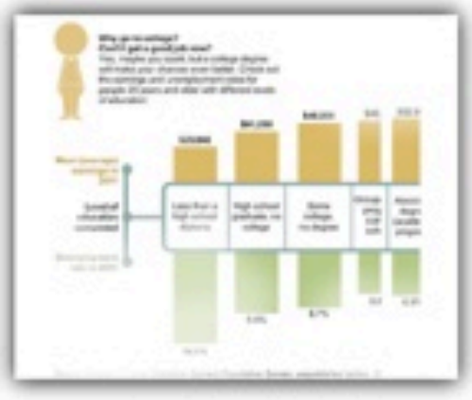
1 Please wait until all images finish loading.
2 Scroll to find the graphic that matches the caption below. The thumbnails summarize each graphic.
3 Click on a thumbnail to see the full graphic.
4 Once you click on the correct graphic you will be able to submit.

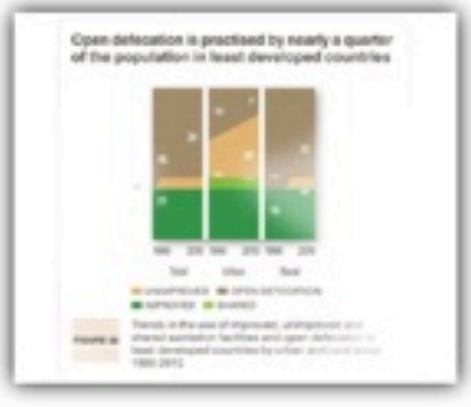
Find a graphic image that matches the caption provided.

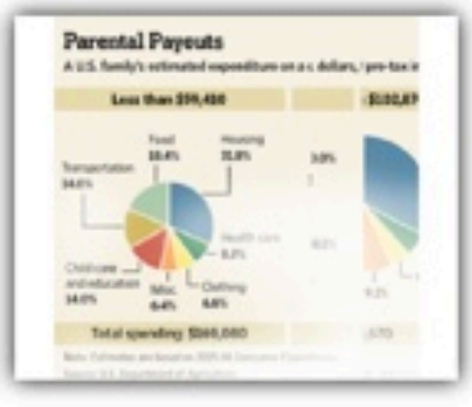
Submit

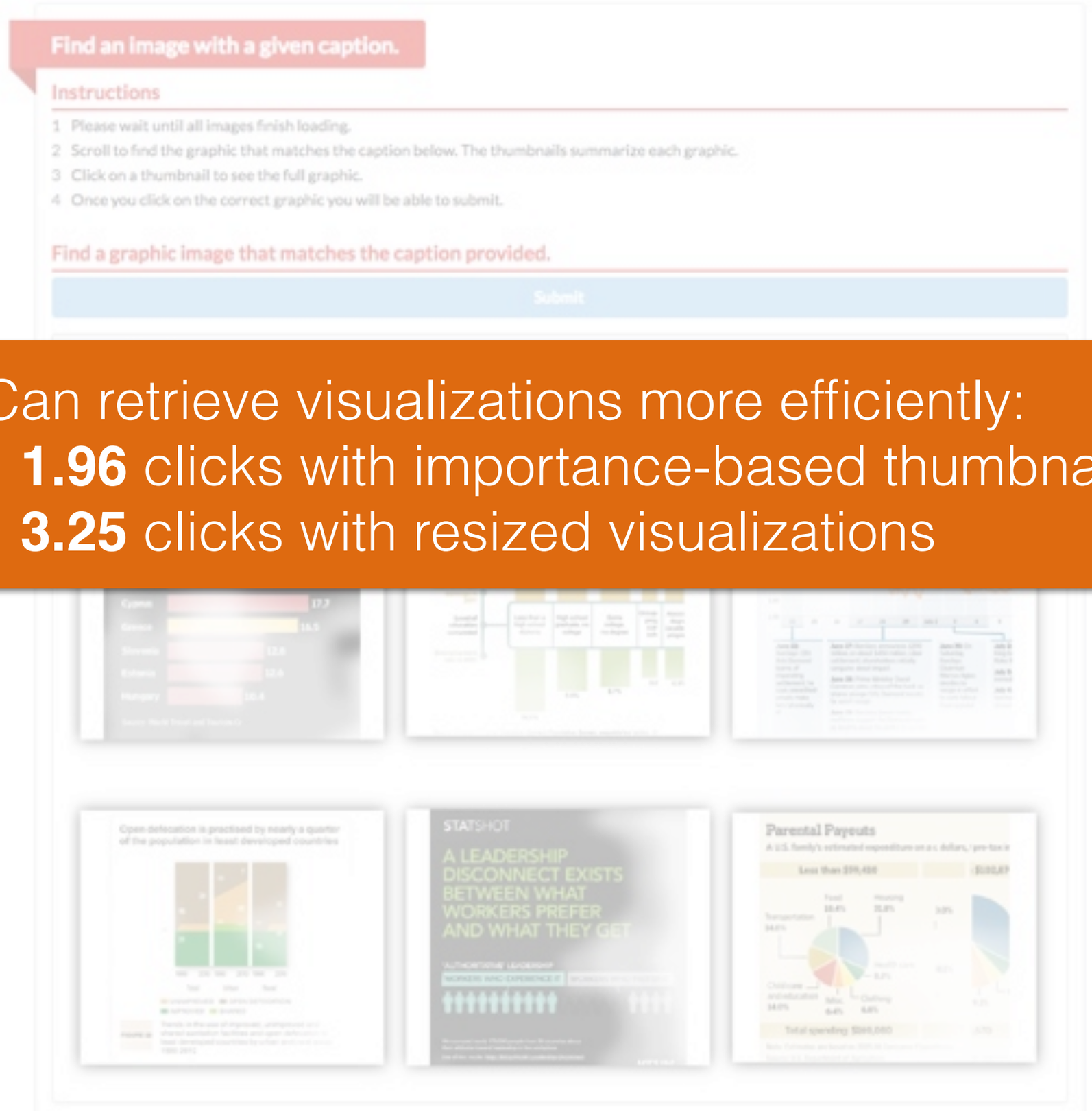
Image Caption

This graph shows that workers don't get what they prefer. There is a disconnect between leadership and workers.







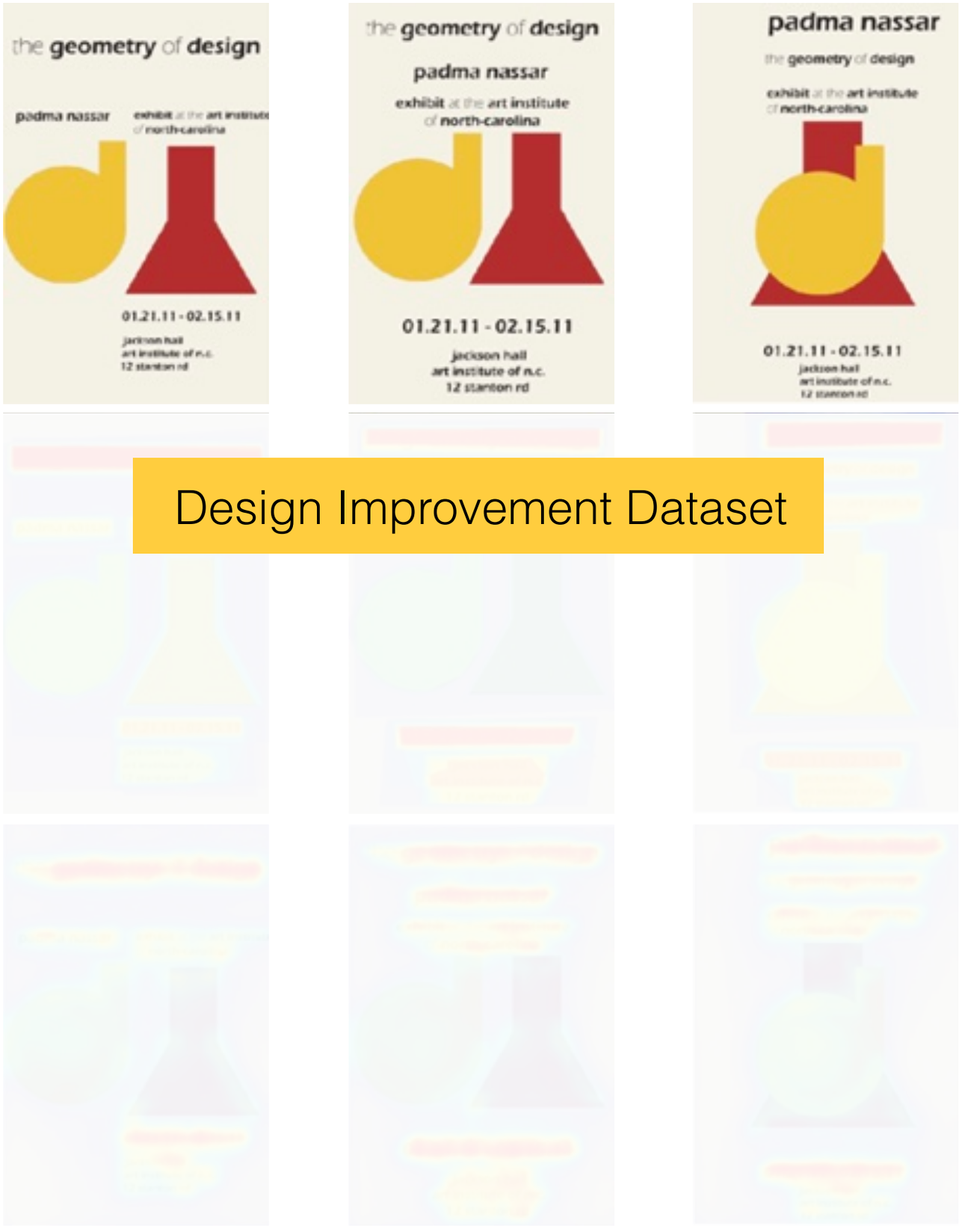


Can retrieve visualizations more efficiently:

- **1.96** clicks with importance-based thumbnails
- **3.25** clicks with resized visualizations

applications

interactive



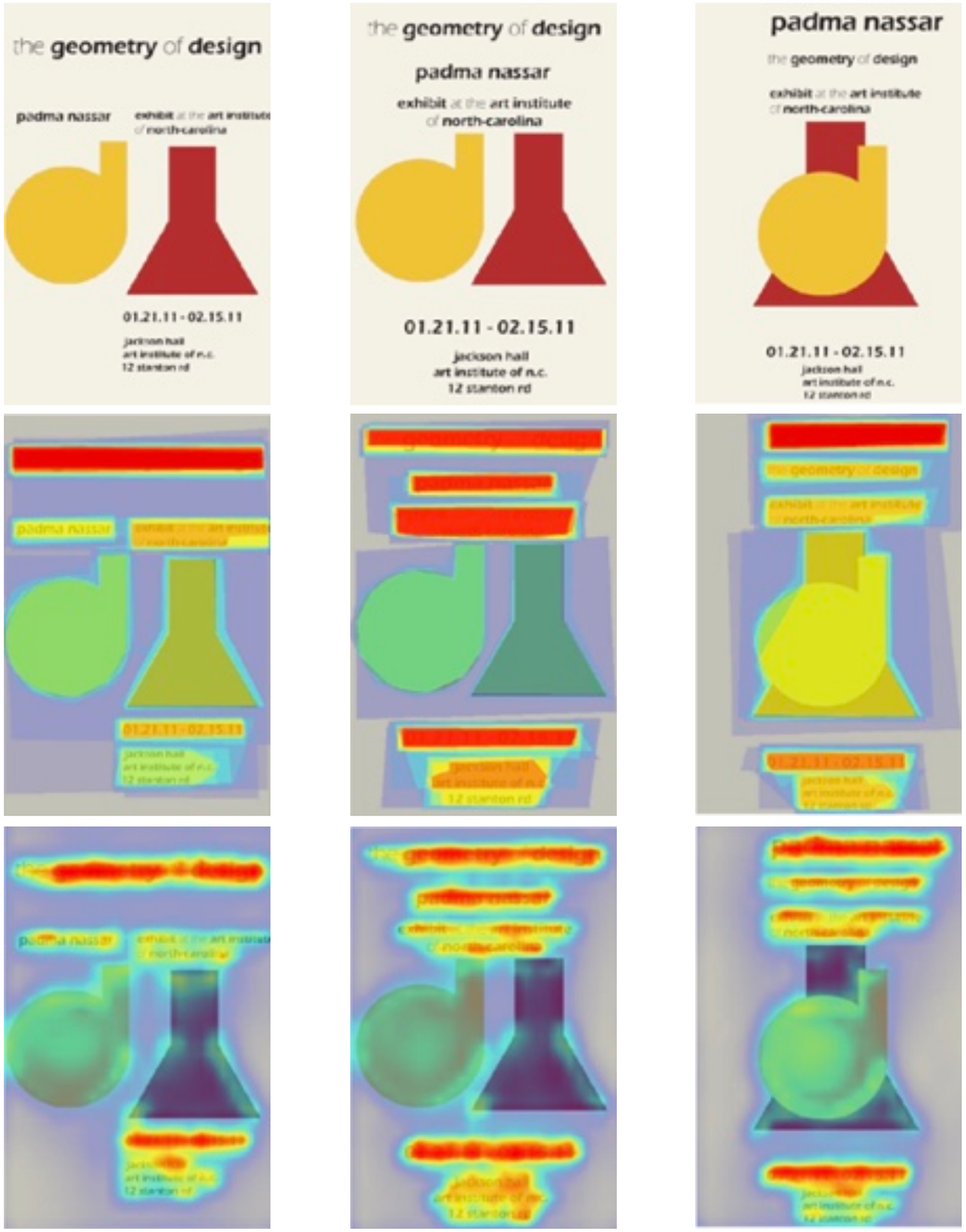
Design Improvement Dataset

applications

interactive

Ground truth

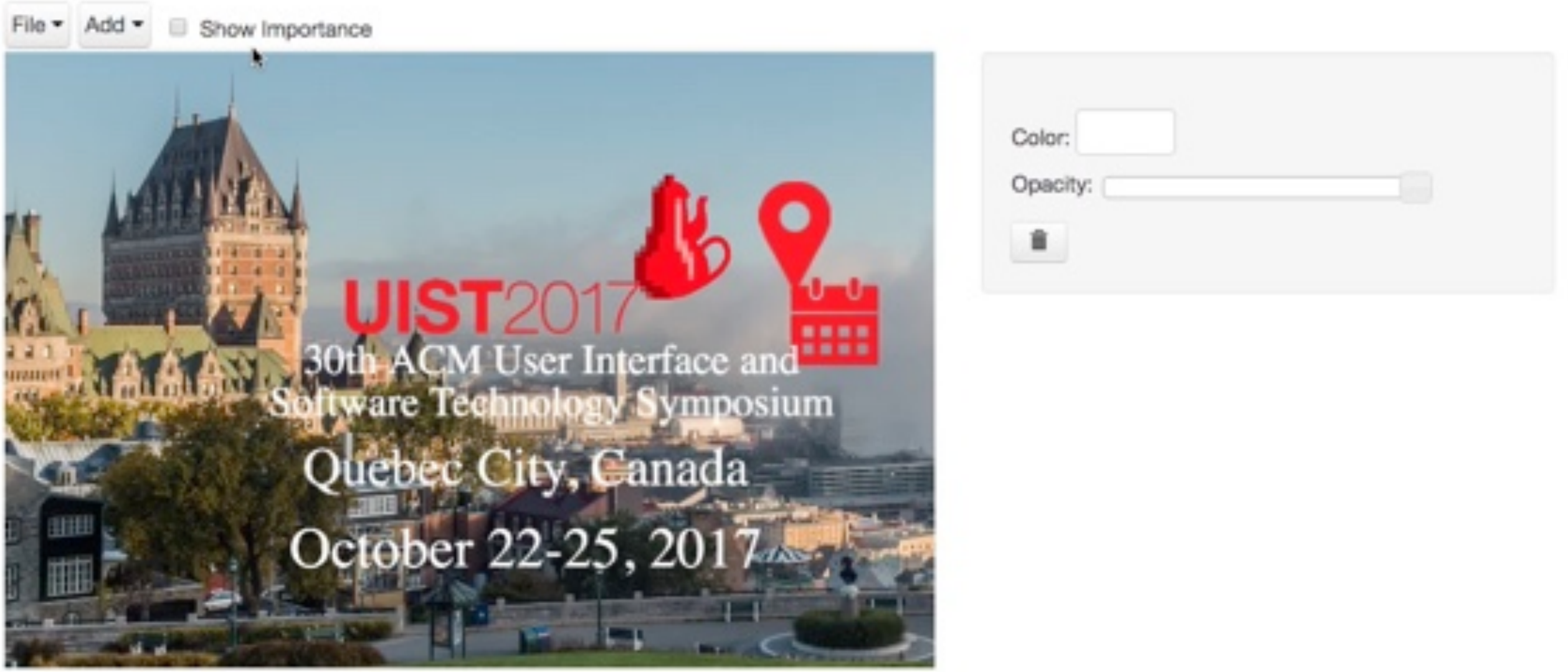
Prediction



applications

interactive

visimportance.csail.mit.edu



website: visimportance.csail.mit.edu

code: github.com/cvzoya/visimportance