

Crowd-Powered Parameter Analysis for Visual Design Exploration

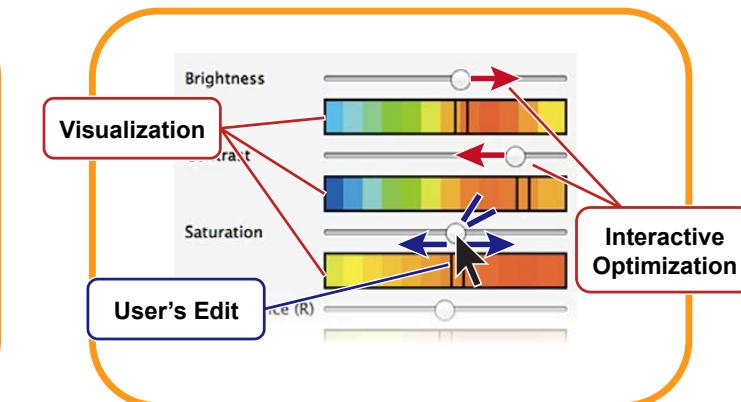
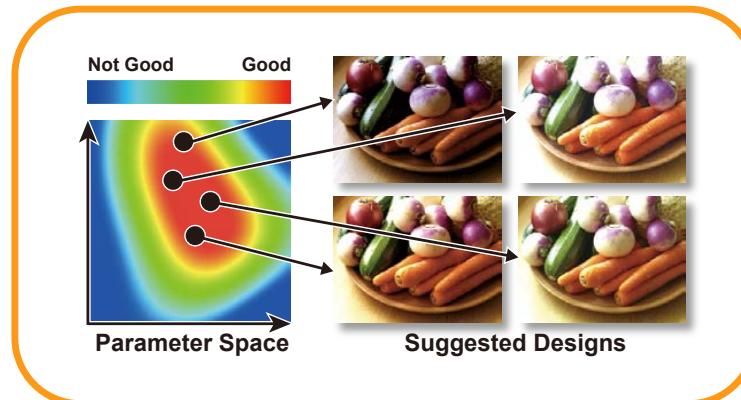
Yuki Koyama

Daisuke Sakamoto

Takeo Igarashi



THE UNIVERSITY OF TOKYO



How can computation help design?

How can computation help design?

Target: design exploration by parameter tweaking

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Target: design exploration by parameter tweaking

The image shows a wooden bowl filled with various vegetables, including carrots, turnips, a green zucchini, and several onions. A white button with the word "Video" in black text is overlaid on the center-left of the bowl. To the right of the bowl is a vertical panel displaying six sliders for color adjustment, each with a numerical value. A cursor arrow points to the "Color Balance (G)" slider, which is set to 0.45.

Parameter	Value
Brightness	0.48
Contrast	0.46
Saturation	0.63
Color Balance (R)	0.62
Color Balance (G)	0.45
Color Balance (B)	0.50

Our Approach

1. Analyze a design space by **human computation**
Estimate a distribution of “goodness” of designs

2. Introduce **user interfaces** for design exploration
Smart Suggestion, VisOpt Slider

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Workflow

Design Task



design parameters

Brightness	<input type="range"/>
Contrast	<input type="range"/>
Saturation	<input type="range"/>
Color Balance (R)	<input type="range"/>
Color Balance (G)	<input type="range"/>
Color Balance (B)	<input type="range"/>

Design Task

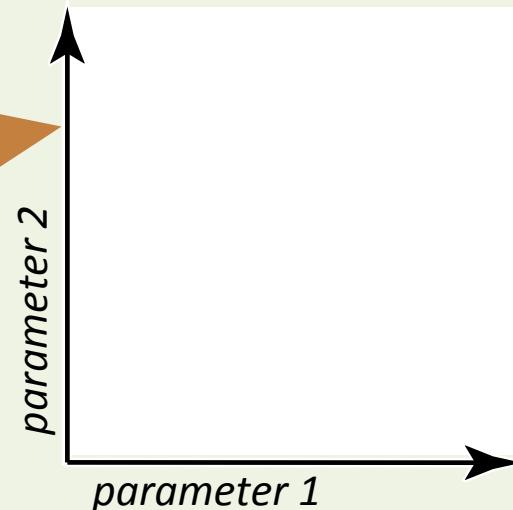


design parameters

- Brightness
- Contrast
- Saturation
- Color Balance (R)
- Color Balance (G)
- Color Balance (B)

Analysis

parameter space



Design Task

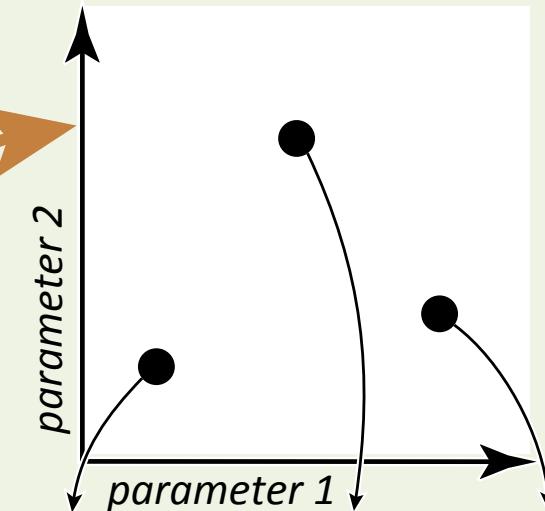


design parameters

- Brightness
- Contrast
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- Color Balance (R)
- Color Balance (G)
- Color Balance (B)

Analysis

parameter space



Design Task

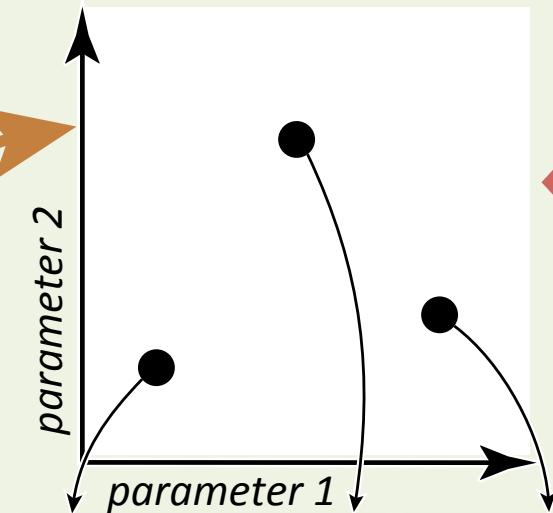


design parameters

- Brightness
- Contrast
- Saturation
- Color Balance (R)
- Color Balance (G)
- Color Balance (B)

Analysis

parameter space



crowd workers



Design Task

Analysis



des

Brightne

Contrast

Saturatio

Color Ba

Color Ba

Color Ba

No.07



Video

Answer for No.07

1	2	3	4	5
<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

③

orkers



Design Task



design parameters

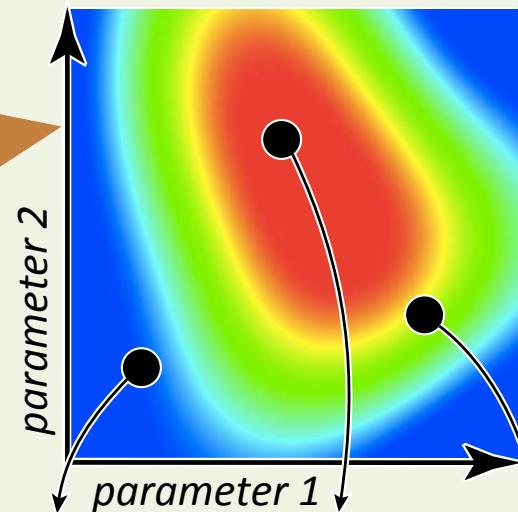
Brightness	<input type="range"/>
Contrast	<input type="range"/>
Saturation	<input type="range"/>
Color Balance (R)	<input type="range"/>
Color Balance (G)	<input type="range"/>
Color Balance (B)	<input type="range"/>

Analysis

not good *good*



parameter space



crowd workers



Design Task



design parameters

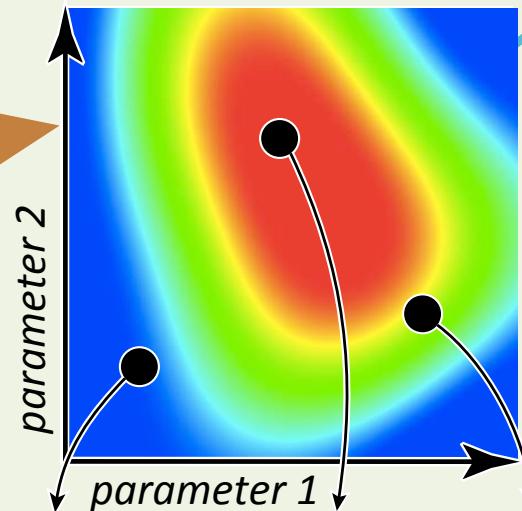
Brightness	<input type="range"/>
Contrast	<input type="range"/>
Saturation	<input type="range"/>
Color Balance (R)	<input type="range"/>
Color Balance (G)	<input type="range"/>
Color Balance (B)	<input type="range"/>

Analysis

not good

good

parameter space



goodness function

$$f : \mathbb{R}^n \rightarrow \mathbb{R}$$

crowd workers



Design Task



design parameters

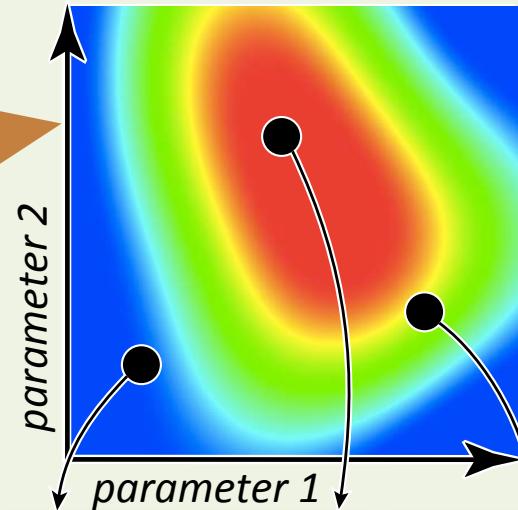
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Analysis

not good

good

parameter space



goodness function

$$f : \mathbb{R}^n \rightarrow \mathbb{R}$$

crowd workers



User Interface

Smart Suggestion

VisOpt Slider

Demo (User Interface)



Design Preview

User Interface

Smart Suggestion

Make It Smart

Show Suggestions

VisOpt Slider

Use Visualization

Use Optimization

Brightness

0.71



Contrast

0.73



Saturation

0.83



Color Balance (R)

0.46



Color Balance (G)

0.59



Color Balance (B)

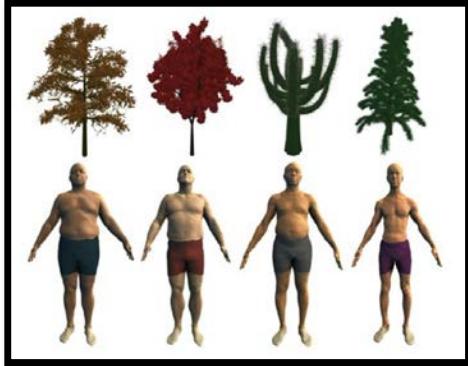
0.72



Real-Time Demo

Related Work

Collaborative Knowledge for Design



[Talton2009]



Voyant [Xu2014]

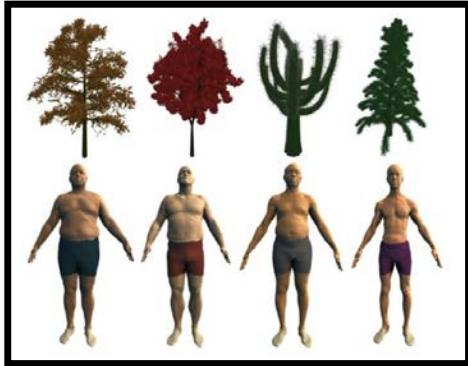
Utilize distribution of user-created good designs

→ Not designed for **on-demand** analysis

Gather feedback for a certain design

→ Not exploration of **parameter space**

Collaborative Knowledge for Design



[Talton2009]



Voyant [Xu2014]

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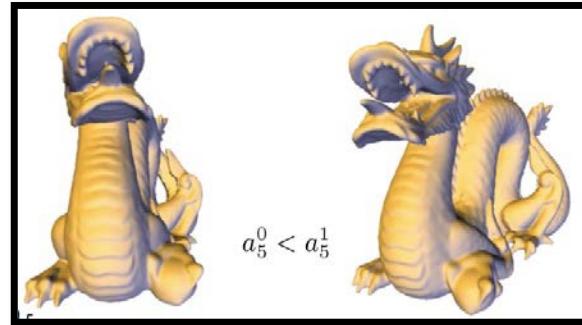
Gather feedback for a certain design

→ Not exploration of **parameter space**

Crowd-Powered Analysis of Design Spaces



Font [O'Donovan2014]



View Direction [Secord2011]



Web [Reinecke2013]

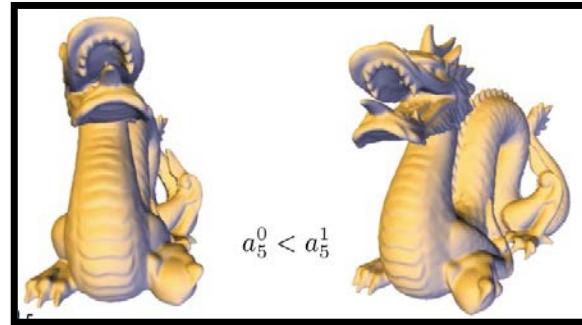
→ Use **domain specific** knowledge

Note: Ours is applicable to **arbitrary** design spaces

Crowd-Powered Analysis of Design Spaces



Font [O'Donovan2014]



View Direction [Secord2011]



Web [Reinecke2013]

→ Use **domain specific** knowledge

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Suggestive Interface



Design Galleries [Marks1997]

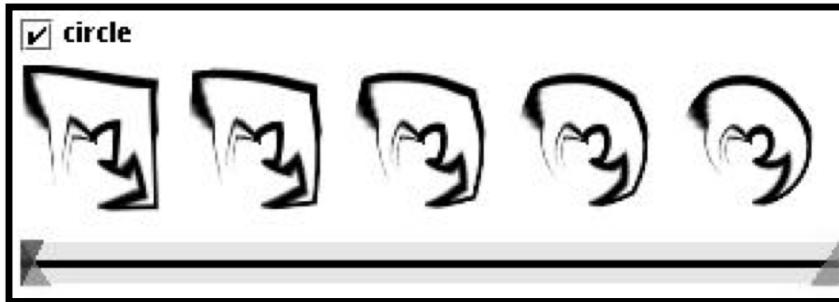


Brainstorm [AfterEffects]

→ Not based on human's aesthetics

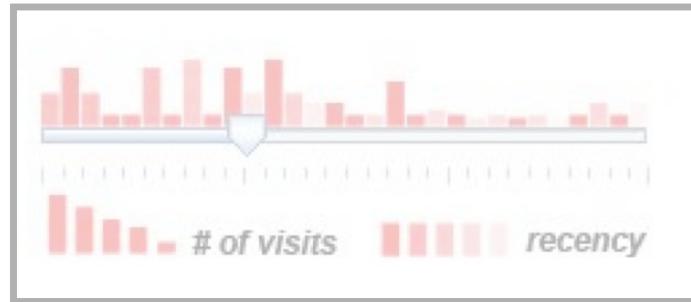
Slider Interface

visualize design previews



Side Views [Terry2002]

visualize related data

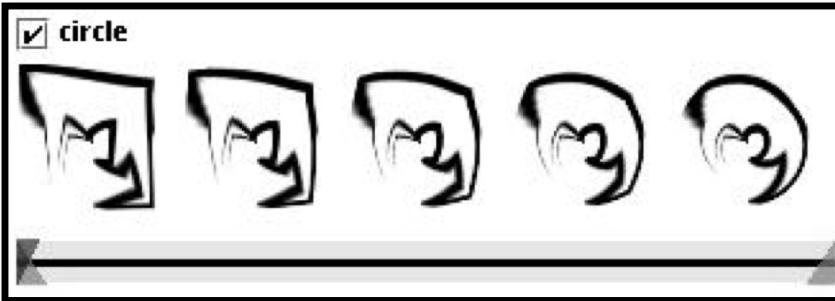


Scented Widget [Willett2007]

- “Raw” information (not goodness values)
- No optimization function

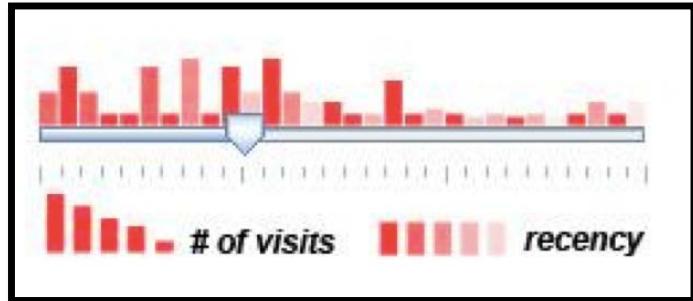
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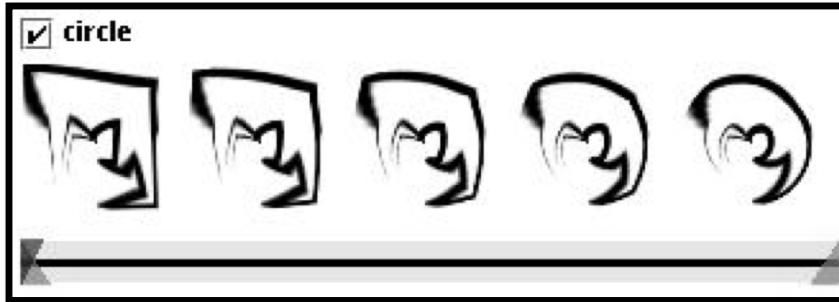


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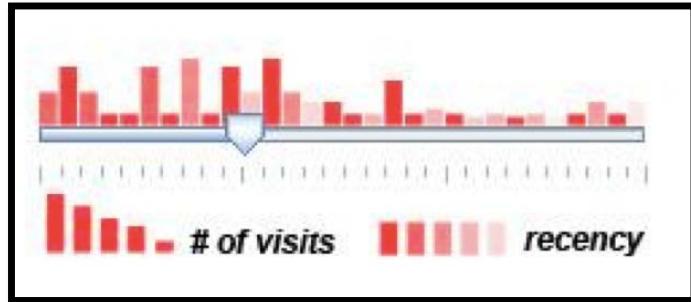
Slider Interface

visualize design previews



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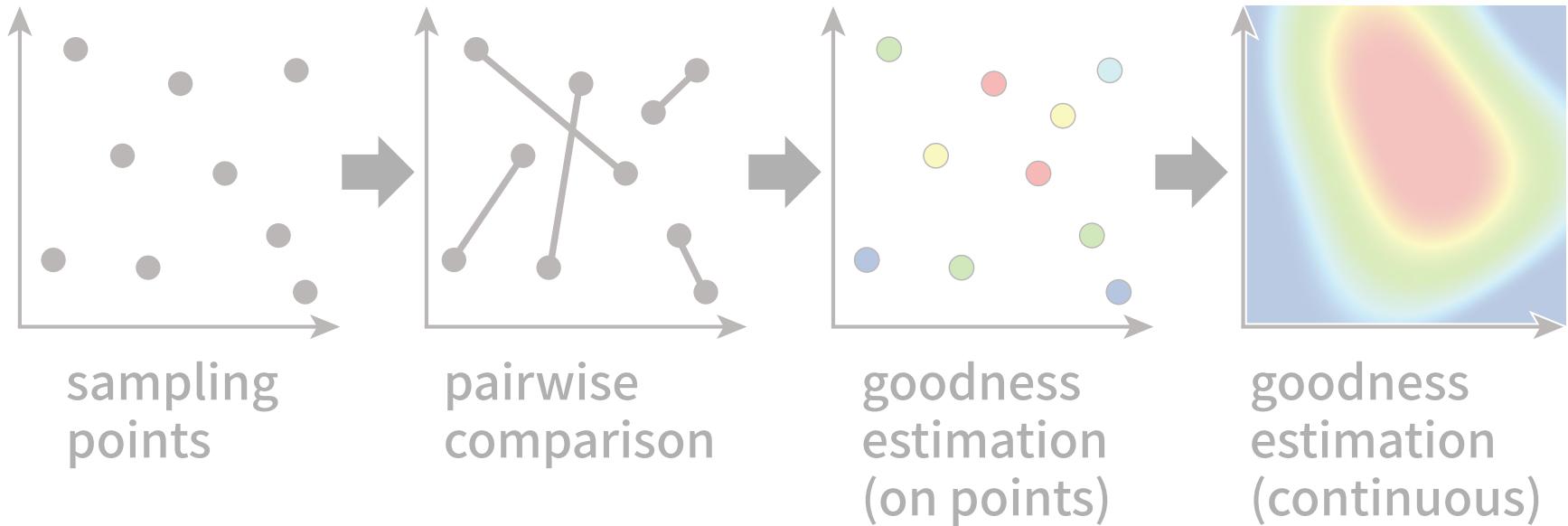


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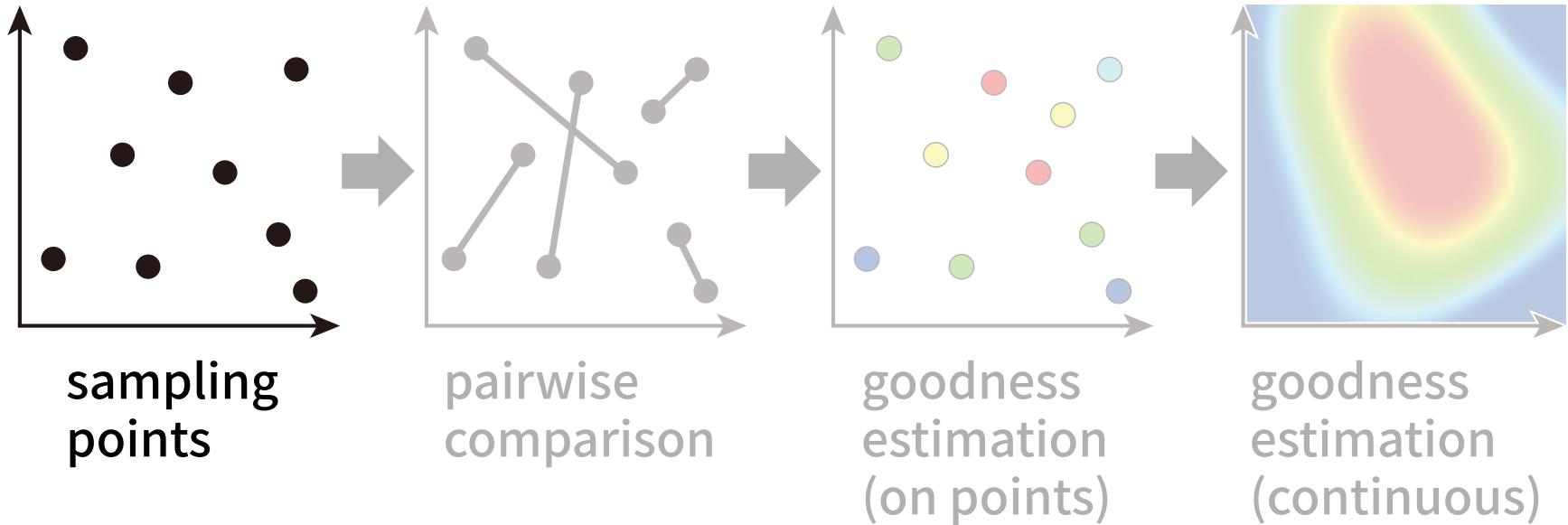
- “Raw” information (not goodness values)
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Analysis

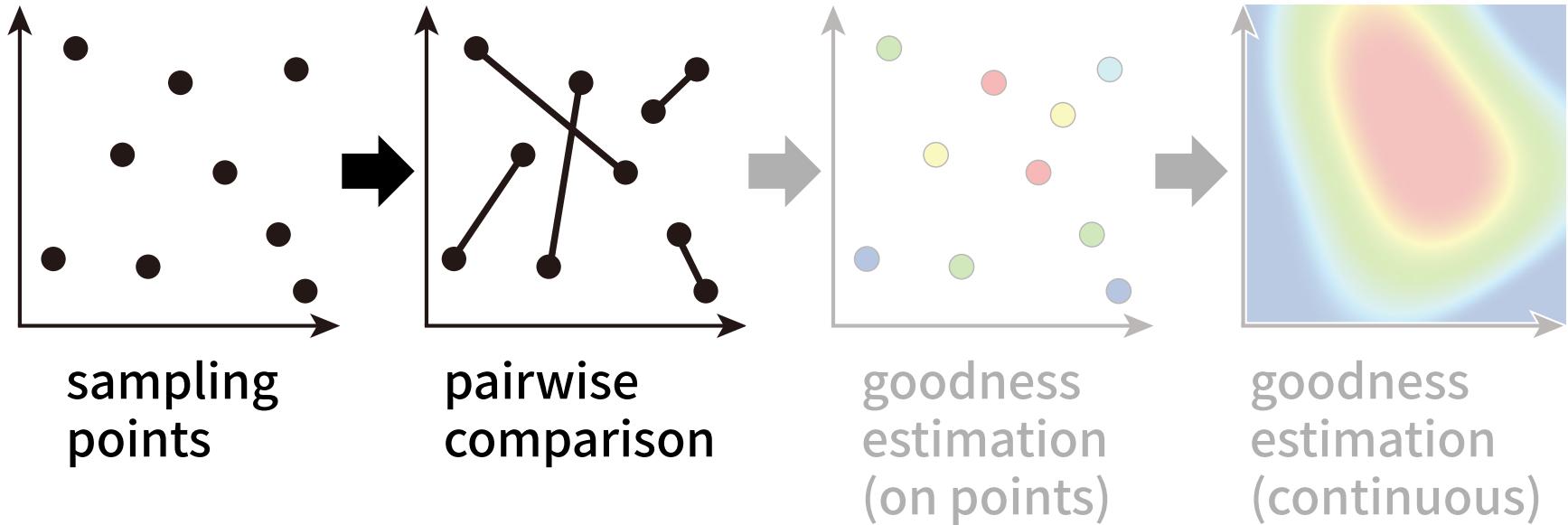
Analysis



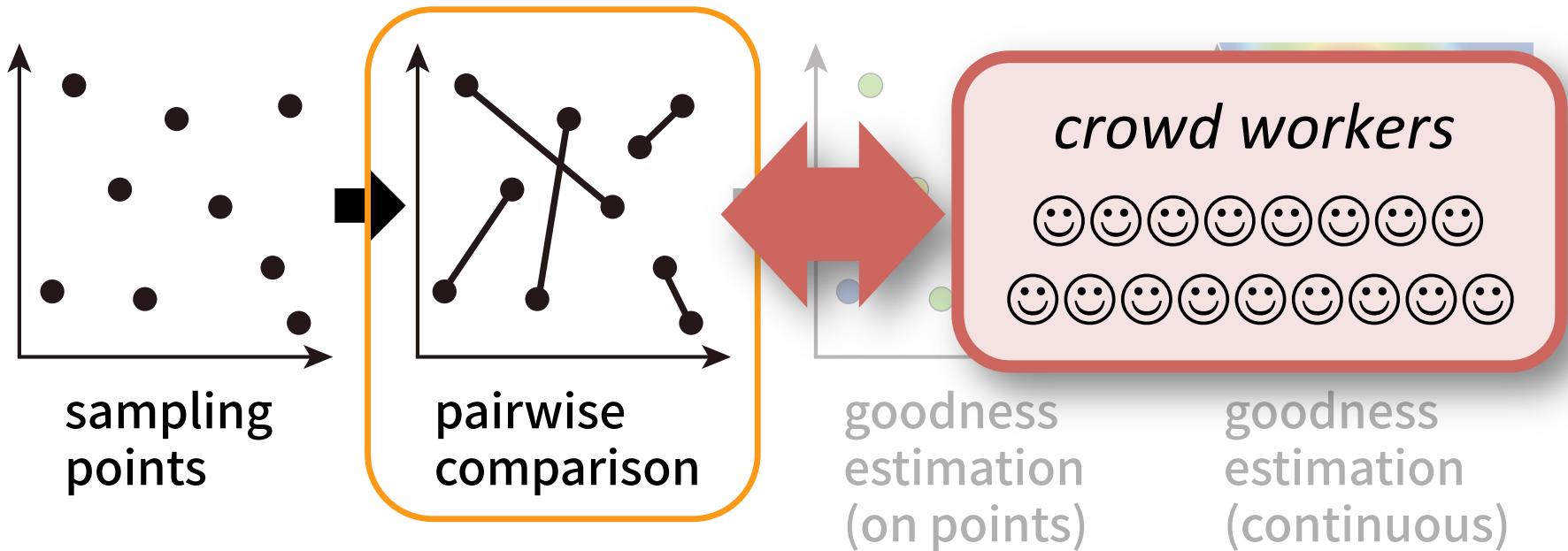
Analysis



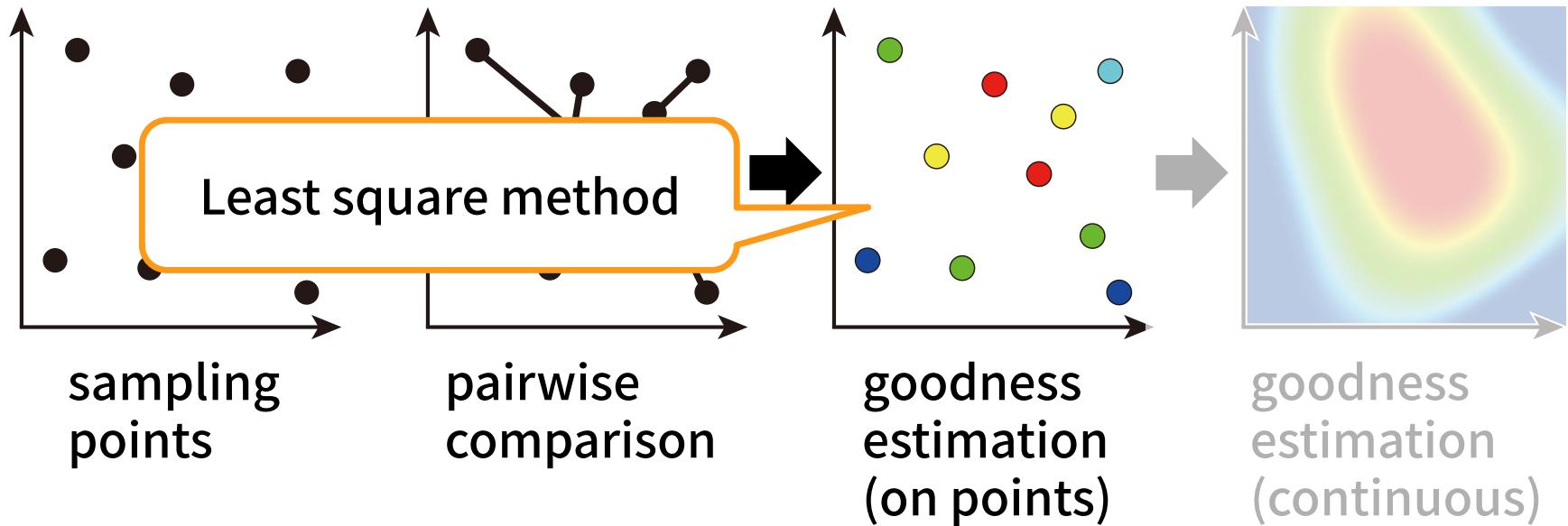
Analysis



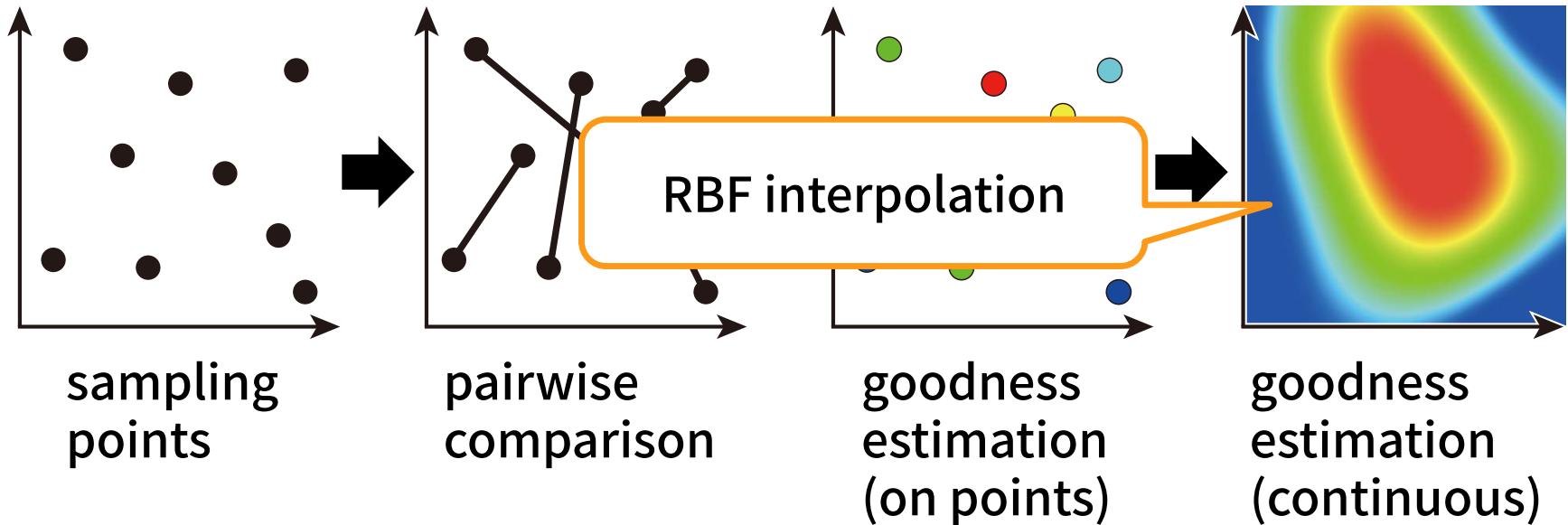
Analysis



Analysis



Analysis

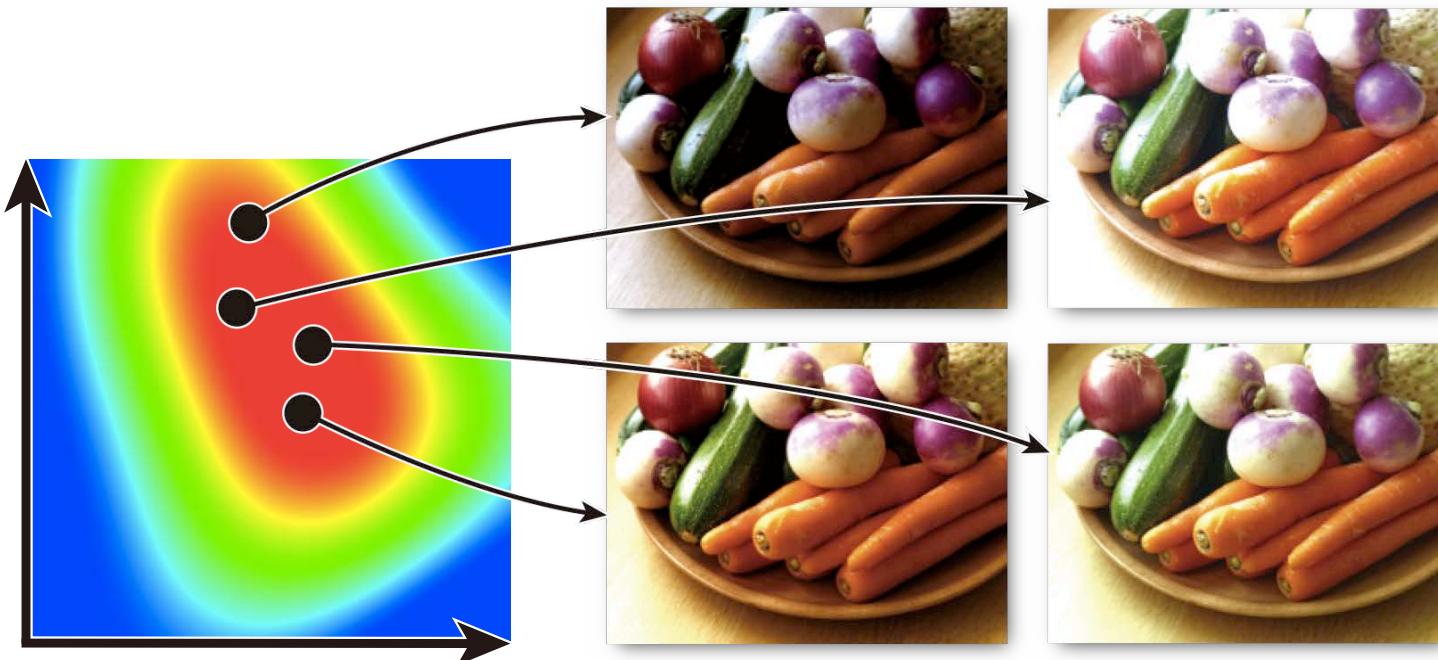


→ See the paper for details

User Interface

User Interface: Smart Suggestion

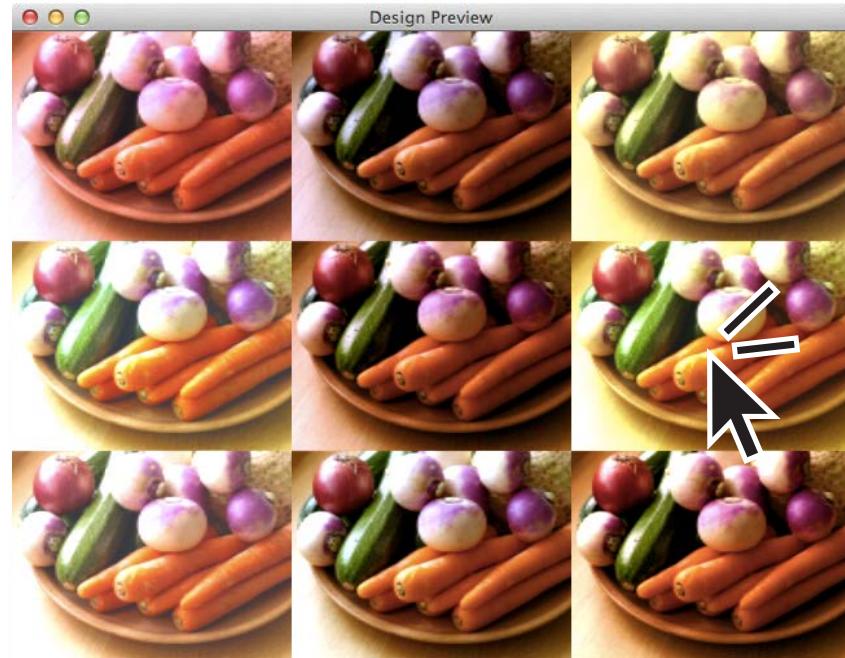
Suggestions based on **goodness**



User Interface: Smart Suggestion

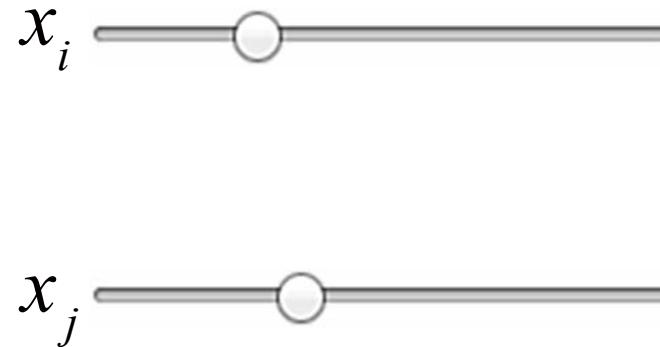
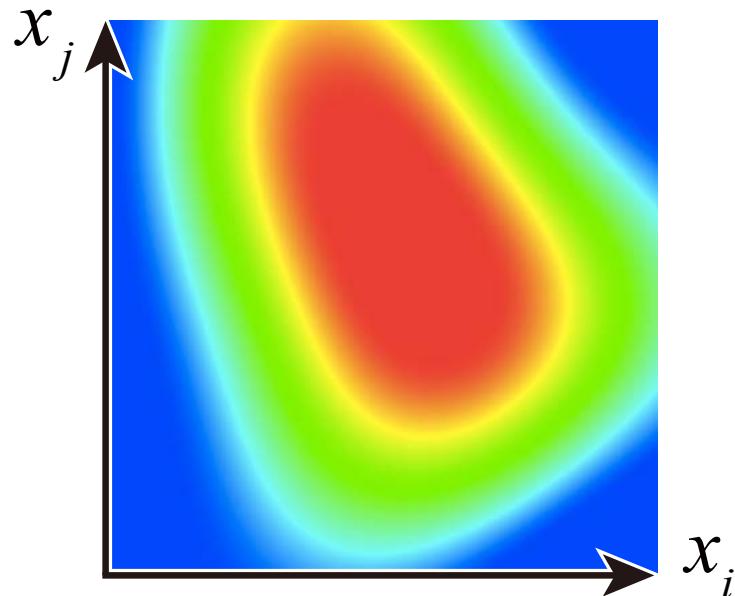
Implementation:

1. Generate 2000 designs randomly
2. Show 9-best designs



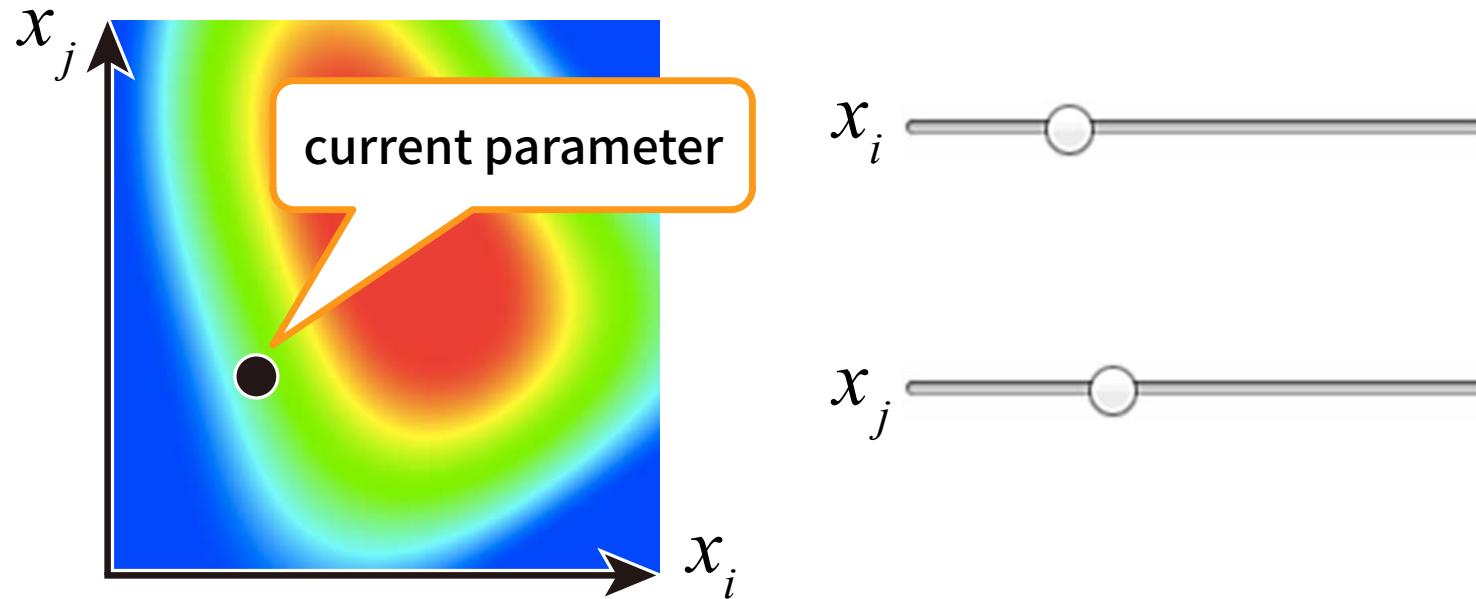
User Interface: VisOpt Slider

Visualization (Vis)



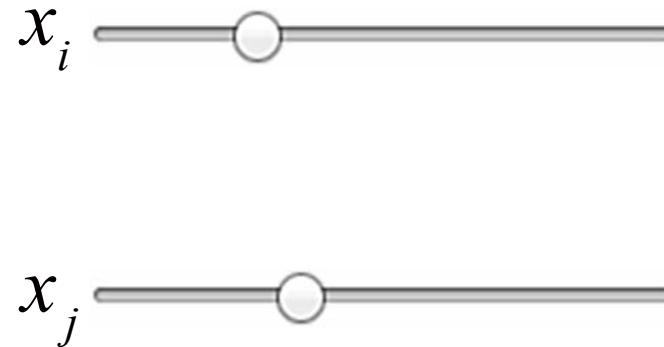
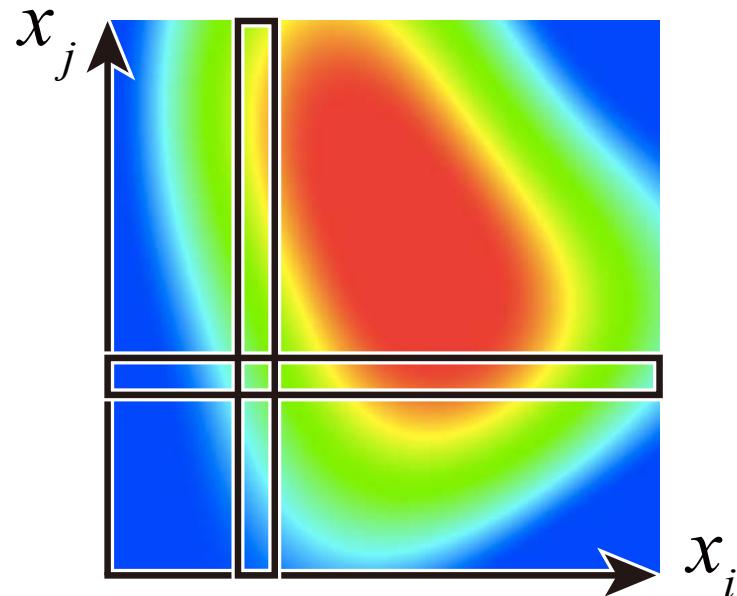
User Interface: VisOpt Slider

Visualization (Vis)



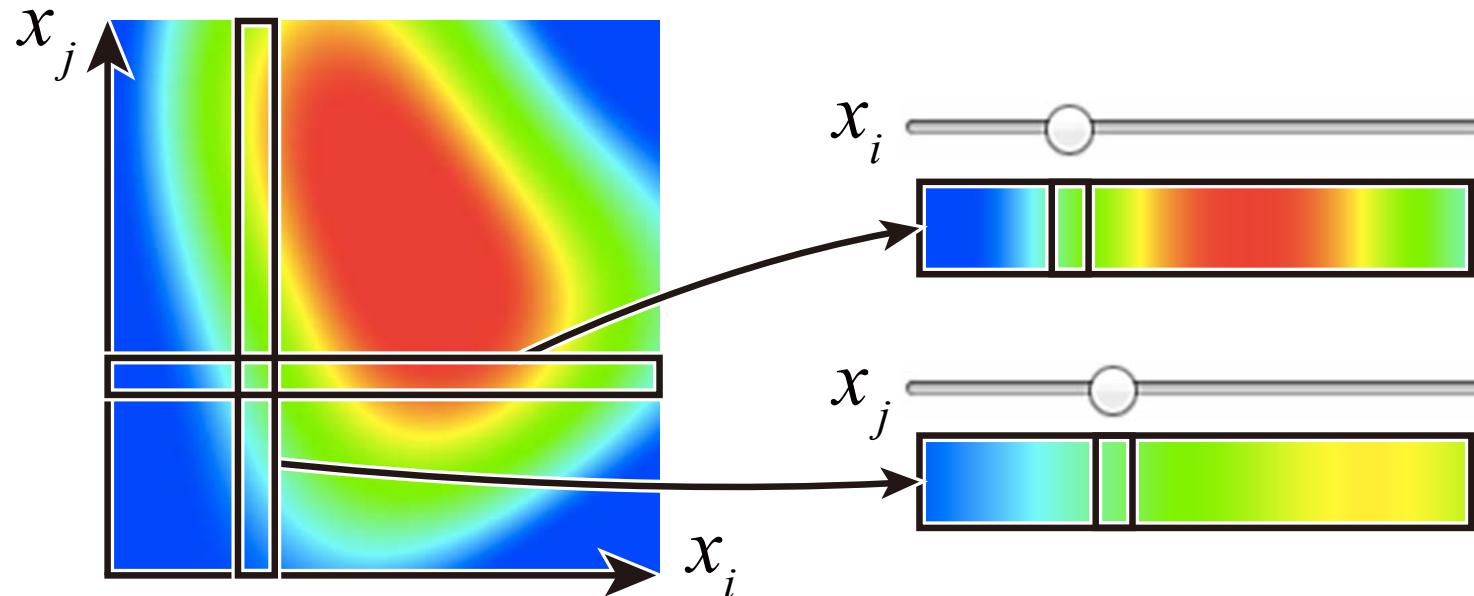
User Interface: VisOpt Slider

Visualization (Vis)



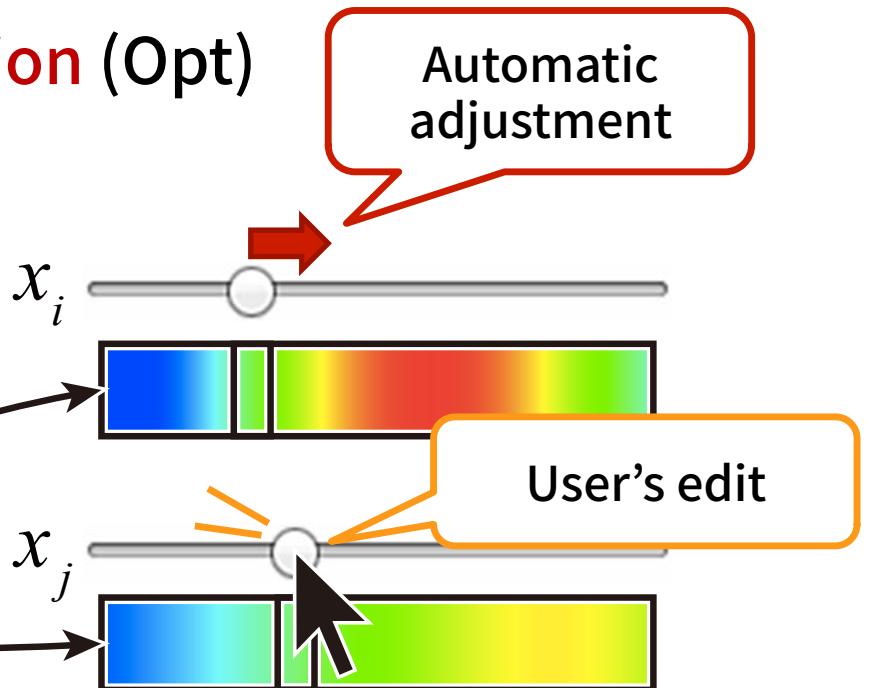
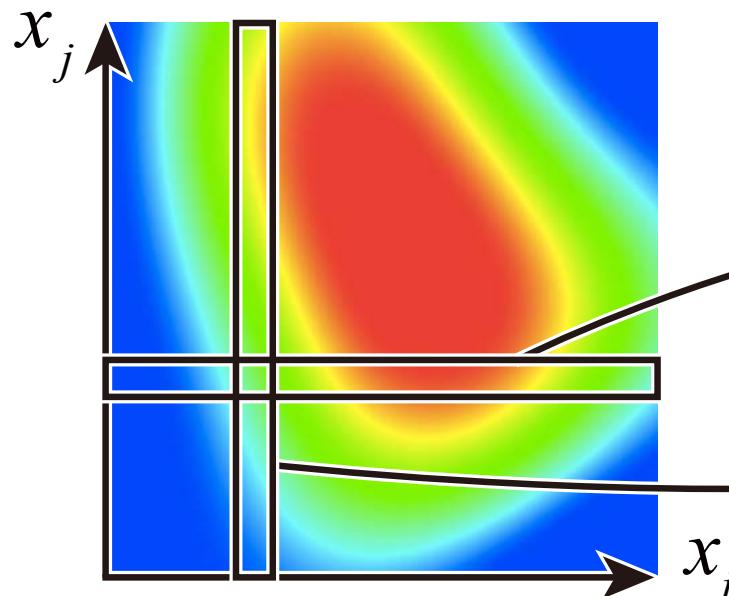
User Interface: VisOpt Slider

Visualization (Vis)



User Interface: VisOpt Slider

Visualization (Vis) + Optimization (Opt)



Applications

Application (1): Color Correction

6 parameters in total



Video

Brightness 0.75

Contrast 0.51

Saturation 0.37

Color Balance (R) 0.32

Color Balance (G) 0.53

Color Balance (B) 0.52

A photograph of various vegetables including carrots, onions, and a zucchini, displayed on a wooden plate. A white rectangular button with the word "Video" in bold black font is overlaid on the image. To the right of the image are six sliders for color correction parameters: Brightness (0.75), Contrast (0.51, with a cursor over it), Saturation (0.37), Color Balance (R) (0.32), Color Balance (G) (0.53), and Color Balance (B) (0.52). The sliders have numerical values and a range from 0.00 to 1.00.

Color Correction



User Interface

Smart Suggestion

Make It Smart

VisOpt Slider

Use Visualization Use Optimization

Brightness 0.50

Contrast 0.50

Saturation 0.50

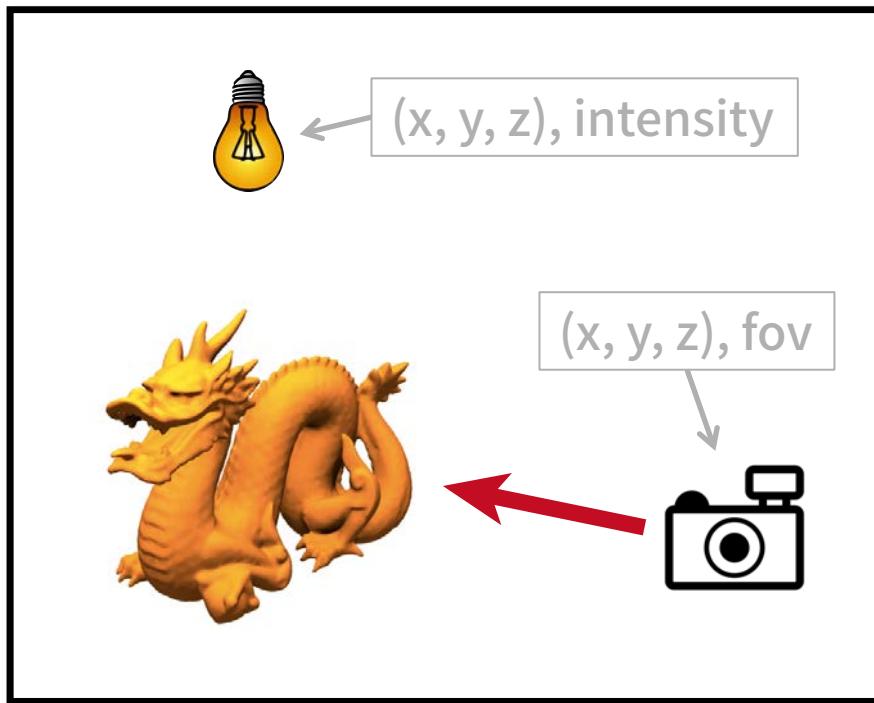
Color Balance (R) 0.50

Color Balance (G) 0.50

Color Balance (B) 0.50

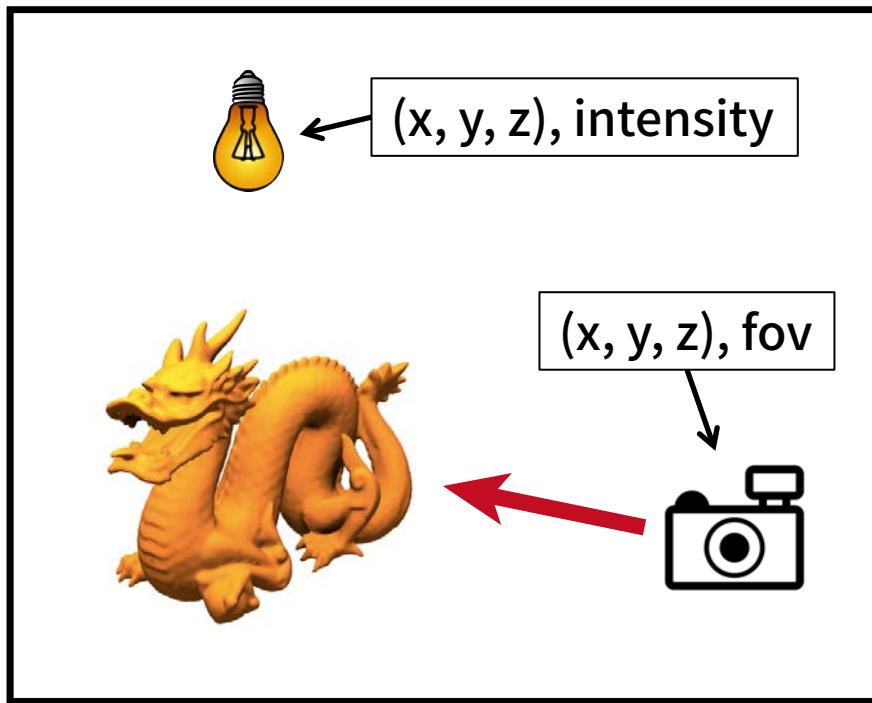
6 parameters

Application (2): Camera & Light



Goal:
find a good view
8 parameters in total

Application (2): Camera & Light



Goal:
find a good view
8 parameters in total

Camera & Light Control



Video

8 parameters

User Interface

Smart Suggestion

Make It Smart

Show Suggestions

VisOpt Slider

Use Visualization Use Optimization

Camera.y		0.67
Camera.z		0.13
Camera.fov		0.64
Light.x		0.75
Light.y		0.59
Light.z		0.85
Light.intensity		0.68

Application (3): Shader (Appearance)

Task: designing appearance of stainless teapot



Application (3): Shader (Appearance)

Task: designing appearance of stainless teapot

Criteria: “**realistic**” as stainless

8 parameters in total



e.g. stainless

Shader

Design Preview

Video

User Interface

Smart Suggestion

Make It Smart [Show Suggestions](#)

VisOpt Slider

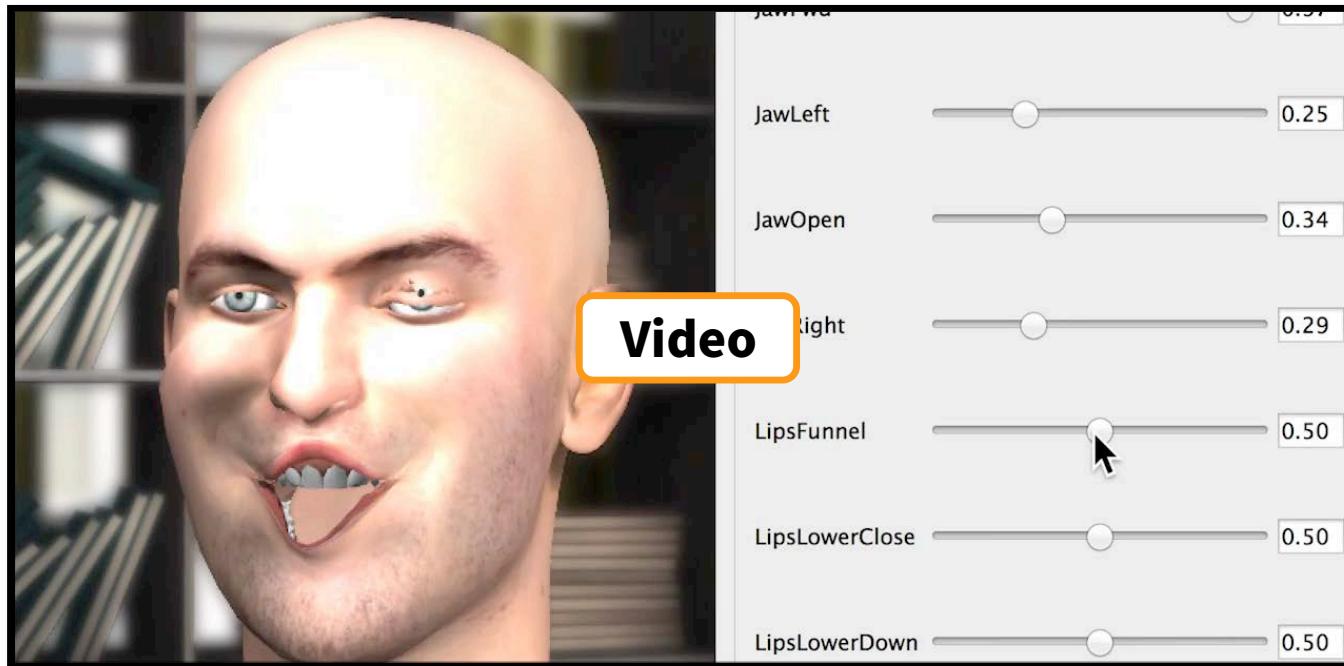
Use Visualization Use Optimization

Parameter	Value
Main Color	0.50
Specular Color	0.29
Shininess	0.50
Gloss	0.27
Reflection	0.87
Fresnel Reflection	0.72
Fresnel/EdgeAlpha Falloff	0.17
Metalics	0.20

8 parameters

Application (4): Facial Expression

Blendshape: control expression by parameters



Video

Application (4): Facial Expression

Blendshape: control expression by parameters

Random designs



→ Most designs are **unnatural** (broken)

Application (4): Facial Expression

Blendshape: control expression by parameters

Criteria: **natural** (not broken)

53 parameters in total

Design Preview User Interface

BlendShape Facial Expression Suggestion

Make It Smart

Show Suggestions

VisOpt Slider

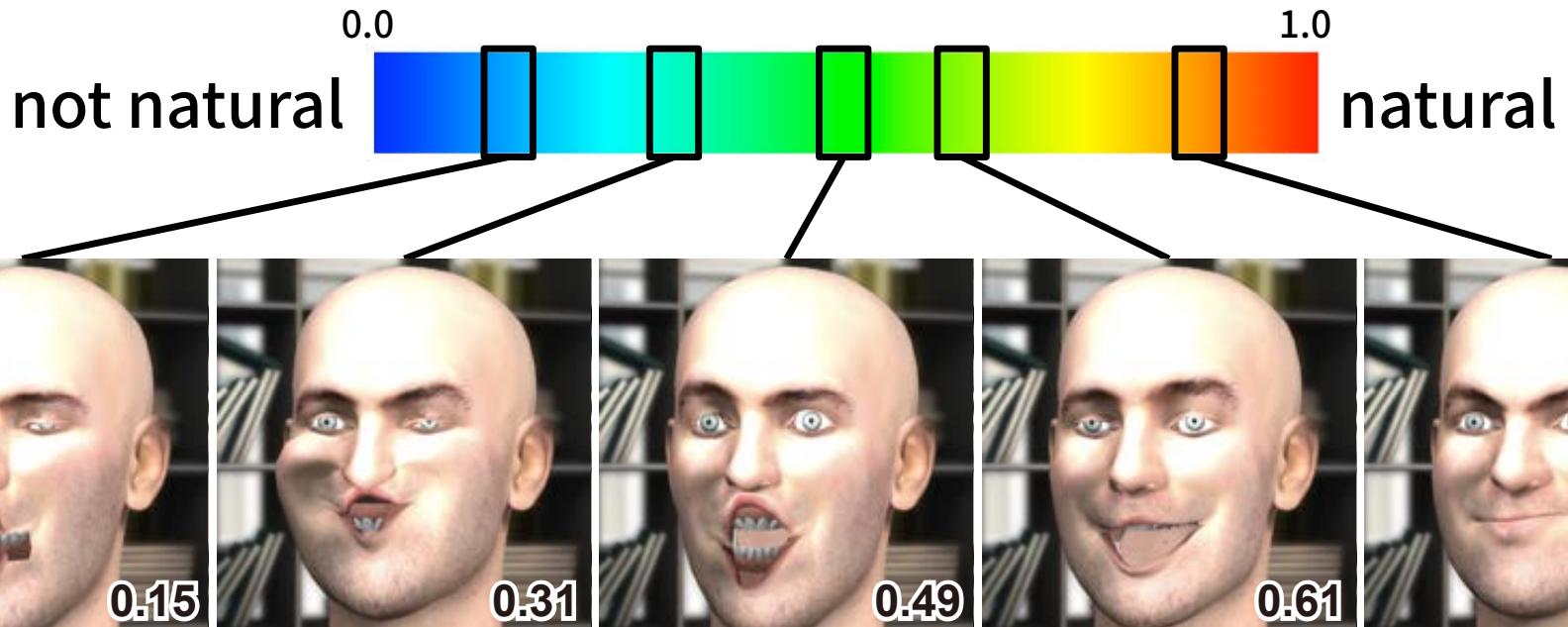
Use Visualization Use Optimization

BrowsD_L	0.57
BrowsD_R	0.43
BrowsU_C	0.06
BrowsU_L	0.89
BrowsU_R	0.87
CheekSquint_L	0.70
CheekSquint_R	0.14

53 parameters

The image displays a 3D facial model of a man with a surprised or shocked expression. A white rectangular button with an orange border is placed over his right cheek, containing the word "Video". The background is a blurred image of a bookshelf filled with books.

Application (4): Facial Expression



→ Achieved visually plausible estimation

Application: Statistics

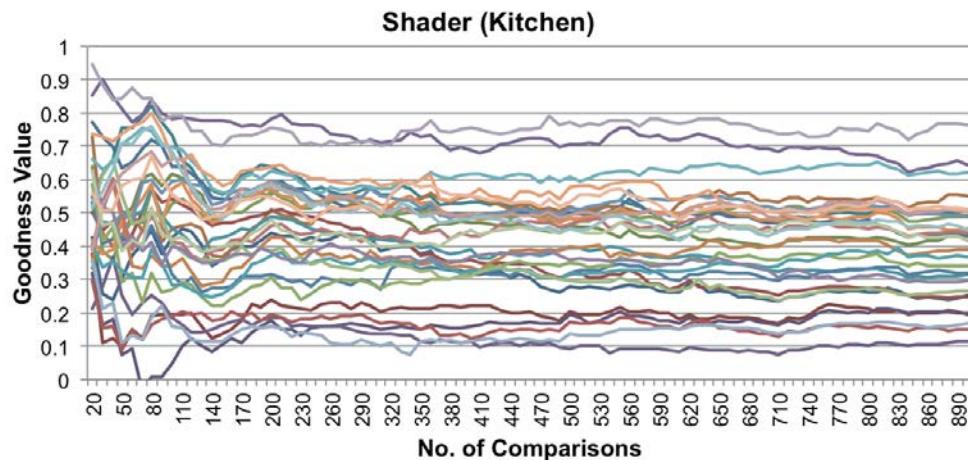


	Color Correction	Camera & Light	Shader	Facial Expression
#parameters	6	8	8	53
criteria	good	good	realistic	natural
#comparisons	1095	1010	907	1771
total cost	4.00 USD	4.00 USD	4.00 USD	12.00 USD
total time	30 min	25 min	34 min	55 min

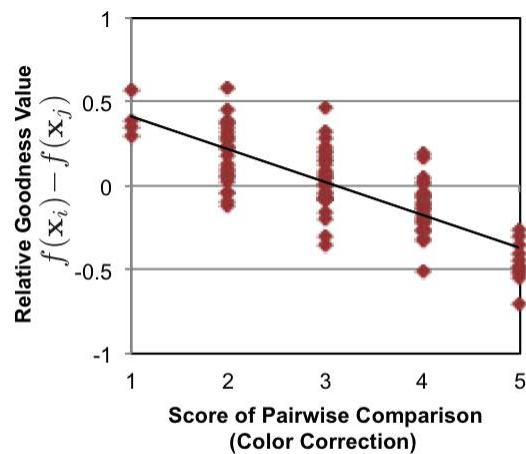
Evaluation

Evaluation: Analysis

Convergence (w.r.t #comparisons)



Cross-Validation



→ See the paper for details

Evaluation: User Interfaces

User study

asked 4 students to use our interfaces

System Usability Scale [Bangor2008]

→ “good” (Average = 77.5, SD = 11.6)

→ See the paper for details

Discussion/Conclusion

Limitation

- Need re-crowdsourcing when the task changes
- Applicable to only continuous parameters (not discrete ones)

Limitation

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Conclusion

- Analysis of (arbitrary) design spaces by using human computation
- Interfaces for design exploration:
Smart Suggestion, VisOpt Slider
- 4 example applications

Conclusion

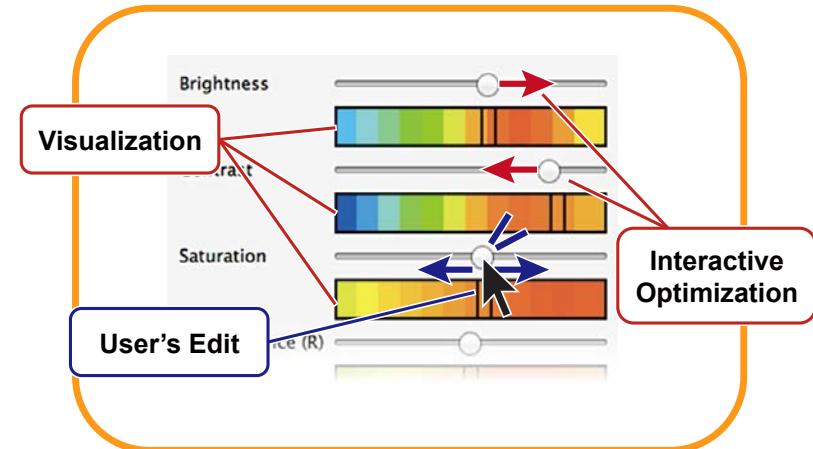
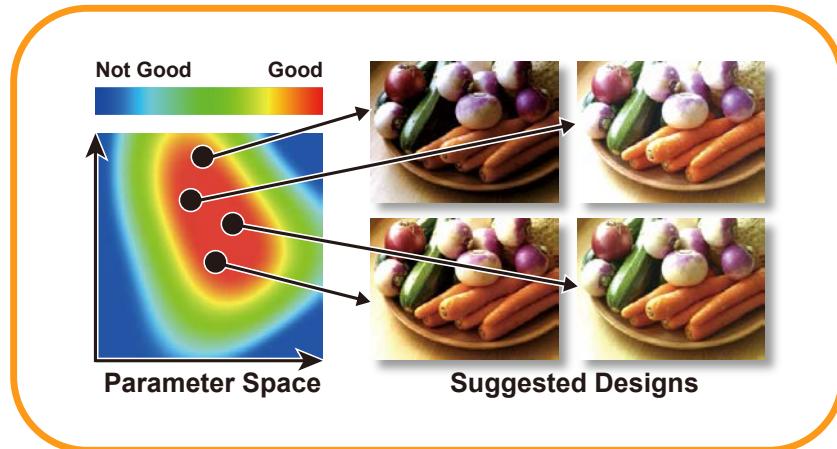
- **Analysis of (arbitrary) design spaces by using human computation**
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Conclusion

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Thank You

Micro-Task for Crowdsourcing



What is the goodness score?

✗ naïve approach (ask absolute value)

- difficult to consistently answer every time
- different scale for each worker

Micro-Task for Crowdsourcing



Which is better?

✓ pairwise comparison

[Secord2011; Gingold2012; Chaudohuri2013]

→ easy for non-experts, suitable for crowdsourcing

Micro-Task for Crowdsourcing

Which of the two images of [noun] is more [adjective]?
For example, [clause].

Please choose the most appropriate one from the 5 options below.

Example of user's specification:

[noun]	vegetable
[adjective]	good
[clause]	suppose that you had to choose one of these two images to appear in a magazine or product advertisement

Micro-Task for Crowdsourcing

Q.03



1

2

3

4

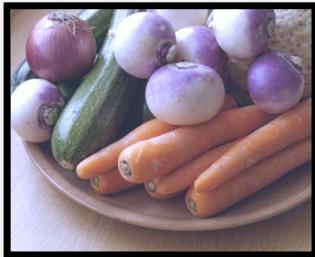
5

Quality Control

“Duplicate” approach

[Secord2011, Gingold2012, Chaudhuri2013]

Q.03



1

2

3

4

5

Q.13



1

2

3

4

5

Detect contradiction

Quality Control

“Duplicate” approach [Secord2011; Gingold2012; Chaudhuri2013]

1. Ask 10 questions first
2. Ask the same 10 questions with **flipped** arrangements

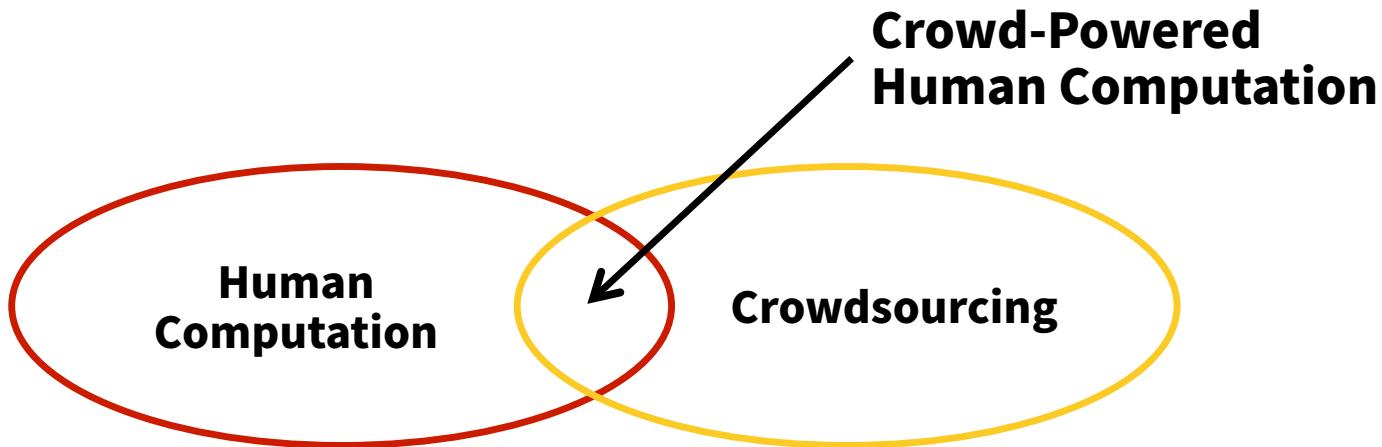
If a pair of answers is contradicted

→ discard them

If over half answers are contradicted

→ discard all of them

Crowdsourcing != Human Computation



Crowdsourcing: ask crowd workers to do some tasks

Human Computation: assume human as a **processor**

→ see [Quinn2011] for details