

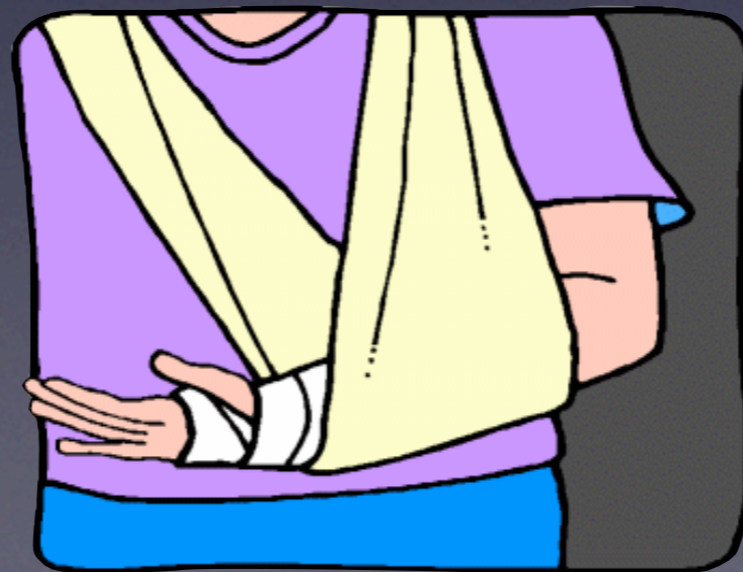
# Automatically Generating User Interfaces Adapted To Users' Motor And Vision Capabilities

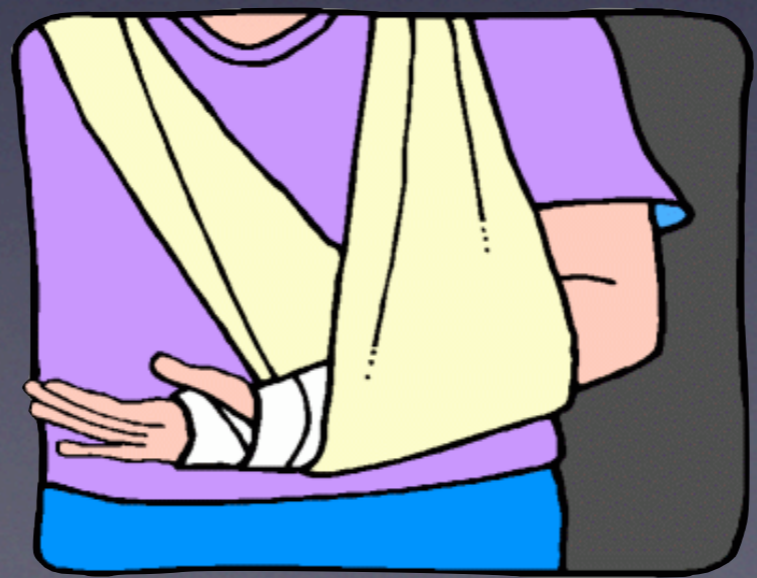
Krzysztof Z. Gajos,  
Jacob O. Wobbrock  
and Daniel S. Weld

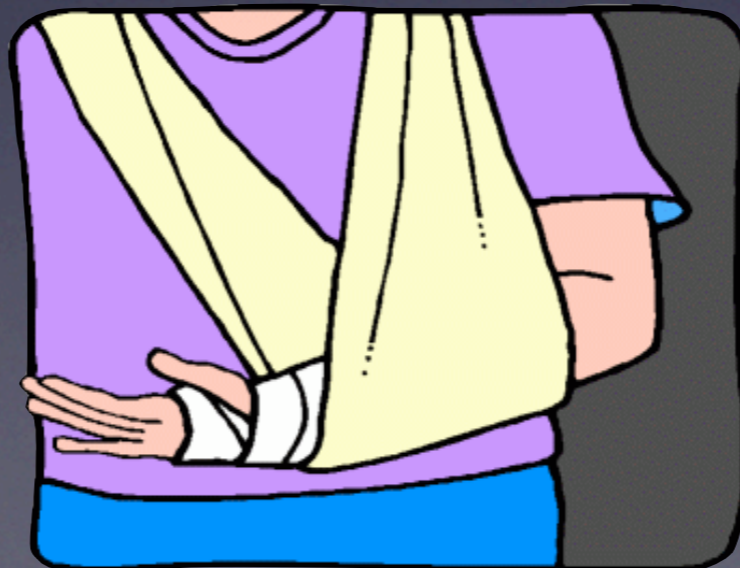
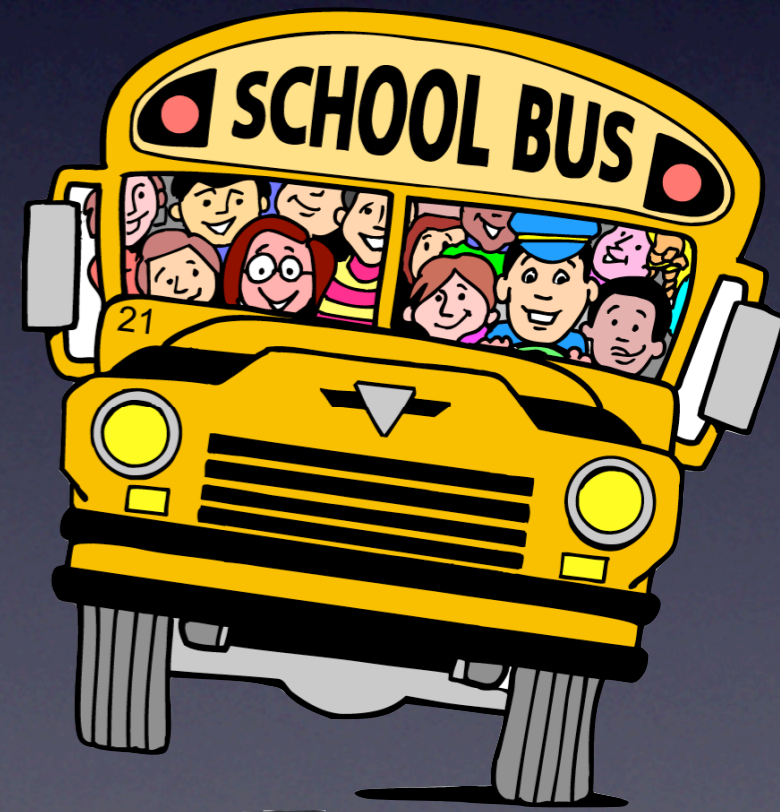


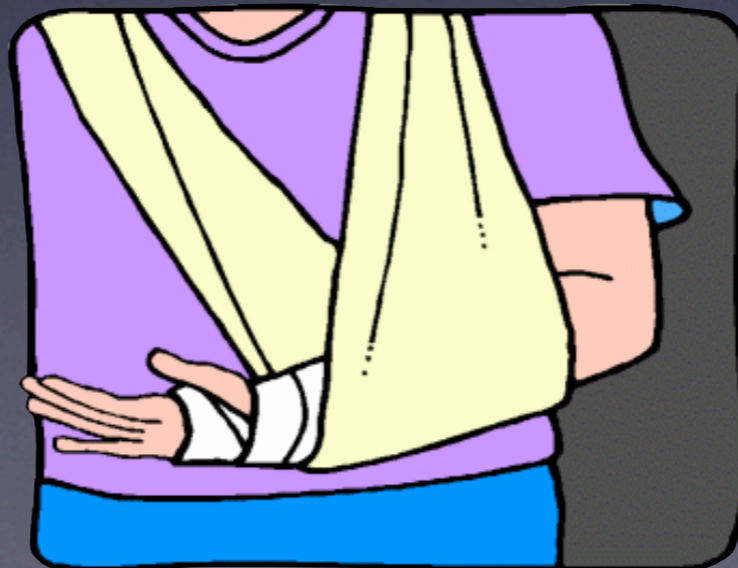
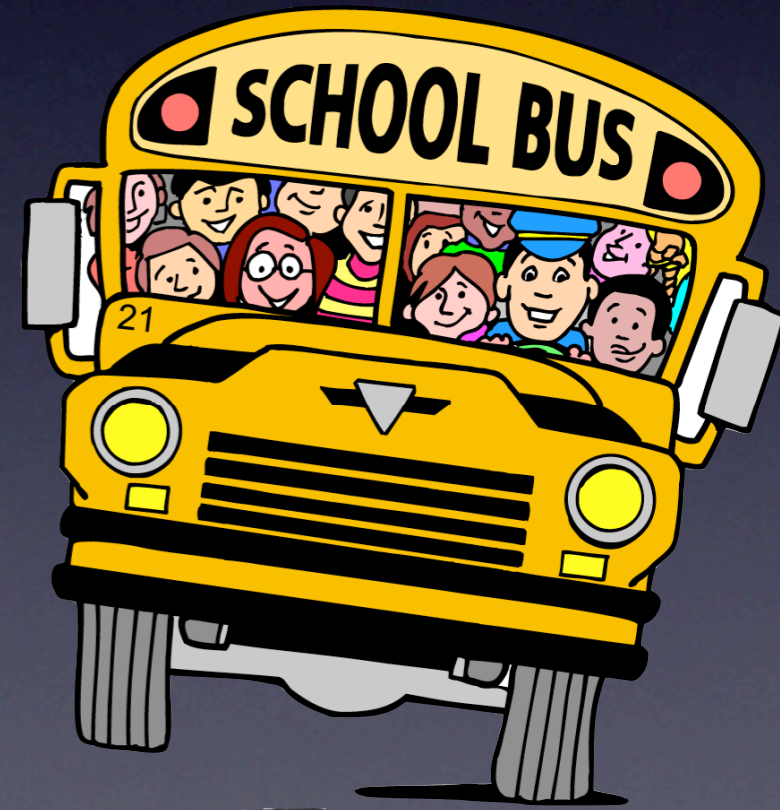
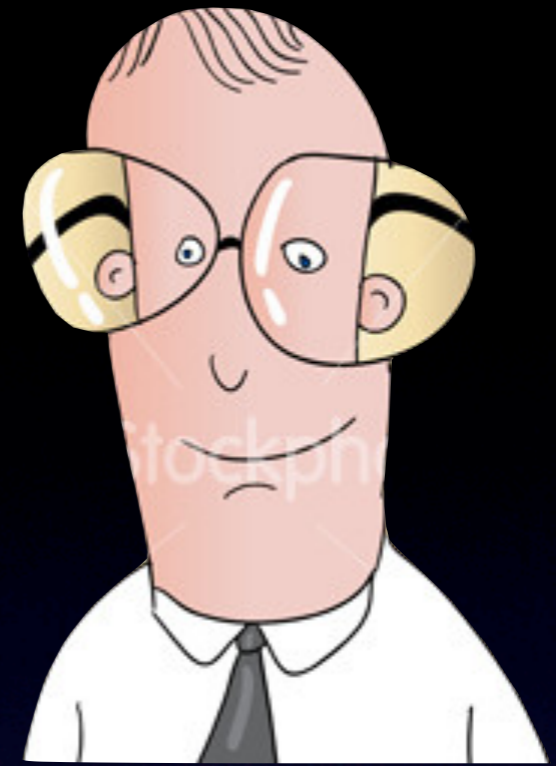
*University of Washington*  
Computer Science & Engineering

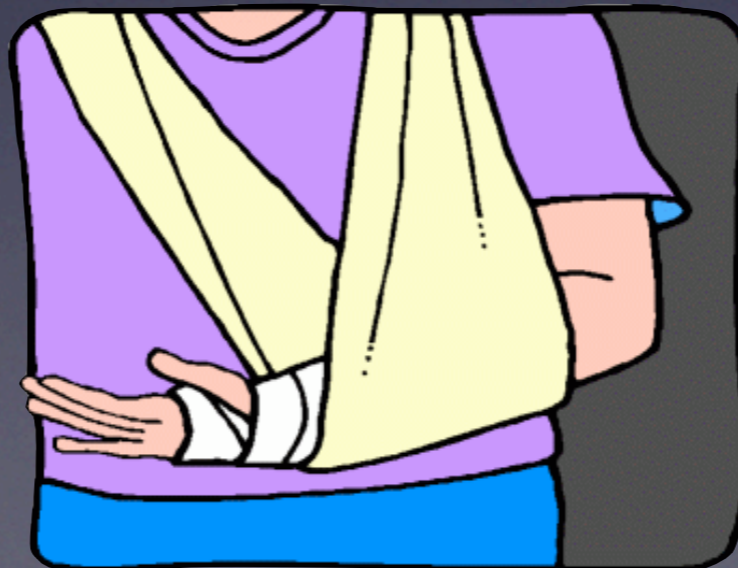
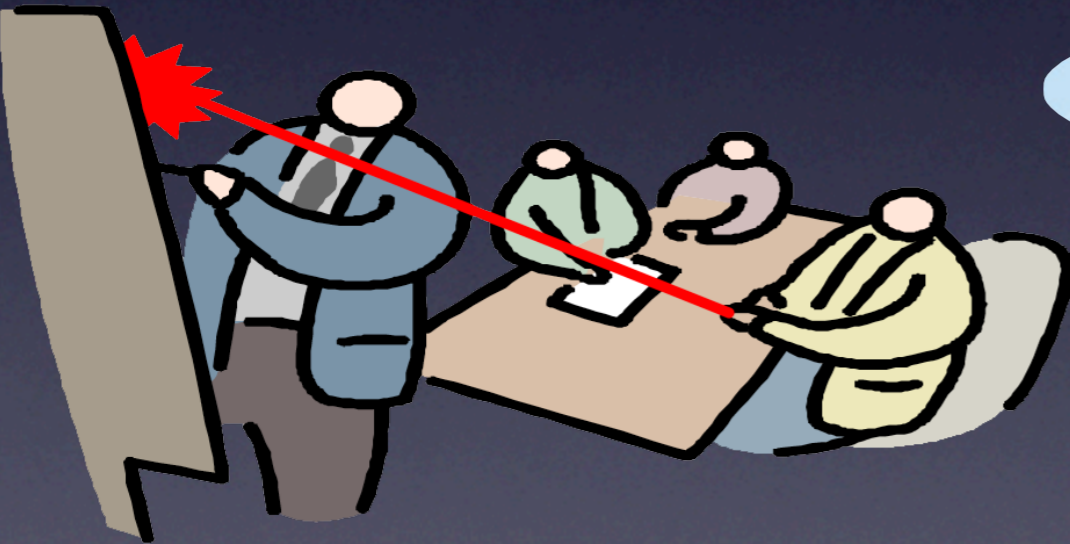
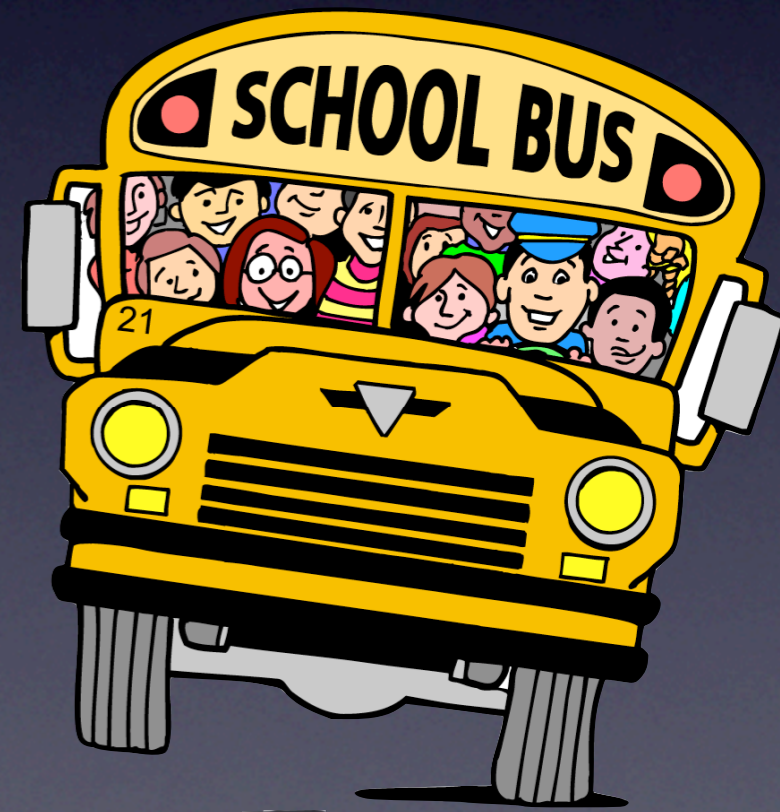
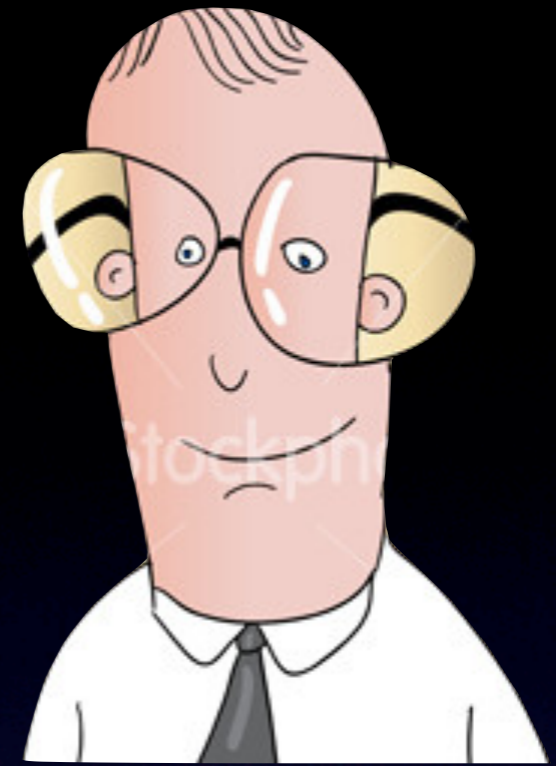


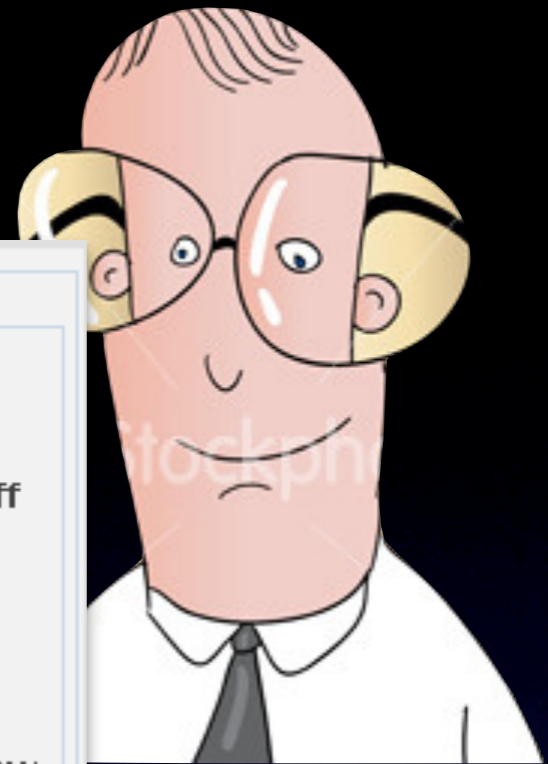












**Classroom**

**Light Bank**

**Left**

Light

Level

0 5 10

**Center**

Light

Level

0 5 10

**Right**

Light

Level

0 5 10

**A/V Controls**

**Projector**

Power

**Input**

Computer 1

Computer2

Video

Screen

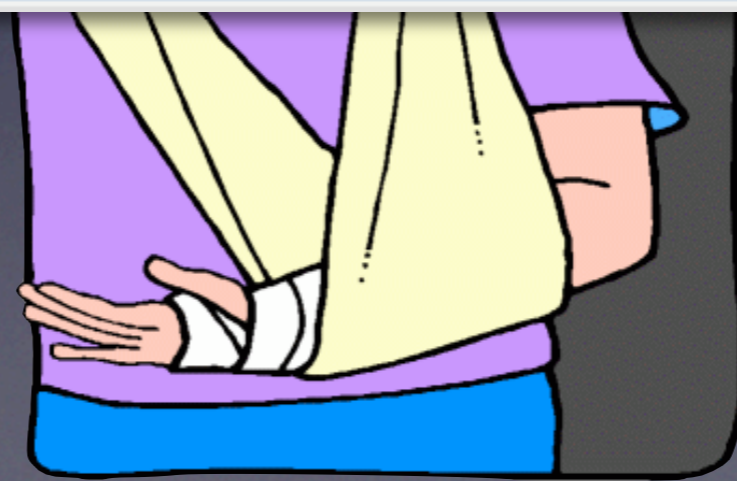
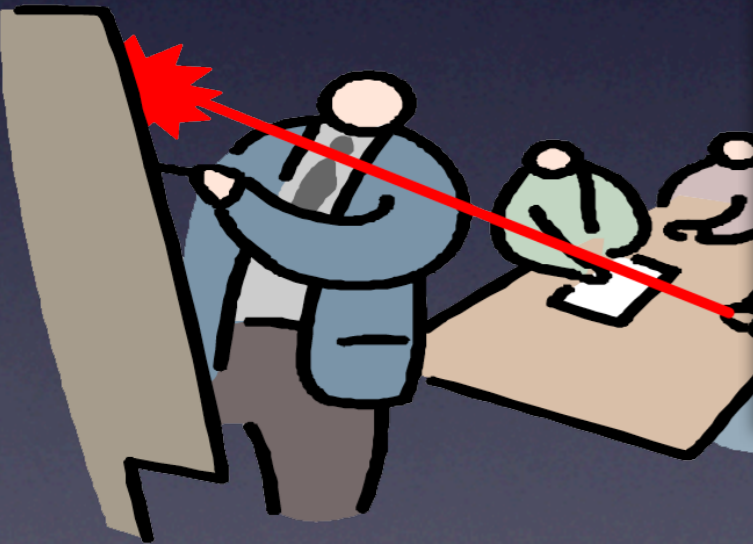
**Vent**

Off

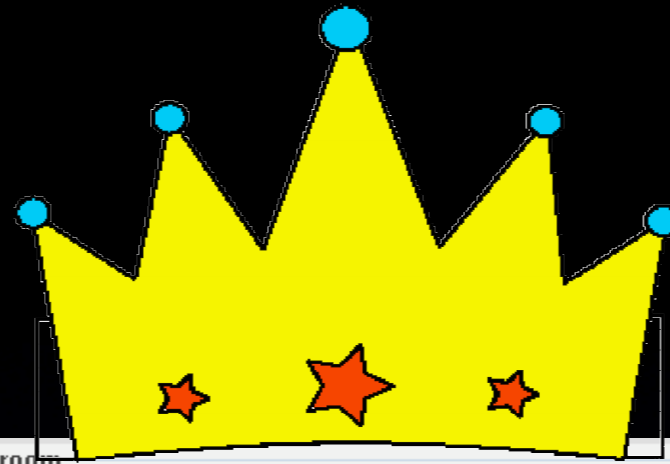
Low

Med

High

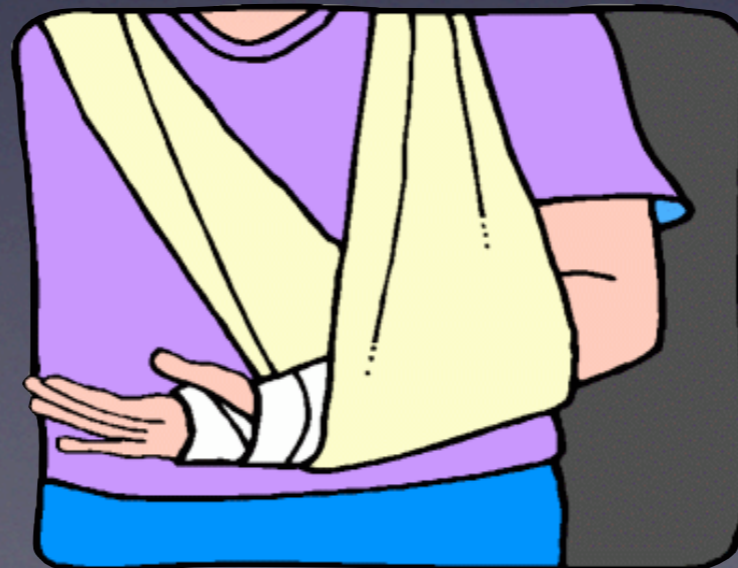


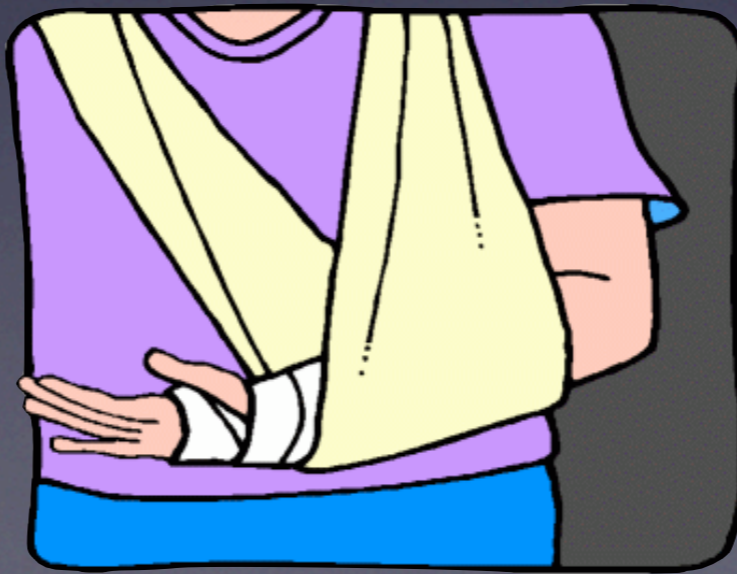
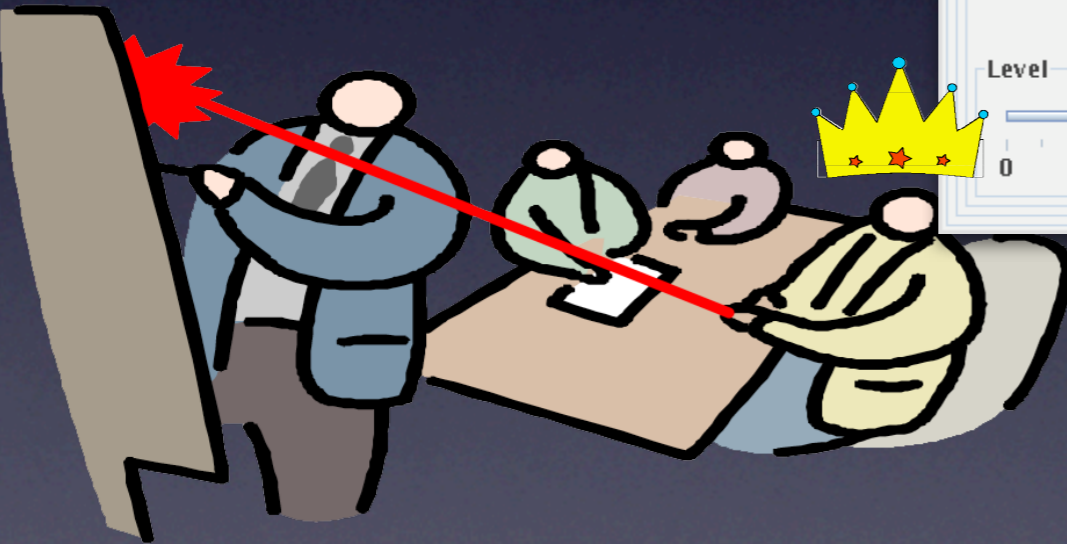
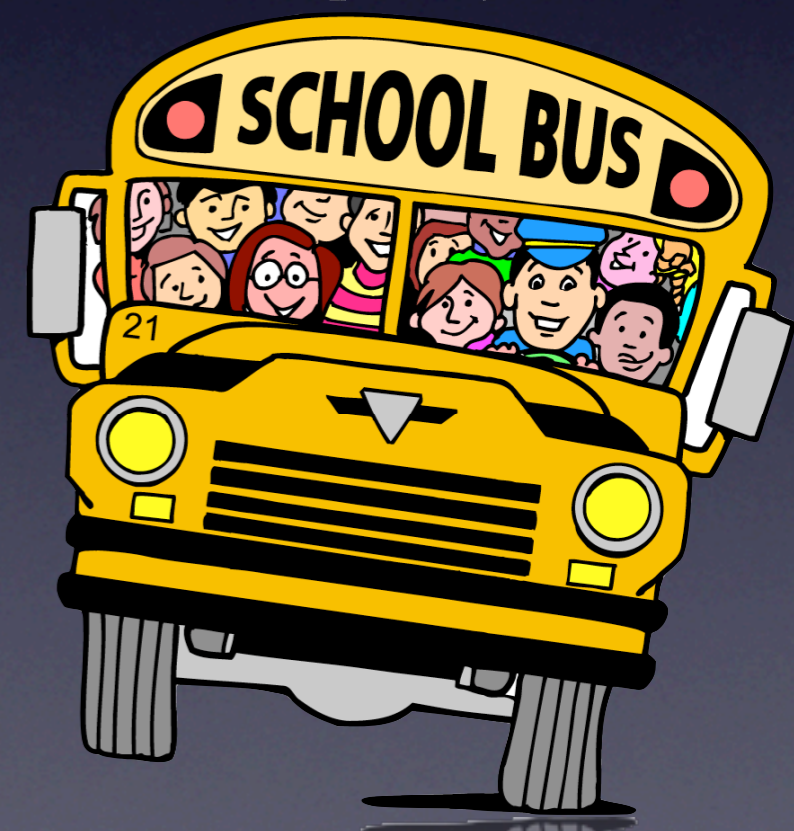
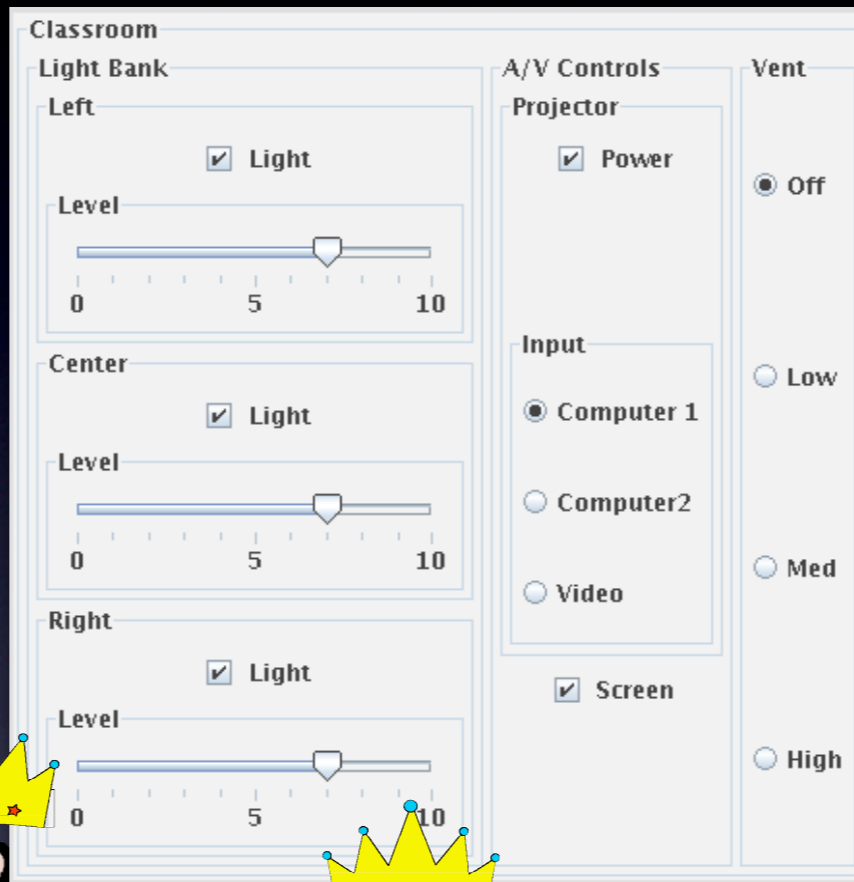
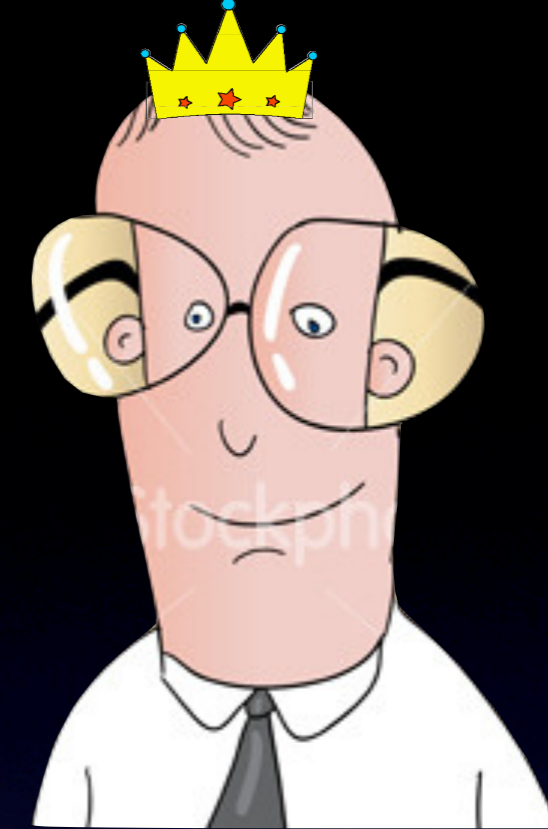
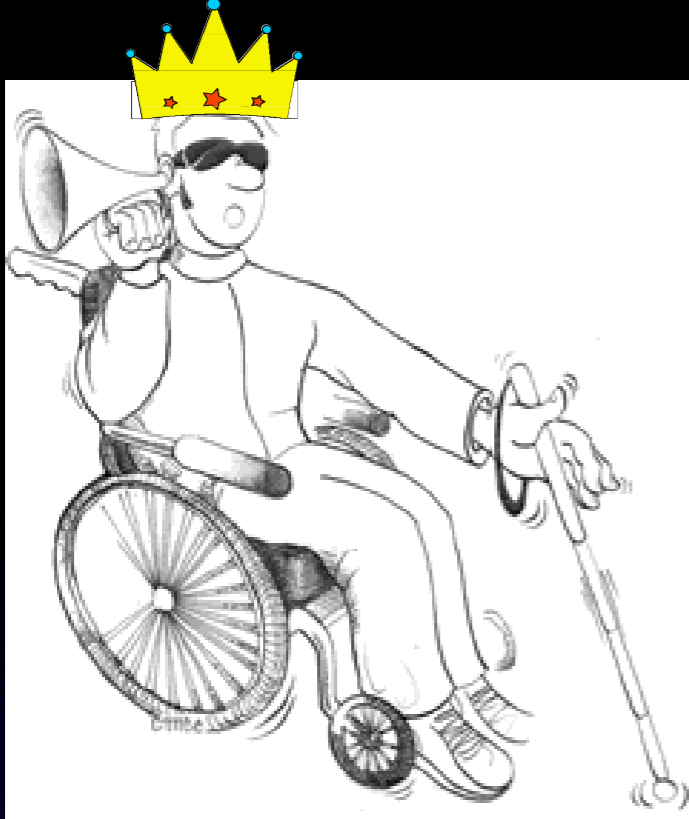


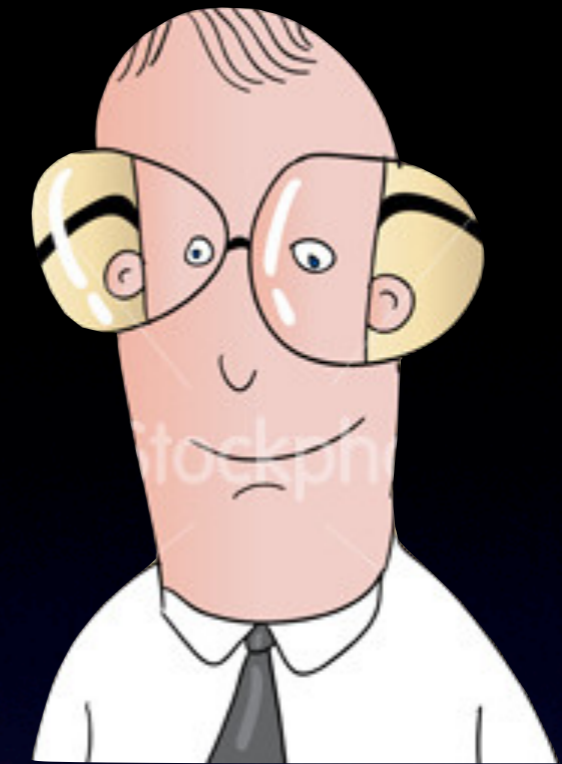


Classroom

<b>Light Bank</b>	<b>A/V Controls</b>	<b>Vent</b>
<b>Left</b>	<b>Projector</b>	<input checked="" type="radio"/> Off
<input checked="" type="checkbox"/> Light	<input checked="" type="checkbox"/> Power	<input type="radio"/> Low
Level	<b>Input</b>	<input type="radio"/> Med
<input type="range" value="7"/>	<input checked="" type="radio"/> Computer 1	<input type="radio"/> High
0 5 10	<input type="radio"/> Computer2	
<b>Center</b>	<input type="radio"/> Video	
<input checked="" type="checkbox"/> Light	<input checked="" type="checkbox"/> Screen	
Level		
<input type="range" value="7"/>		
0 5 10		
<b>Right</b>		
<input checked="" type="checkbox"/> Light		
Level		
<input type="range" value="7"/>		
0 5 10		

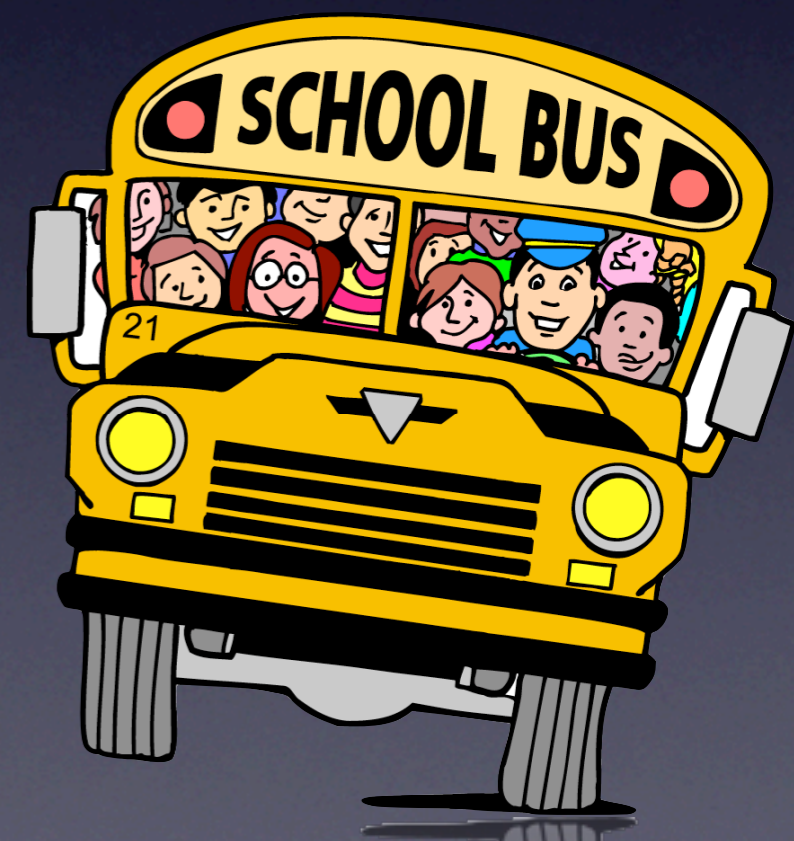
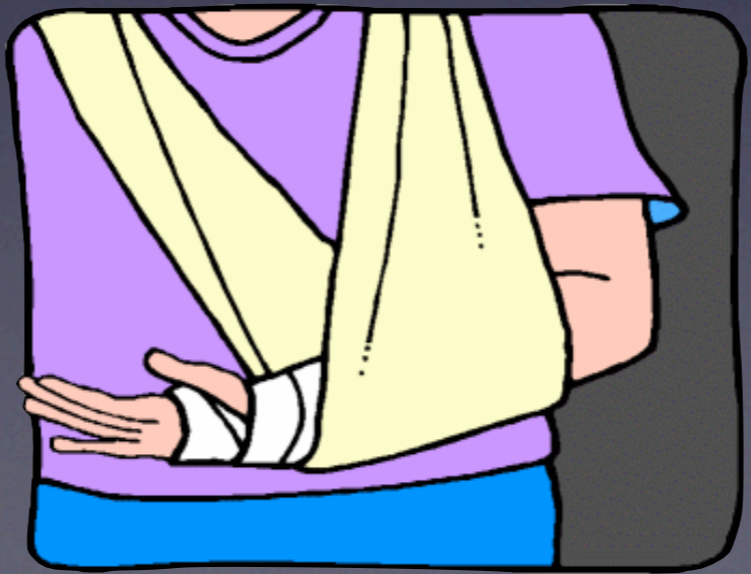
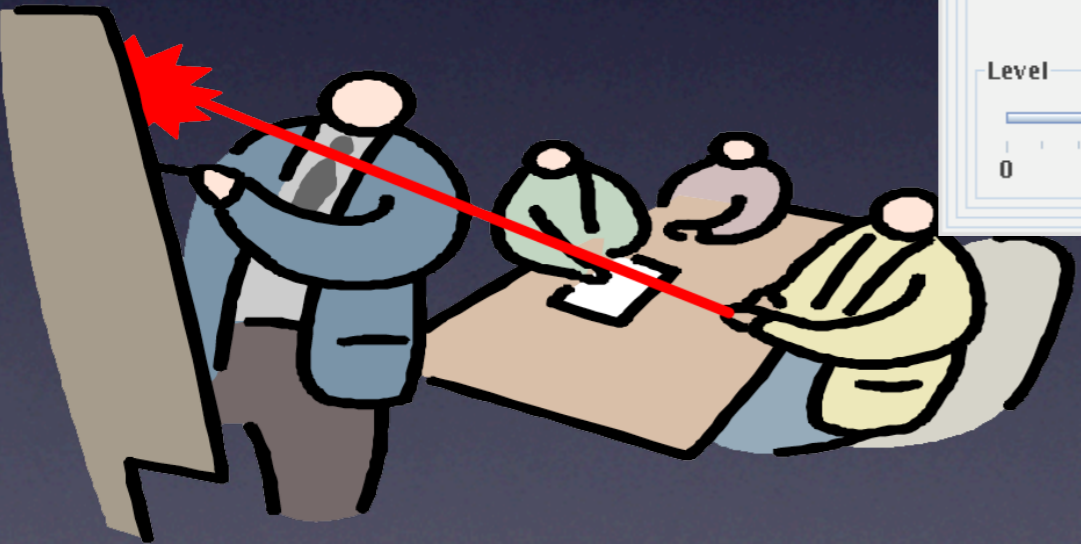


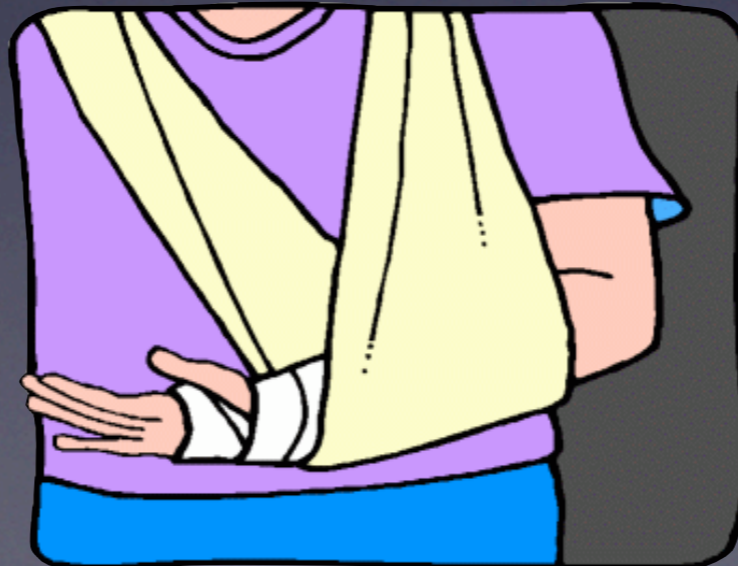
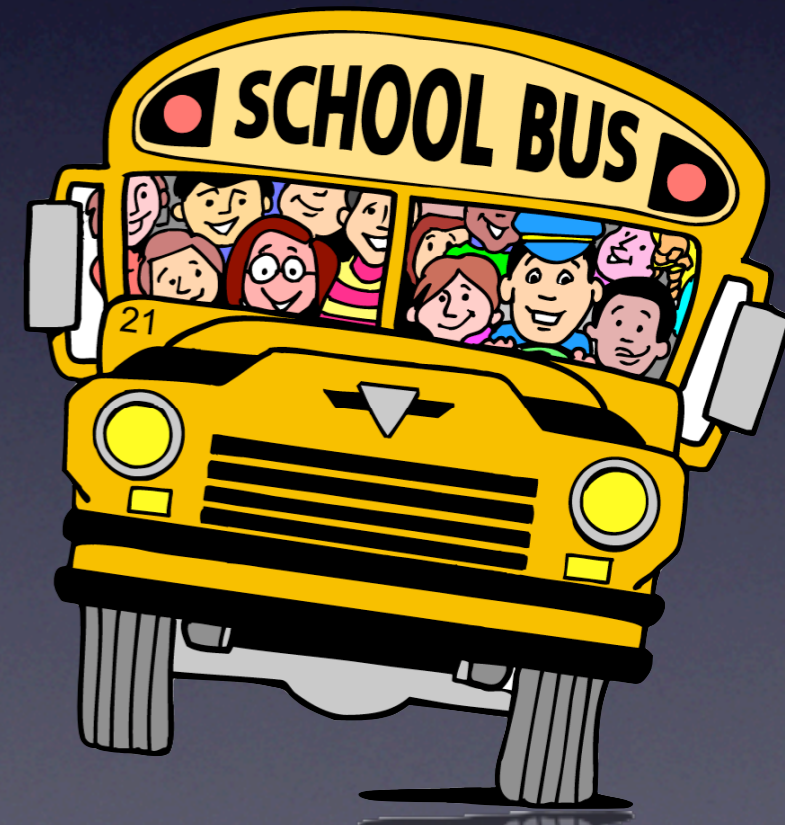
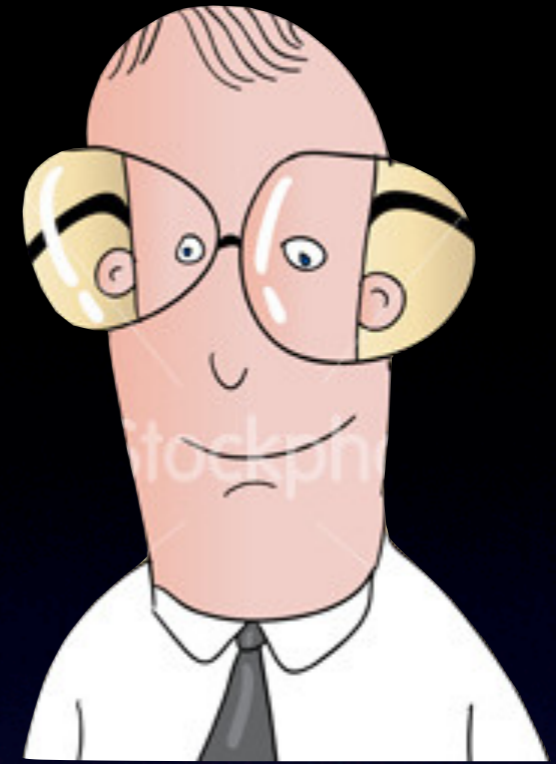




Classroom

<b>Light Bank</b>	<b>A/V Controls</b>	<b>Vent</b>
<b>Left</b>	<b>Projector</b>	<input checked="" type="radio"/> Off
<input checked="" type="checkbox"/> Light	<input checked="" type="checkbox"/> Power	<input type="radio"/> Low
Level	<b>Input</b>	<input type="radio"/> Med
<input type="range" value="7"/>	<input checked="" type="radio"/> Computer 1	<input type="radio"/> High
0 5 10	<input type="radio"/> Computer2	
<b>Center</b>	<input type="radio"/> Video	
<input checked="" type="checkbox"/> Light	<input checked="" type="checkbox"/> Screen	
Level		
<input type="range" value="7"/>		
0 5 10		
<b>Right</b>		
<input checked="" type="checkbox"/> Light		
Level		
<input type="range" value="7"/>		
0 5 10		





**Classroom**

**Light Bank**

**Left**

Light: On

**Level**

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**Center**

Light: On

**Level**

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**Right**

Light: On

**Level**

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**A/V Controls**

**Projector**



Power

**Input**

Computer 1

Computer2

Video



Screen

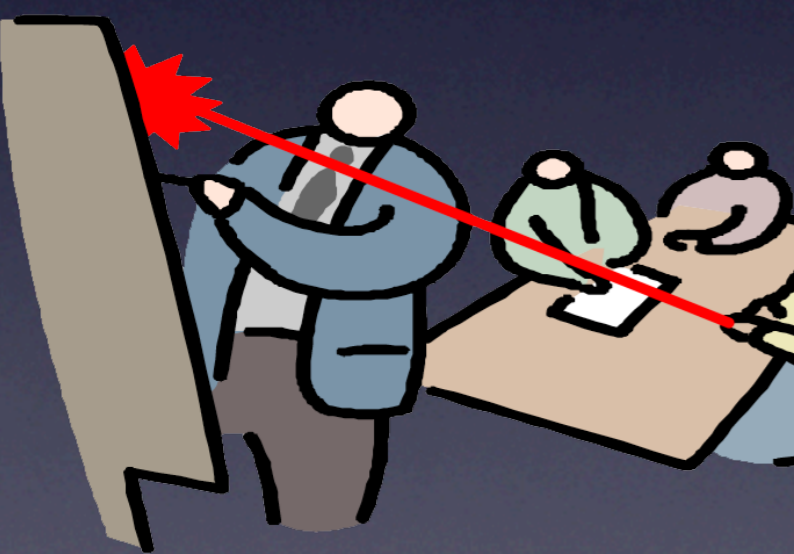
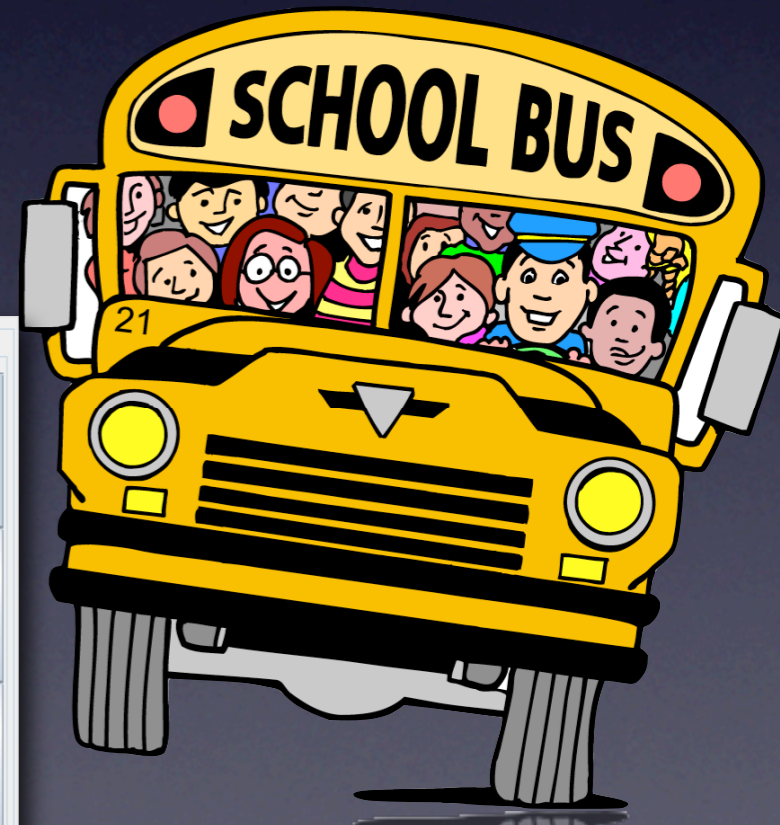
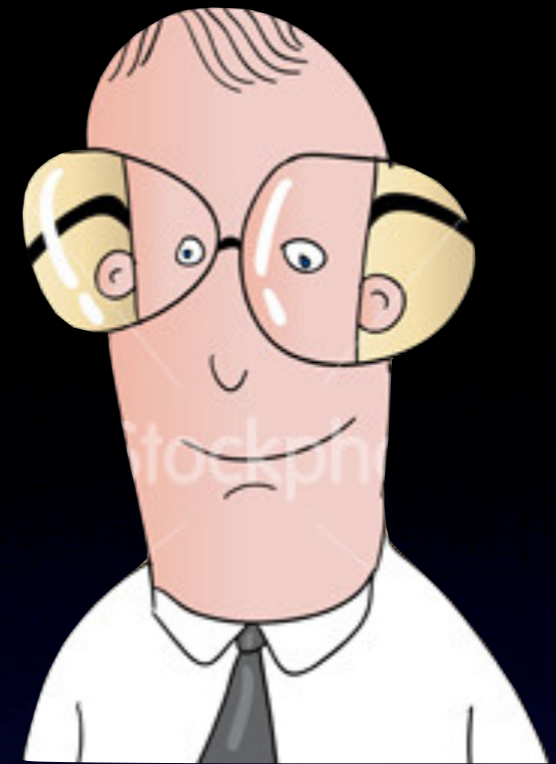
**Vent**

Off

Low

Med

High



Classroom

Light Bank

Left

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Center

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Right

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

A/V Controls

Projector

Power

Input

Computer 1

Computer 2

Video

Screen

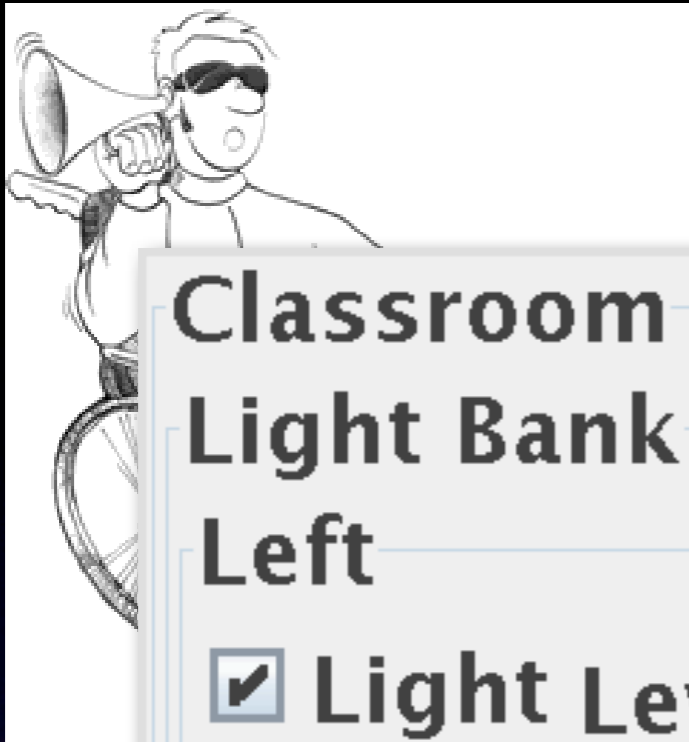
Vent

Off

Low

Med

High



# Classroom

## Light Bank

### Left

Light Level

### Center

Light Level

### Right

Light Level

## A/V Controls

### Projector

Power

### Input

Computer 1

Computer2

Video

Screen

## Vent

Off

Low

Med

High



0 1 2 3 4 5 6 7 8 9 10

Center

Light: On

Level

0 1 2 3 4 5 6 7 8 9 10

Right

Light: On

Level

0 1 2 3 4 5 6 7 8 9 10

Input

Computer 1

Computer2

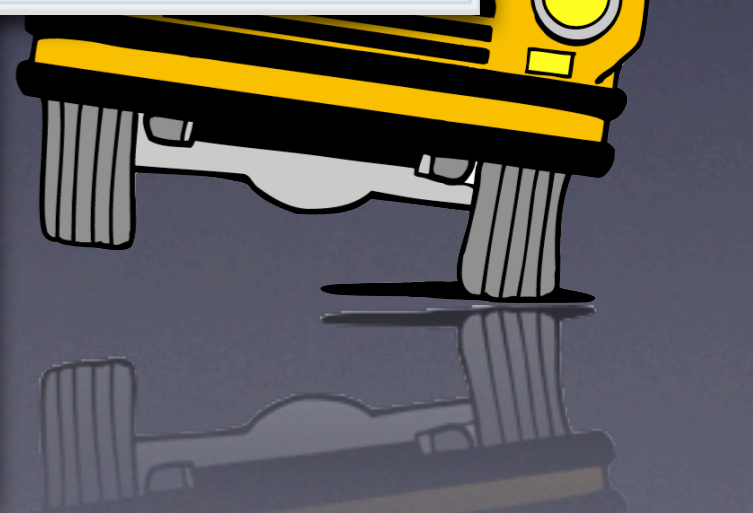
Video

Screen

Low

Med

High





**Classroom**

**Light Bank**

**Left**

Light Level

**Center**

Light Level

**Right**

Light Level

**A/V Controls**

**Projector**

Power

**Input**

Computer 1

Computer2

Video

Screen

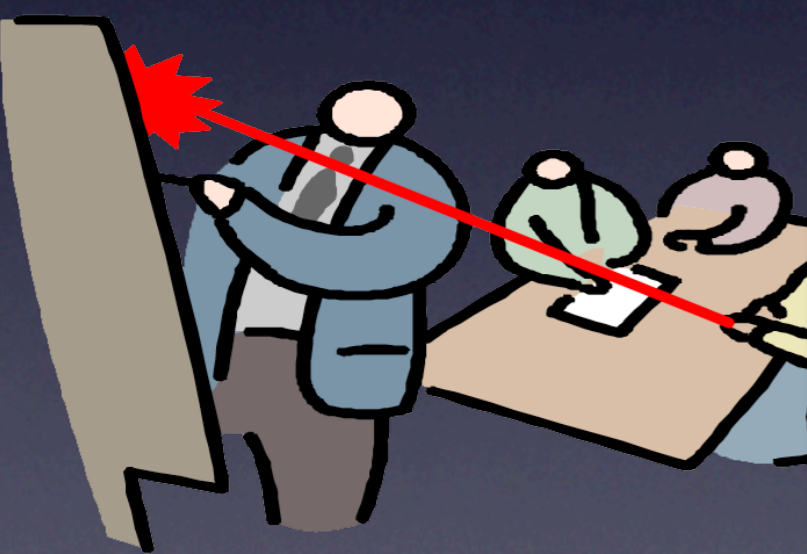
**Vent**

Off

Low

Med

High



**Classroom**

**Light Bank**

**Left**

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**Center**

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**Right**

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

**A/V Controls**

**Projector**

Power

**Input**

Computer 1

Computer2

Video

Screen

**Vent**

Off

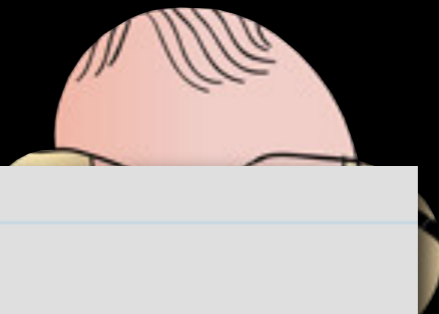
Low

Med

High







# Classroom

Light Bank A/V Controls Vent

**Left Light Level**

On	0	▲
	1	
	2	
Off	3	
	4	▼

**Center Light Level**

On	0	▲
	1	
	2	
Off	3	
	4	▼

**Right Light Level**

On	0	▲
	1	
	2	
Off	3	
	4	▼

Controls

Computer 1

Computer 2

Screen

Vent

- Off
- Low
- Med
- High



Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Right

Light: On

Level

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

Computer 1

Computer 2

Video

Screen

Med

High



**Classroom**

Light Bank A/V Controls Vent

Left Light Level			Center Light Level			Right Light Level		
On	0	▲	On	0	▲	On	0	▲
	1		On	1		On	1	
	2		On	2		On	2	
Off	3		Off	3		Off	3	
	4	▼	Off	4	▼	Off	4	▼



**Classroom**

Light Bank A/V Controls Vent

Left

Light Level 7

Center

Light Level 7

Right

Light Level 7

Projector

Power

Input

Computer 1

Computer 2

Video

Screen

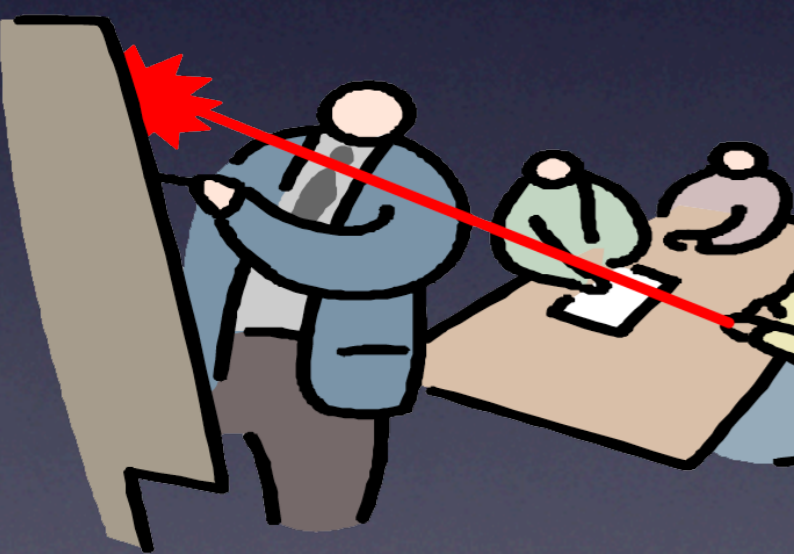
Vent

Off

Low

Med

High



**Classroom**

Light Bank

Left

Light: On

Level

0 1 2 3 4 5 6 7 8 9 10

Center

Light: On

Level

0 1 2 3 4 5 6 7 8 9 10

Right

Light: On

Level

0 1 2 3 4 5 6 7 8 9 10

A/V Controls

Projector

Power

Input

Computer 1

Computer 2

Video

Screen

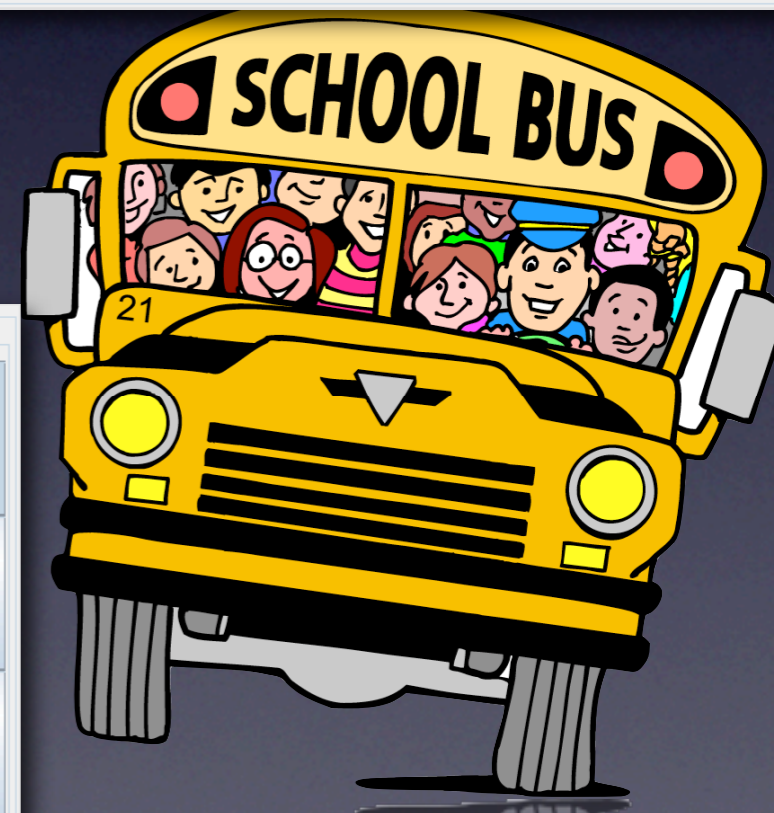
Vent

Off

Low

Med

High



# Road Map

- ✓ Introduction
- > **Interface generation as optimization**
- Modeling motor capabilities
- Adapting to motor capabilities
- Adapting to vision capabilities
- Adapting to motor and vision capabilities together
- Pilot User Study
- Lessons learned

# Automatic Interface Generation

- Manually capture design knowledge as rules
- Automatically apply rules to generate new interfaces

# Automatic Interface Generation

- Manually capture design knowledge as rules
- Automatically apply rules to generate new interfaces
- **Problems:**

# Automatic Interface Generation

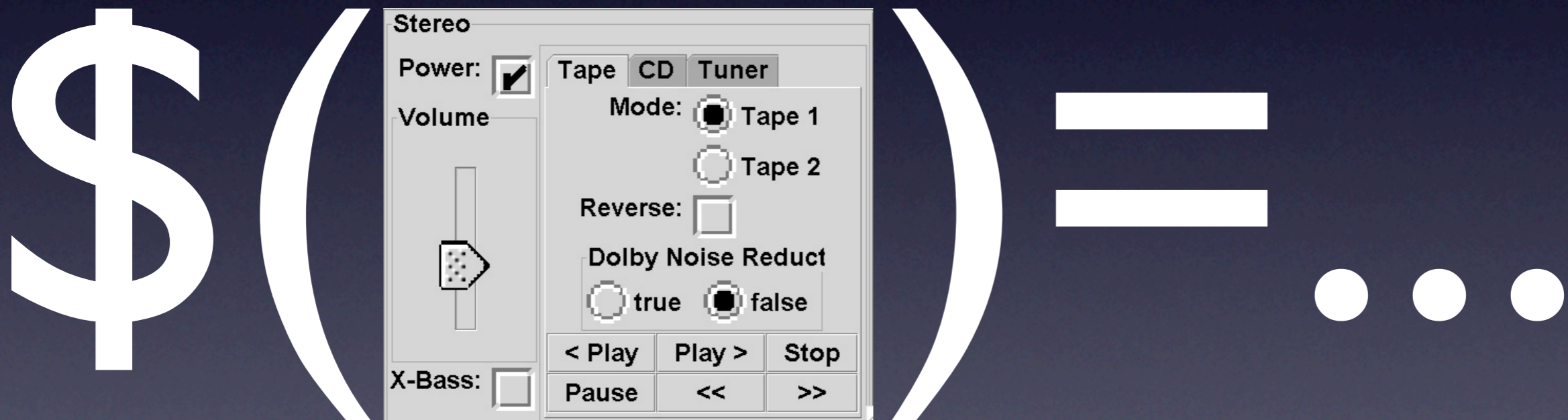
- Manually capture design knowledge as rules
- Automatically apply rules to generate new interfaces
- **Problems:**
- New rule sets necessary for every device type, interaction style or even screen size

# Automatic Interface Generation

- Manually capture design knowledge as rules
- Automatically apply rules to generate new interfaces
- **Problems:**
- New rule sets necessary for every device type, interaction style or even screen size
- No good way to adapt to individual preferences or needs

# Our Approach: User Interface Generation as Optimization

Driven by a “cost function”:



and constraints

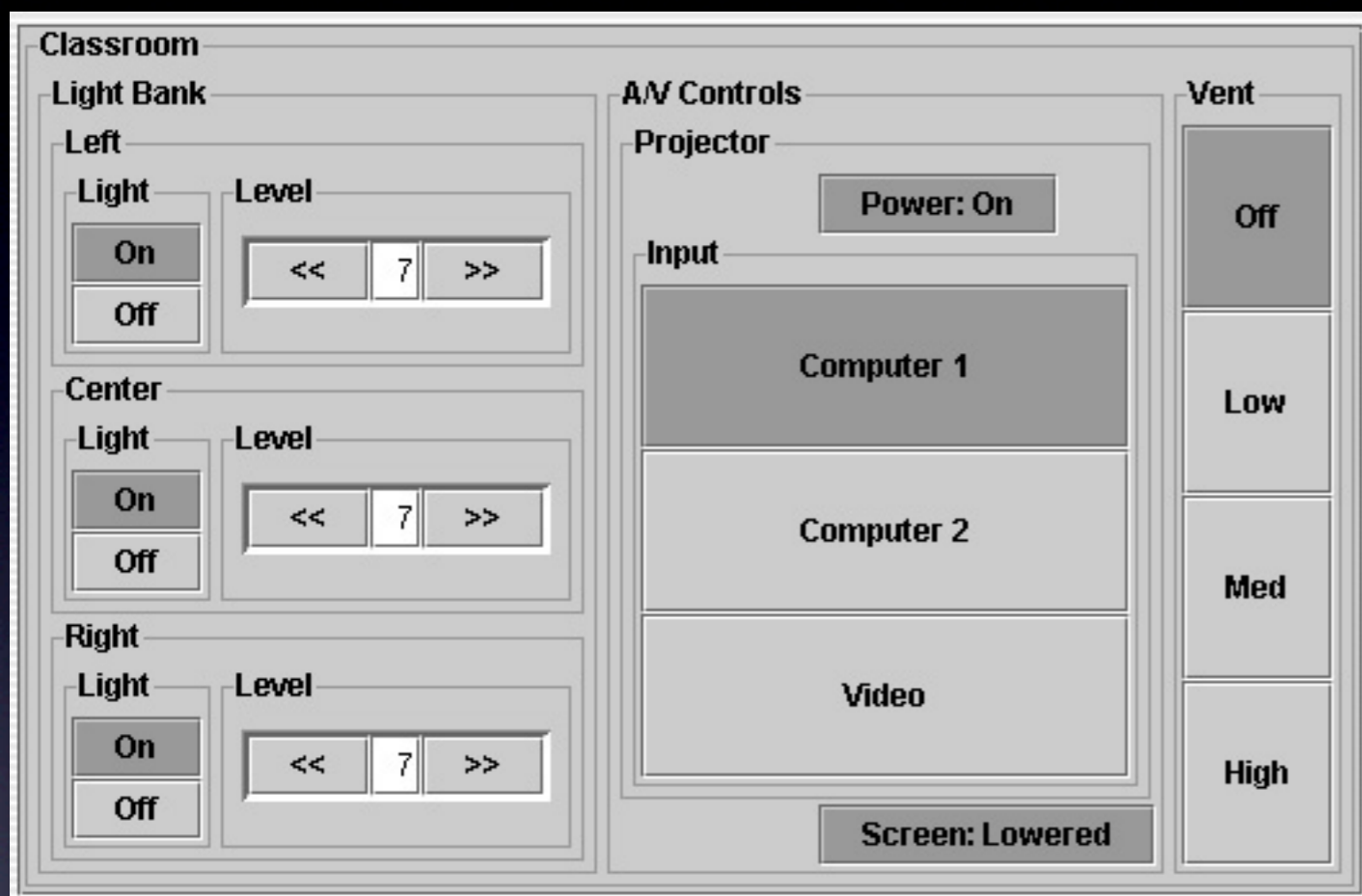


Find the interface  
that minimizes

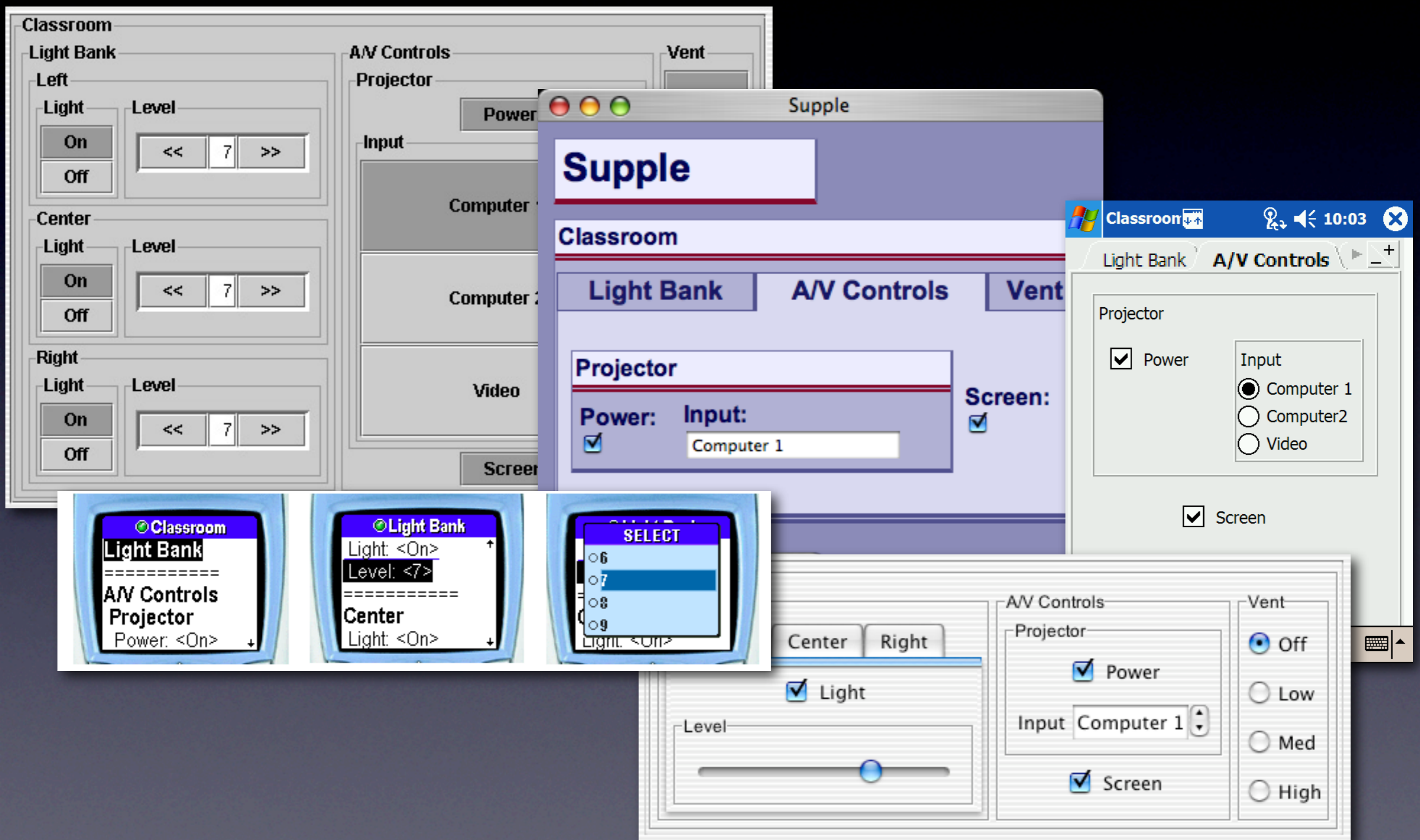


without violating constraints

# Single Algorithm -- Many Devices

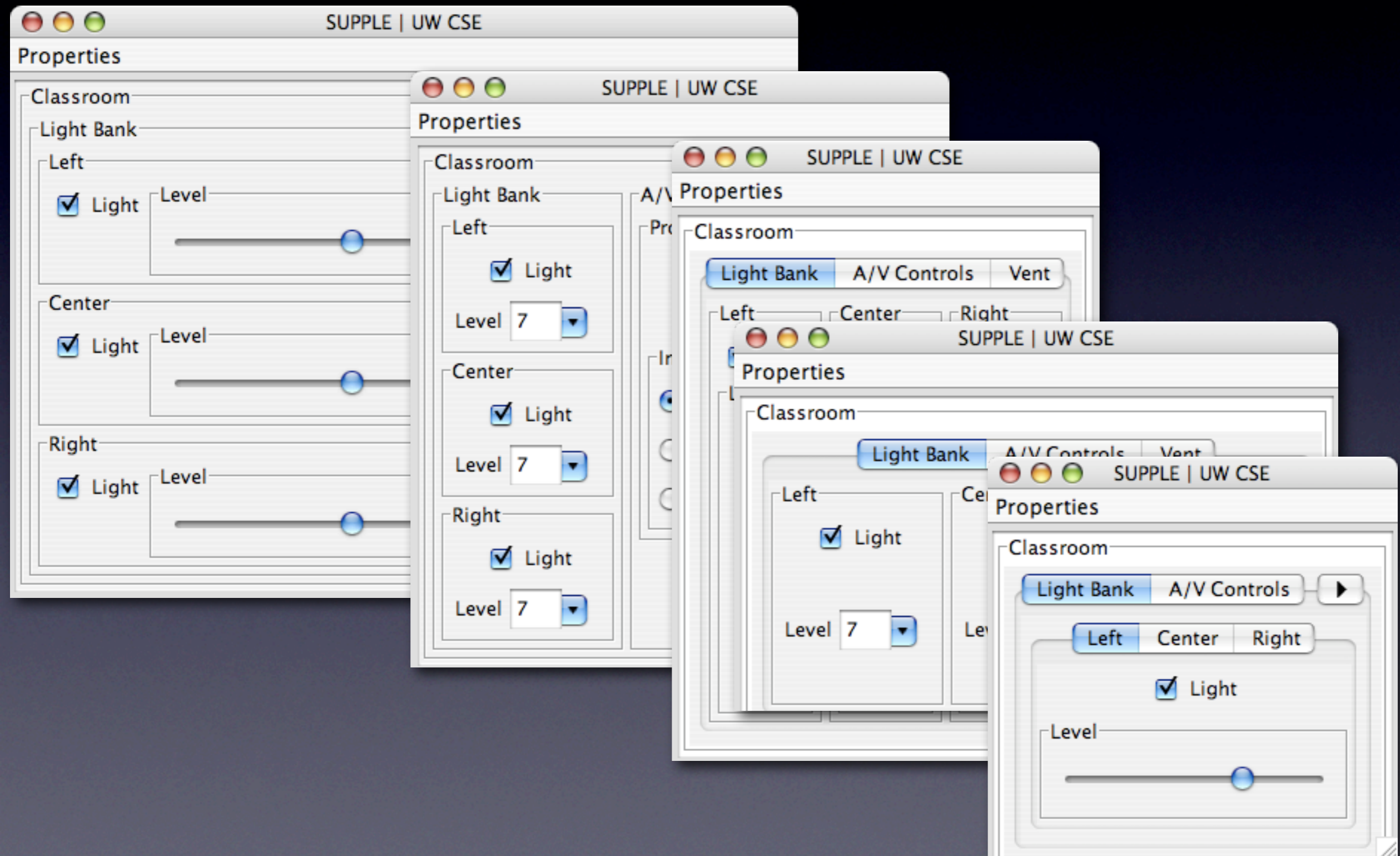


# Single Algorithm -- Many Devices



# Robustly Adapting to Different Screen Sizes

# Robustly Adapting to Different Screen Sizes



Properties

Folders

- New Folder
- Junk-E-Mail
- New Folder 1
- New Folder 2
- Unerwünscht**
- Unbekannt
- INBOX
- Entwurf
- Papierkorb
- Gesendet
- Postausgang

- New
- Rename
- Delete
- Expunge

Configuration

Messages

- 25.04 04:40 PM Noel Garner <XTHFREZONZHS@BIBEWELL.COM>
- 25.04 05:36 AM Suzette Schulz <CHWIZOKAIVQ@ADSVISION.COM> Sandy, check it out
- \* 25.04 05:25 AM Elsie Bassett <BECEZKRWRTH@ACCESSIBLEINFO.COM> No Obliiii gation
- \* 24.04 10:00 PM Fred Pace <jbibktyesnamt@beveragebooks.com> Professional Loans w
- \* 24.04 02:36 PM OEM on Sale <zvrjhn@hurting.com> Get 96% Dis.counted OEM Microsc
- 24.04 06:01 AM Stephen Hood <Vern@be-lax.com> What do you think
- 24.04 04:35 AM Vito Aguirre <Guidry@ilovethemovies.com> Lose it
- 24.04 03:19 AM Meghan <hwdwysowbypek@jornaldiario.com> Swiss meds
- 24.04 02:42 AM Perdue <HMHTV@merseymail.com> , who do u want 2 win?
- 23.04 04:42 PM Thekla Upchurch <mira53.mcclimons@freemail.com.ua> Heisse News**
- 23.04 02:05 PM Anthony Wright <dhsqinsvfmvot@visinweb.com> Hi !!D

- New
- Reply
- Forward
- Delete
- Move

Details

**Details**

Senders: Thekla Upchurch <mira53.mcclimons@freemail.com.ua>  
 Date: 23.04 04:42 PM  
 Recipients: Olaf <supple@web.de>  
 Subject: Heisse News

**Content**

Flatratesex, für nur 14,99 Euro kannst Du Dir einen monat lang über 200  
 Private Livecams  
 anschaun, dazu noch unzählige Bilder und Videos, ohne 0190 ohne versteckte  
 Kosten.  
 Der absolute Hammer !

<http://www.sexania.com>

Kein Bock mehr auf unsere Mails? Dann einfach hier austragen lassen:  
<http://www.netporni.com/unsubscribe.php?8410347460104875643874087>

Status:



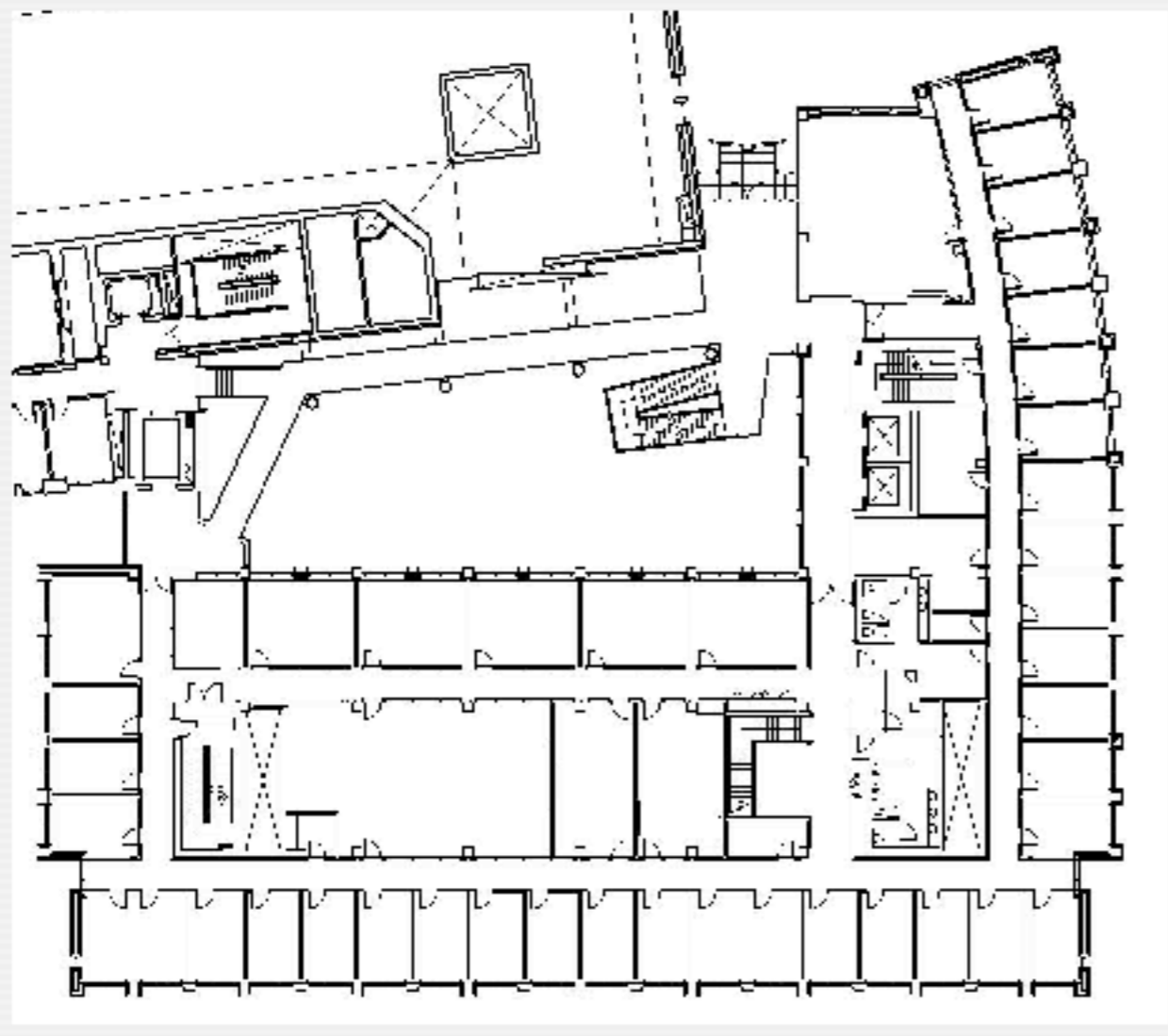
Supple: Map Demo

## Properties

Map Demo

Pick a location

The Map



Location: (847.0,240.0)

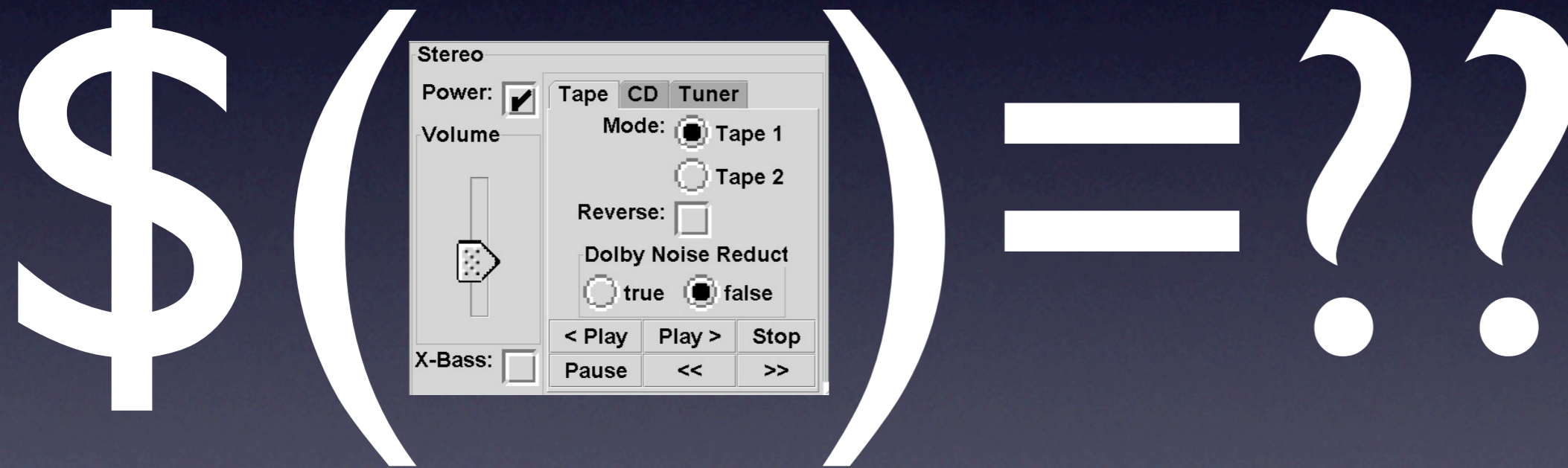
Info

Photo



Name: Dan  
Office: 588

# Highly Personalizable!





# Adapting to Preferences



Preference  
estimate

# Adapting to Motor Capabilities



Estimated  
task  
completion  
time

# Road Map

- ✓ Introduction
- ✓ Interface generation as optimization
- > **Modeling motor capabilities**
- Adapting to motor capabilities
- Adapting to vision capabilities
- Adapting to motor and vision capabilities together

# Participants

		Device used	Impairment		
Motor- impaired		Mouse	Muscular Dystrophy	device	Unusual
		Trackball	Spinal cord injury		
		Head Mouse	Spinal cord injury		
	Eye Tracker	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Mouse	<i>none</i>			
	Track Pad	<i>none</i>			

# Participants

		Device used	Impairment		
Motor- impaired		Mouse	Muscular Dystrophy	device	Unusual
		Trackball	Spinal cord injury		
		Head Mouse	Spinal cord injury		
	Eye Tracker	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Mouse	<i>none</i>			
	Track Pad	<i>none</i>			

# Participants

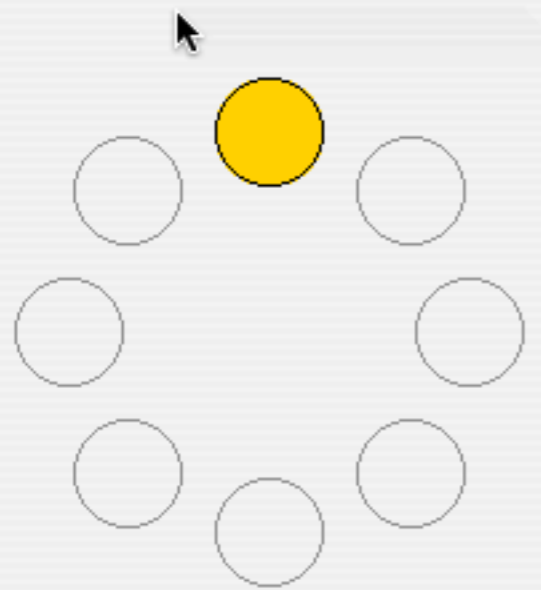
		Device used	Impairment		
Motor- impaired		Mouse	Muscular Dystrophy	device	Unusual
		Trackball	Spinal cord injury		
		Head Mouse	Spinal cord injury		
		Eye Tracker	<i>none</i>		
		Vocal Joystick	<i>none</i>		
		Vocal Joystick	<i>none</i>		
		Mouse	<i>none</i>		
		Track Pad	<i>none</i>		

# Participants

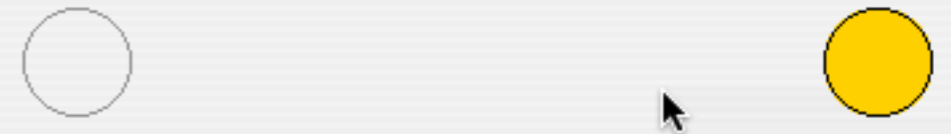
		Device used	Impairment		
Motor- impaired		Mouse	Muscular Dystrophy	device	Unusual
		Trackball	Spinal cord injury		
		Head Mouse	Spinal cord injury		
	Eye Tracker	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Vocal Joystick	<i>none</i>			
	Mouse	<i>none</i>			
	Track Pad	<i>none</i>			

# Elicit a Person's Motor Abilities Model

Pointing



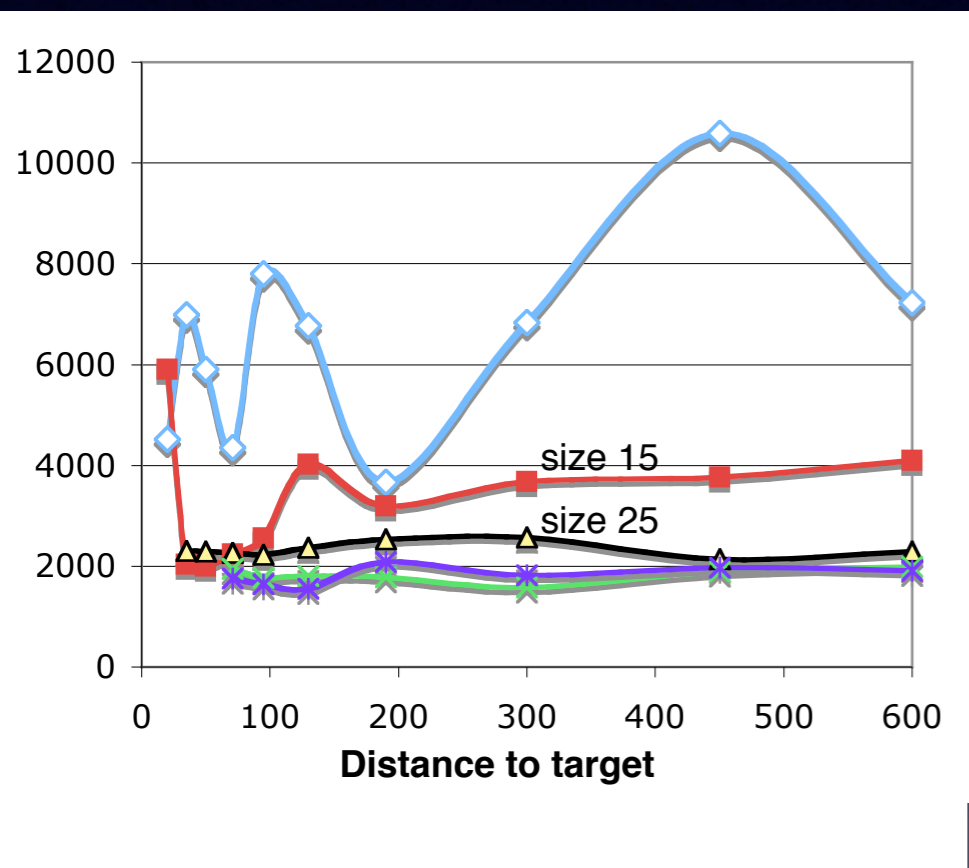
Dragging





# Predicting Movement Time

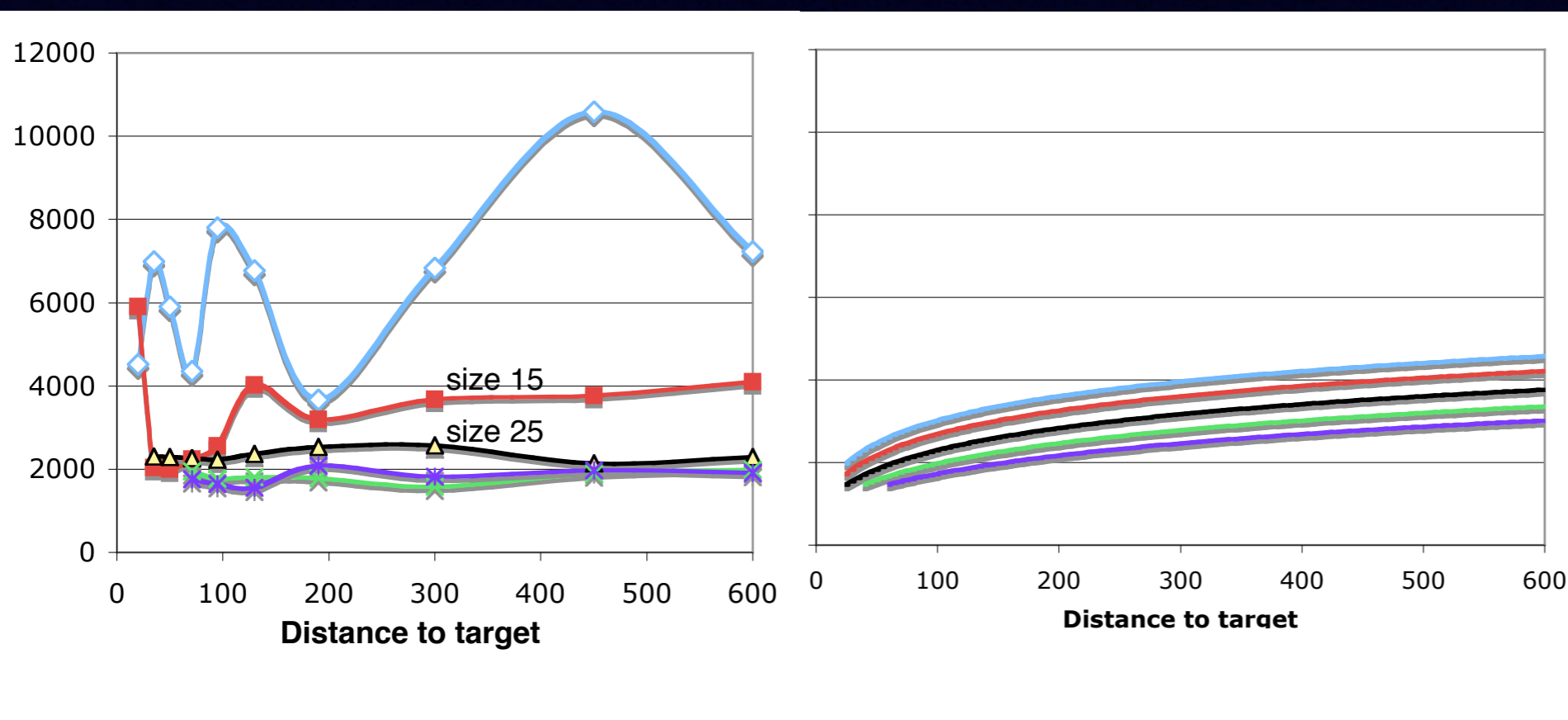
## Actual Data



# Predicting Movement Time

## Actual Data

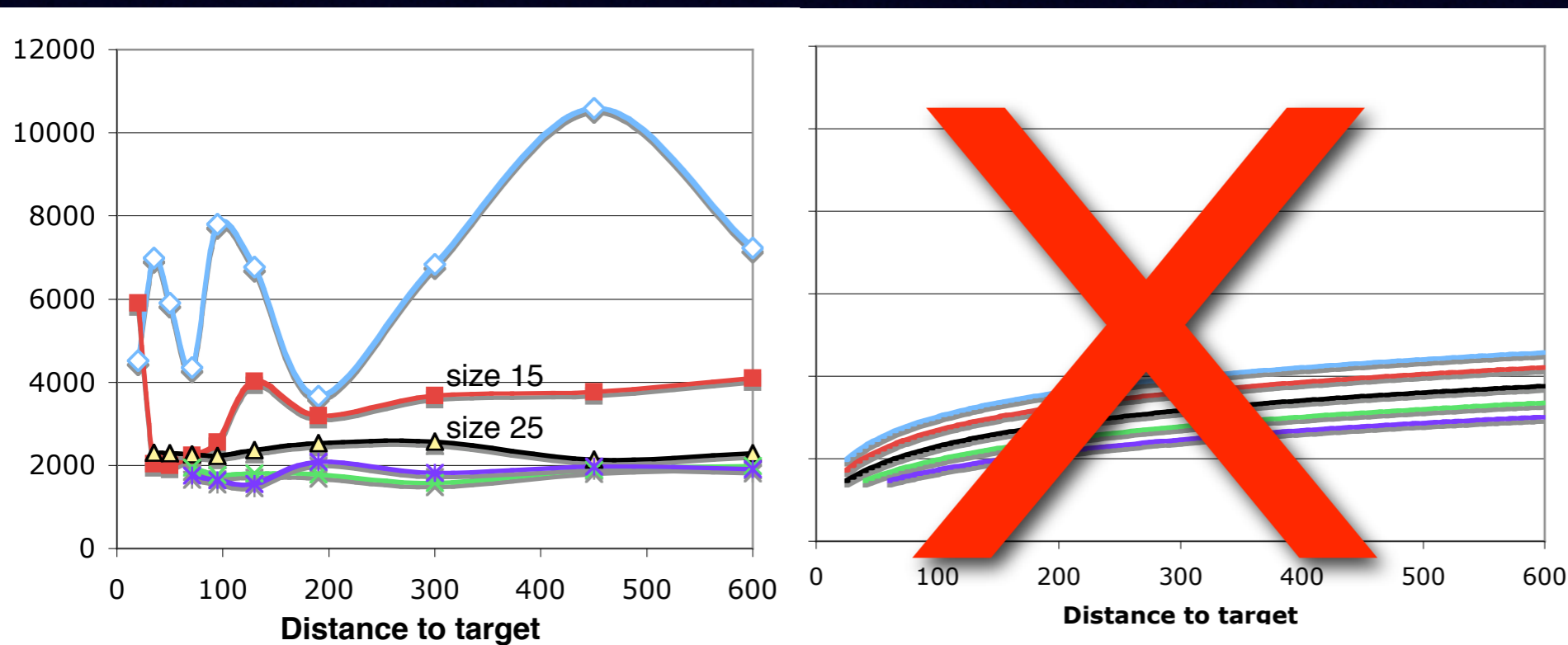
## Fitts' Law Prediction



# Predicting Movement Time

## Actual Data

## Fitts' Law Prediction



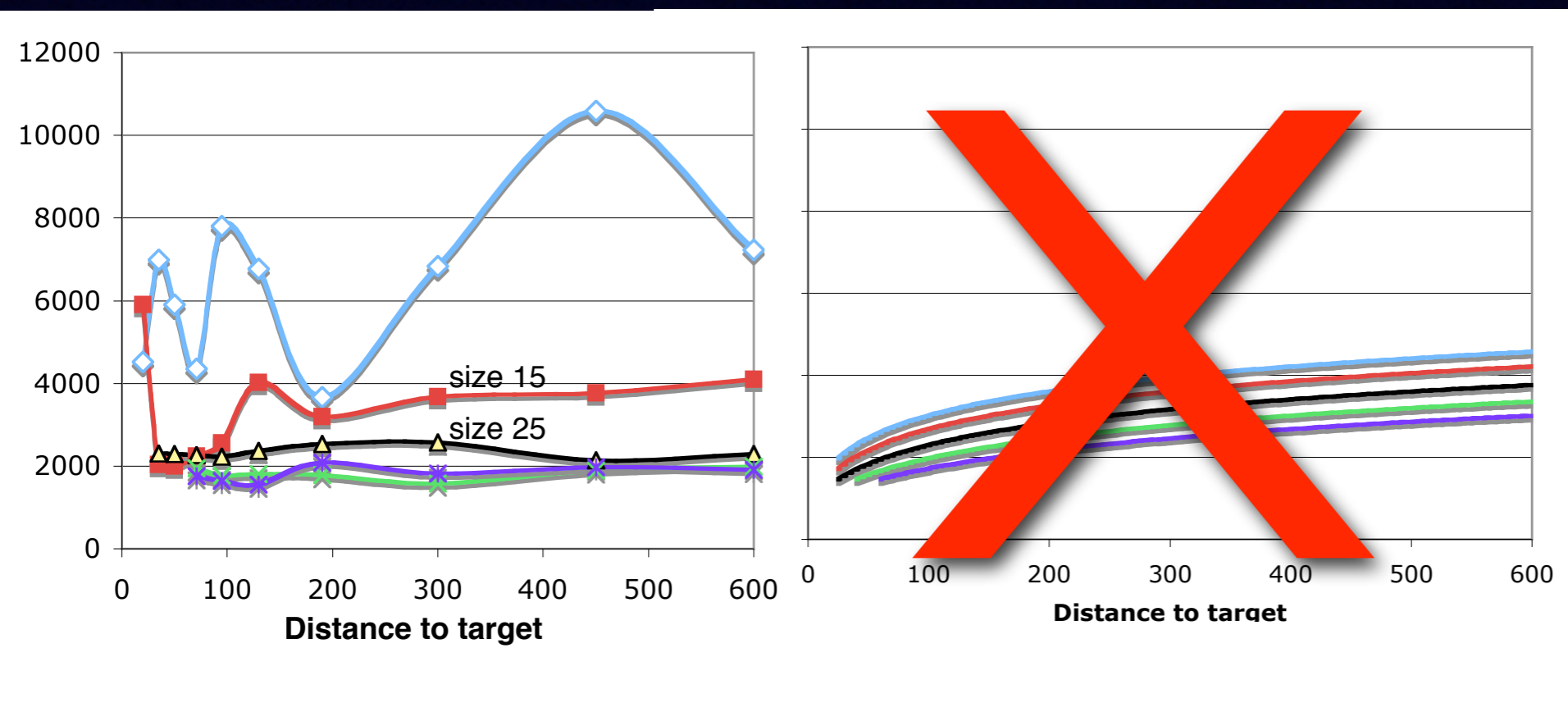
# Custom Motor Capability Models

- Supple++
  - Automatically selects the best set of features for a **custom regression model** for each participant from:  
ID, 1,  $\log(D)$ ,  $\log(W)$ ,  $D$ ,  $1/W$ ,  $W$
  - Trains the models

# Predicting Movement Time

## Actual Data

## Fitts' Law Prediction

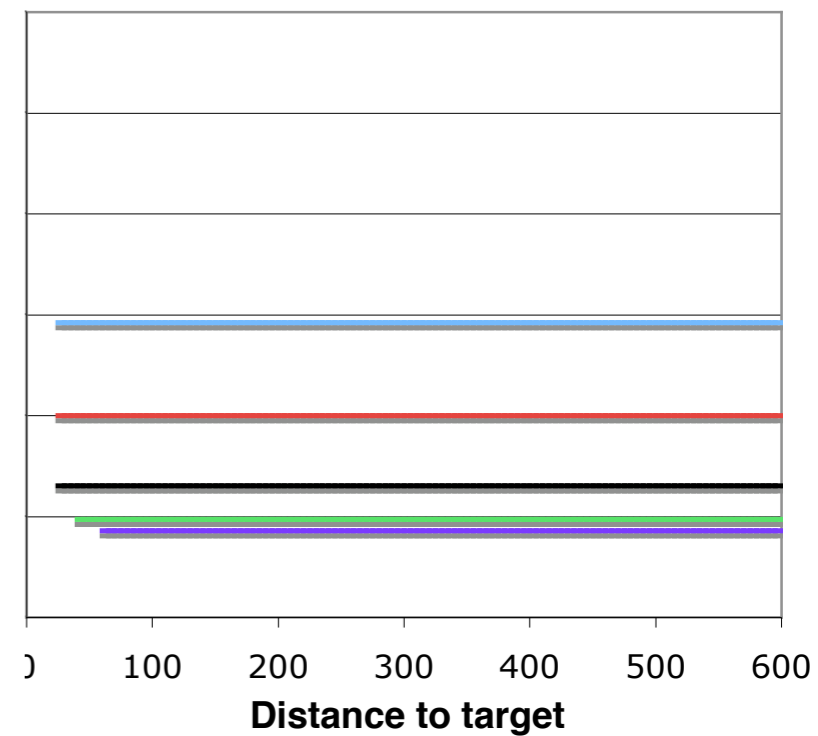
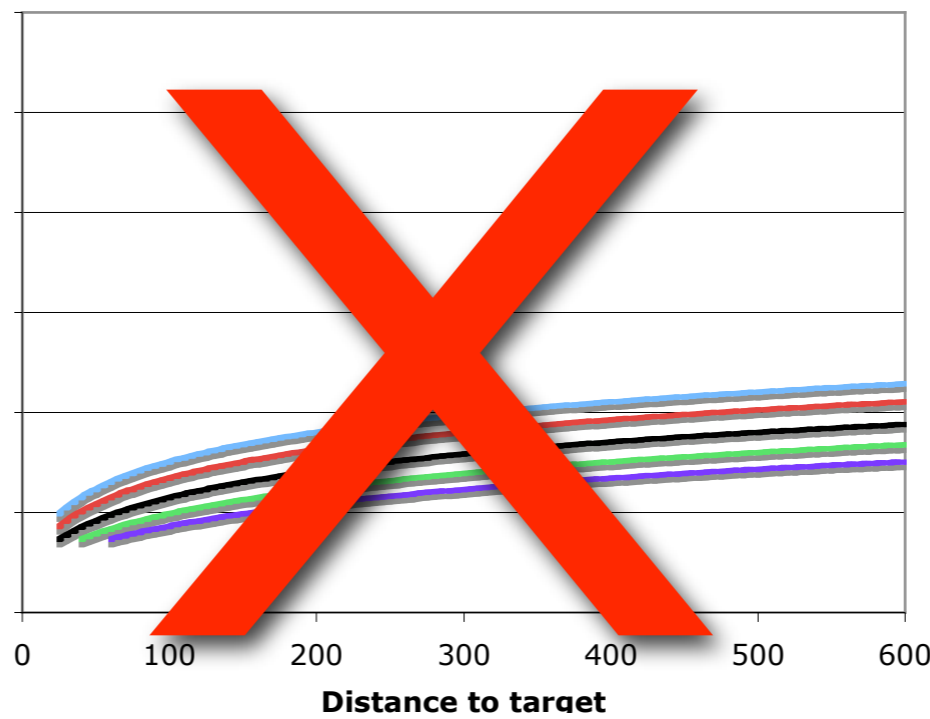
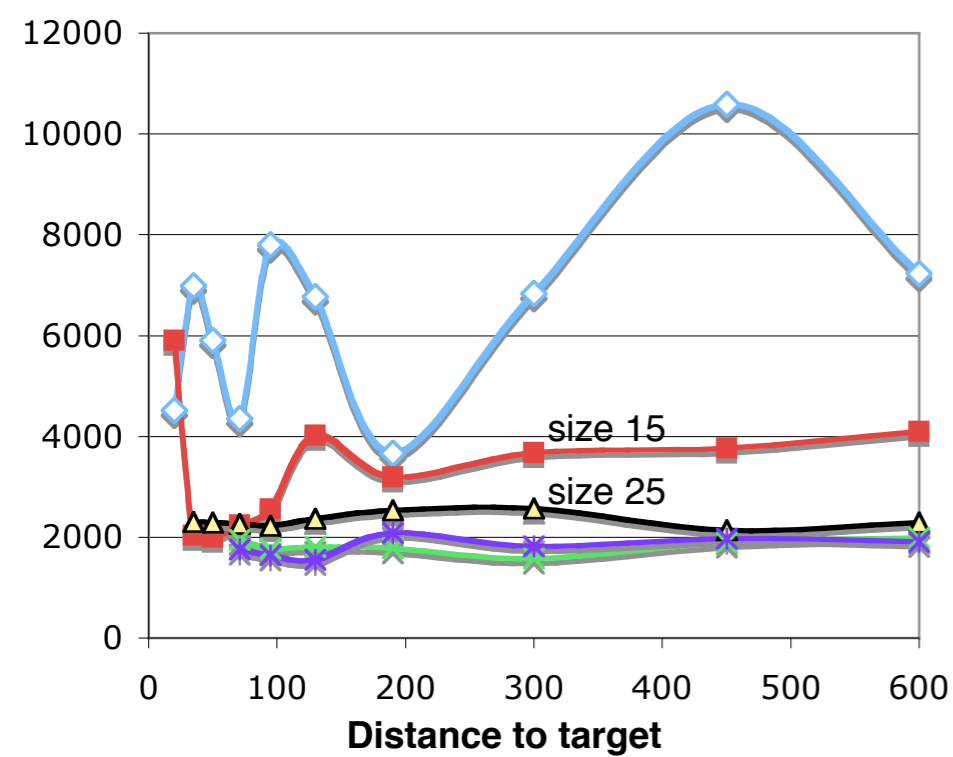


# Predicting Movement Time

Actual Data

Fitts' Law Prediction

Custom Model



# Road Map

- ✓ Introduction
- ✓ Interface generation as optimization
- ✓ Modeling motor capabilities
- > **Adapting to motor capabilities**
- Adapting to vision capabilities
- Adapting to motor and vision capabilities together
- Pilot User Study
- Lessons learned

# UI Building Blocks

- Widgets



# UI Building Blocks

- Widgets
- Layout

# UI Building Blocks

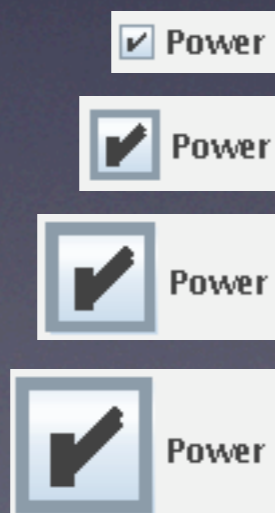
- Widgets
- Layout
- Structure (divide into windows, pop-ups, tabs)

# UI Building Blocks

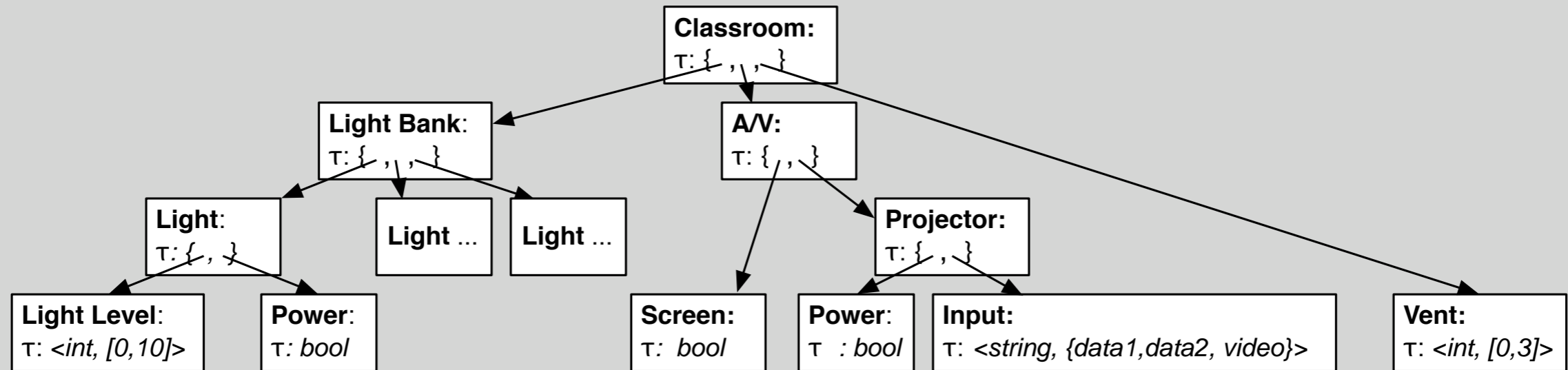
- Widgets
- Layout
- Structure (divide into windows, pop-ups, tabs)
- Size of interactors

# UI Building Blocks

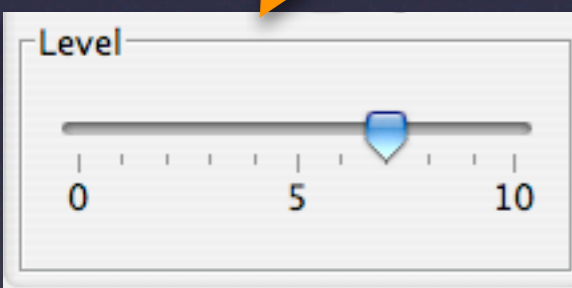
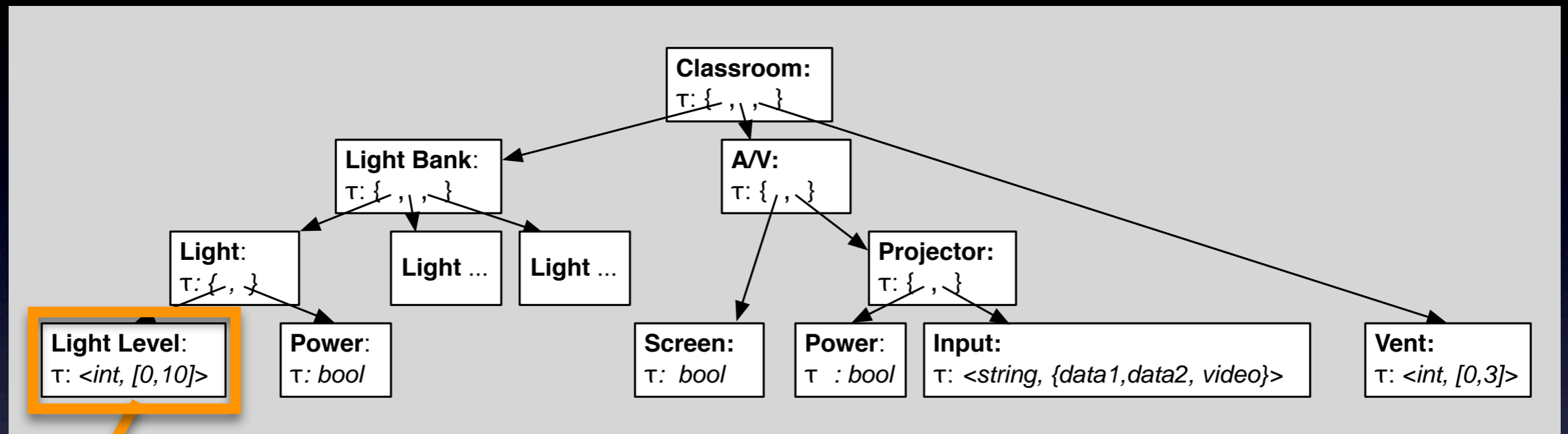
- Widgets
- Layout
- Structure (divide into windows, pop-ups, tabs)
- Size of interactors



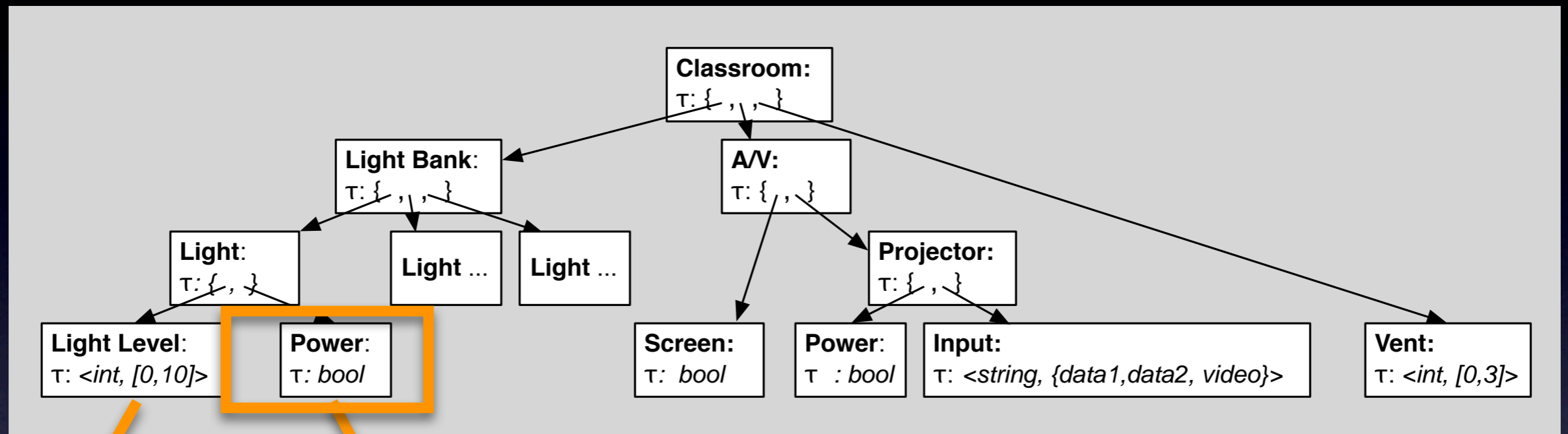
# Optimization as Search



# Optimization as Search



# Optimization as Search

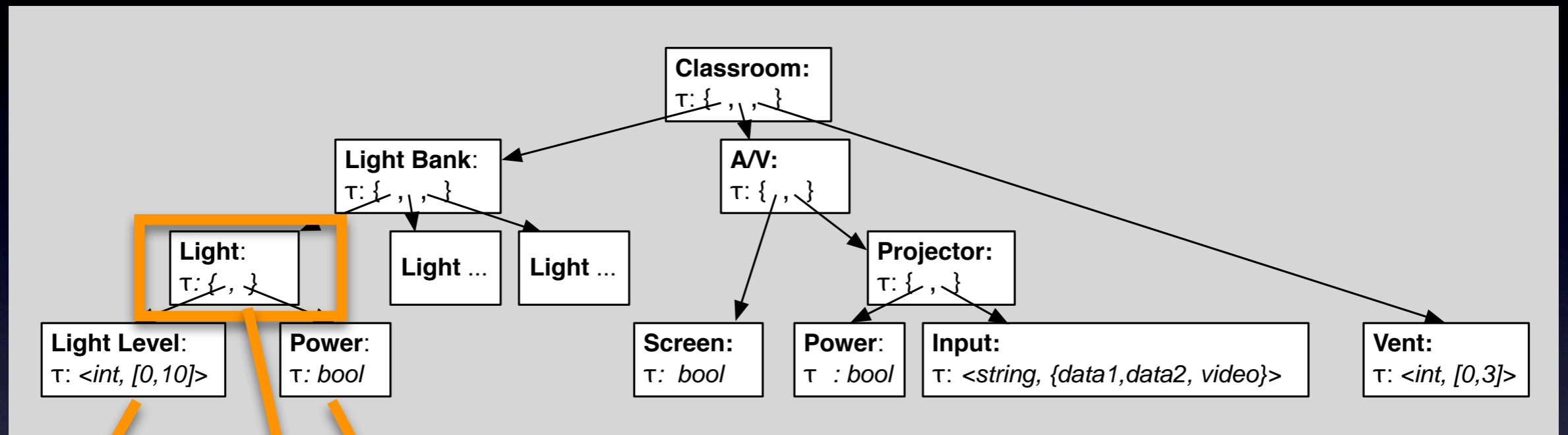


Level

0 5 10

Light

# Optimization as Search



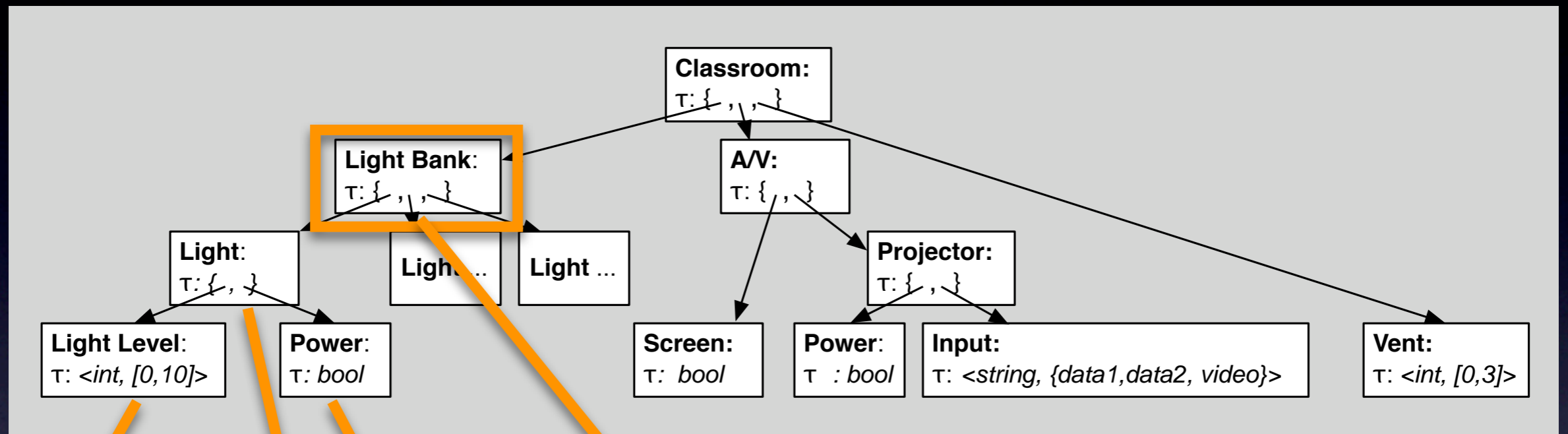
Level

0 5 10

Light



# Optimization as Search



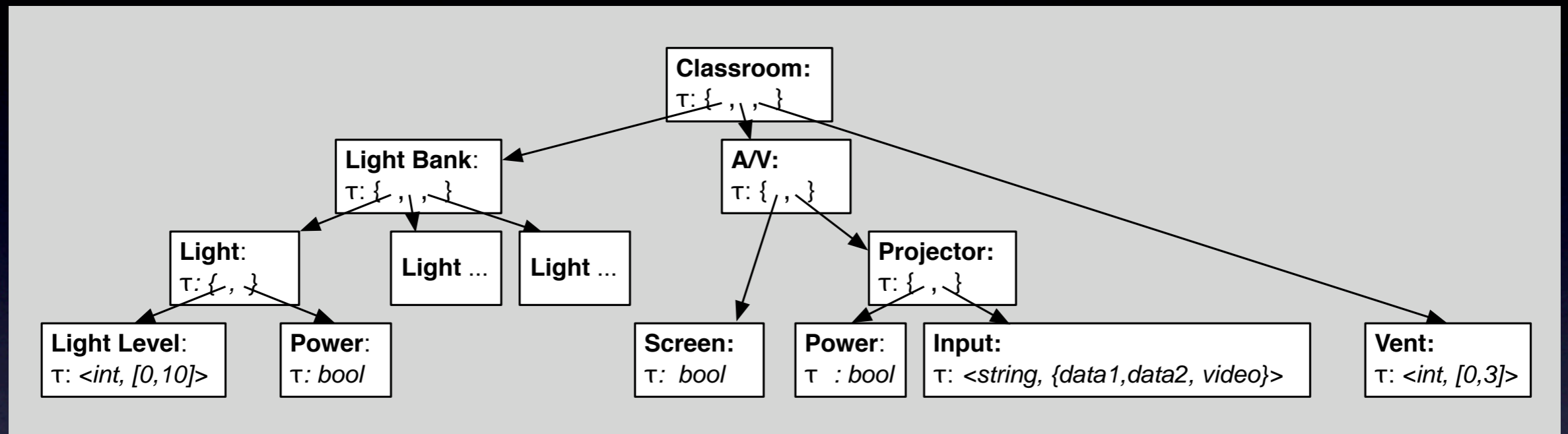
Level

0 5 10

Light

Left Center Right

# Optimization as Search



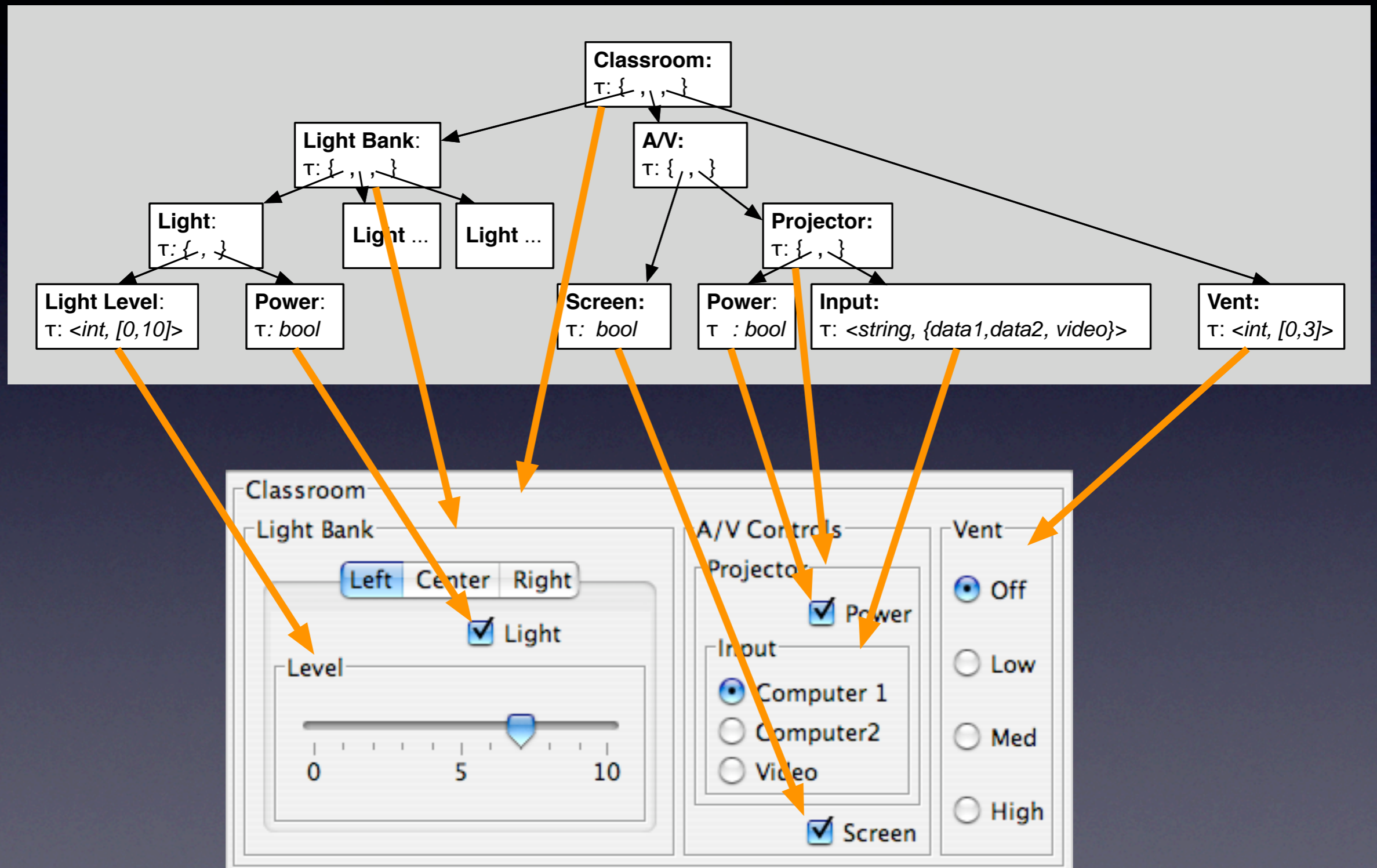
Level

0 5 10

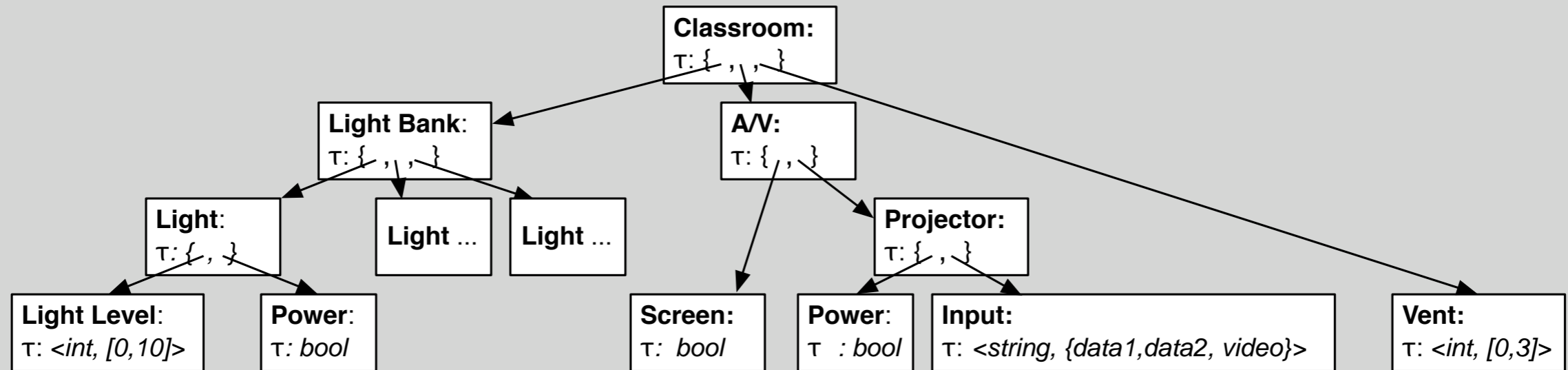
Light

Left Center Right

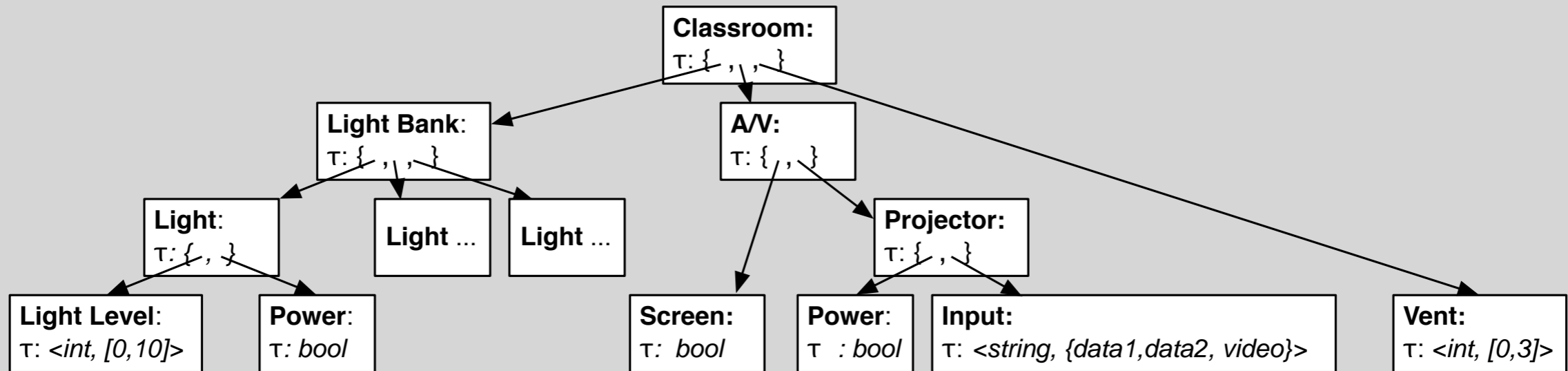
# Optimization as Search



# Optimization as Search



# Optimization as Search



Classroom

Light Bank

Left Center Right

Level

0 5 10

Light

A/V Controls

Projector

Power

Input

Computer 1

Computer 2

Video

Screen

Vent

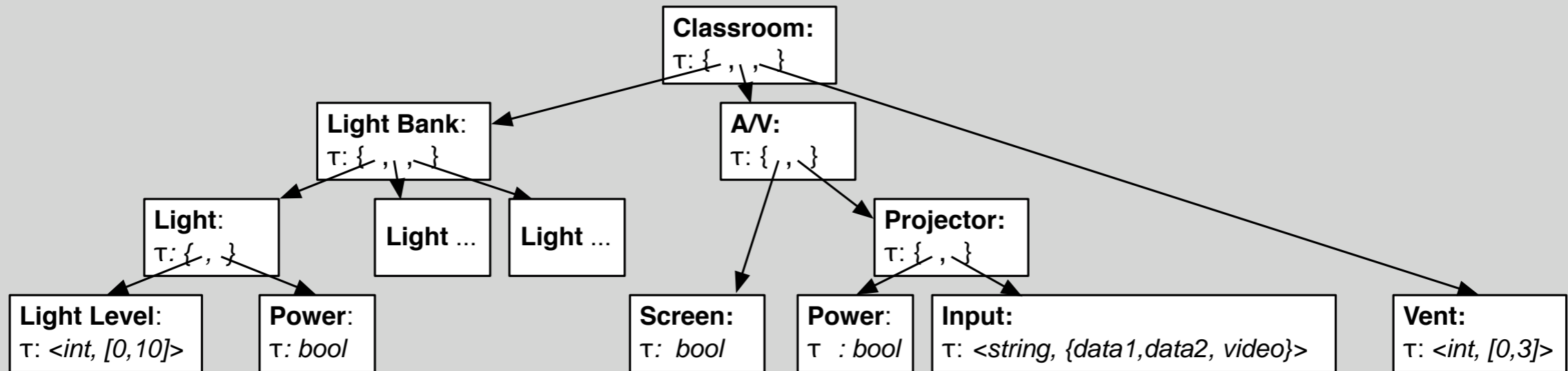
Off

Low

Med

High

# Optimization as Search



Classroom

Light Bank

Left Center Right

Level

0 5 10

Light

A/V Controls

Projector

Power

Screen

Input

Computer 1

Computer 2

Video

Vent

Off

Low

Med

High

# Optimization as Search

Enumerate all the options: **~370 years**

Light Level:  
 $\tau: \langle \text{int}, [0, 10] \rangle$

Power:  
 $\tau: \text{bool}$

Screen:  
 $\tau: \text{bool}$

Power:  
 $\tau: \text{bool}$

Input:  
 $\tau: \langle \text{string}, \{\text{data1}, \text{data2}, \text{video}\} \rangle$

Vent:  
 $\tau: \langle \text{int}, [0, 3] \rangle$

The screenshot shows a control panel for a classroom with three main sections:

- Light Bank:** Includes a radio button for "Left" (selected), "Center", and "Right". Below is a "Level" slider ranging from 0 to 10, with a blue knob positioned at approximately 7. A "Light" checkbox is checked.
- A/V Controls:** Includes a "Projector" section with a checked "Power" checkbox and an "Input" dropdown menu showing "Computer 1" (selected), "Computer 2", and "Video". A "Screen" checkbox is also checked.
- Vent:** Includes radio buttons for "Off" (selected), "Low", "Med", and "High".

# Optimization as Search

Enumerate all the options: **~370 years**

Supple: **~2 seconds**

Light Le  
τ: <int, [

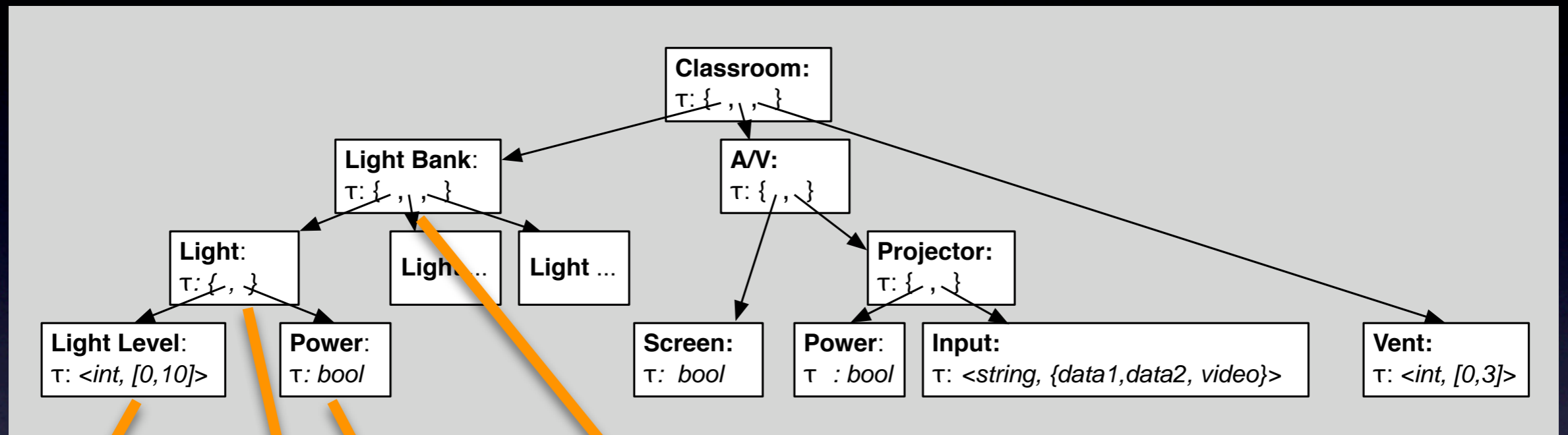
[0,3]>

The screenshot shows a control panel for a classroom with three main sections:

- Classroom**
  - Light Bank**: Includes a radio button for "Left" (selected), "Center", and "Right". Below is a "Level" slider ranging from 0 to 10, with a blue shield icon positioned at approximately 7. A checked checkbox labeled "Light" is to the left.
- A/V Controls**
  - Projector**: Includes a checked checkbox for "Power" and a sub-section for "Input" with radio buttons for "Computer 1" (selected), "Computer2", and "Video".
  - Screen**: Includes a checked checkbox.
- Vent**: Includes radio buttons for "Off" (selected), "Low", "Med", and "High".



# Optimization as Search



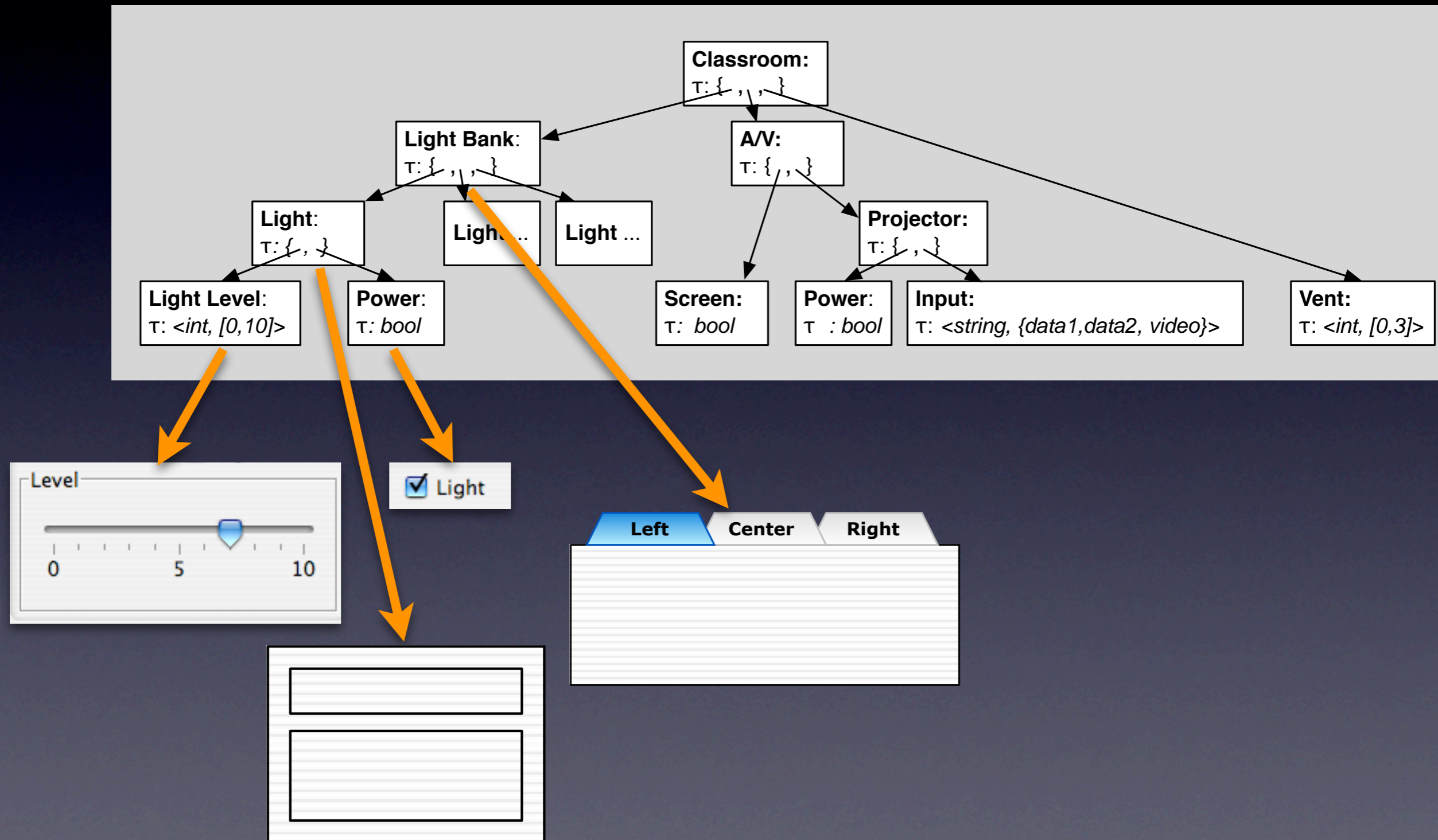
Level

0 5 10

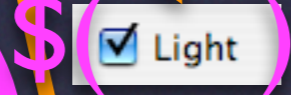
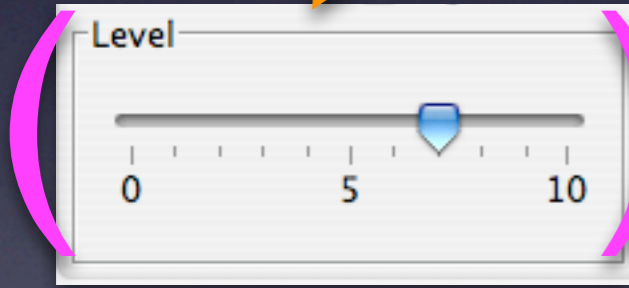
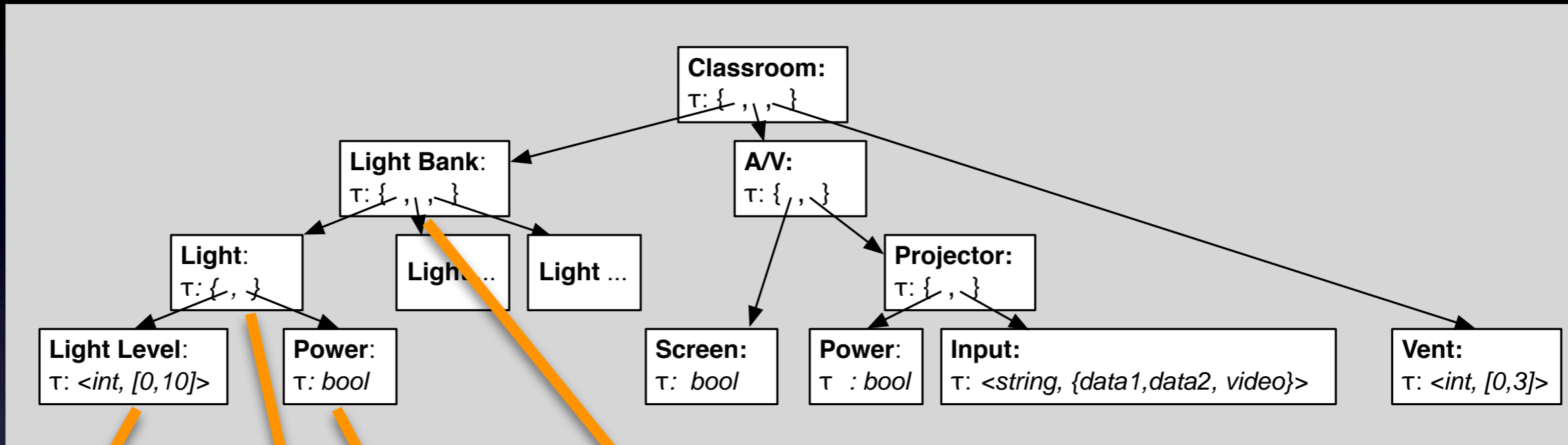
Light

Left Center Right

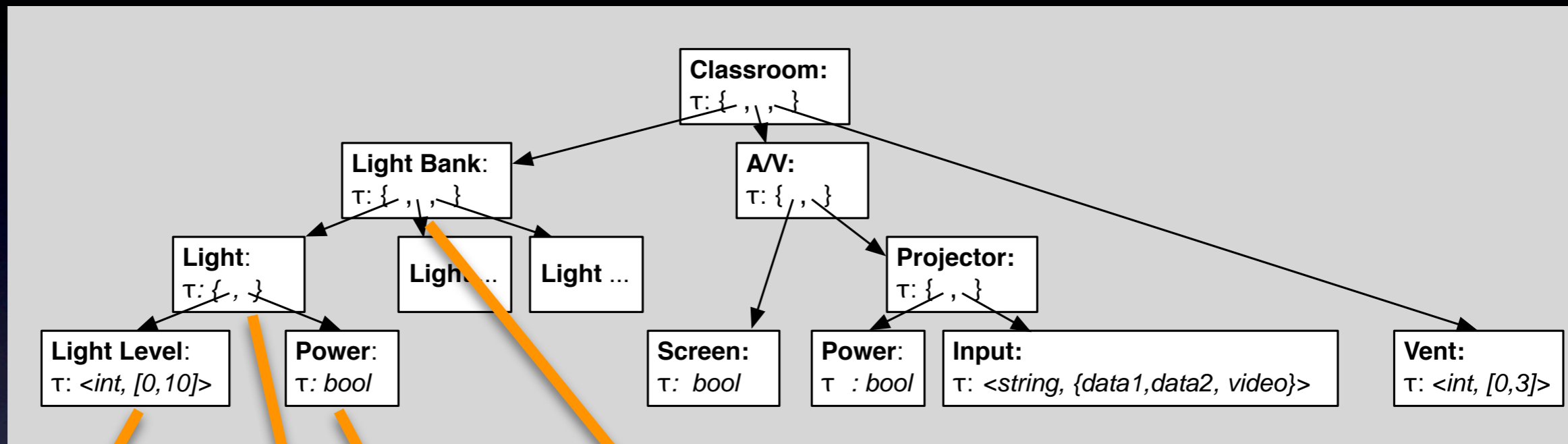
# Optimization as Search



# Optimization as Search



# Optimization as Search



Level

0 5 10

Light

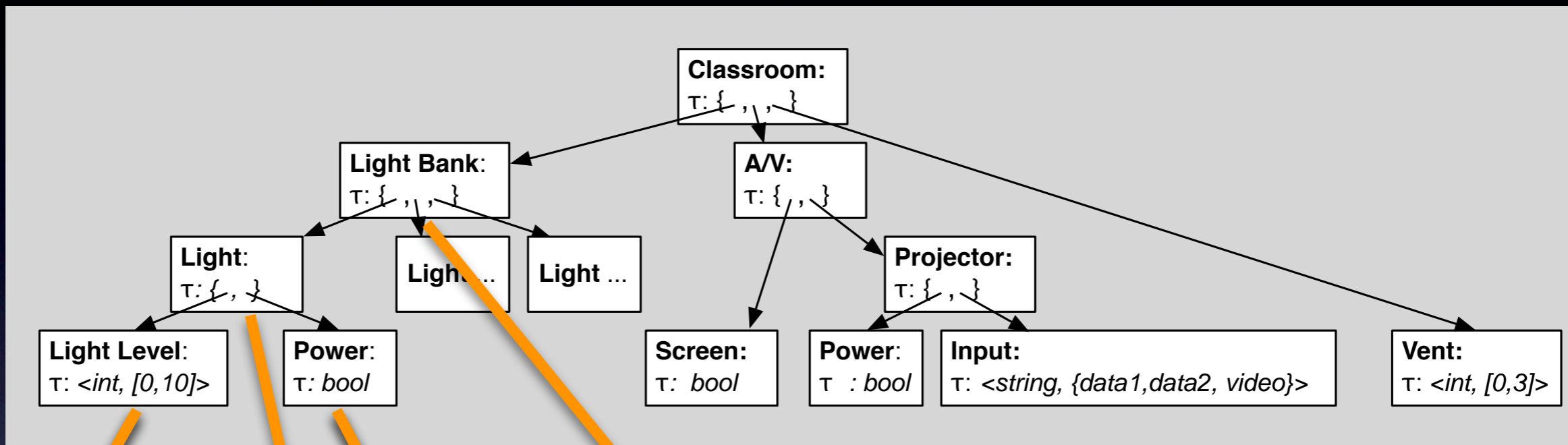
(\$ ( ))

(\$ ( ))

Left Center Right

(\$ ( ))

# Optimization as Search



Level

0 5 10

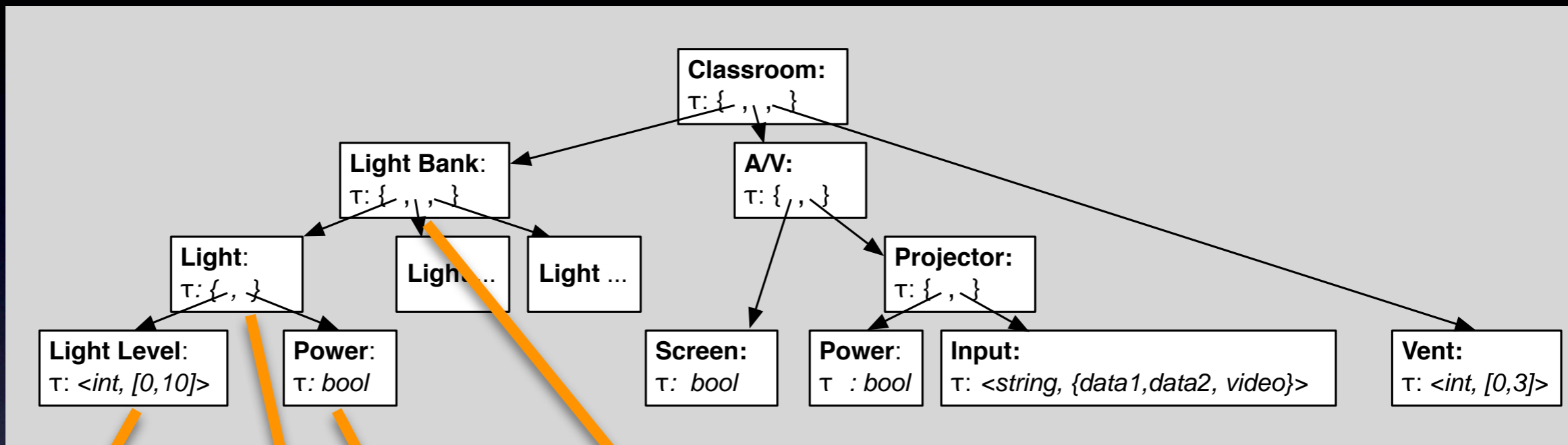
Light

Left Center Right

MT

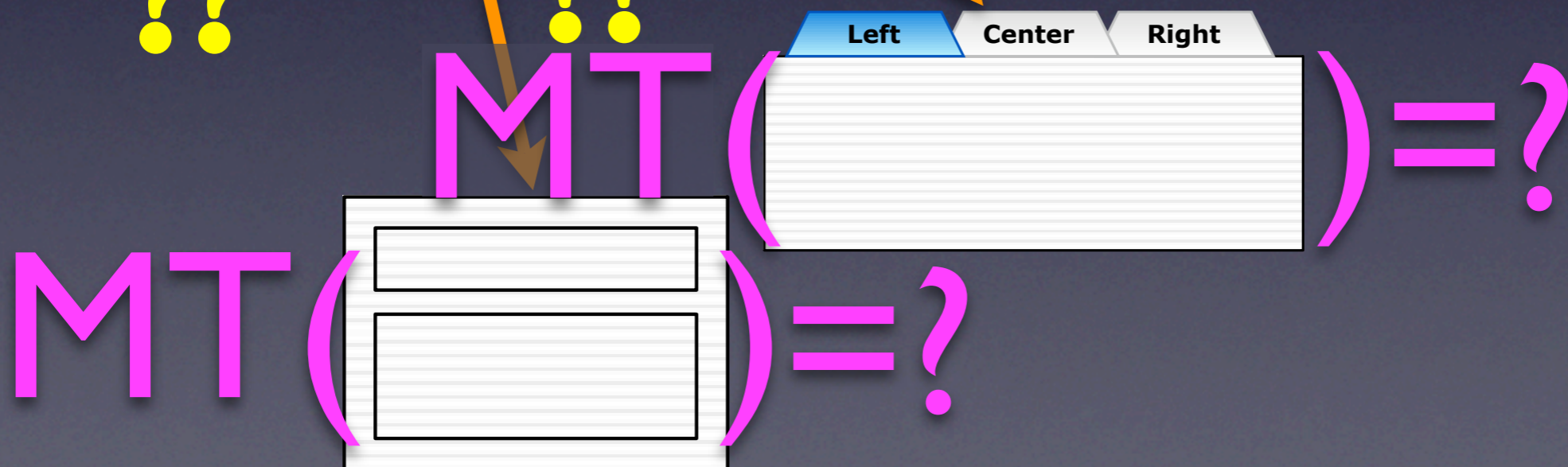
MT

# Optimization as Search



??

??



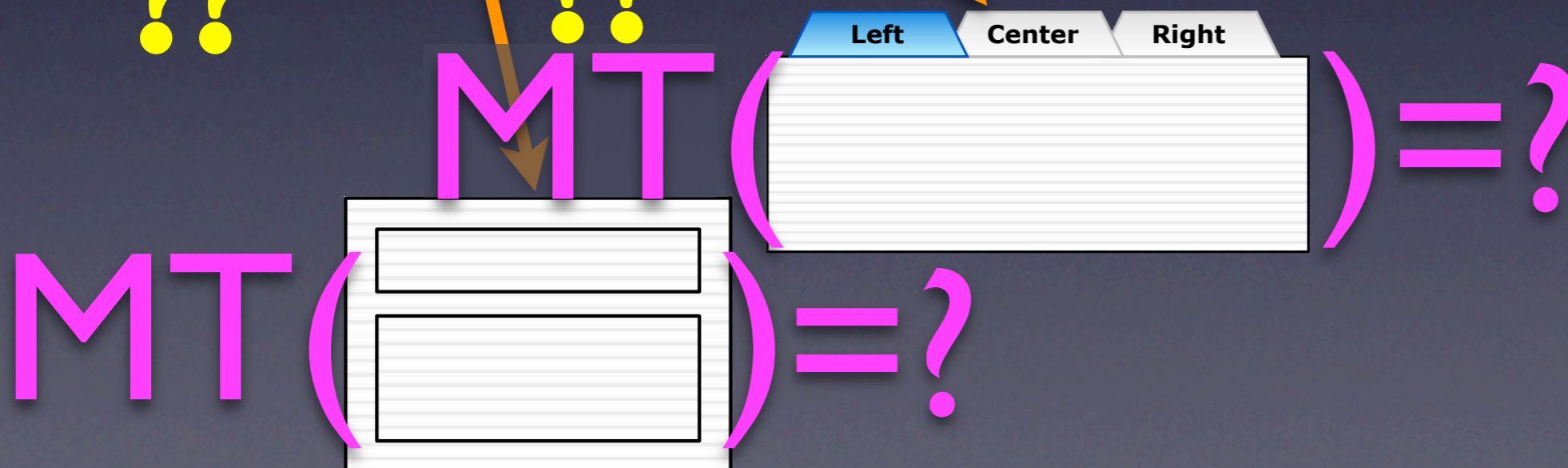
# Optimization as Search

Use Supple to optimize for motor abilities:  
**hours or days**

Vent:  
 $\tau: \langle \text{int}, [0,3] \rangle$

??

??



# Supple++

- Novel optimization-based algorithm computes a lower bound on movement time through a layout even before all the widgets are chosen

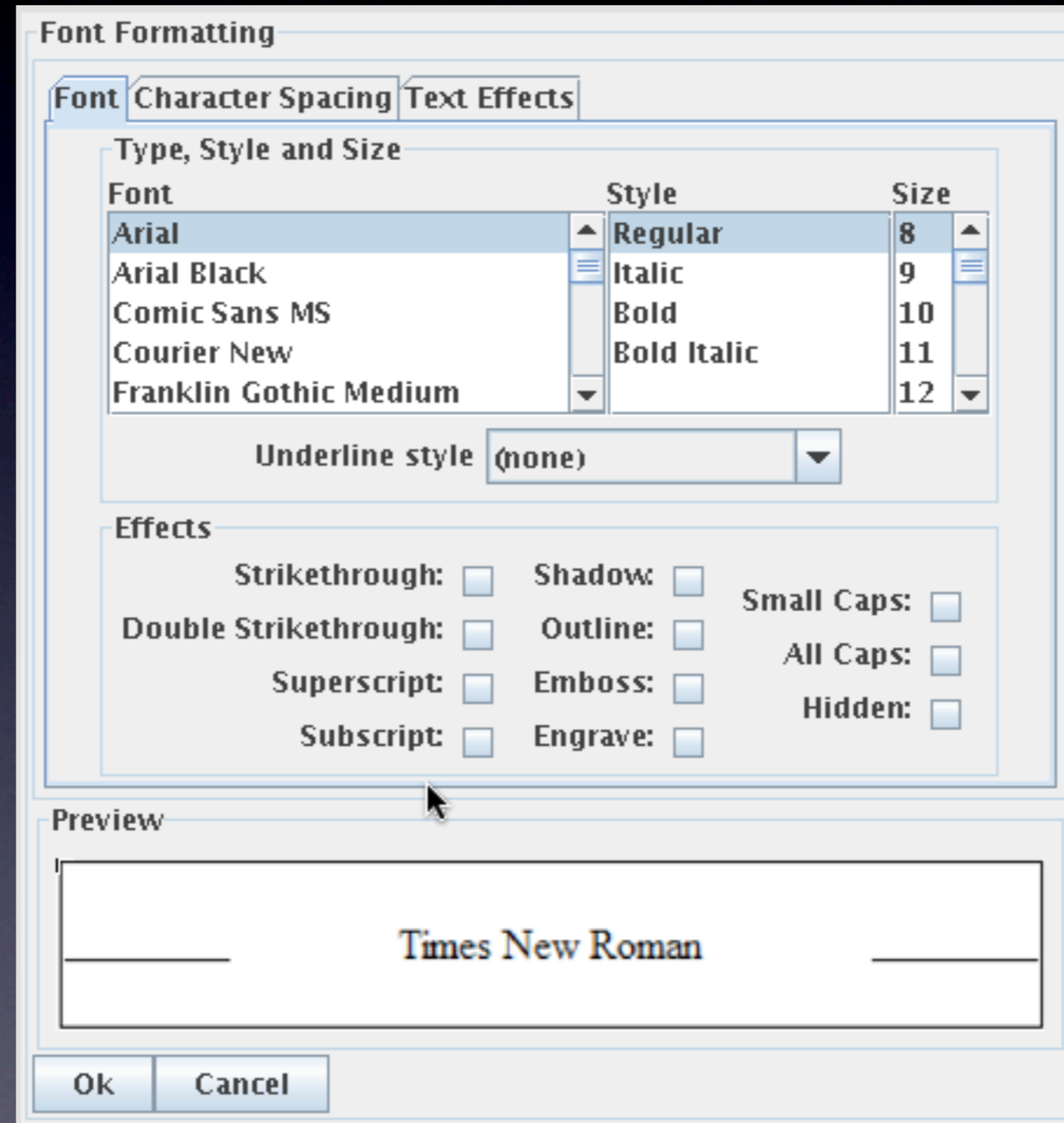


# Supple++

- Novel optimization-based algorithm computes a lower bound on movement time through a layout even before all the widgets are chosen

Use **Supple++** to optimize for motor abilities:  
**seconds or minutes**

# Results



Type, Style and Size

Font	Style	Size	Underline style
Arial	Regular	8	<input checked="" type="radio"/> (none)
Arial Black	Italic	9	
Comic Sans MS	Bold	10	
Courier New	Bold Italic	11	
Franklin Gothic Medium		12	
Italic		13	
Gautami		14	
Georgia		15	
Helvetica		16	
Latha		17	
Lucida Console		18	<input type="radio"/> Single solid
Lucida Sans Unicode		19	
Microsoft Sans Serif		20	
Modern MS Sans Serif		21	
MS Serif		22	
Mv Boli		23	
Palatino Linotype		24	
Roman		25	
Script		26	
Small Fonts		27	
Symbol		28	<input type="radio"/> Double solid
Tahoma		29	
Times New Roman		30	
Trebuchet MS		31	
Tunga		32	
Verdana		33	
Webdings		34	
WingDings		35	
		36	
		37	

- Effects
- Strikethrough
  - Double Strikethrough
  - Superscript
  - Subscript
  - Shadow
  - Outline
  - Emboss
  - Engrave
  - Small Caps
  - All Caps
  - Hidden

Ok  
Cancel

Preview

Times New Roman

Type, Style and Size

Font	Style	Size	Underline style
Arial	Regular	8	(none)
Arial Black	Italic	9	
Comic Sans MS	Bold	10	
Courier New	Bold Italic	11	
Franklin Gothic Medium		12	
Italic		13	Single solid
Gautami		14	
Georgia		15	
Helvetica		16	Double solid
Latha		17	
Lucida Console		18	
Lucida Sans Unicode		19	Dotted
Microsoft Sans Serif		20	
Modern MS Sans Serif		21	
MS Serif		22	Dashed
Mv Boli		23	
Palatino Linotype		24	
Roman		25	
Script		26	Wavy
Small Fonts		27	

- Effects
- Strikethrough
  - Double Strikethrough
  - Superscript
  - Subscript
  - Shadow
  - Outline
  - Emboss
  - Engrave
  - Small Caps
  - All Caps
  - Hidden

Ok  
Cancel

Preview

Times New Roman

Font dialog box for Times New Roman. The font name is "Times New Roman" and the size is "8". The "Underline style" section is highlighted with a red border. The "Effects" section is also highlighted with a red border.

Size	Underline style
8	<input checked="" type="radio"/> (none)
9	<input type="radio"/> Single solid
10	<input type="radio"/> Double solid
11	<input type="radio"/> Dotted
12	<input type="radio"/> Dashed
13	<input type="radio"/> Wavy

Effects:

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

Buttons: Ok, Cancel

Font dialog box for Times New Roman. The font name is "Times New Roman" and the size is "8". The "Underline style" section is highlighted with a red border. The "Effects" section is also highlighted with a red border.

Size	Underline style
8	<input checked="" type="radio"/> (none)
9	<input type="radio"/> Single solid
10	<input type="radio"/> Double solid
11	<input type="radio"/> Dotted
12	<input type="radio"/> Dashed
13	<input type="radio"/> Wavy

Effects:

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

Buttons: Ok, Cancel

Times New Roman

Times New Roman

Font dialog box for Times New Roman. The font name is "Times New Roman". The font style is "Italic". The font size is 12. The underline style is "Single solid". The effects are: Strikethrough, Double Strikethrough, Superscript, Subscript, Shadow, Outline, Emboss, Engrave, Small Caps, All Caps, and Hidden.

Font Style	Size	Underline style
Regular	8	(none)
Italic	9	(none)
Italic	10	(none)
Italic	11	(none)
Italic	12	Single solid
Italic	13	(none)
Italic	14	(none)
Italic	15	(none)
Italic	16	Double solid
Italic	17	(none)
Italic	18	(none)
Italic	19	Dotted
Italic	20	(none)
Italic	21	(none)
Italic	22	Dashed
Italic	23	(none)
Italic	24	(none)
Italic	25	(none)
Italic	26	Wavy
Italic	27	(none)

Effects:

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

Buttons: Ok, Cancel

Times New Roman

Font dialog box for Times New Roman. The font name is "Times New Roman". The font style is "Regular". The font size is 12. The underline style is "Single solid". The effects are: Strikethrough, Double Strikethrough, Superscript, Subscript, Shadow, Outline, Emboss, Engrave, Small Caps, All Caps, and Hidden.

Font Style	Size	Underline style
Regular	8	(none)
Italic	9	(none)
Bold	10	(none)
Bold Italic	11	(none)
Regular	12	Single solid
Regular	13	(none)
Regular	14	(none)
Regular	15	(none)
Regular	16	Double solid
Regular	17	(none)
Regular	18	(none)
Regular	19	(none)
Regular	20	Double solid
Regular	21	(none)
Regular	22	(none)
Regular	23	(none)
Regular	24	(none)
Regular	25	Dotted
Regular	26	(none)
Regular	27	(none)
Regular	28	(none)
Regular	29	Dashed
Regular	30	(none)
Regular	31	(none)
Regular	32	(none)
Regular	33	(none)
Regular	34	Wavy
Regular	35	(none)
Regular	36	(none)
Regular	37	(none)

Effects:

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

Buttons: Ok, Cancel

Times New Roman

Font Character Spacing Text Effects

Type, Style and Size

Font	Style	Size	Underline style
Arial	Regular	8	
Arial Black	Italic	9	
Comic Sans MS	Bold	10	
Courier New	Bold Italic	11	
Franklin Gothic Medium		12	
Italic		13	
Gautami		14	
Georgia		15	
Helvetica		16	
Latha		17	
Lucida Console		18	
Lucida Sans Unicode		19	
Microsoft Sans Serif		20	
Modern MS Sans Serif		21	
MS Serif		22	
Mv Boli		23	
Palatino Linotype		24	
Roman		25	
Script		26	
Small Fonts		27	

Font Character Spacing Text Effects

Type, Style and Size

Font	Style	Size	Underline style
Arial	Regular	8	
Arial Black	Italic	9	
Comic Sans MS	Bold	10	<input checked="" type="radio"/> (none)
Courier New	Bold Italic	11	
Franklin Gothic Medium		12	
Italic		13	
Gautami		14	
Georgia		15	<input type="radio"/> Single solid
Helvetica		16	
Latha		17	
Lucida Console		18	
Lucida Sans Unicode		19	
Microsoft Sans Serif		20	<input type="radio"/> Double solid
Modern MS Sans Serif		21	
MS Serif		22	
Mv Boli		23	
Palatino Linotype		24	
Roman		25	<input type="radio"/> Dotted
Script		26	
Small Fonts		27	
Symbol		28	
Tahoma		29	
Times New Roman		30	<input type="radio"/> Dashed
Trebuchet MS		31	
Tunga		32	
Verdana		33	
Webdings		34	
WingDings		35	<input type="radio"/> Wavy

Effects

- Strik
- Doub
- Supe
- Subs
- Shad
- Outli
- Embo
- Engr
- Smal
- All C
- Hidd

Preview

Times New Roman

Preview

Times New Roman

Font Formatting

Font

Type, Style and Size

Font	Style	Size
Arial	Regular	8
Arial Black	Italic	9
Comic Sans MS	Bold	10
Courier New	Bold Italic	11
Franklin Gothic Medium		12
Italic		13
Gautami		14
Georgia		15
Helvetica		16
Latha		17
Lucida Console		18
Lucida Sans Unicode		19
Microsoft Sans Serif		20
Modern MS Sans Serif		21
MS Serif		22
Mv Boli		23
Palatino Linotype		24
Roman		25
Script		26
Small Fonts		27
Symbol		28
Taberna		29

Underline style

- (none)
- Single solid
- Double solid
- Dotted
- Dashed
- Wavy

Effects

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

Character Spacing

Scale

- 200%
- 150%
- 100%
- 90%
- 80%

Spacing

	By
	0
	1
	2
Normal	3
Expanded	4
Condensed	5
	6
	7
	8
	9

Position

	By
Normal	0
Raised	1
Lowered	2
	3
	4

Kerning for fonts

Points and above

- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17

Text Effects

Animations

- (none)
- Blinking Background
- Las Vegas Lights
- Marching Black Ants
- Marching Red Ants
- Shimmer
- Sparkle Text

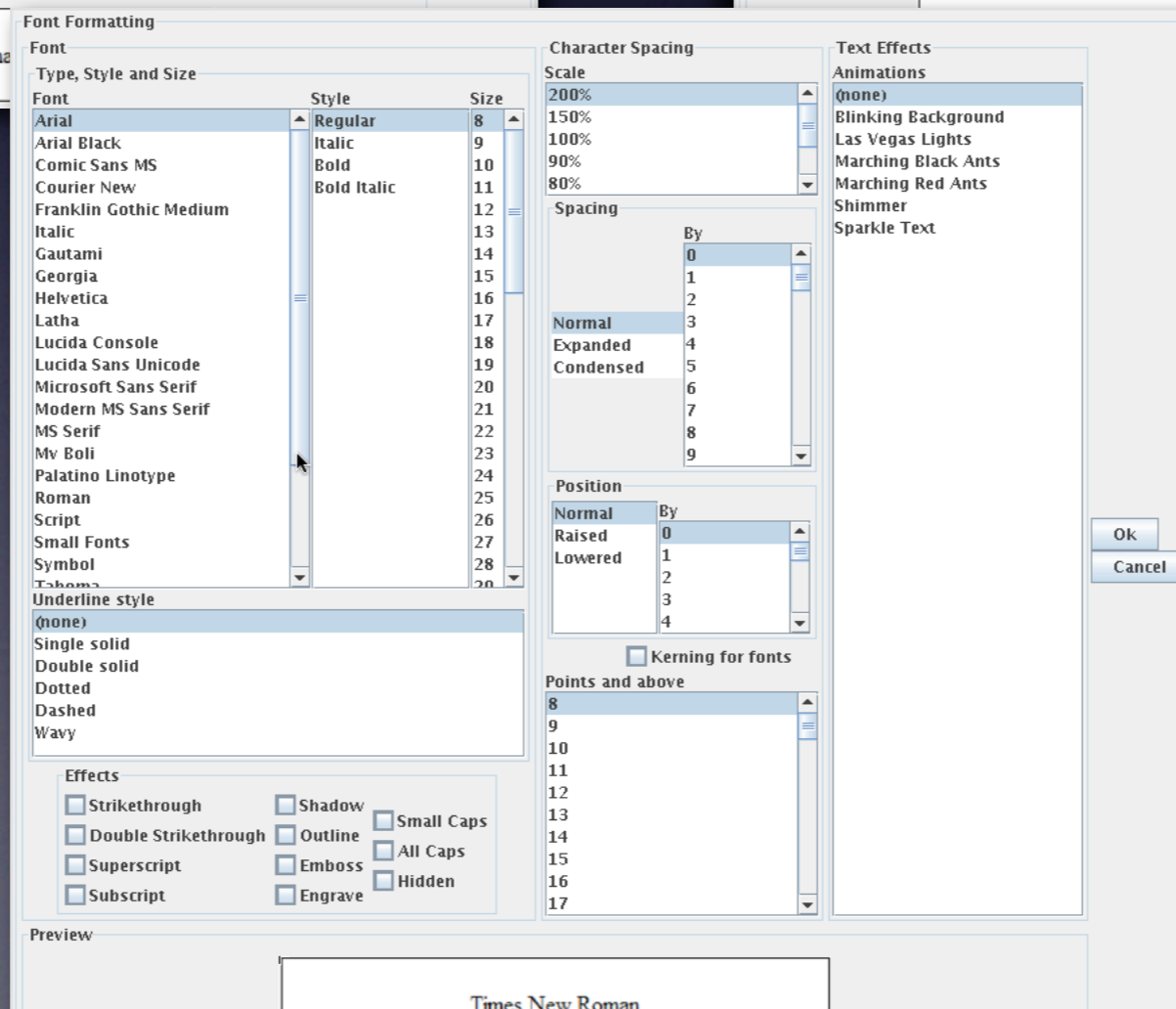
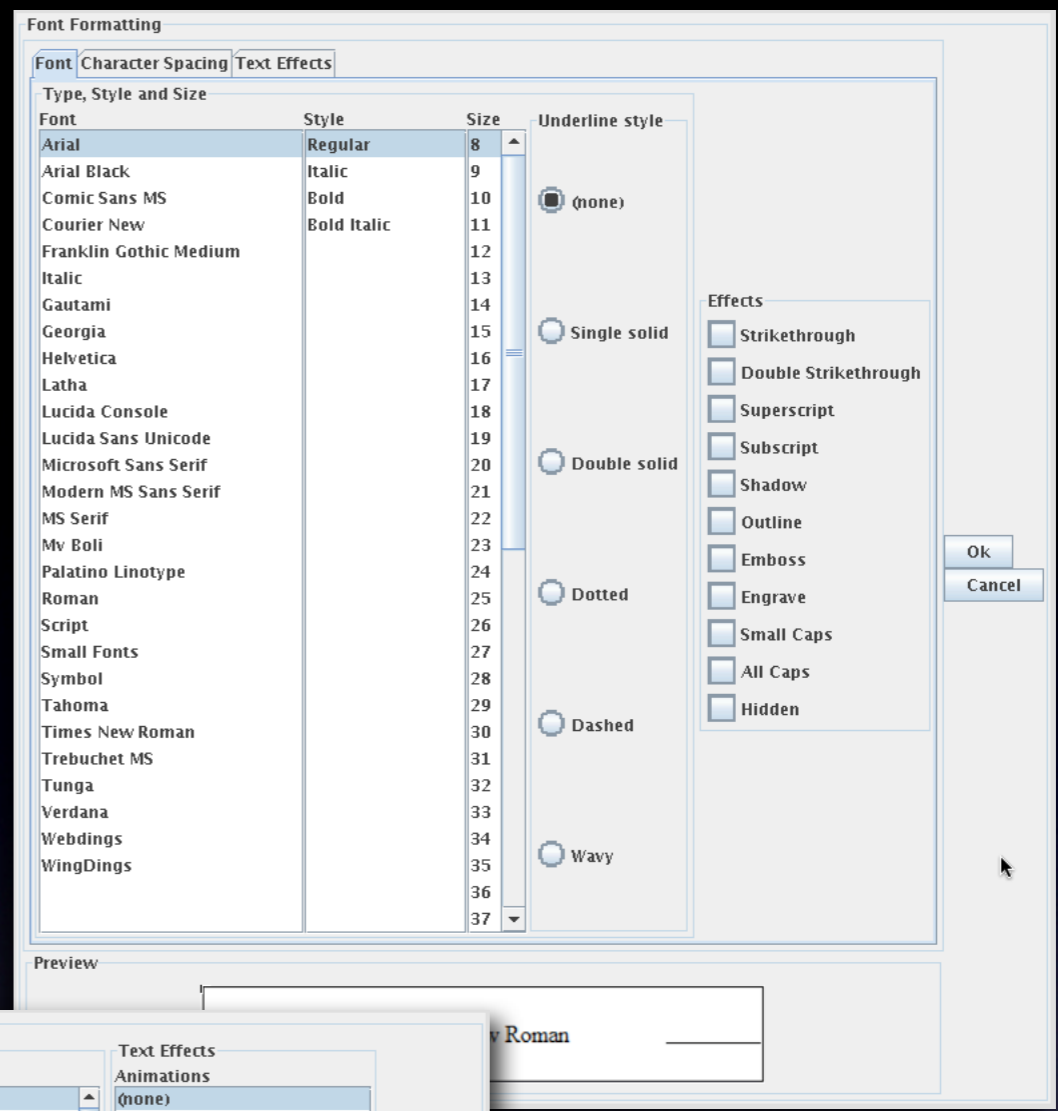
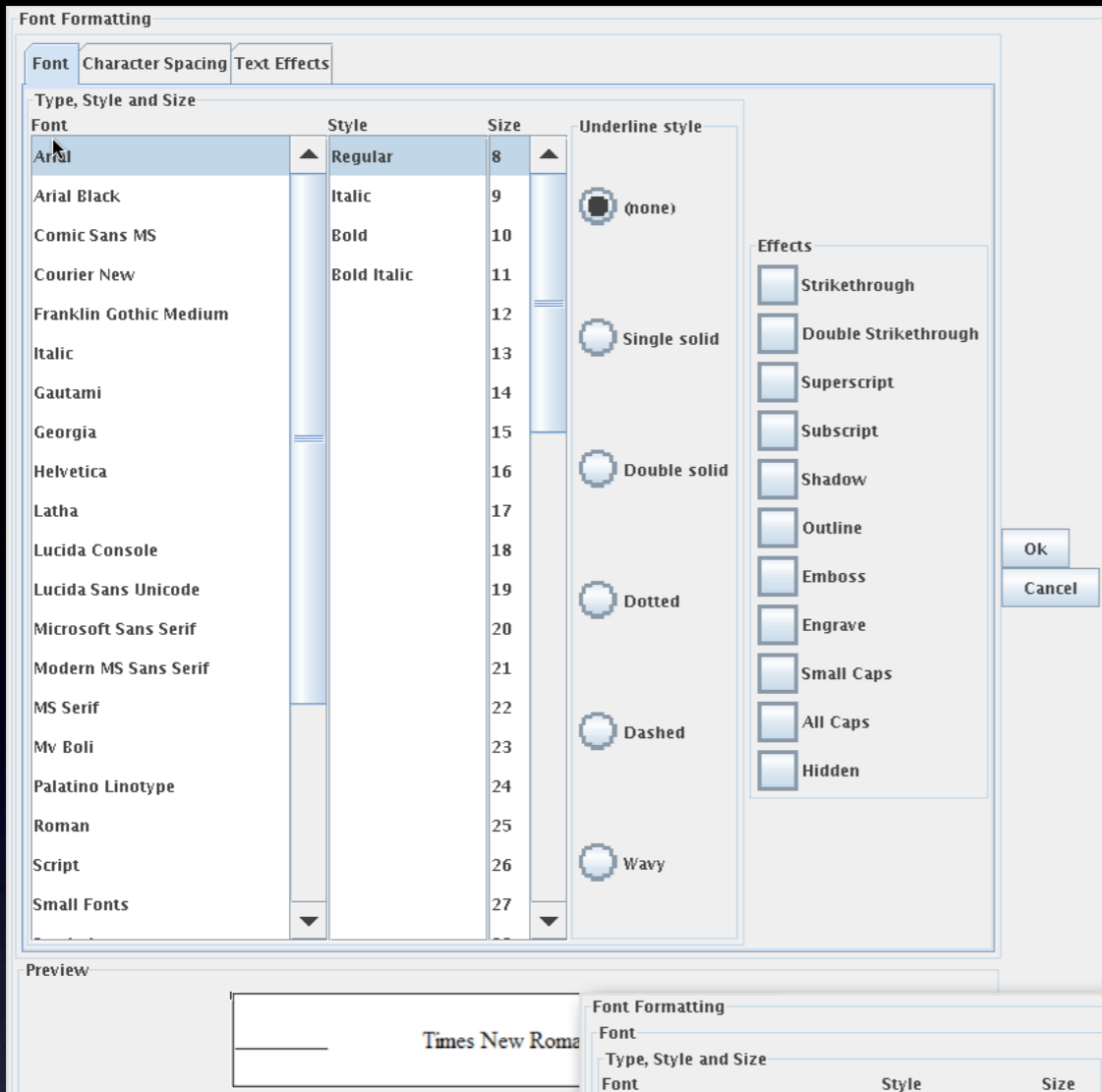
Ok

Cancel

Preview

Times New Roman





Impaired  
dexterity

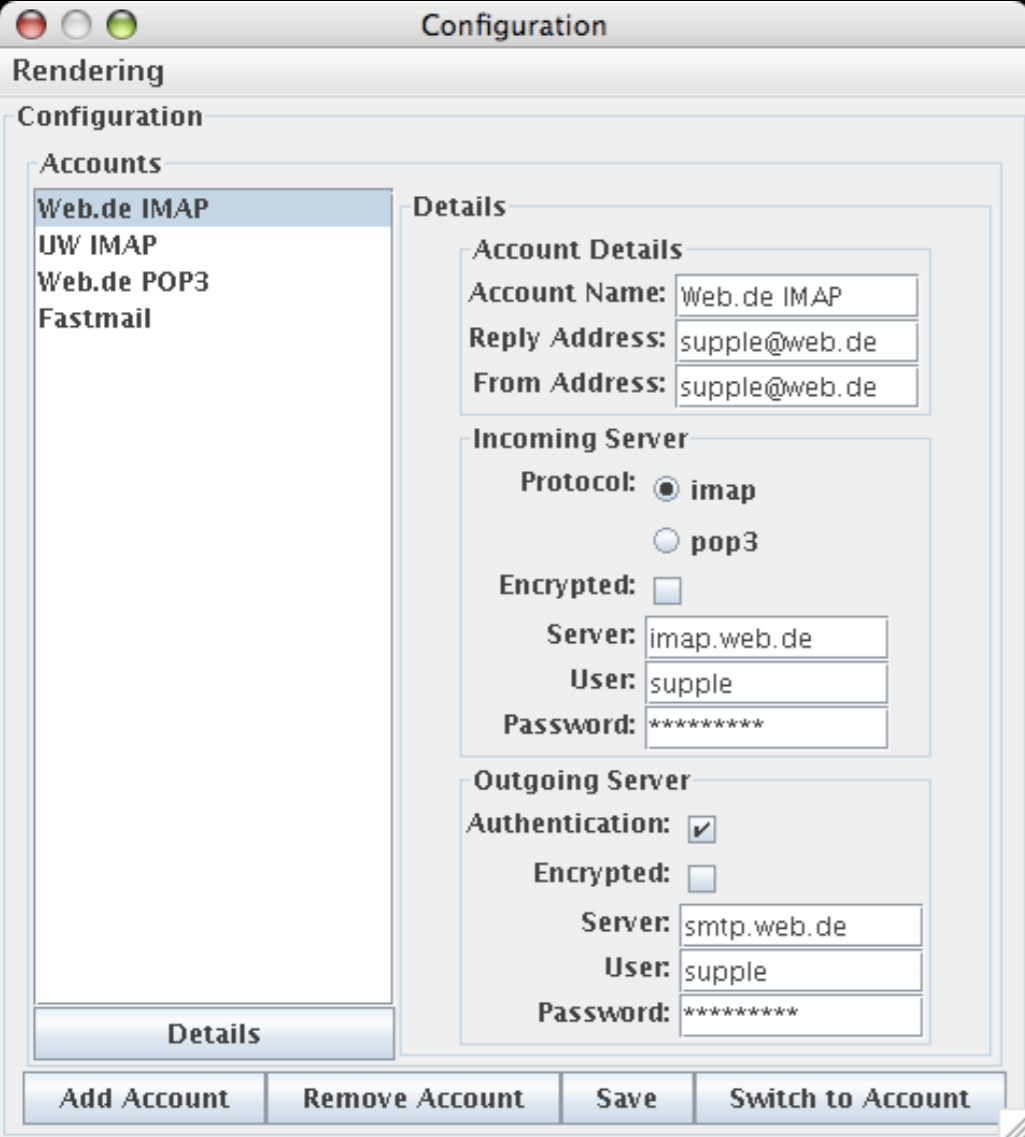
Able-bodied

Low strength

# Road Map

- ✓ Introduction
- ✓ Interface generation as optimization
- ✓ Modeling motor capabilities
- ✓ Adapting to motor capabilities
- > **Adapting to vision capabilities**
- Adapting to motor and vision capabilities together
- Pilot User Study
- Lessons learned





# Configuration

## Accounts

Web.de IMAP

UW IMAP

Web.de POP3

Fastmail

## Details

### Account Details

Account Name: Web.de IMAP

Reply Address: supple@web.de

From Address: supple@web.de

### Incoming Server

Protocol:  imap

pop3

Encrypted:

Server: imap.web.de

User: supple

Password: \*\*\*\*\*

pop3

Encrypted:

Server:

User:

Password:

### Outgoing Server

Authentication:

Encrypted:

Server:

User:

Password:

Details

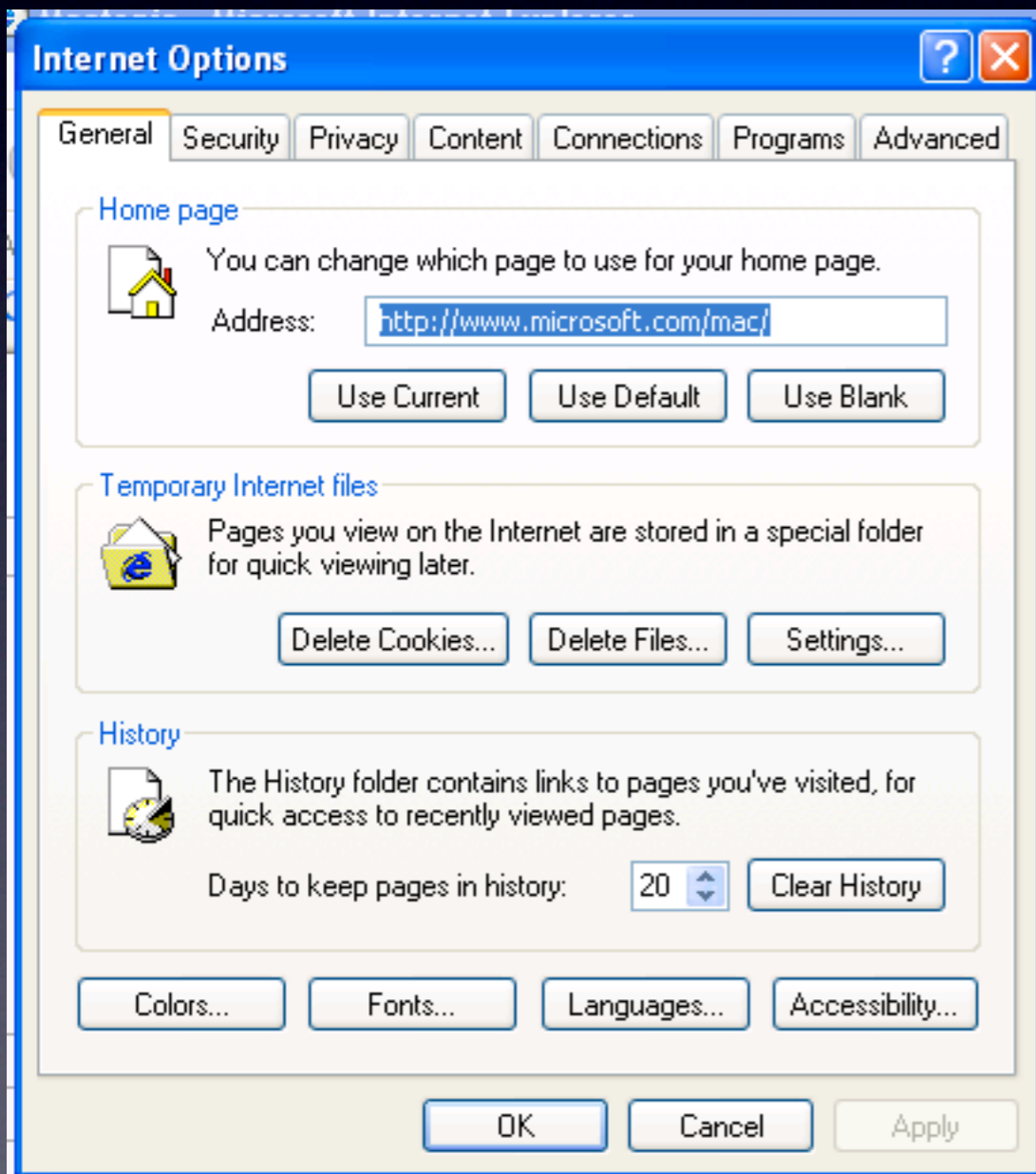
Account

Remove Account

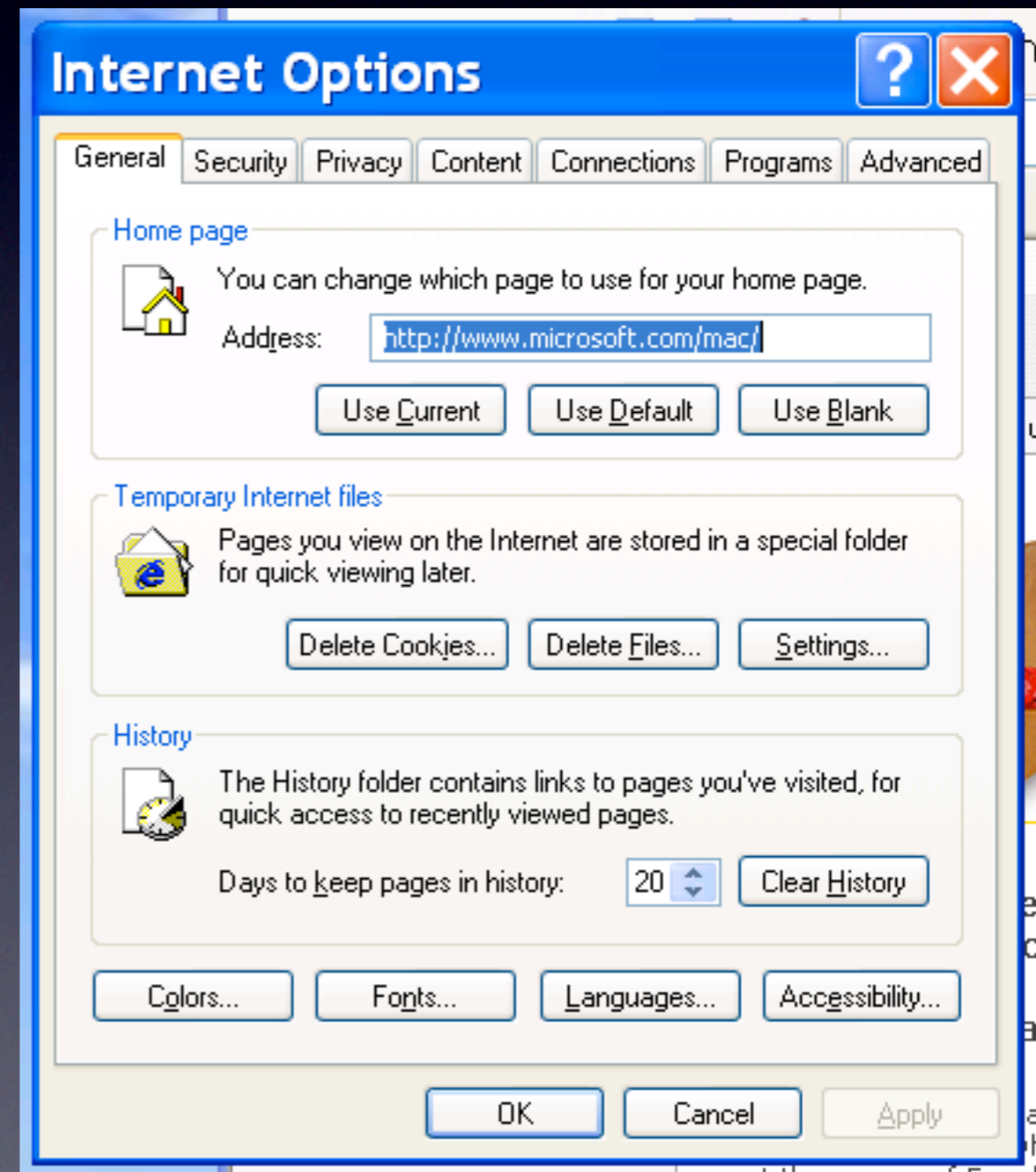
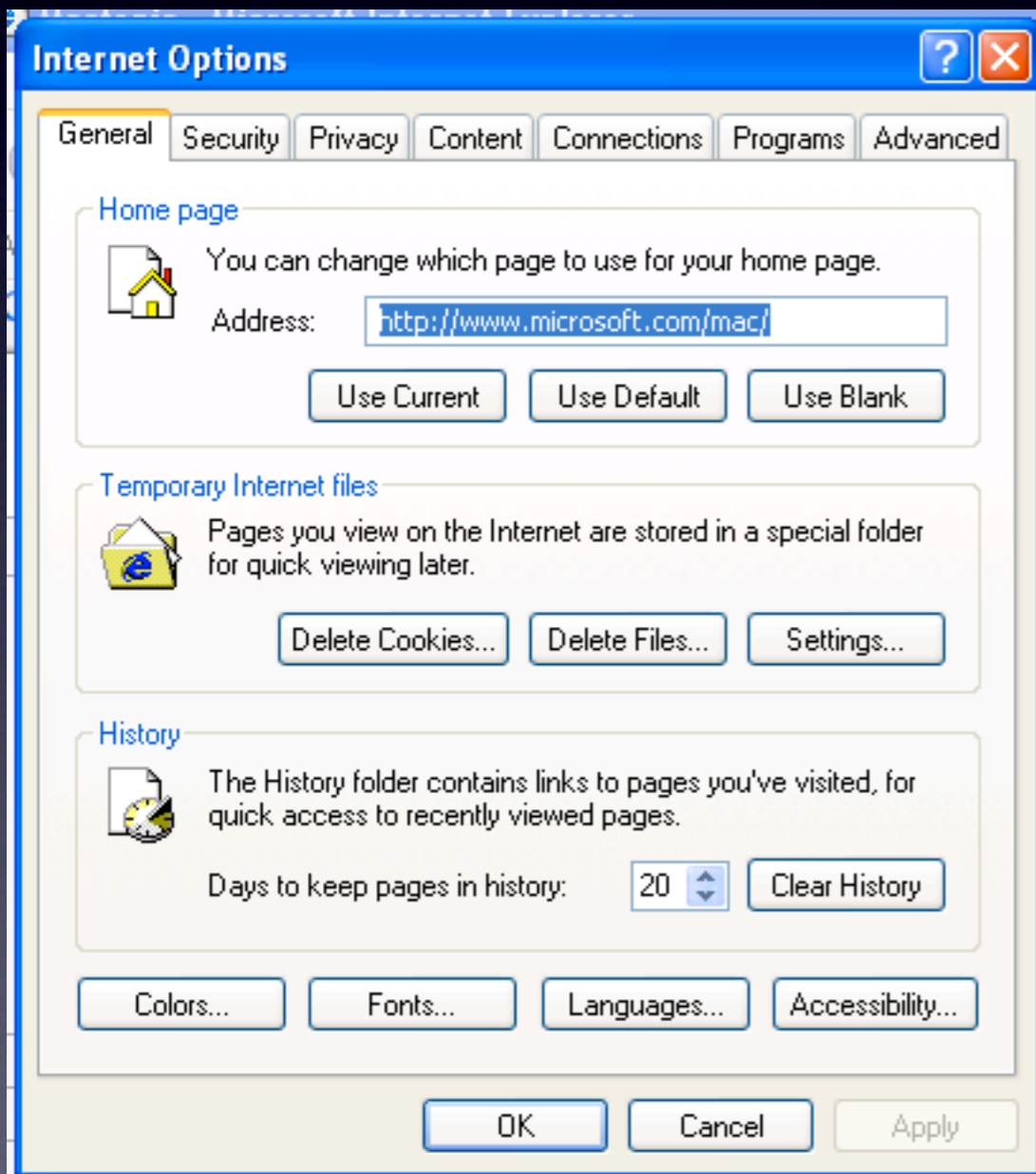
Save

Switch to Account

# Popular OS Solution: “Large Fonts”

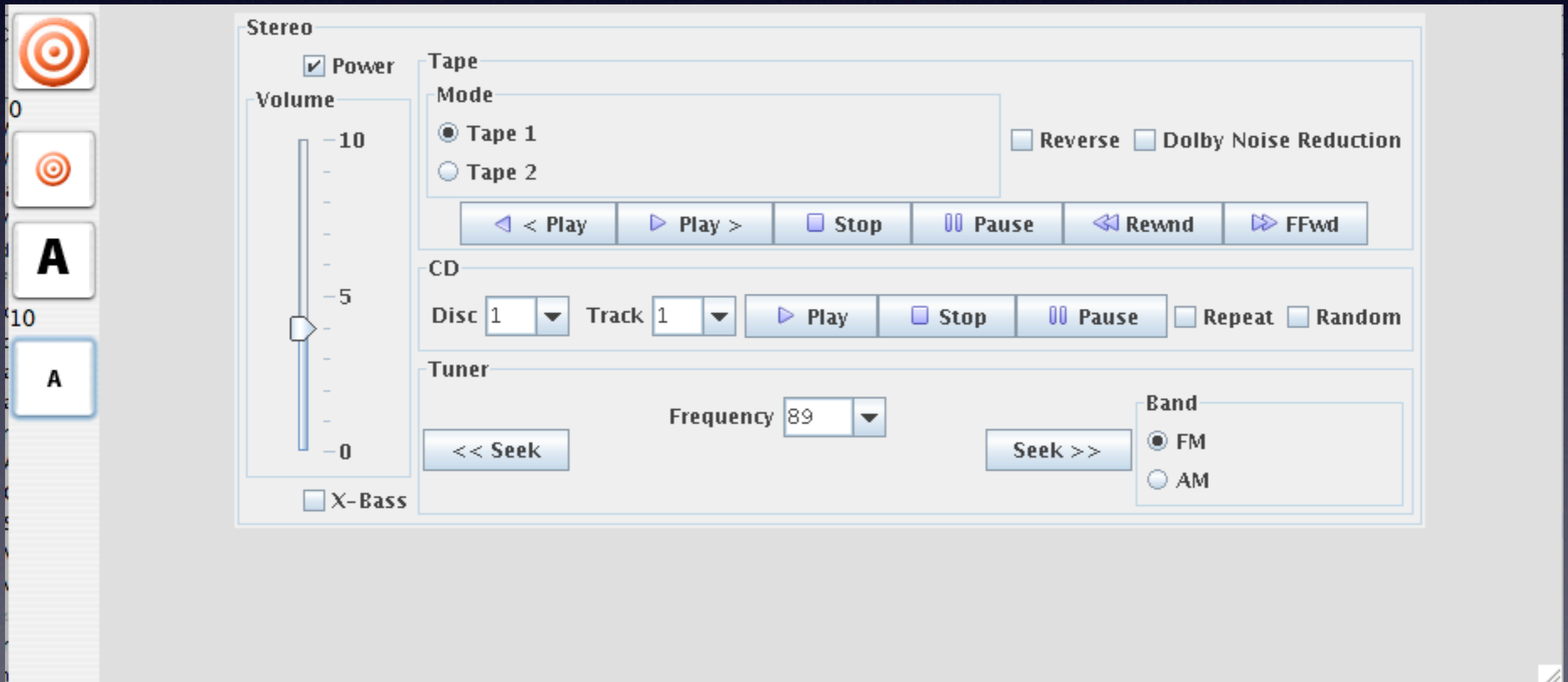


# Popular OS Solution: “Large Fonts”

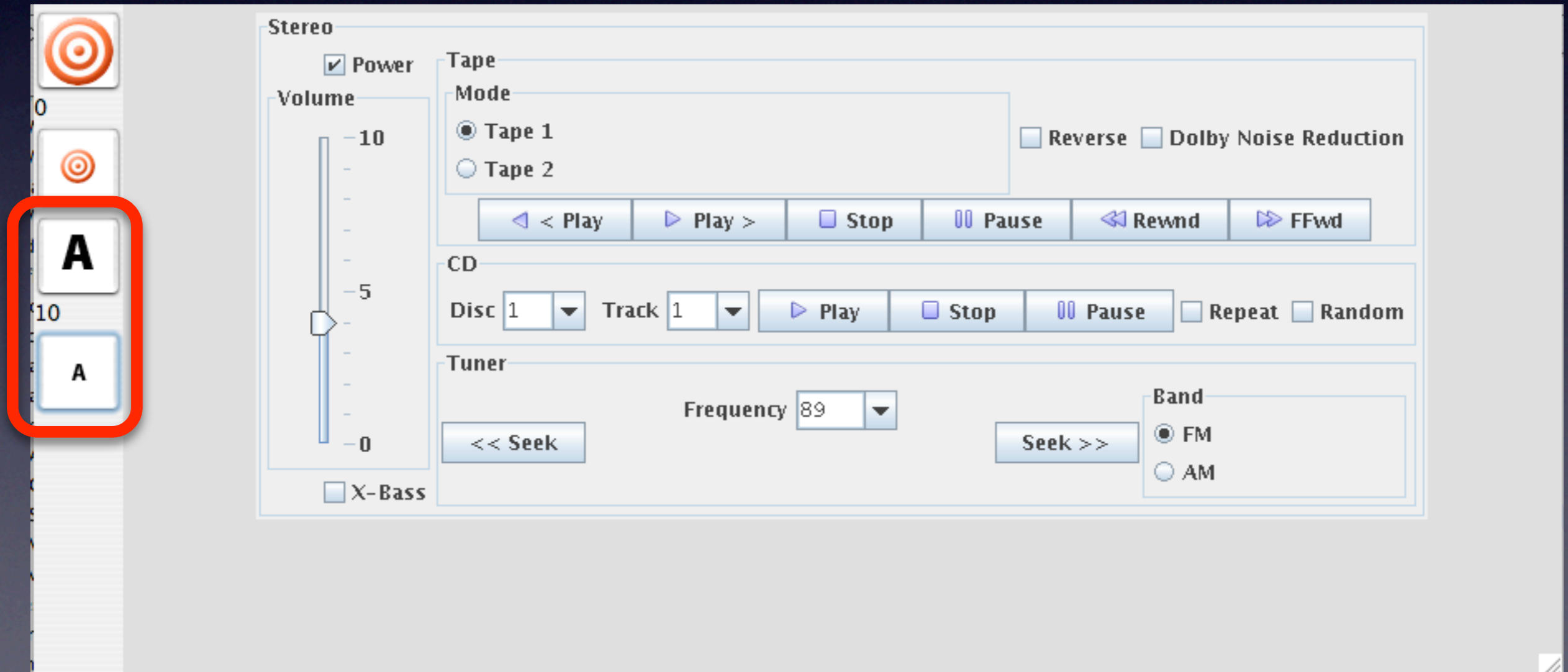




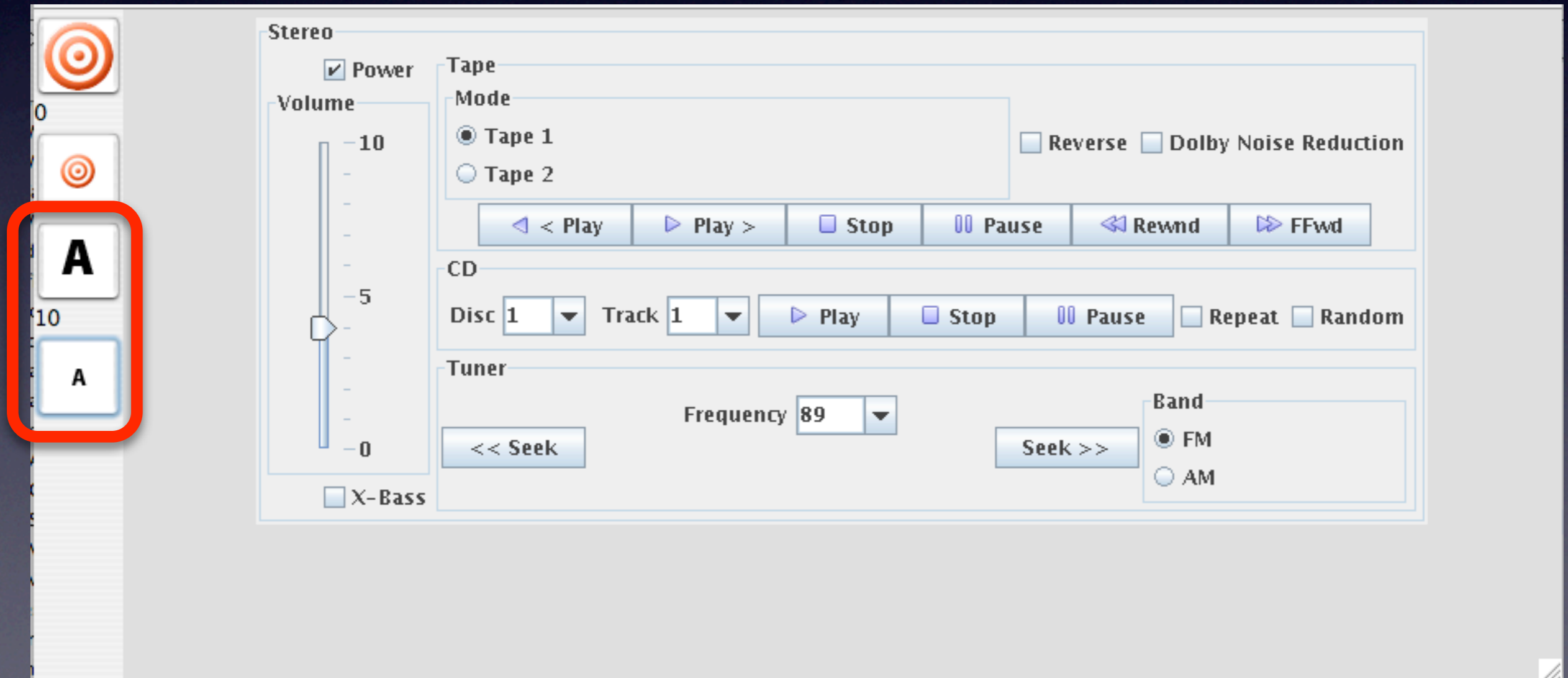
# Supple++ Solution

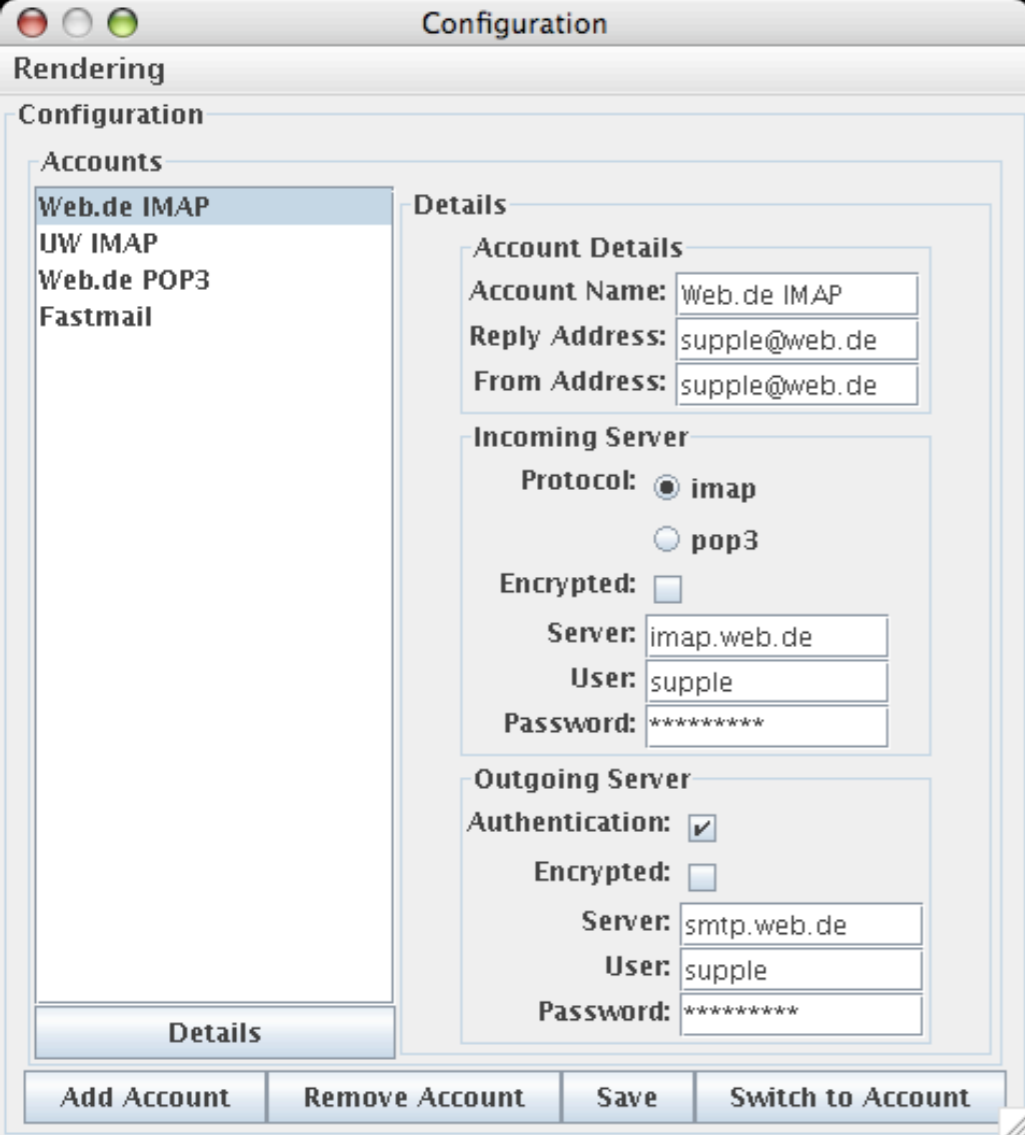


# Supple++ Solution



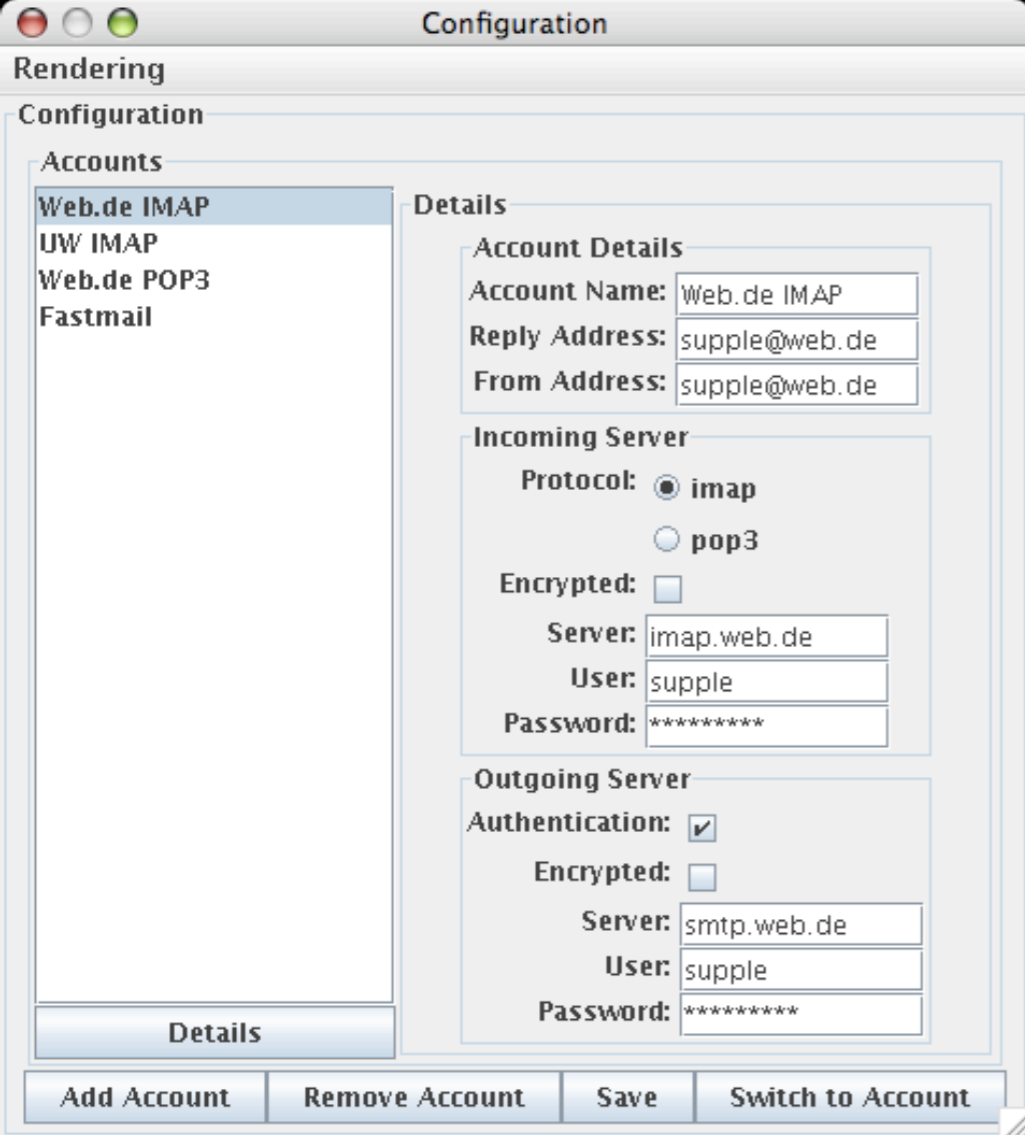
# Supple++ Solution





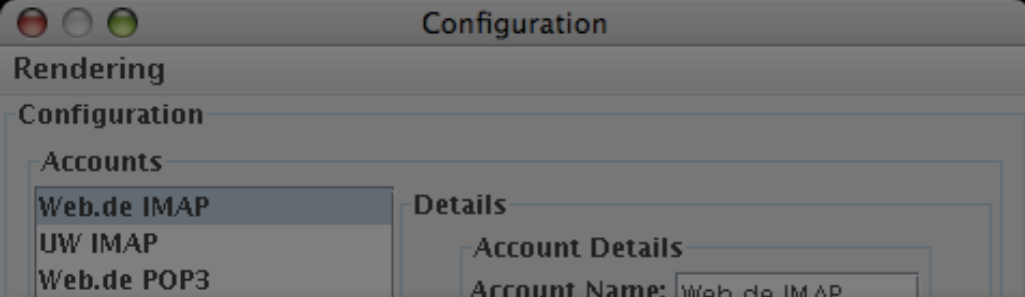
# Our Approach

- User selects desired minimum size for all visual cues
- User interface generation constrained to meet desired visual cue size
- Fast “resize and reflow”

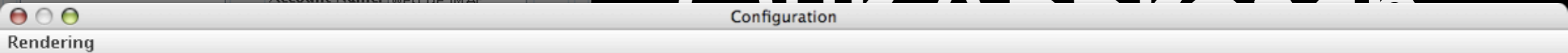


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# Outlook



## Configuration

### Accounts

- Web.de IMAP**
- UW IMAP
- Web.de POP3
- Fastmail

### Details

#### Outgoing Server

#### Account Details

#### Incoming Server

Authentication:

Encrypted:

Server: smtp.web.de

User: supple

Password: \*\*\*\*\*

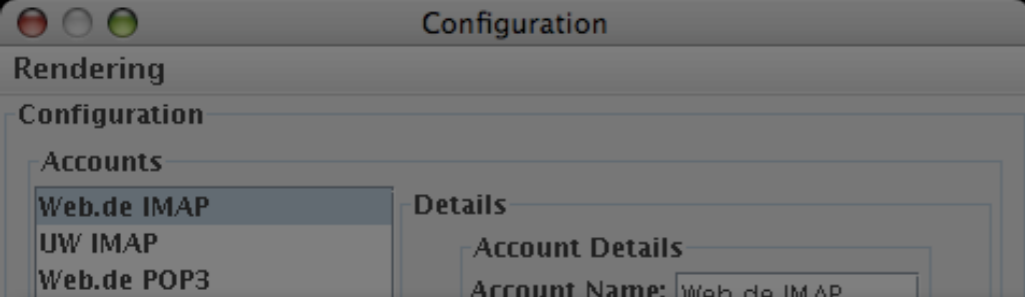
### Details

Add Account

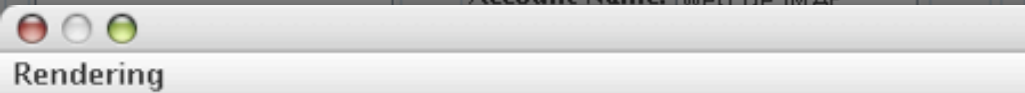
Remove Account

Save

Switch to Account



# Outlook Desktop



## Configuration

### Accounts

- Web.de IMAP
- UW IMAP
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### Details

Content arranged in tabs



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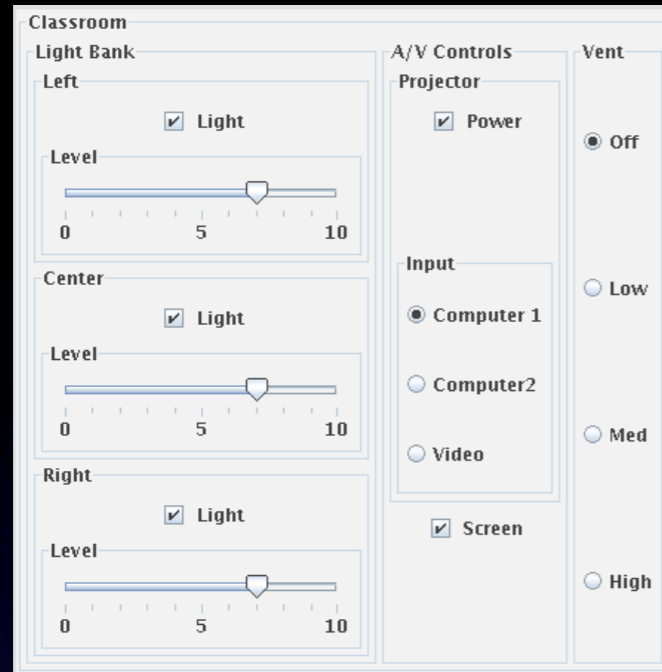
Add Account Remove Account Save Switch to Account

# Road Map

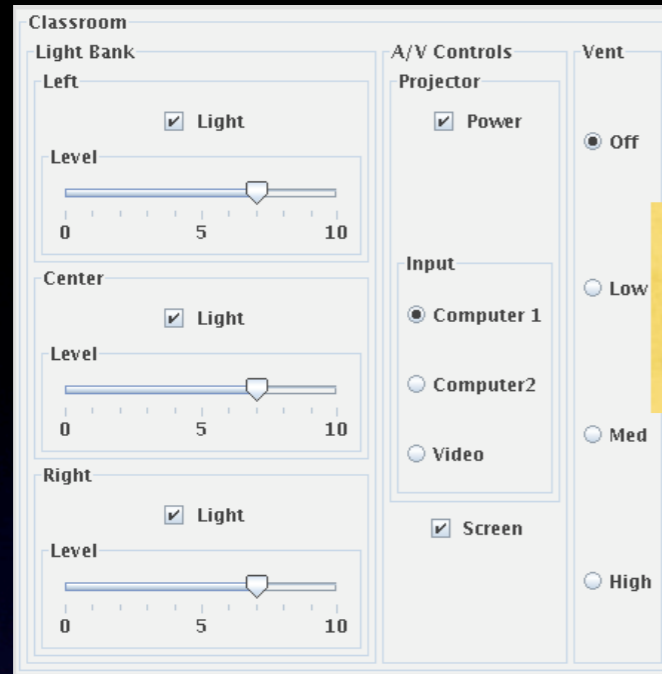
- ✓ Introduction
- ✓ Interface generation as optimization
- ✓ Modeling motor capabilities
- ✓ Adapting to motor capabilities
- > **Adapting to vision capabilities**
- Adapting to motor and vision capabilities together
- Pilot User Study
- Lessons learned



# for “typical” users

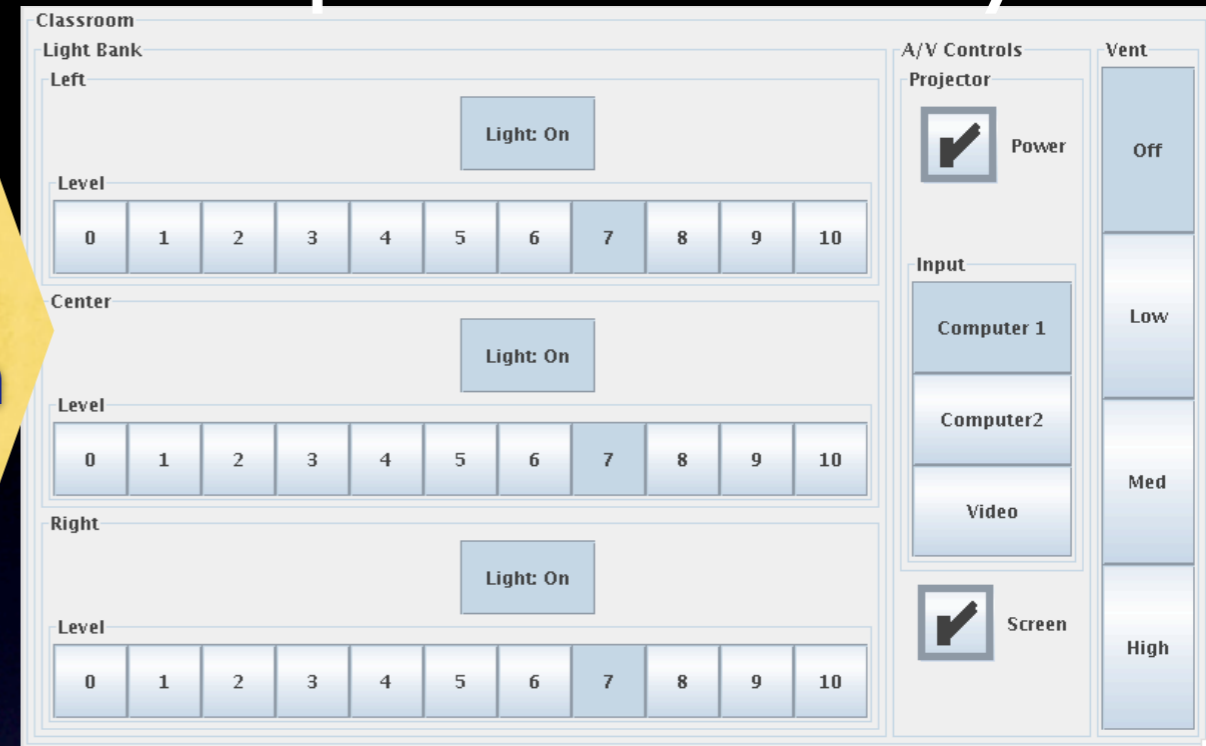


for “typical” users

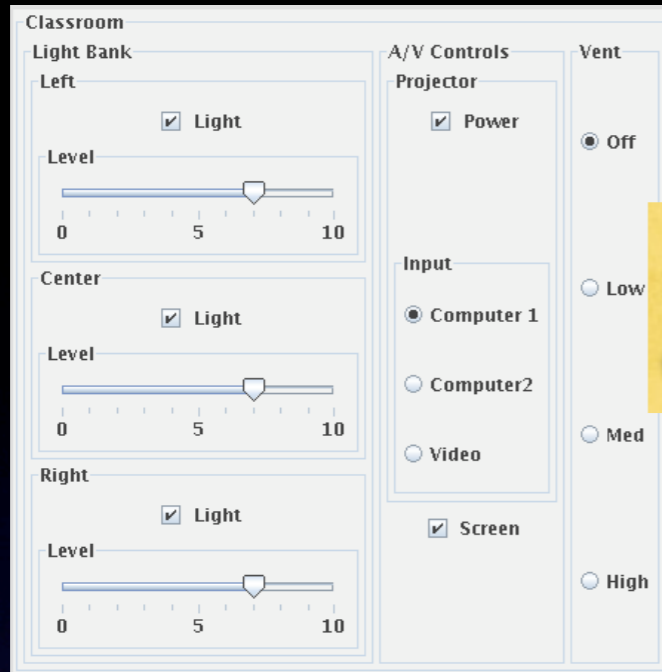


modified  
cost function

impaired dexterity

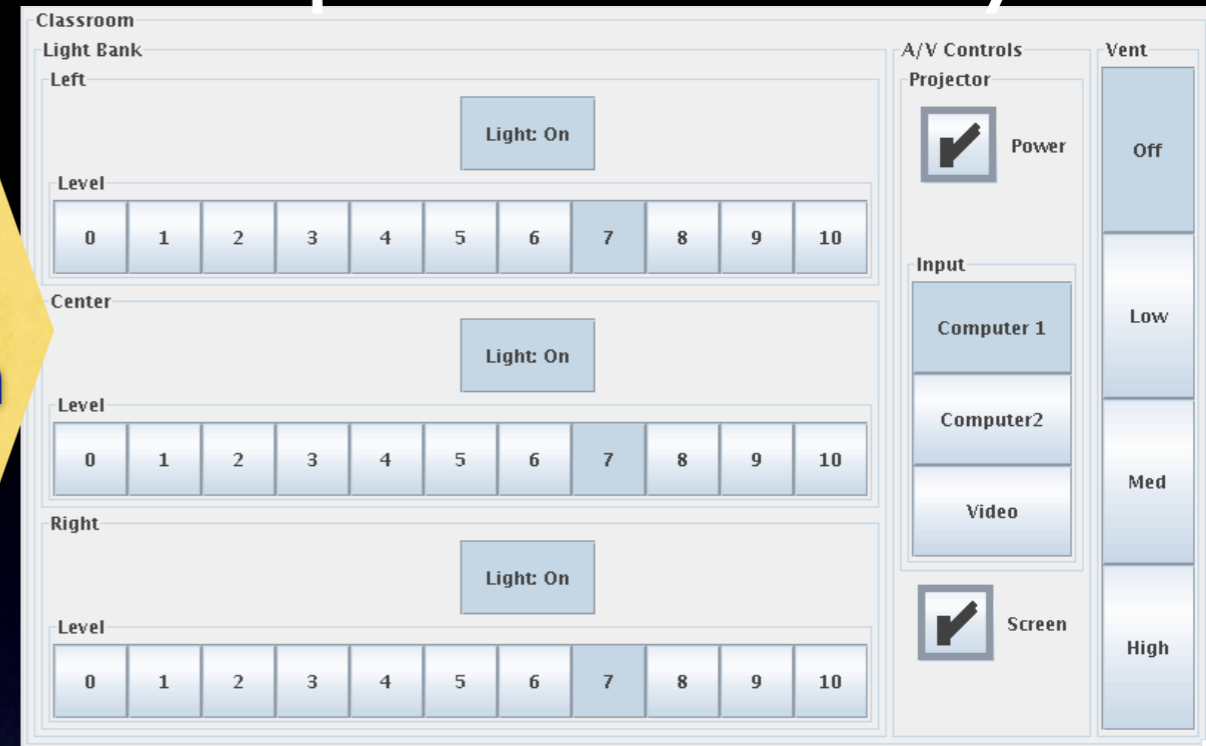


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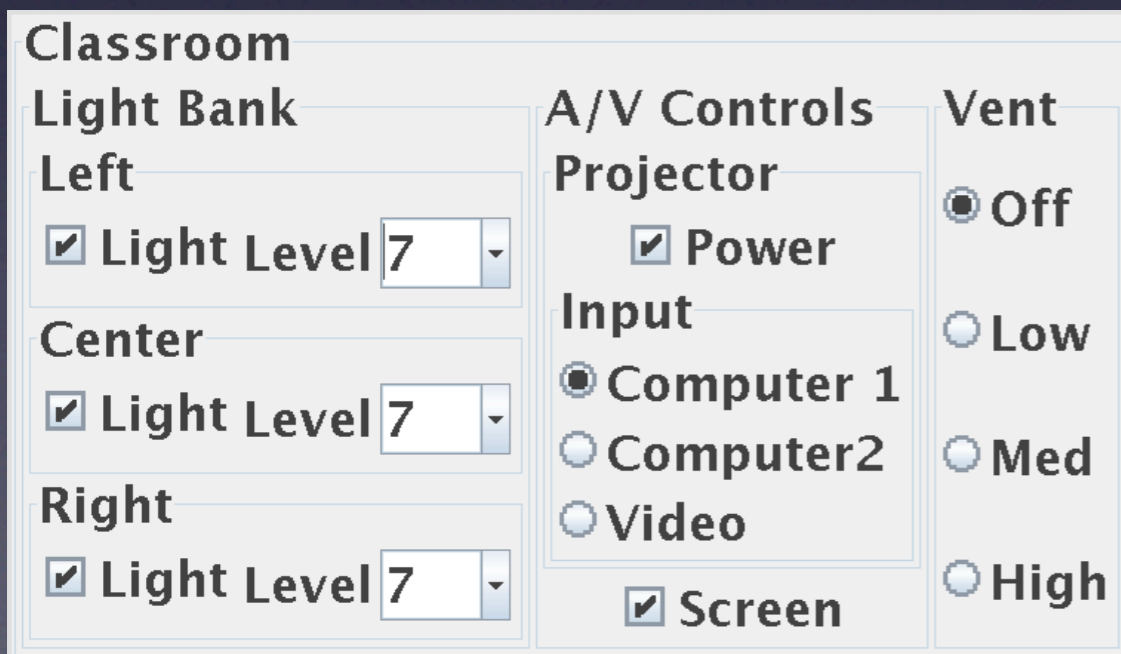


modified  
cost function

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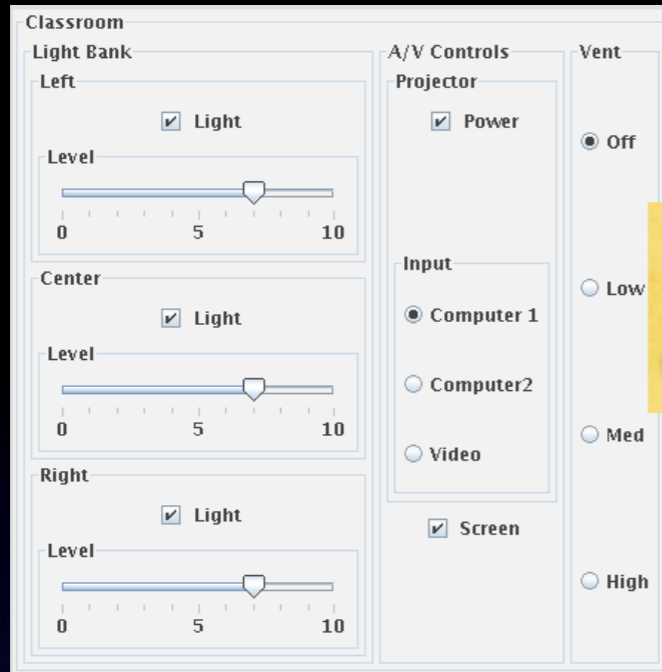


modified  
constraints



low vision

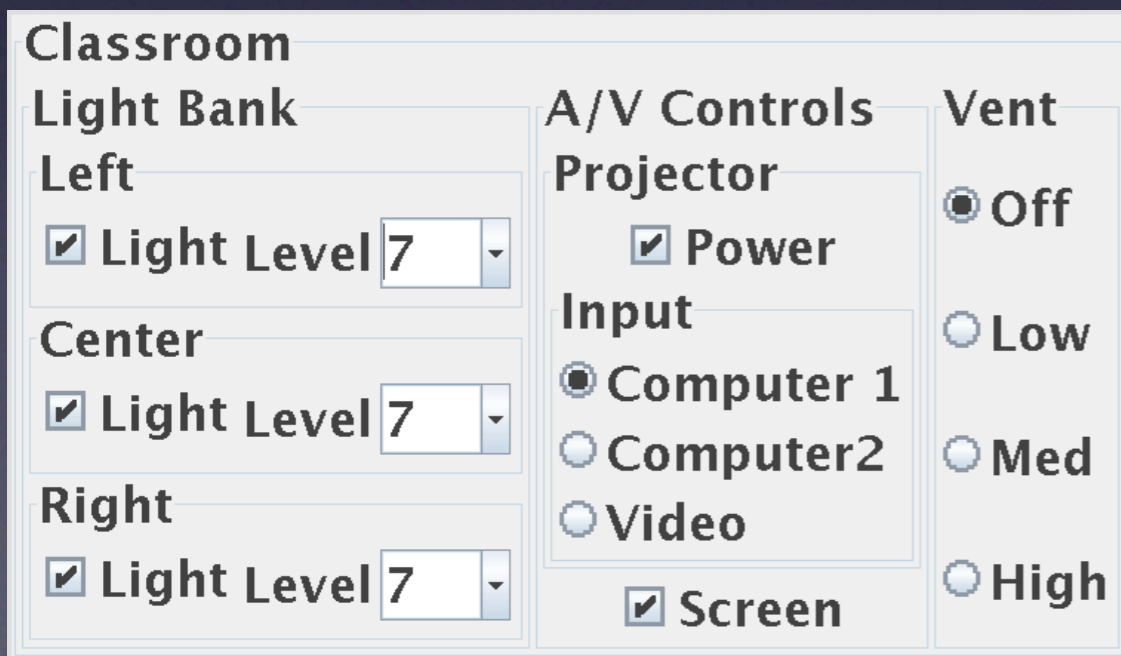
for "typical" users



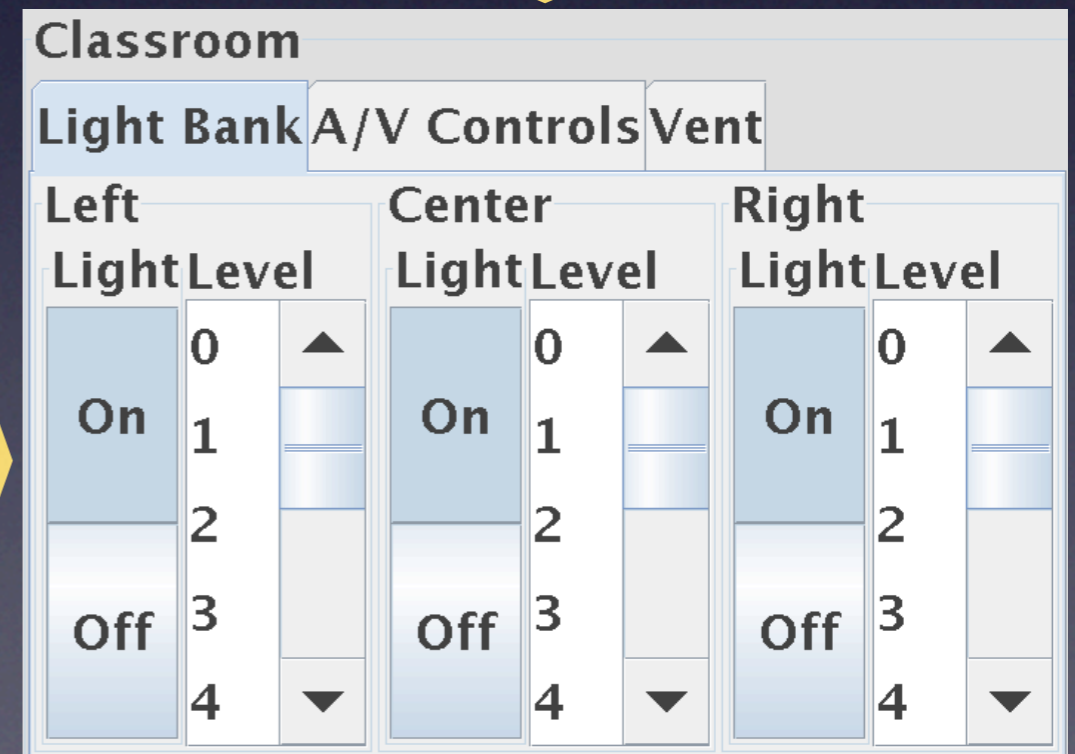
modified cost function



modified constraints



low vision



low vision & impaired dexterity

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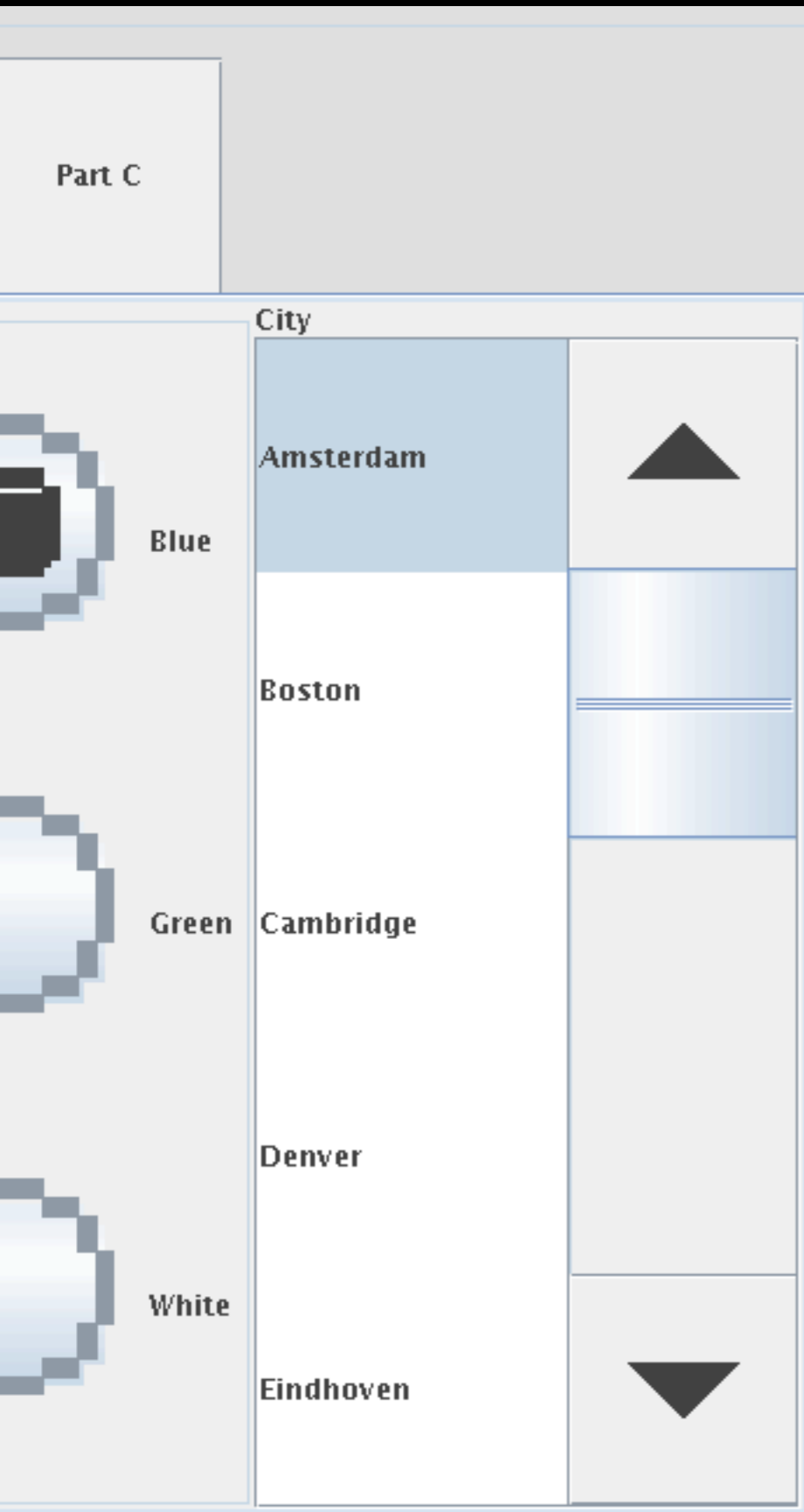
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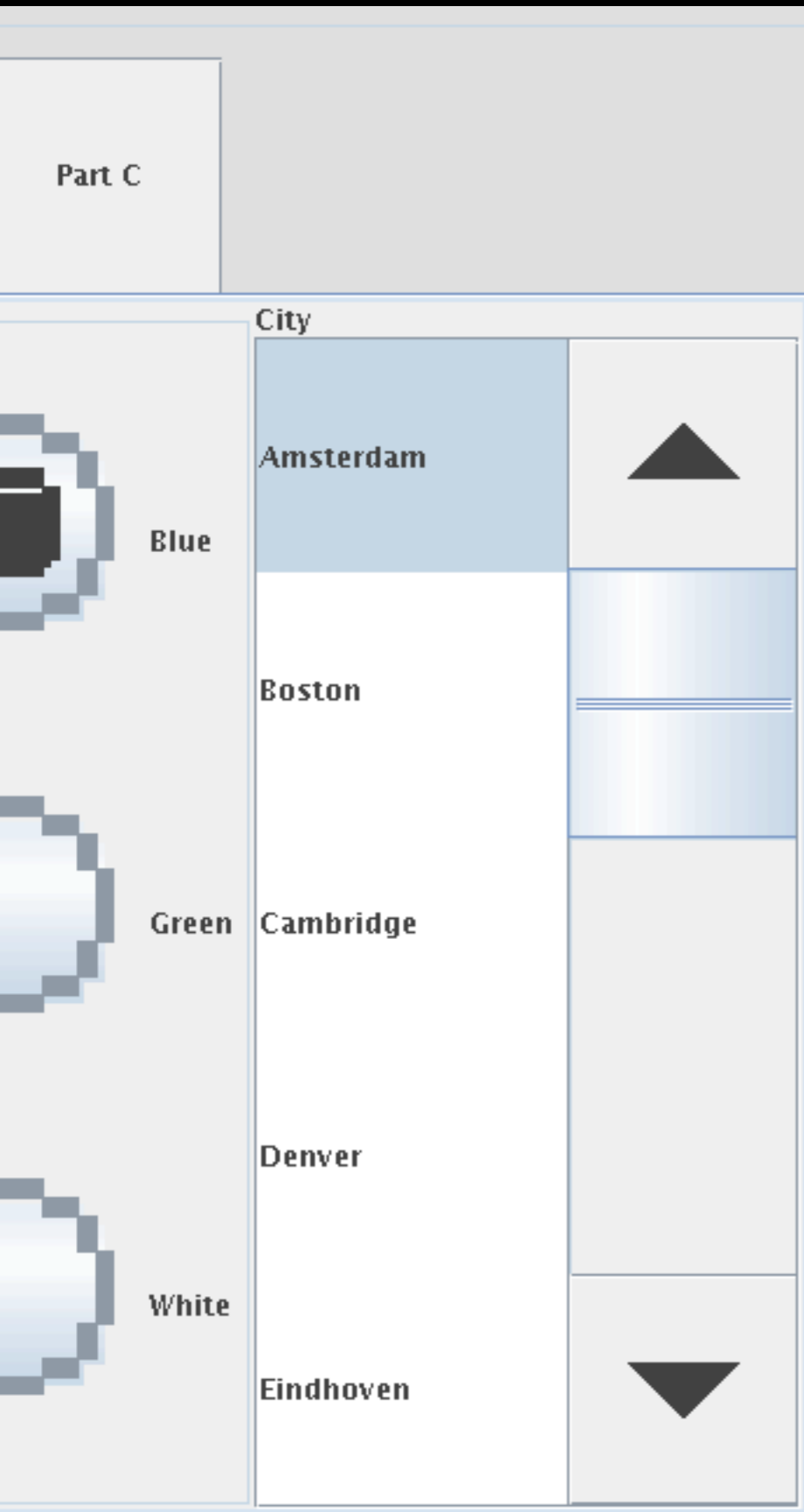
- Large variance
- Better but not best

# Problems uncovered



- List selection  $\neq$  drag + point

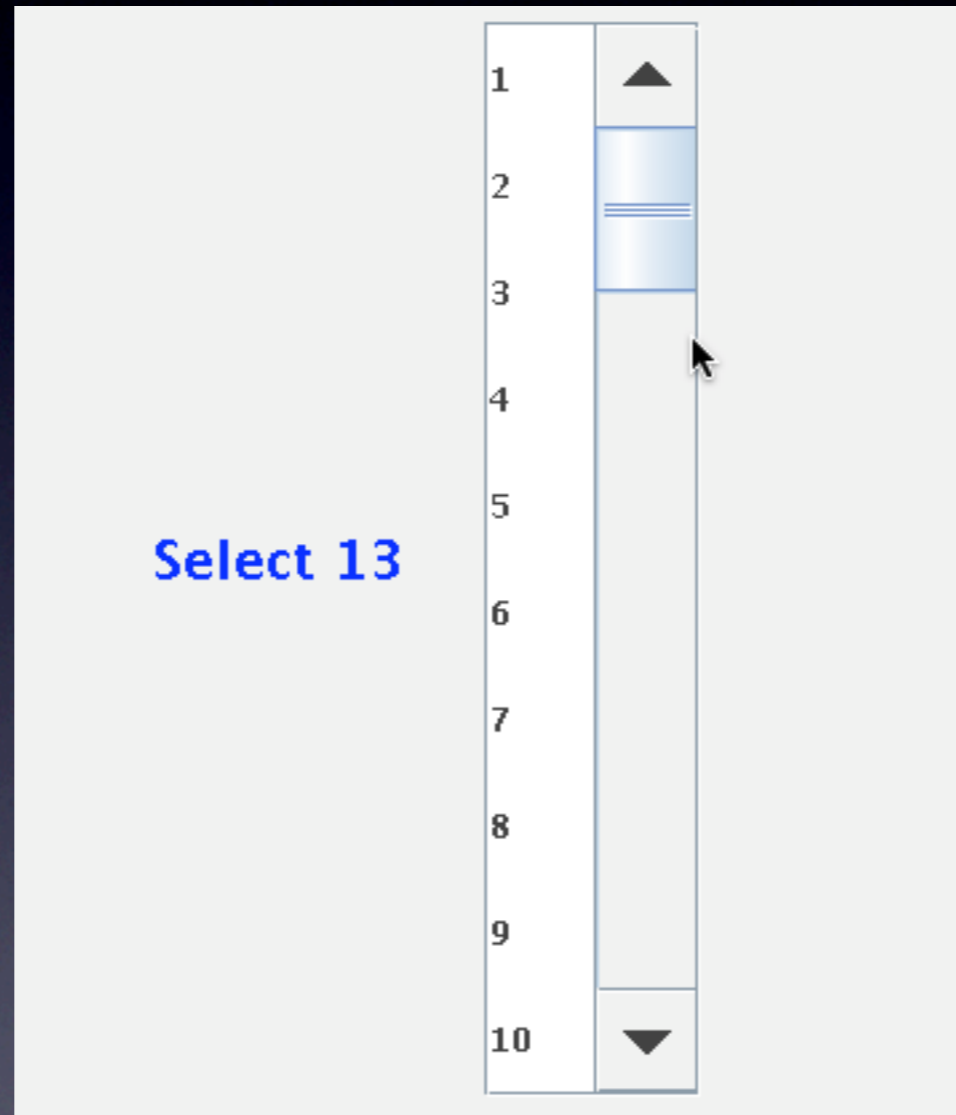
# Problems uncovered



- List selection  $\neq$  drag + point

$$R^2 = .09$$

# Modeling List Selection Times



direct model:  $R^2 = .64$

# Since this paper...

**Print**

Printer

Name:   Print to File

Status: Idle  Manual Duplex

Type: Ink jet

Where: Printer room

Page range

All  Current Page  Pages

Copies

Number of copies:   Collate

Print Content

Print what:   Print what:   Scale to paper size:

Print:

**Font Formatting**

Font Character Spacing Text Effects

Type, Style and Size

Font	Style	Size
Arial	Regular	8
Arial Black	Italic	9
Comic Sans MS	Bold	10
Courier New	Bold Italic	11
Franklin Gothic Medium		12

Underline style:

Effects

Strikethrough:  Shadow:  Small Caps:

Double Strikethrough:  Outline:  All Caps:

Superscript:  Emboss:  Hidden:

Subscript:  Engrave:

Preview

**Times New Roman**

# Since this paper...

- In the new study, we found that participants with motor impairments
  - were consistently **faster** (by 26%) using interfaces generated by Supple++
  - made 73% **fewer errors**
  - strongly **preferred** Supple++ interfaces to manufacturers' baselines

# Summary of Contributions



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- **Supple++** for automatically generating user interfaces adapted to user's motor and vision capabilities
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  - Custom regression models for individual motor capabilities
  - Novel optimization-based algorithm for efficient ability-based GUI generation

# Limitations & Future Work

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# Limitations & Future Work

- Limitations of modeling
  - Pointer-only interactions
  - Movement time as proxy for performance
  - How to address other concerns?
- Design tools

# More Information

- **SUPPLE:**  
<http://supple.cs.washington.edu/>  
or Google : supple interfaces
- **Krzysztof Gajos:**  
[kgajos@cs.washington.edu](mailto:kgajos@cs.washington.edu)
- **Jacob Wobbrock:**  
[wobbrock@u.washington.edu](mailto:wobbrock@u.washington.edu)
- **Daniel Weld:**  
[weld@cs.washington.edu](mailto:weld@cs.washington.edu)