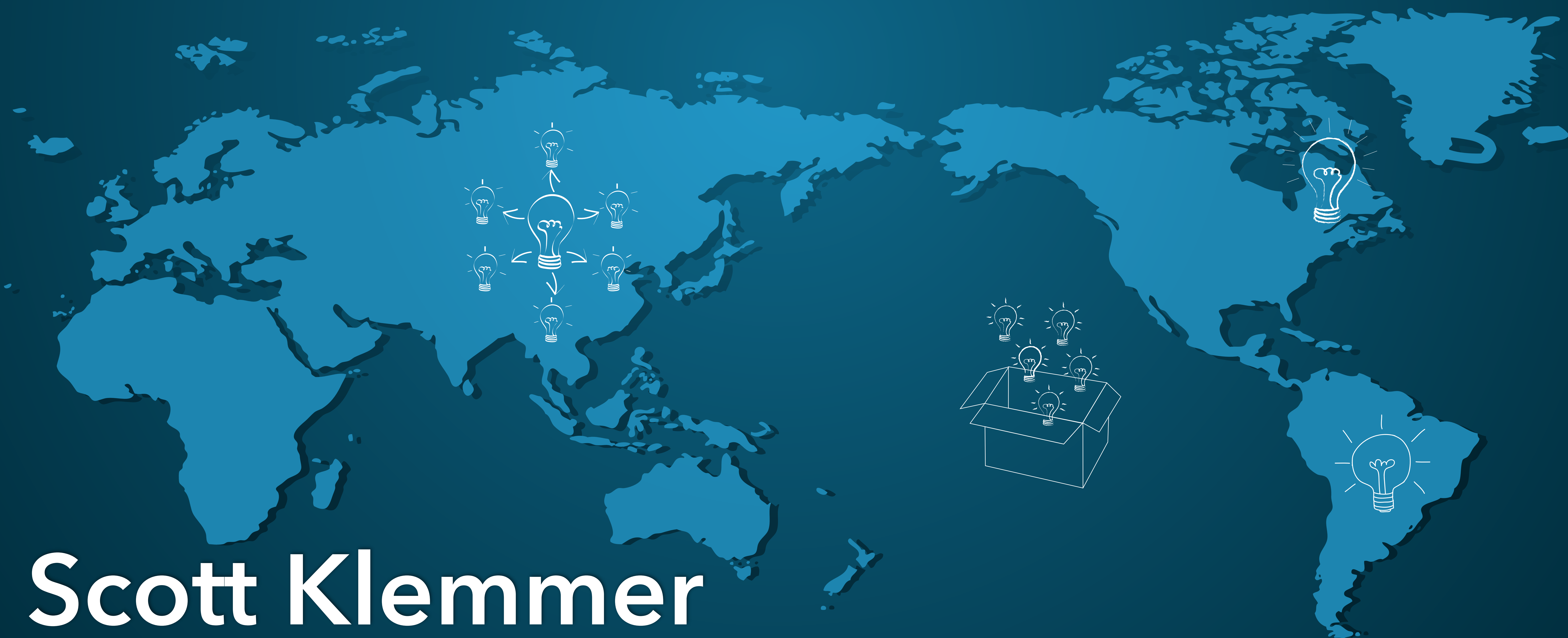
Input

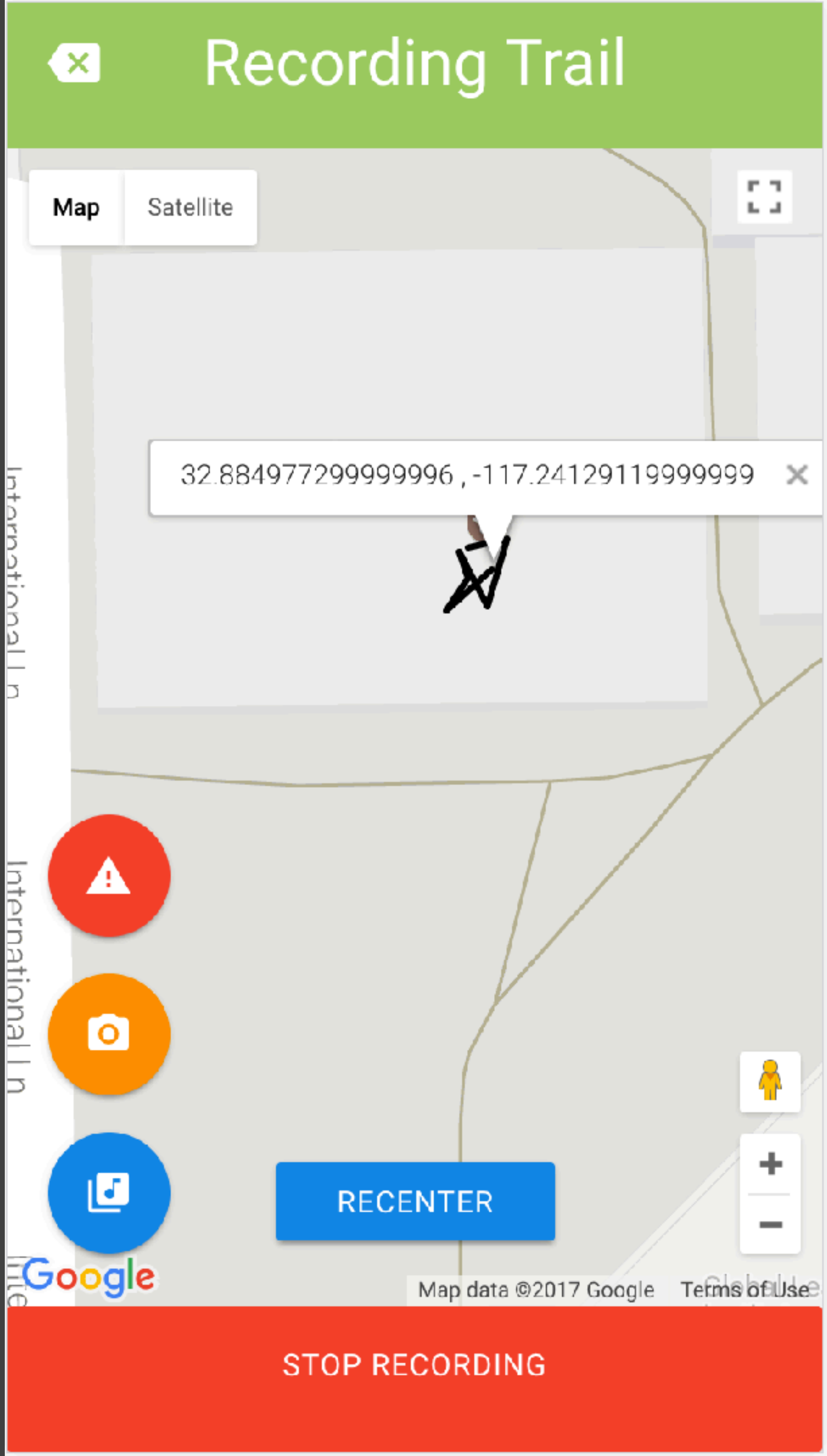


Scott Klemmer

HCI Design. with materials from Bjoern Hartmann, Stu Card, Pat Hanrahan

A7 Example

Xu Li,
Hans Yuan,
Brian Nguyen,

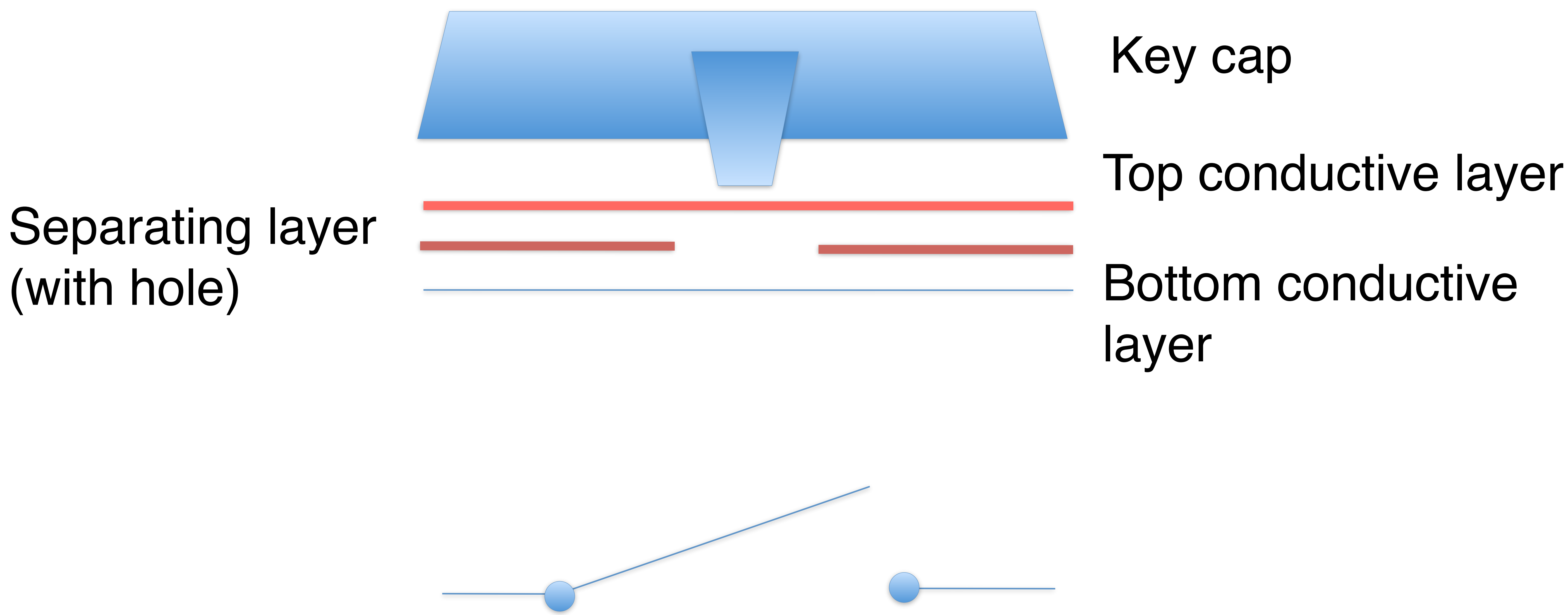


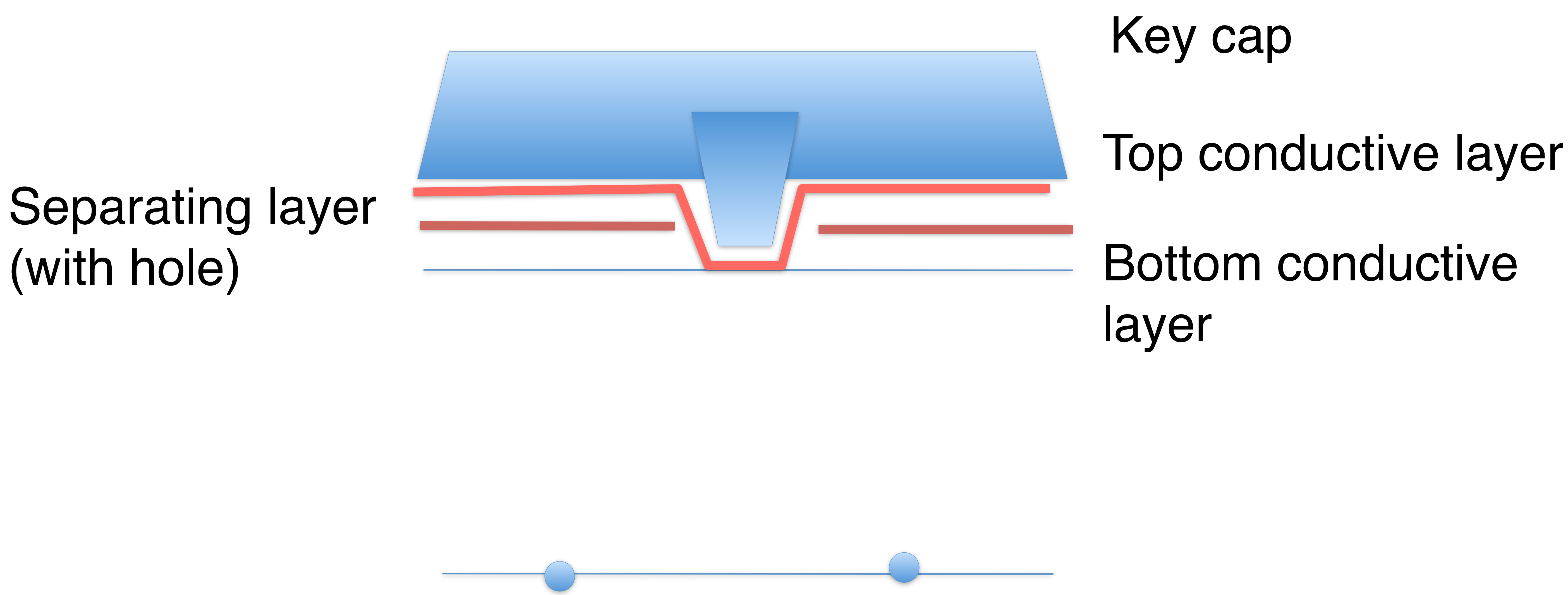

Input

Input

- How do these devices work for getting information into the computer?
- Some Frameworks:
  - How do input devices effect the nature of the interaction?
  - What’s coming next?


DELL
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
Print Screen SysRq
Scroll Lock
Pause Break
Num Lock
Backspace
Insert
Home
Page Up
Delete
End
Page Down
Enter
Shift
Ctrl
Alt
Caps Lock
Q
W
E
R
T
Y
U
I
O
P
A
S
D
F
G
H
J
K
L
Z
X
C
V
B
N
M


Key cap
Top conductive layer
Separating layer
(with hole)
Bottom conductive
layer

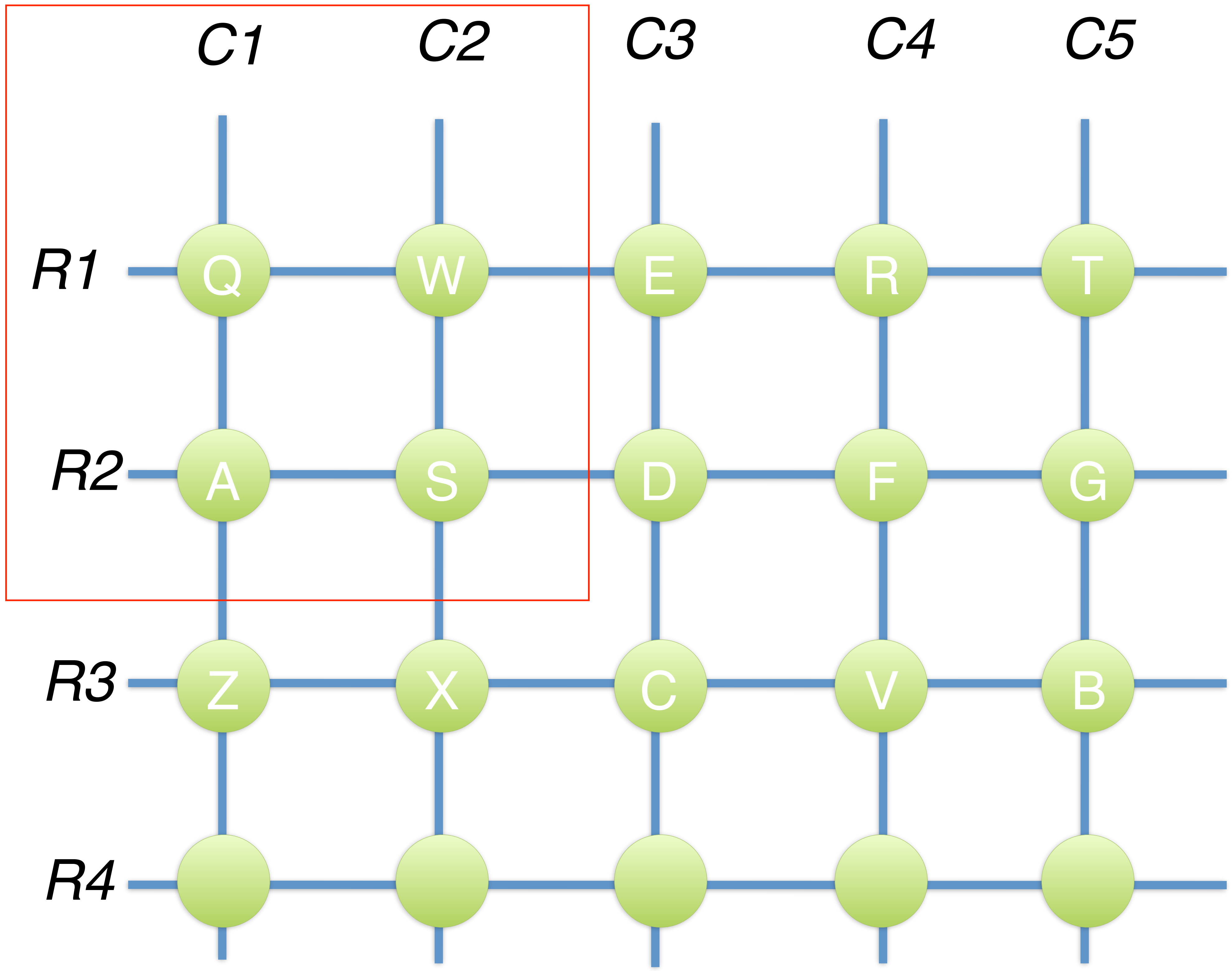

Key cap
Top conductive layer
Separating layer
(with hole)
Bottom conductive
layer

Keyboard Encoder

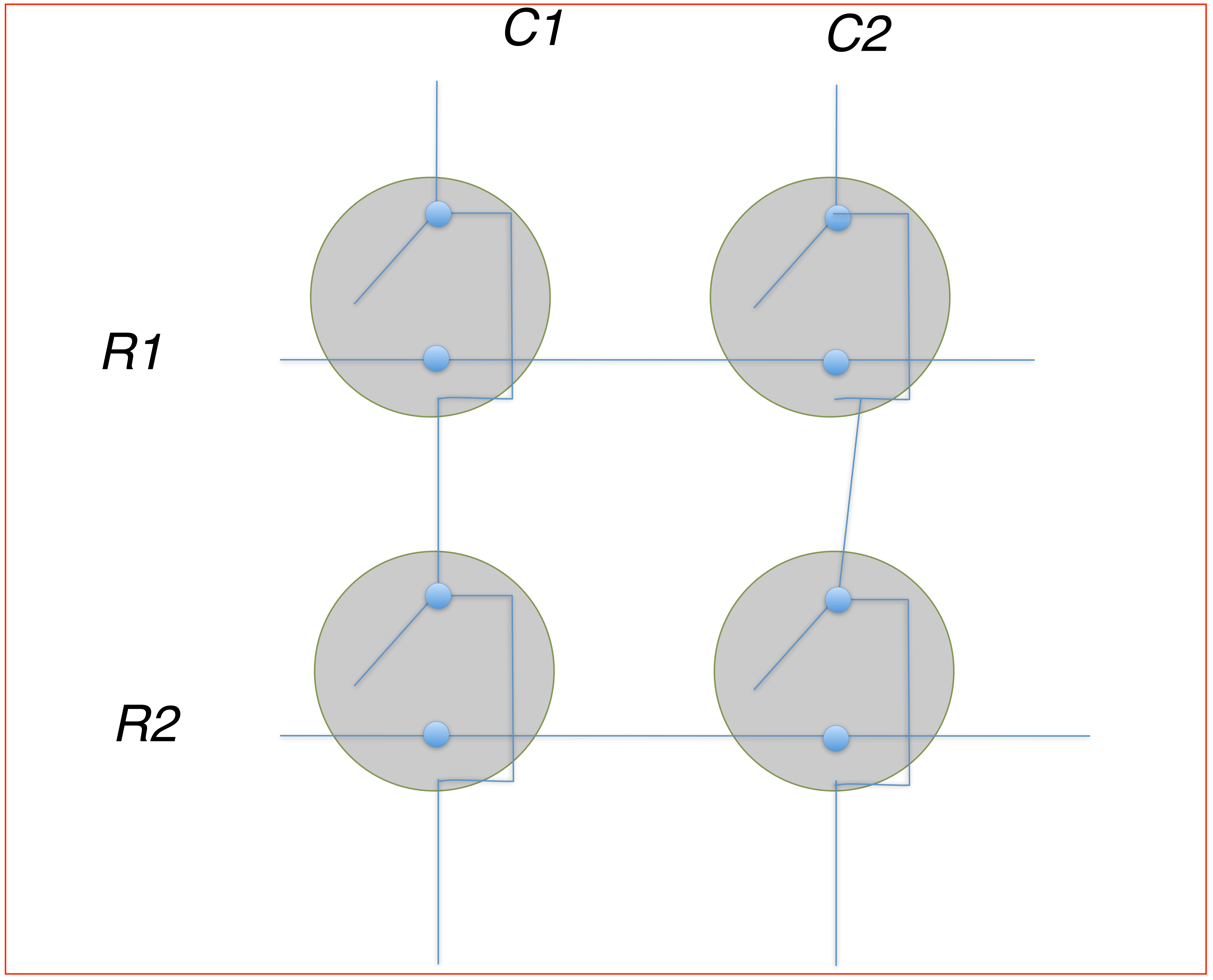
Row/Column Scanning

9 lines

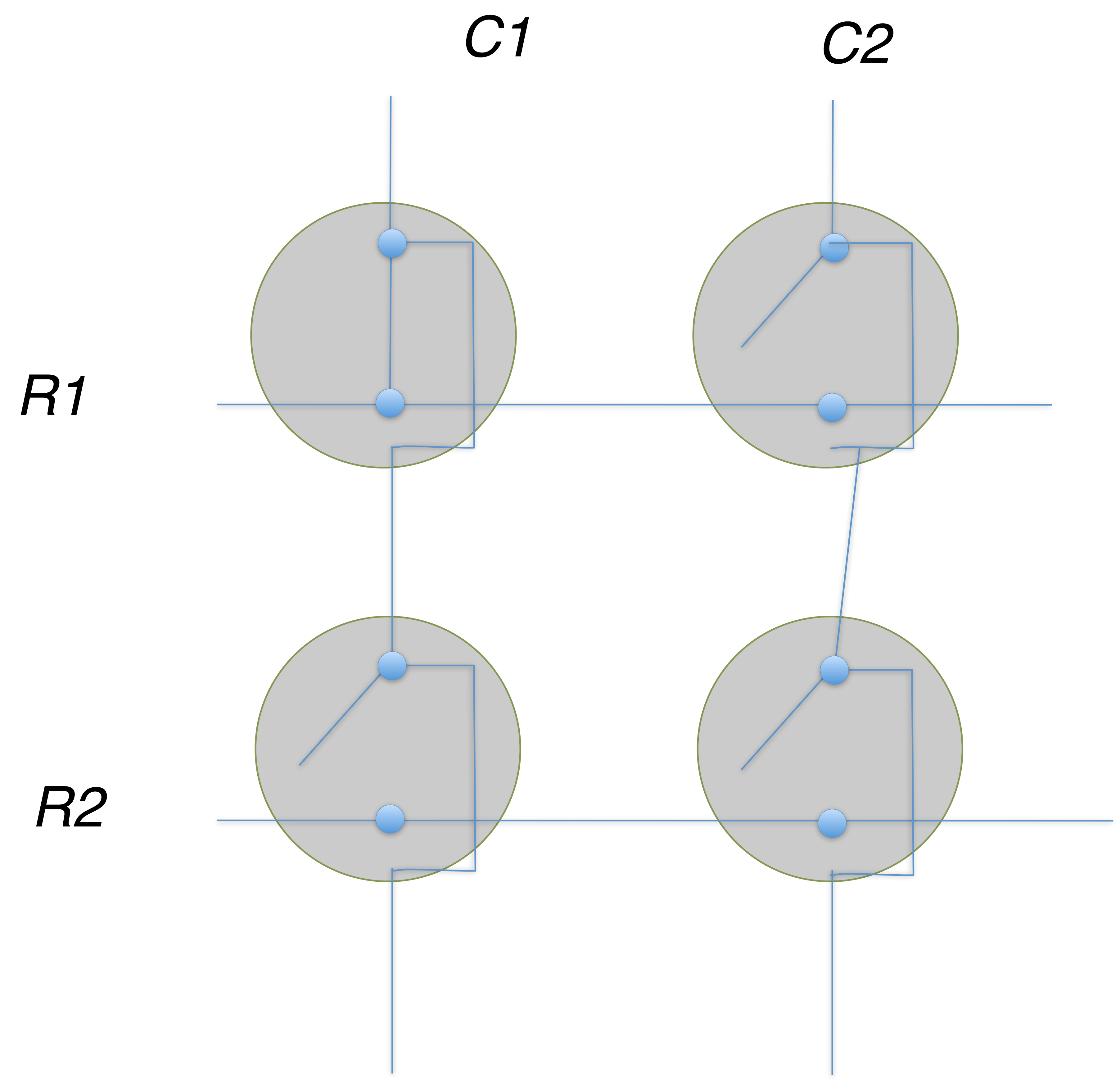
20 keys



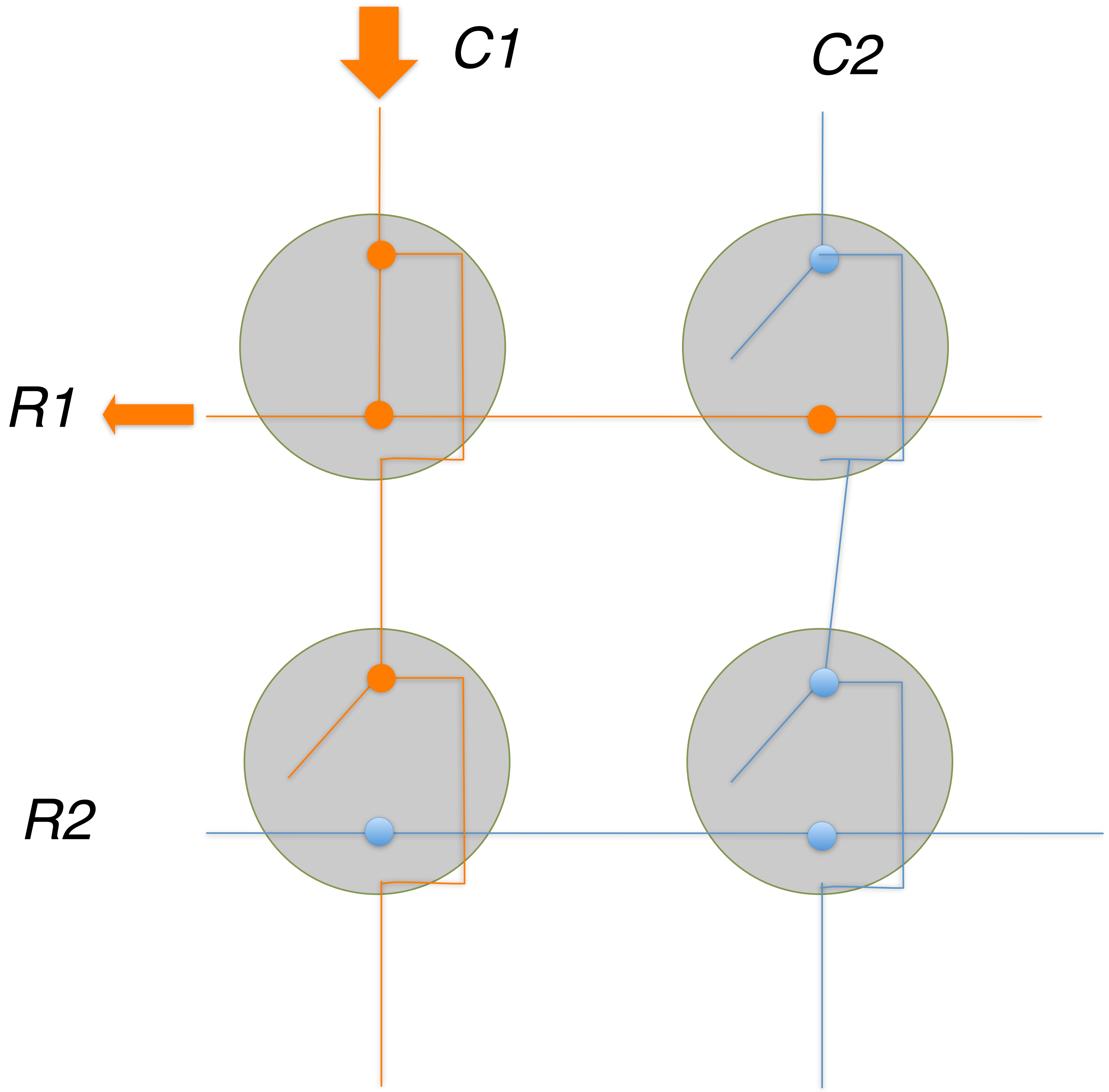
Closeup



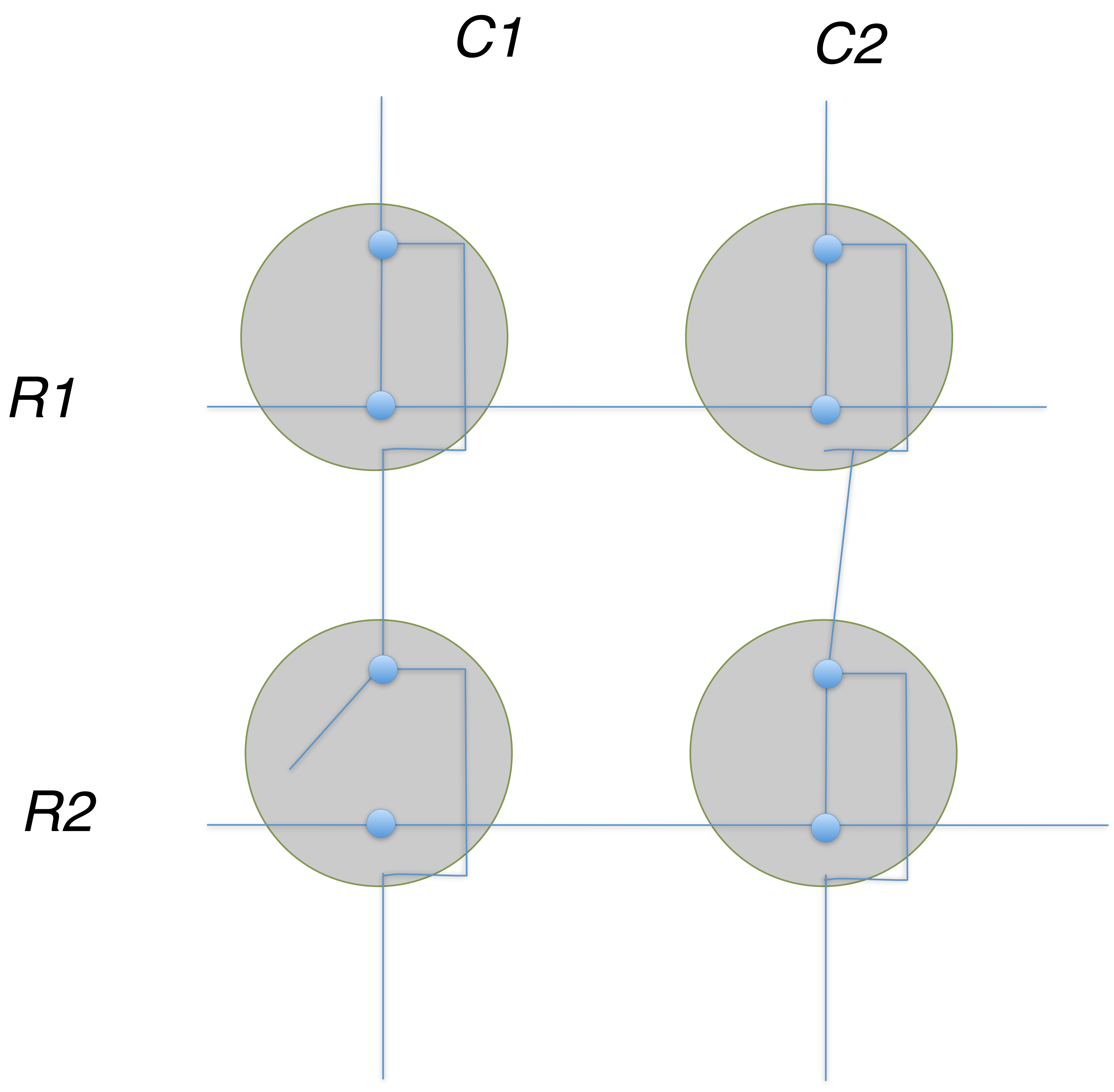
One Key Down



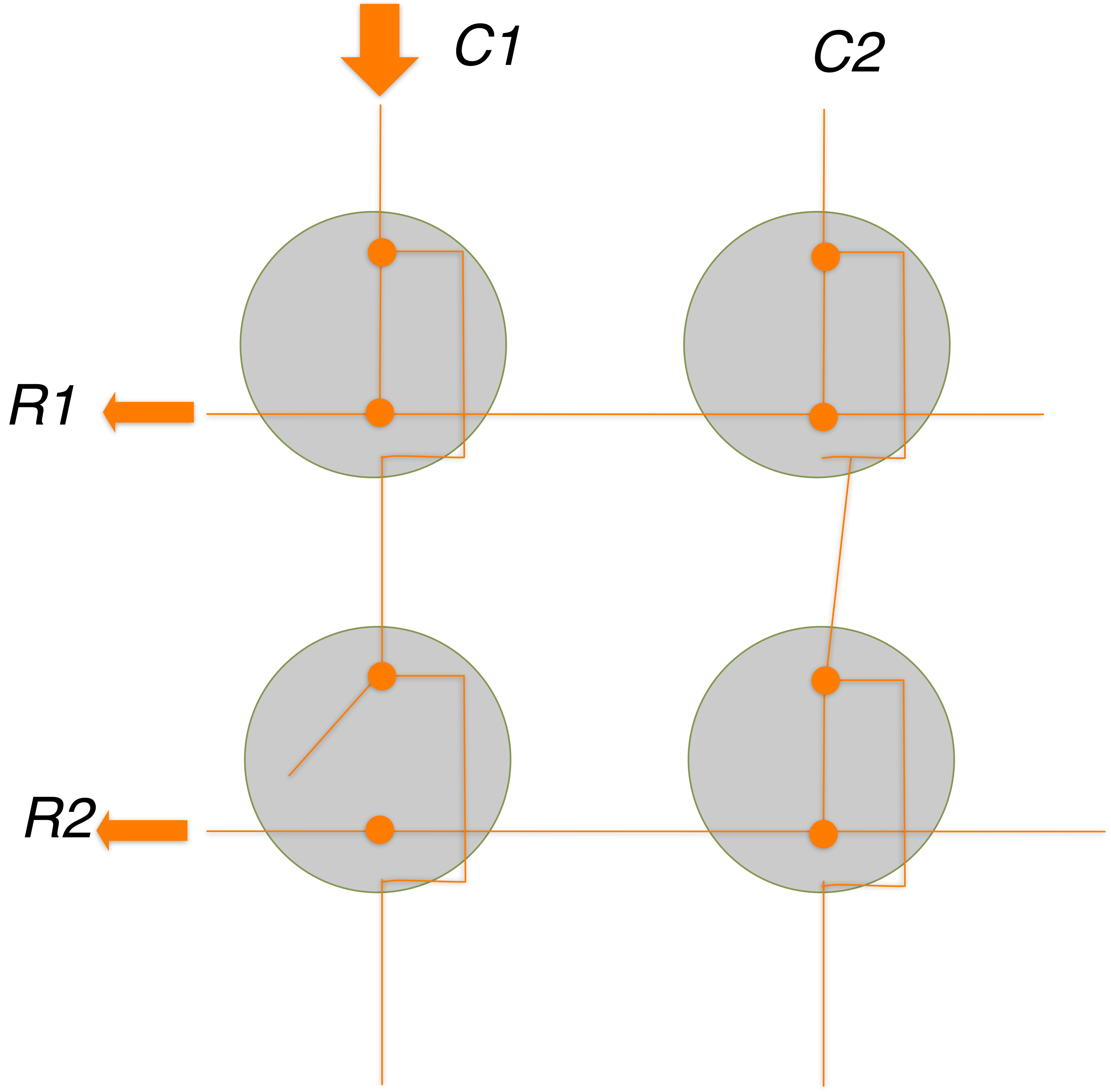
One Key Down



3 Keys Down



3 Keys Down



Keys → Scan Codes

Make (onPress) and Break (onRelease) codes

http://www.computer-engineering.org/ps2keyboard/

Keys (Scan Codes) !=

- Special keys - interpreted by the OS or App
  - F1, ..., F12
  - Insert, Delete, Home, ...
- Duplicated keys
  - Numbers on keypad vs. keyboard
  - Left-shift, Right-shift, Left-cmd, Right-cmd

Layered Model of Input

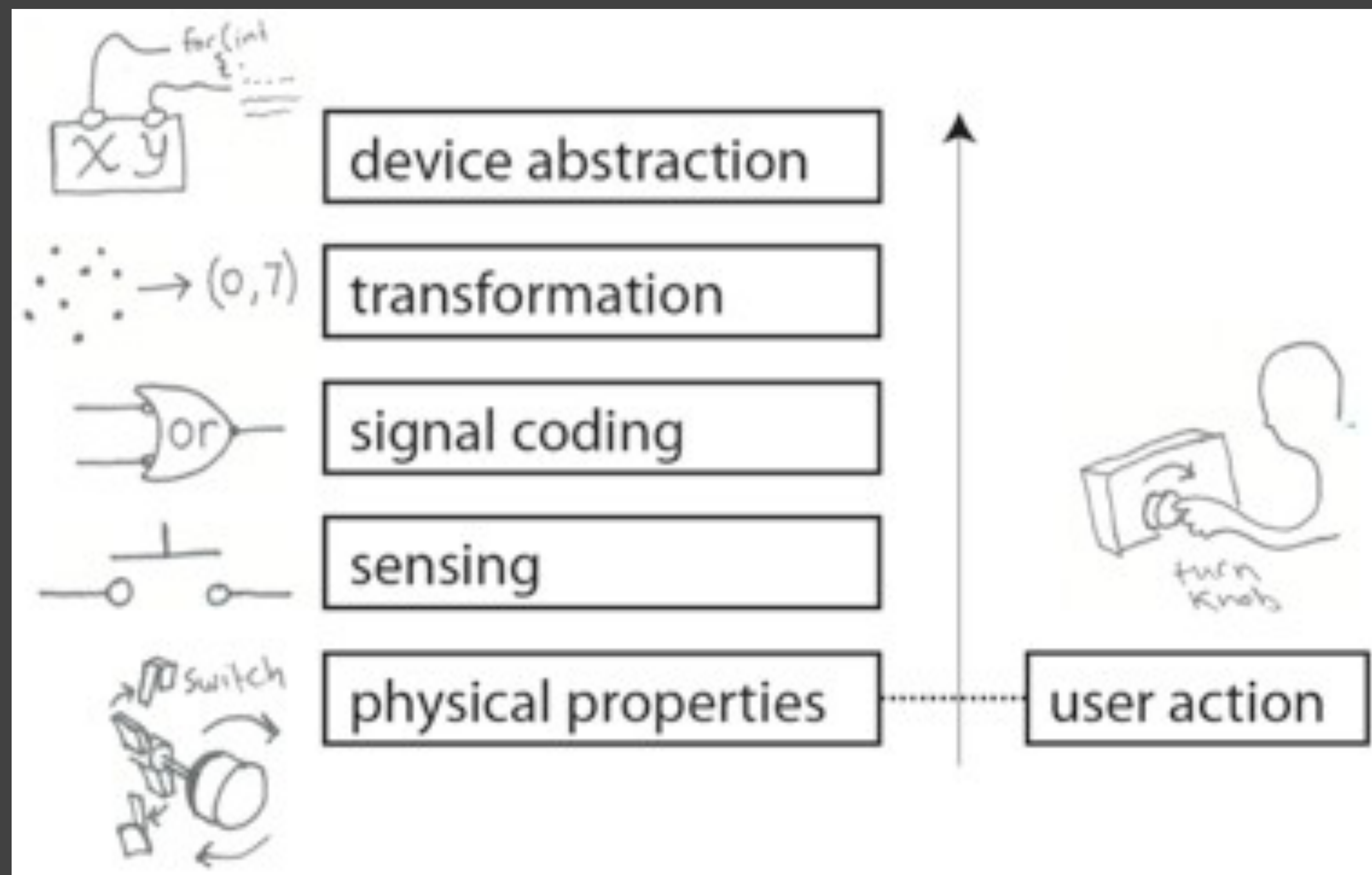
Keyboard

Characters

Scan Codes

Switches

Keys



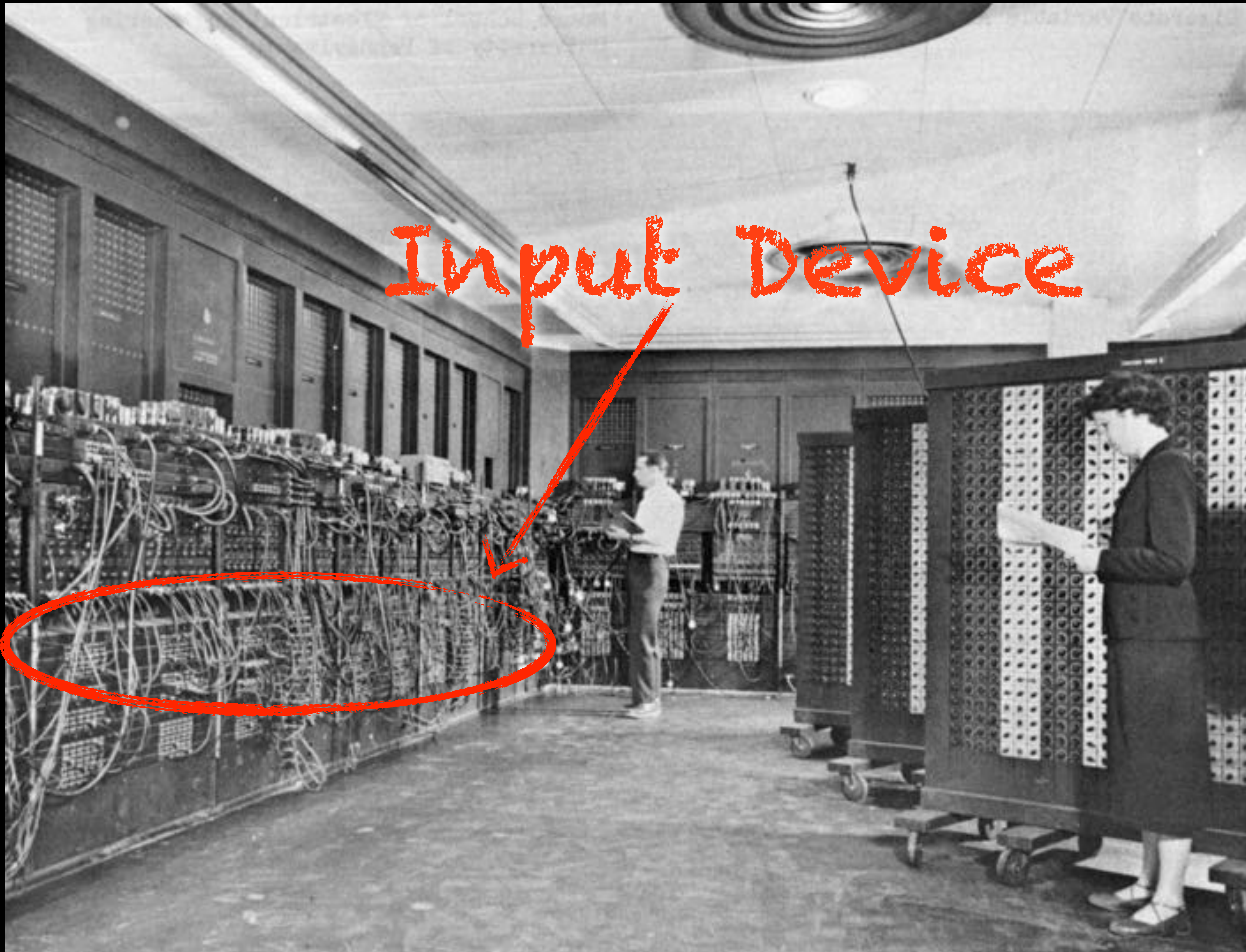
Keyboard

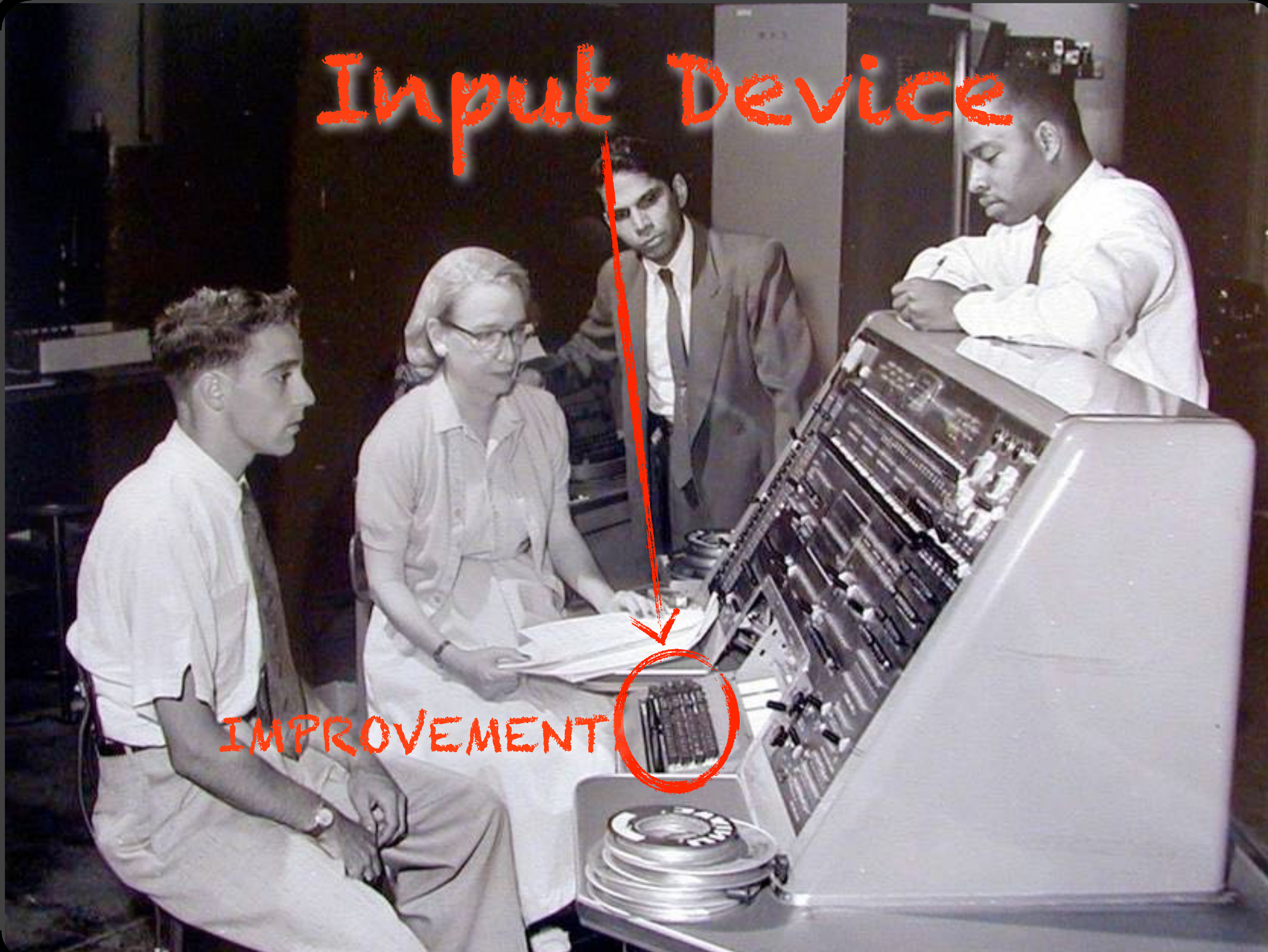
G

59h 34h
F0h
59h F0h
F12

b7a2 b1a6

SHIFT g


Input Device



Input Device
IMPROVEMENT

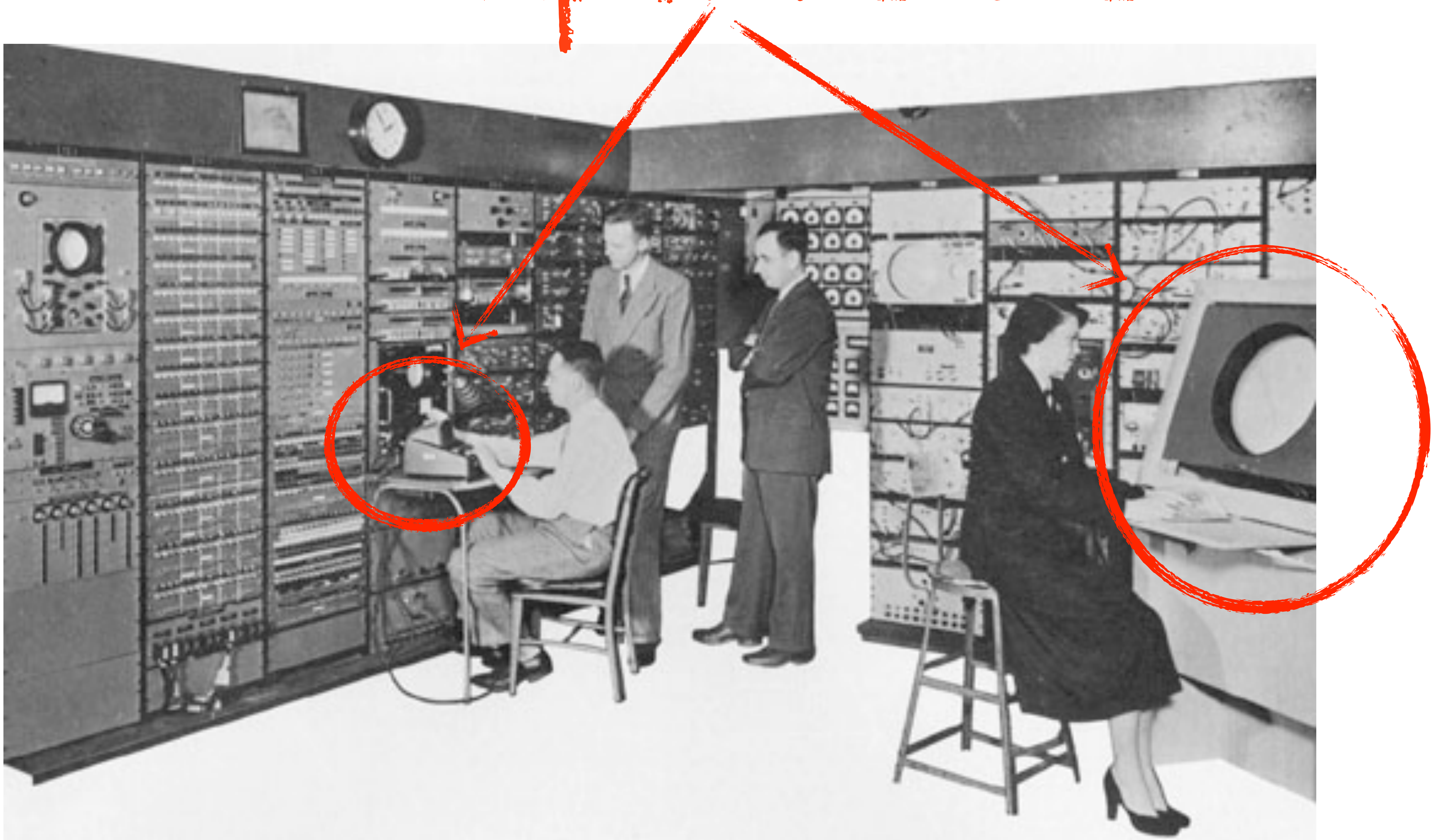
But we can do much better

The real problem:

ASYMMETRY OF OUTPUT TO INPUT

Typewriter limits input speed (and expressibility)

Input Device



Whirlwind (MIT, 1951)

Big Idea:

INPUT ON OUTPUT

Input on Output

SAGE

J. C. R. LICKLIDER

HUMAN-MACHINE SYMBIOSIS:

"The hope is that in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain ever thought."

Graphical Direct Manipulation

SKETCHPAD (1963)

TX-2 (MIT, 1959)

- **Direct Manipulation**
- **Tiled windows**
- **File icons**
- **Menus**

Changing visual element part of interaction loop

Lightpen

Point and Click,

NLS (SRI, 1968)

- Mouse
- Point & Click editing
- Hypertext
- Rapid interaction
- Text/graphic integration

Clickable Text

Video

Command Chordset

Mouse

The Mouse:
Small, Cheap, Fast,
Small Targets

Mouse. Engelbart and English ~1964

Source: Card, Stu. Lecture on Human Information Interaction. Stanford, 2007.

(cc) Flickr user John Chuang
http://www.flickr.com/photos/13184584@N08/1362760884/


XEROX

Graphical UI, Windows

- Digital Mouse
- Ball mouse
- Bitmapped CRT
- Overlapped windows
- Desktop metaphor
- Object-oriented UI
- Pull-down menus
- Cut & Paste
- Icons
- Typography

Bitmapped Display

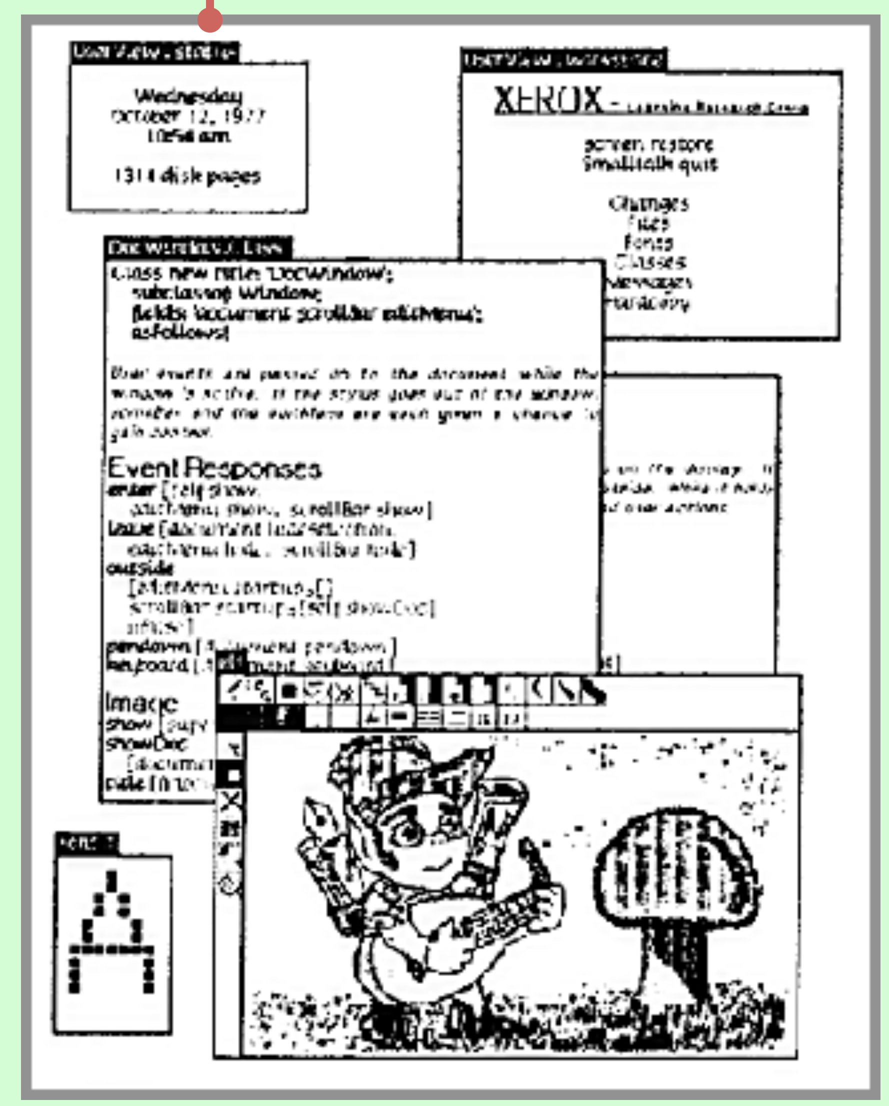
Chordset

Mouse

Overlapped Windows

Alto (Xerox, 1974)

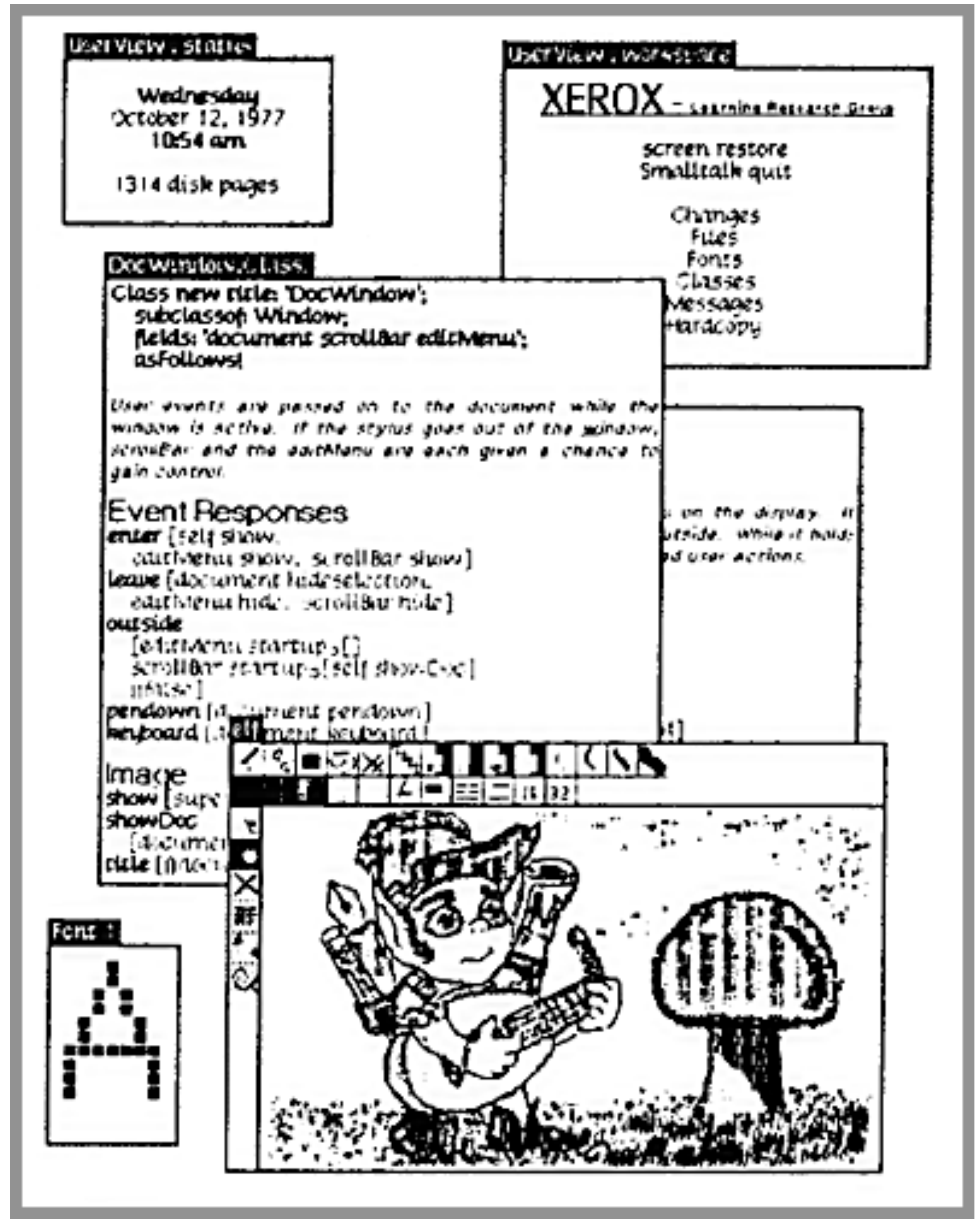
-ARCHETYPE-



Smalltalk (Xerox, 1976)

Independent information

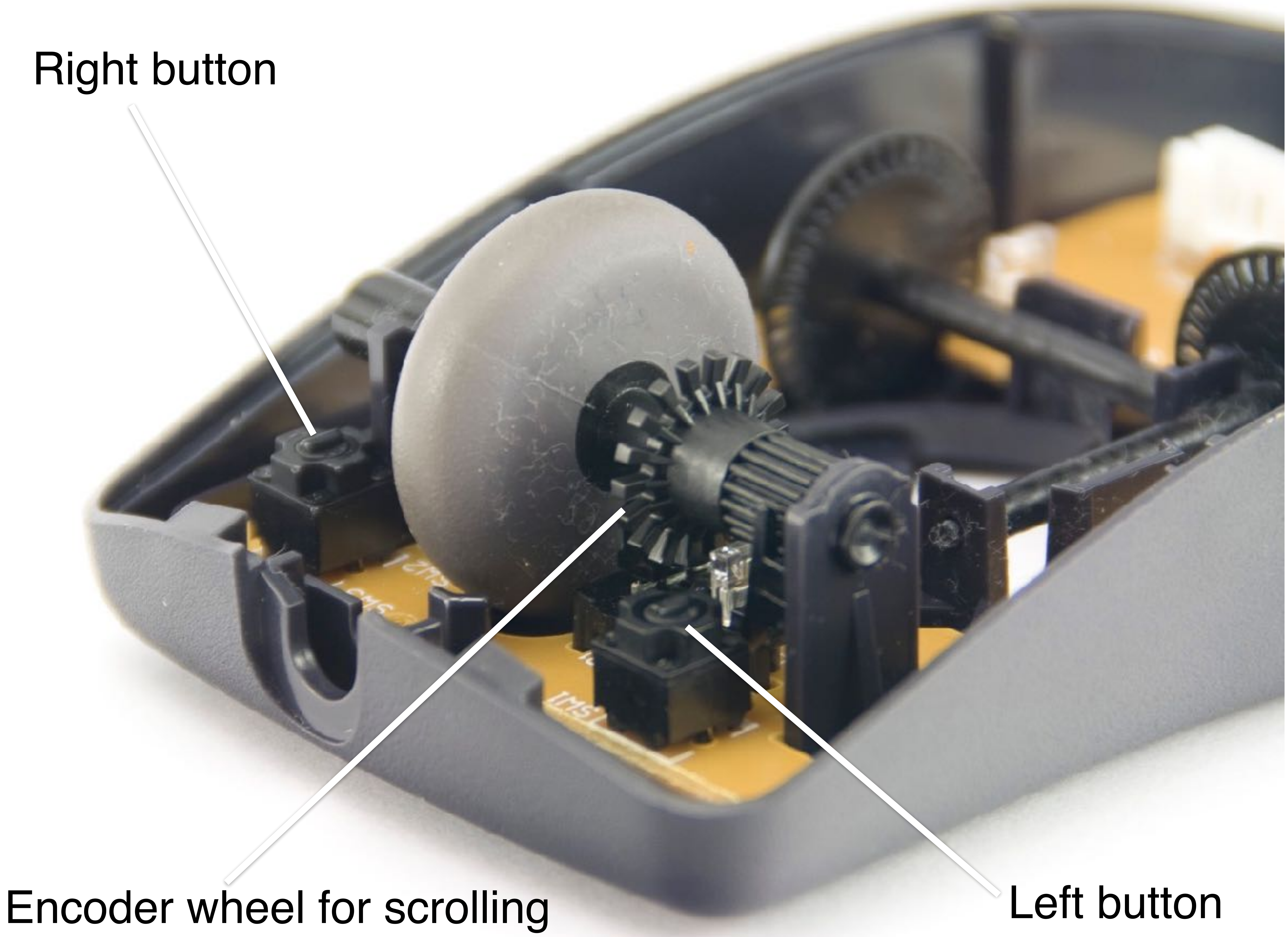
Alto (Xerox, 1974)

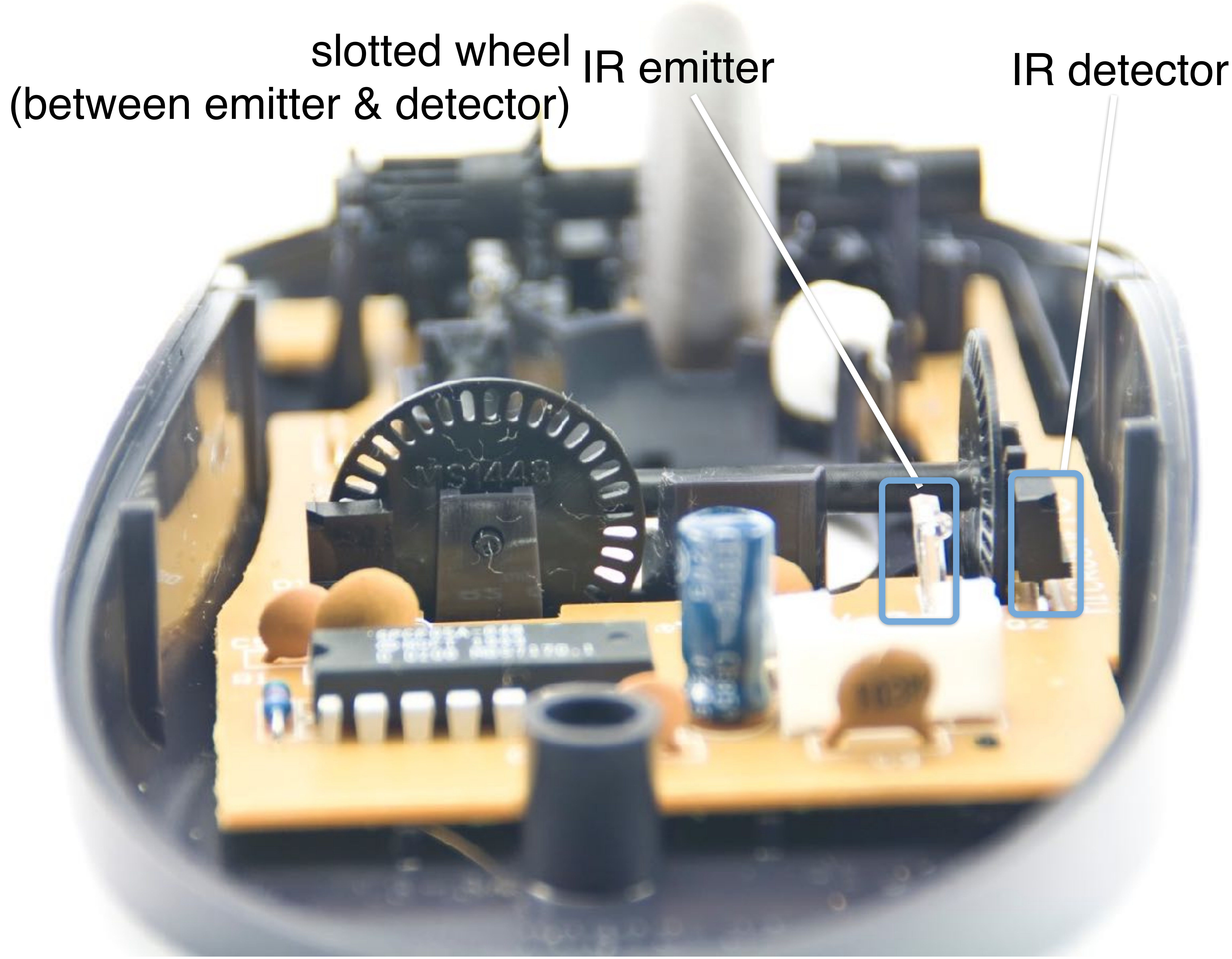


Smalltalk
(Xerox, 1976)

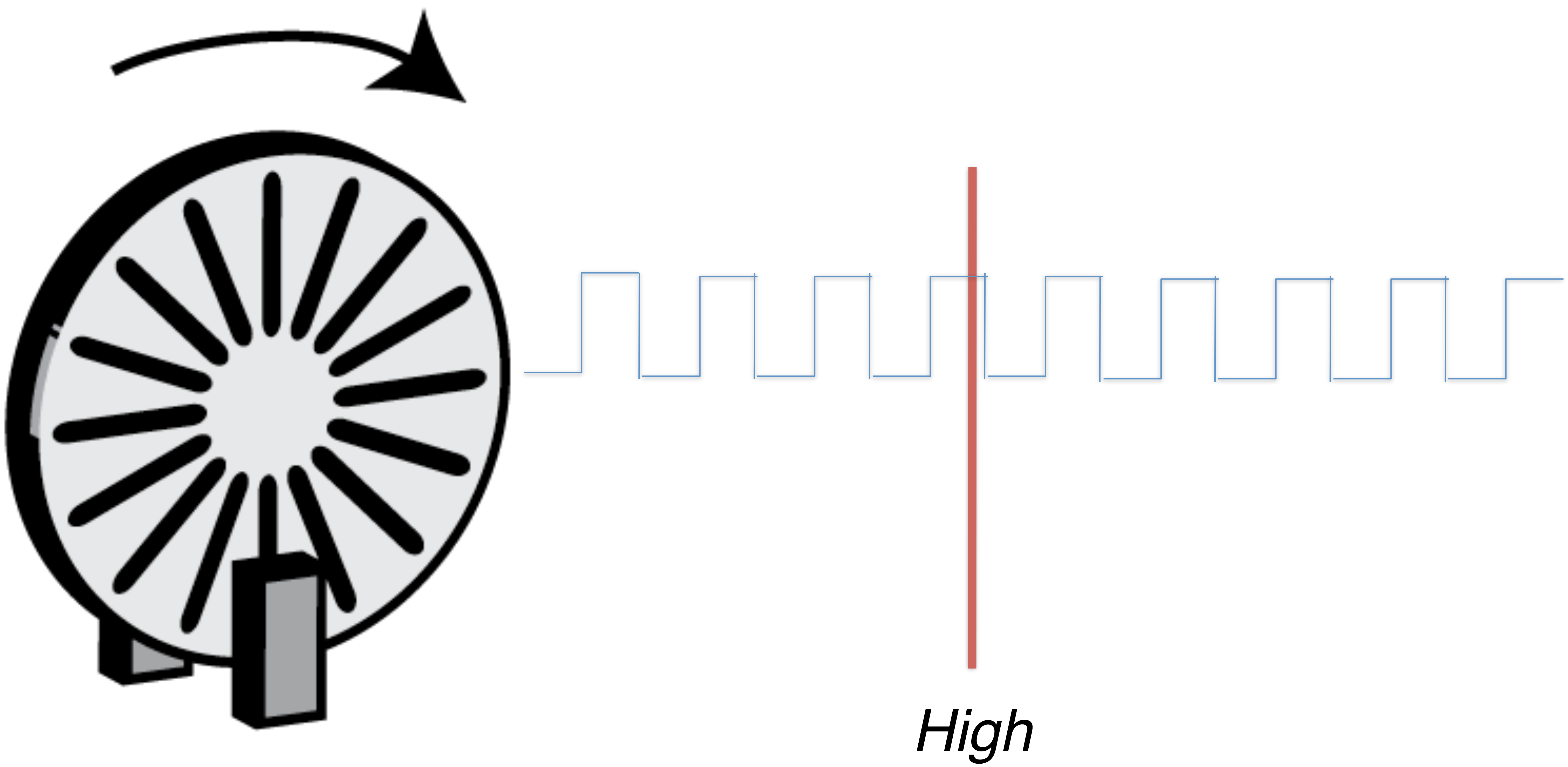

DELL
by Microsoft


D3
D2
Q2
94V-0
R2 CCTC4
U1
C3
C6
R1

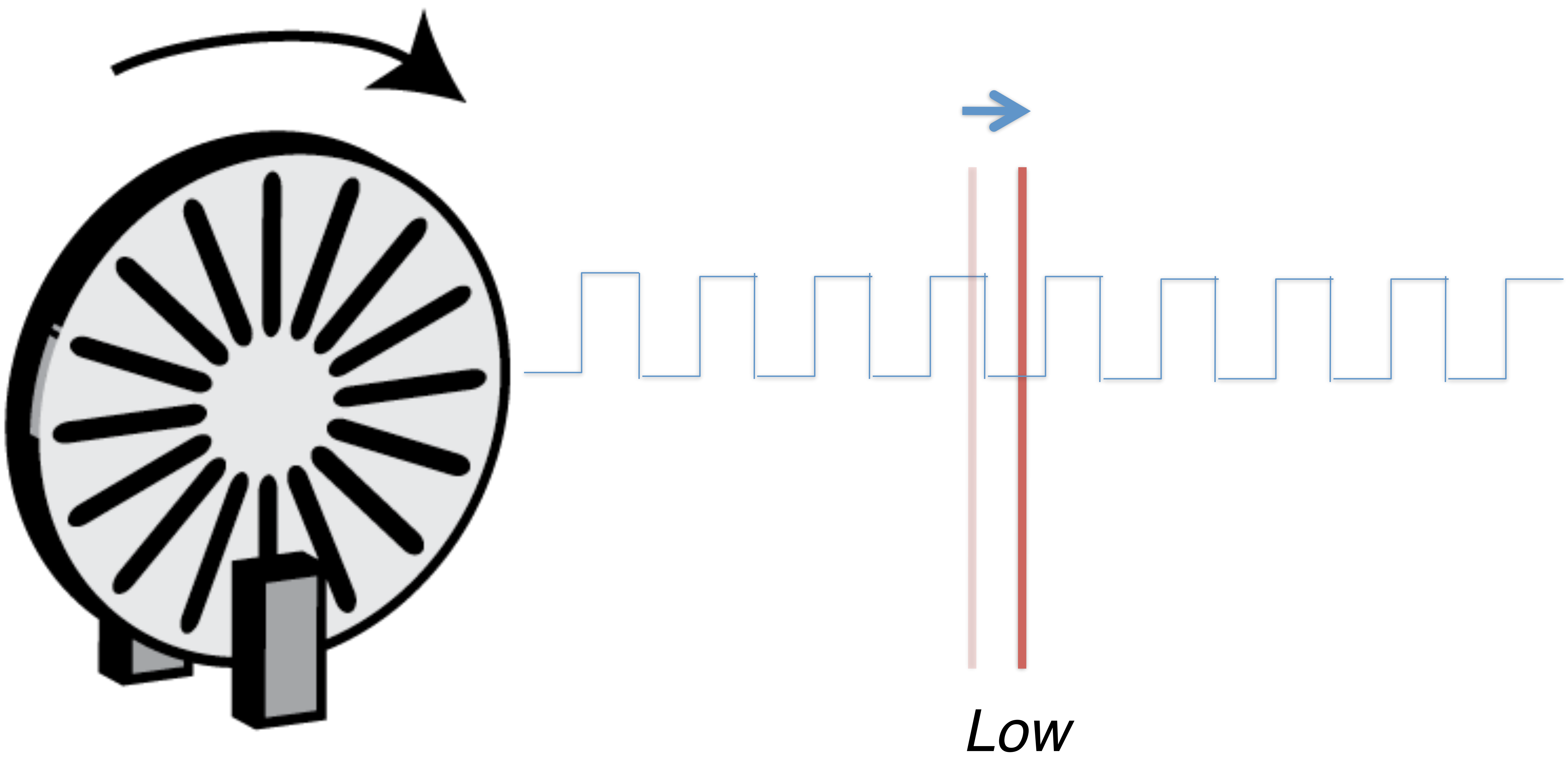

Right button
Encoder wheel for scrolling
Left button


slotted wheel
(between emitter & detector)
IR emitter
IR detector

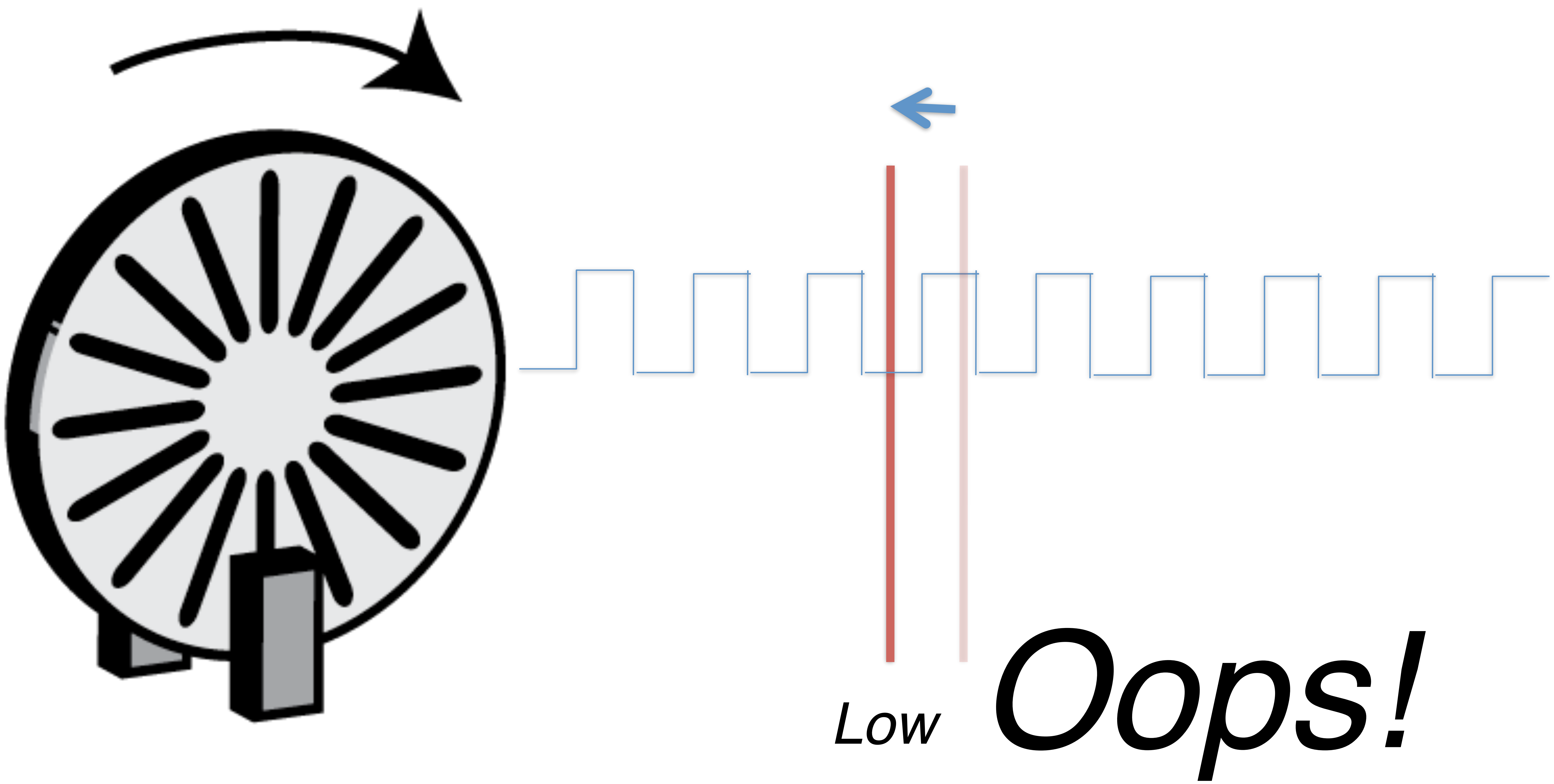
Sensing: Rotary Encoder



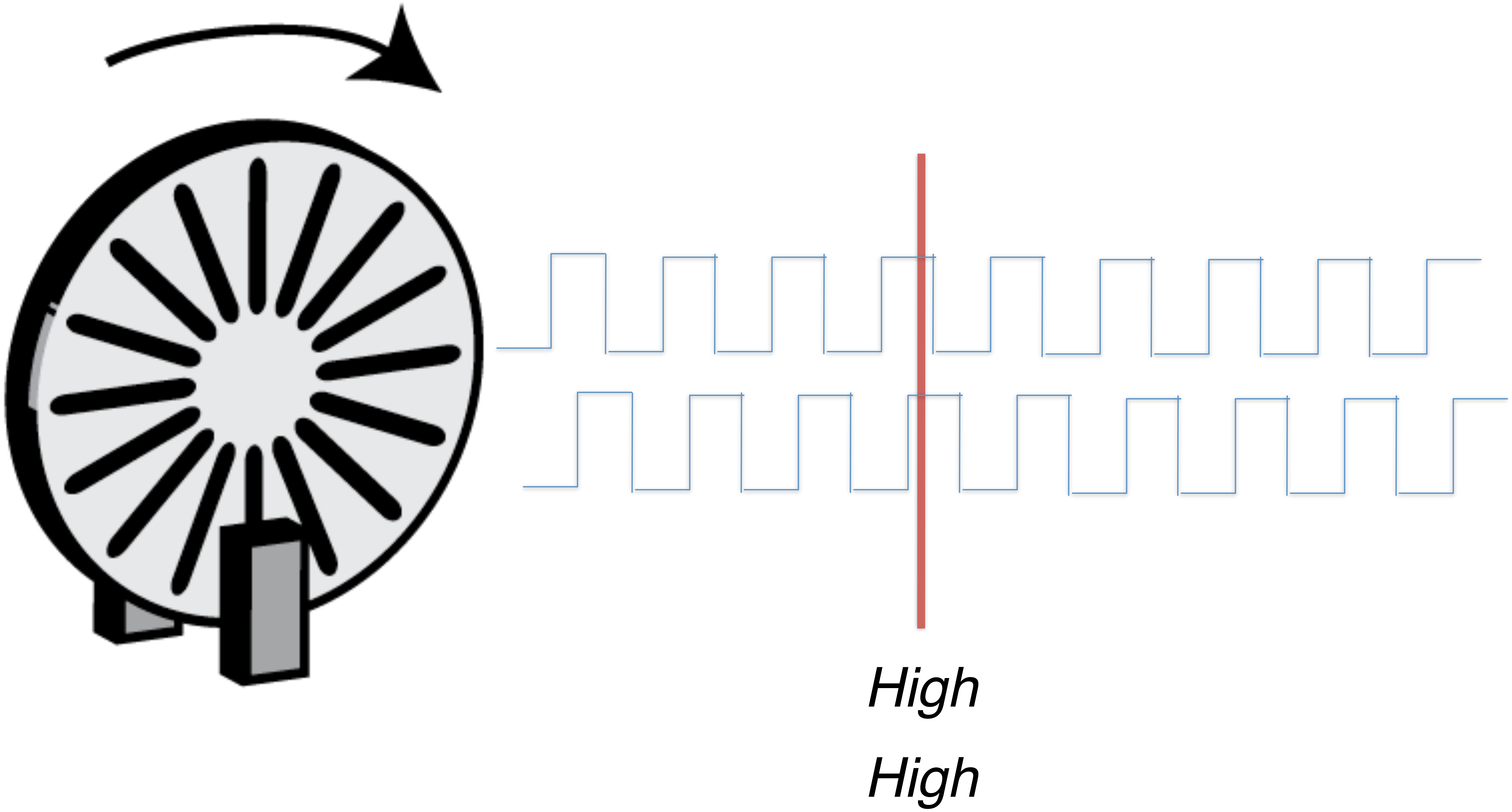
Sensing: Fwd Rotation



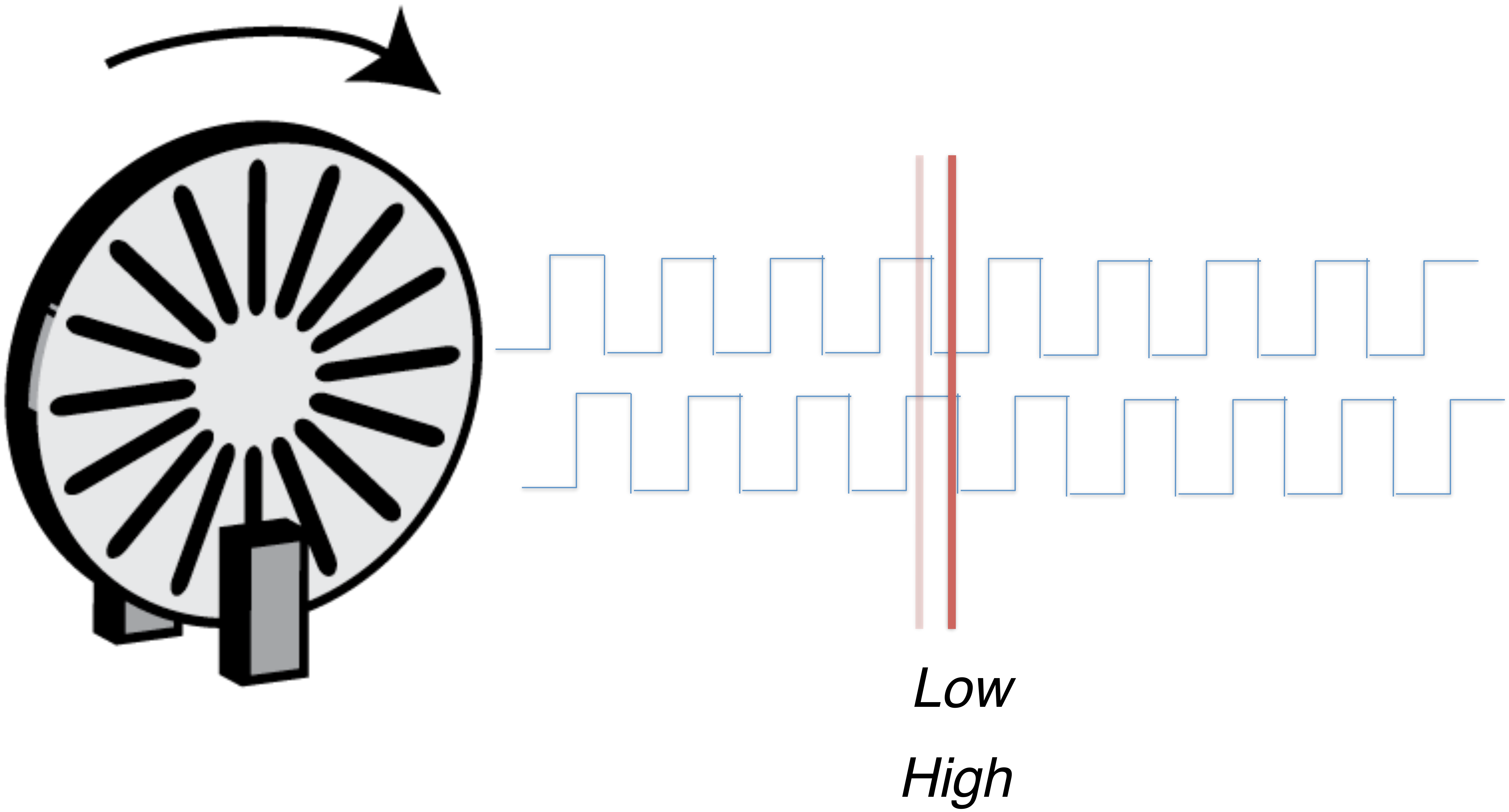
Sensing: Backwd Rotation



Solution: Use two out-of-phase



Sensing: Rotary Encoder

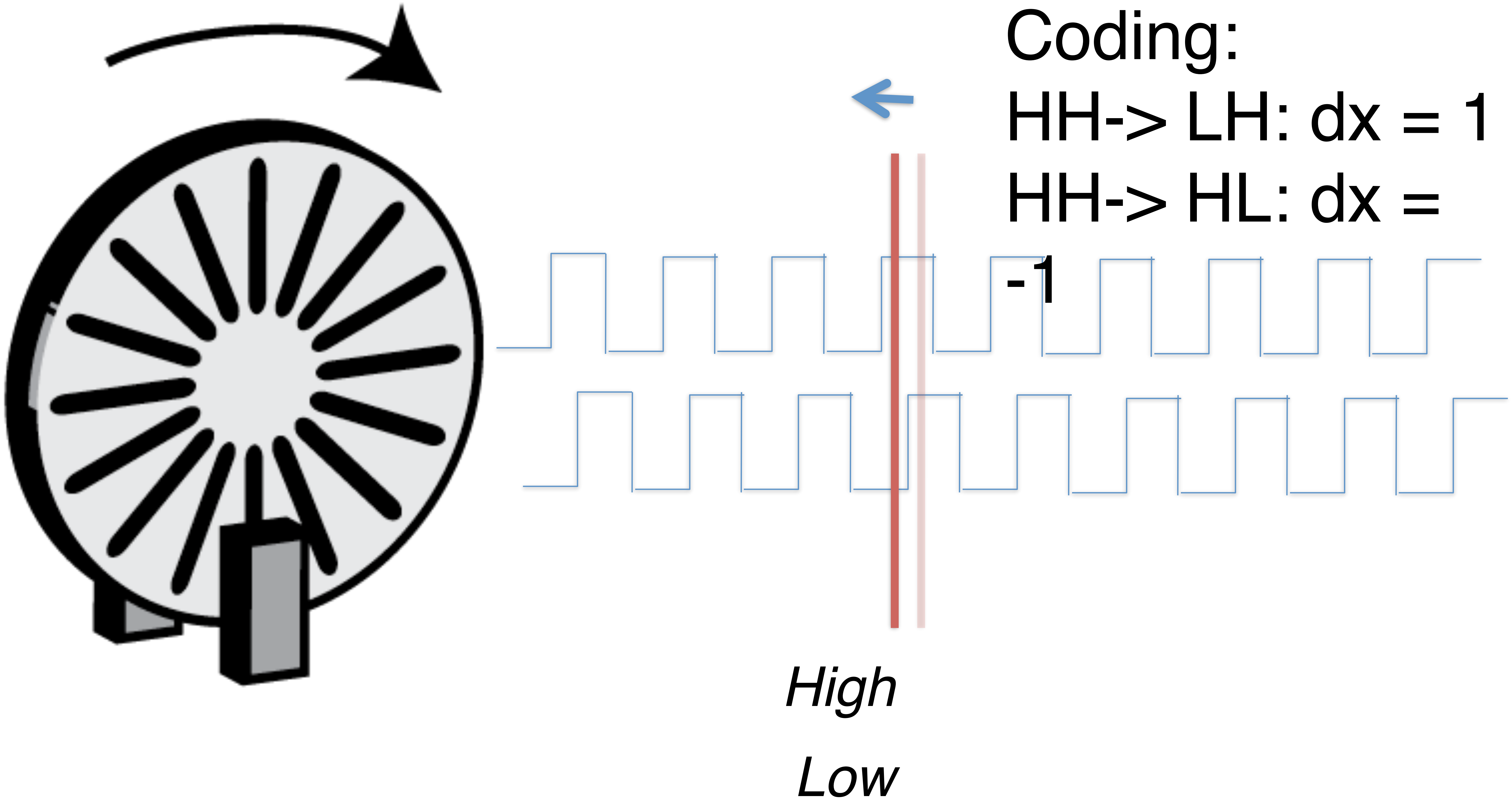


Sensing: Rotary Encoder

Coding:

HH-> LH: dx = 1

HH-> HL: dx = -1

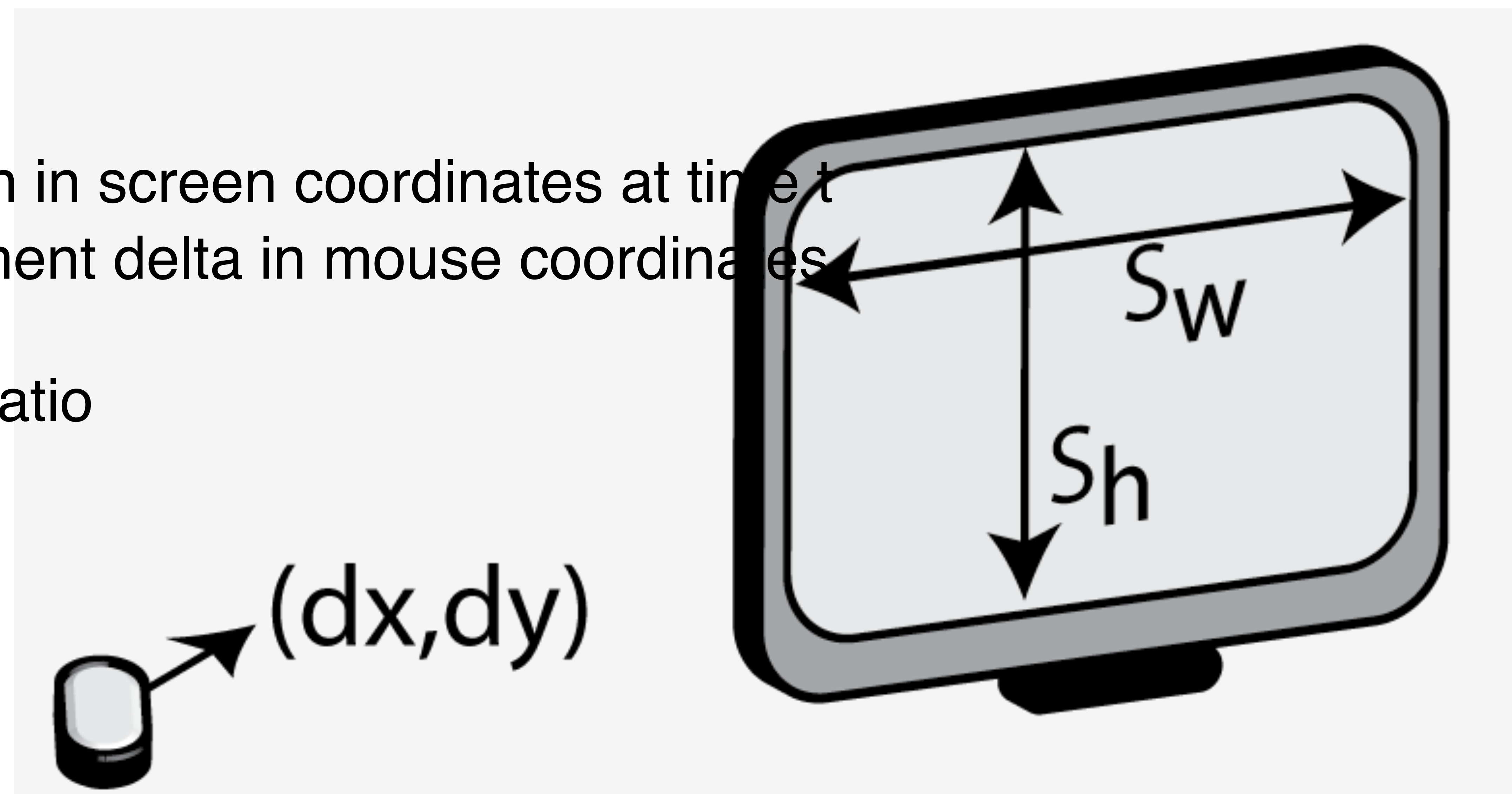


Transformation

$$cx_t = \max(0, \min(sw, cx_{t-1}+dx*cd))$$

$$cy_t = \ldots$$

cx_t: cursor x position in screen coordinates at time t
dx: mouse x movement delta in mouse coordinates
sw: screen width
cd: control-display ratio



Optical Mouse

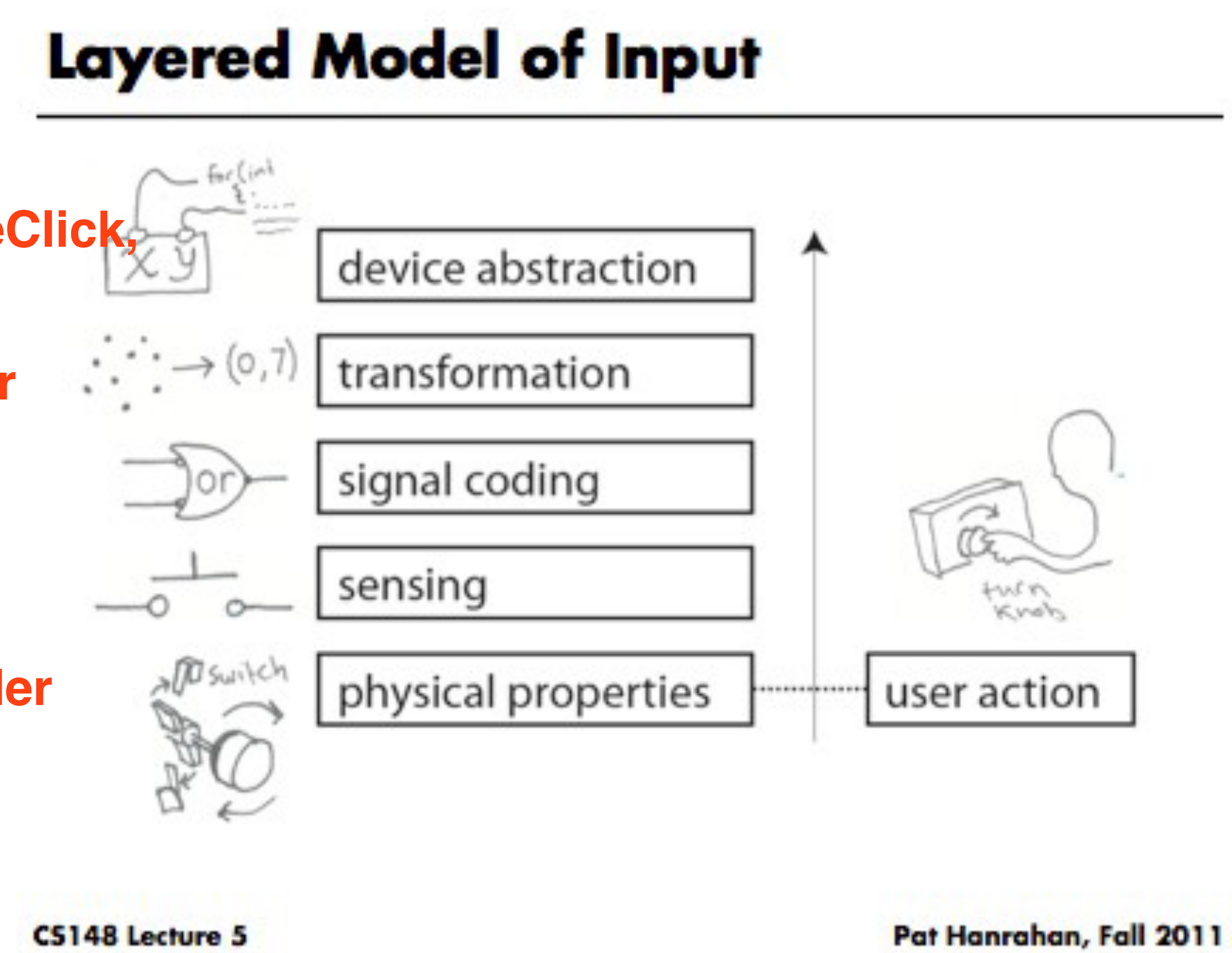
Move, DoubleClick, etc

Screen cursor Position

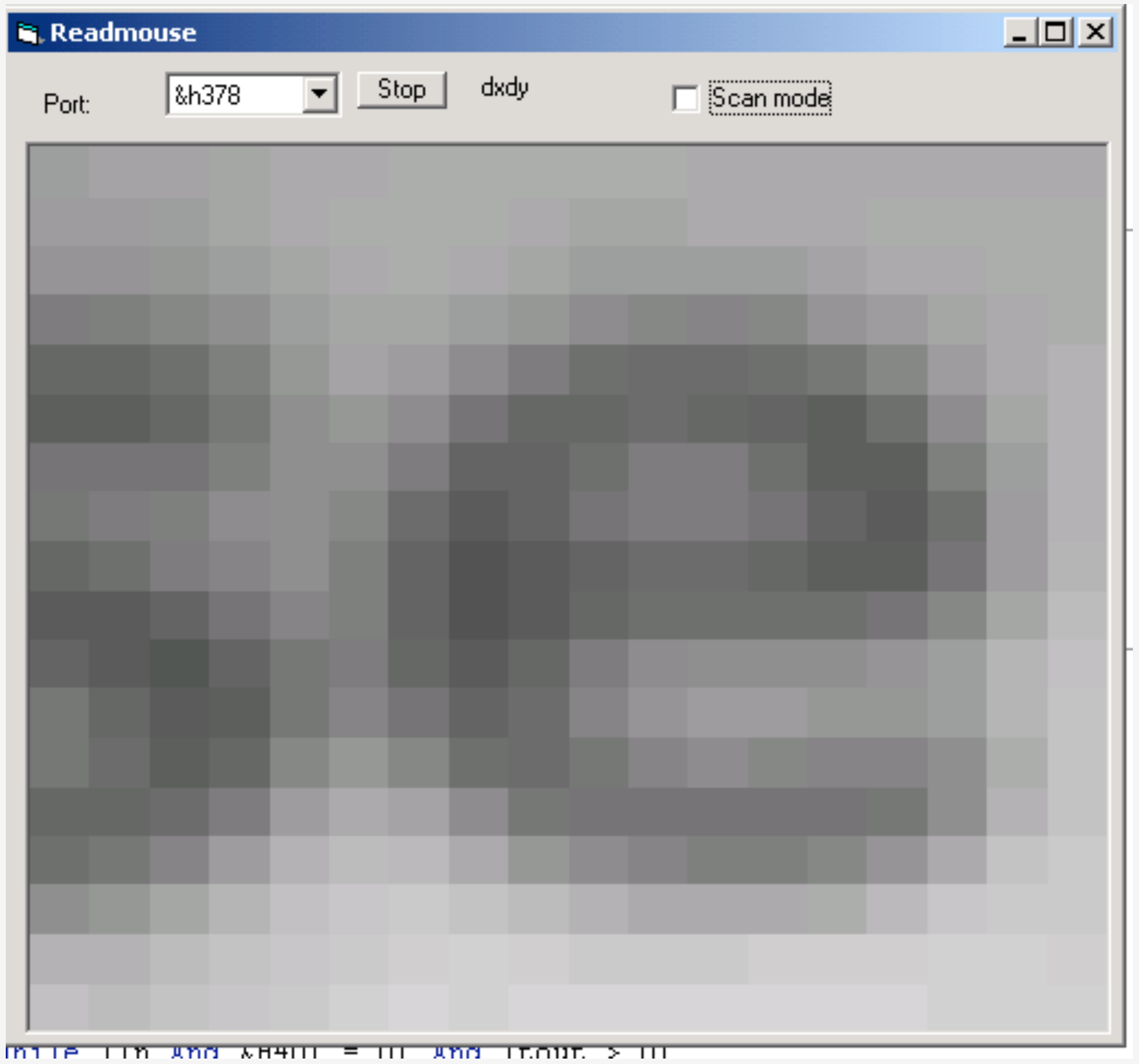
Quadrature Encoding

Rotary Encoder

Mover x,y



What about optical mice?



Source: http://spritesmods.com/?art=mouseeye

A design space of input

Table I. Physical Properties Used by Input Devices

	Linear	Rotary
Position		
Absolute	Position **P**	Rotation **R**
Relative	Movement **dP**	Delta rotation **dR**
Force		
Absolute	Force **F**	Torque **T**
Relative	Delta force **dF**	Delta torque **dT**

Card, S. K., Mackinlay, J. D., and Robertson, G. G. 1991.
A morphological analysis of the design space of

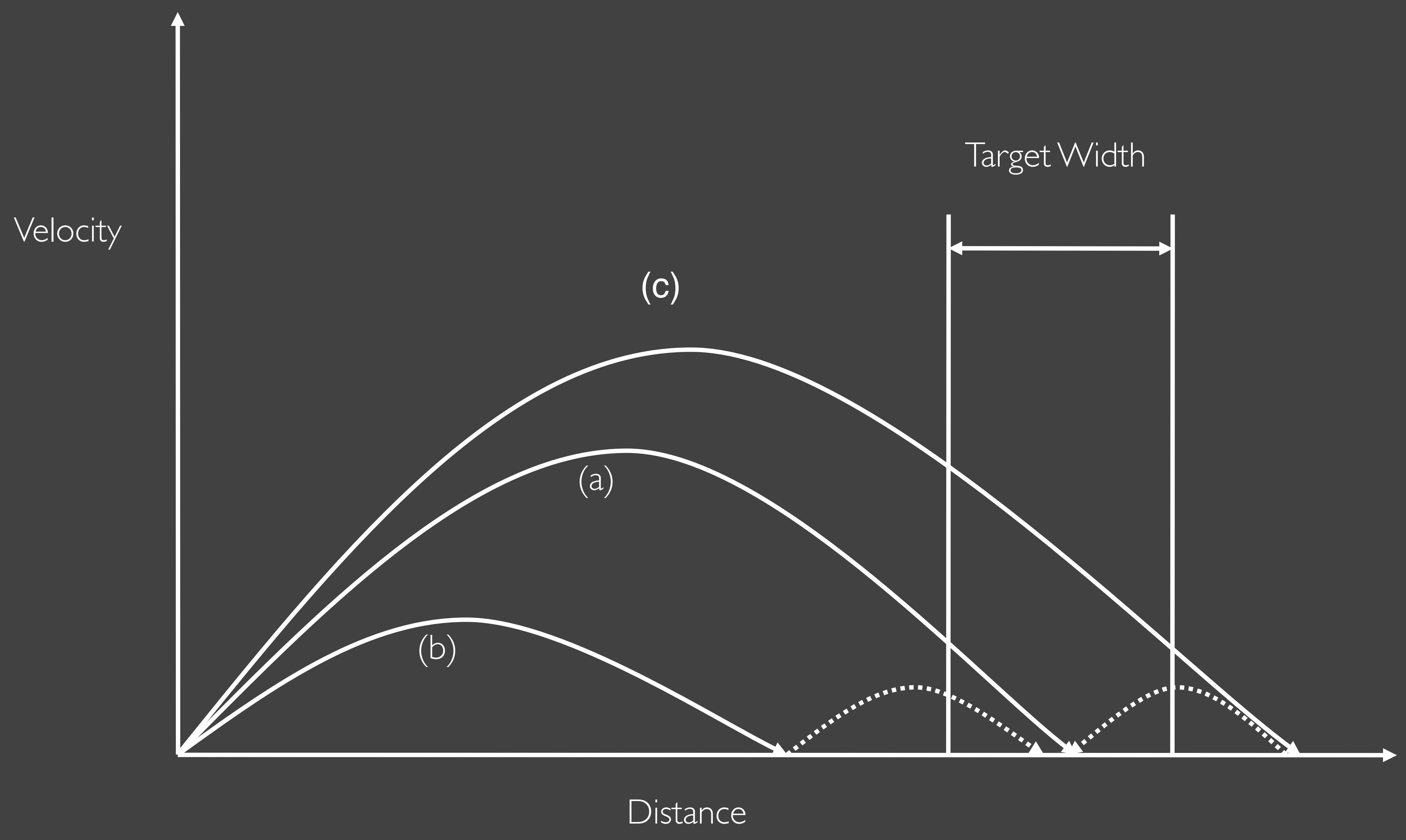
How about People?

Can we model human performance?

Principles of Operation

- Fitts' Law
  - Time Tpos to move the hand to target size S which is distance D away is given by:
    - Tpos = a + b log2 (Distance/Size + 1)
    - The log part is the "index of difficulty" of the target; it's units are bits
  - summary
    - time to move the hand depends only on the relative precision required

What does Fitts' law really model?



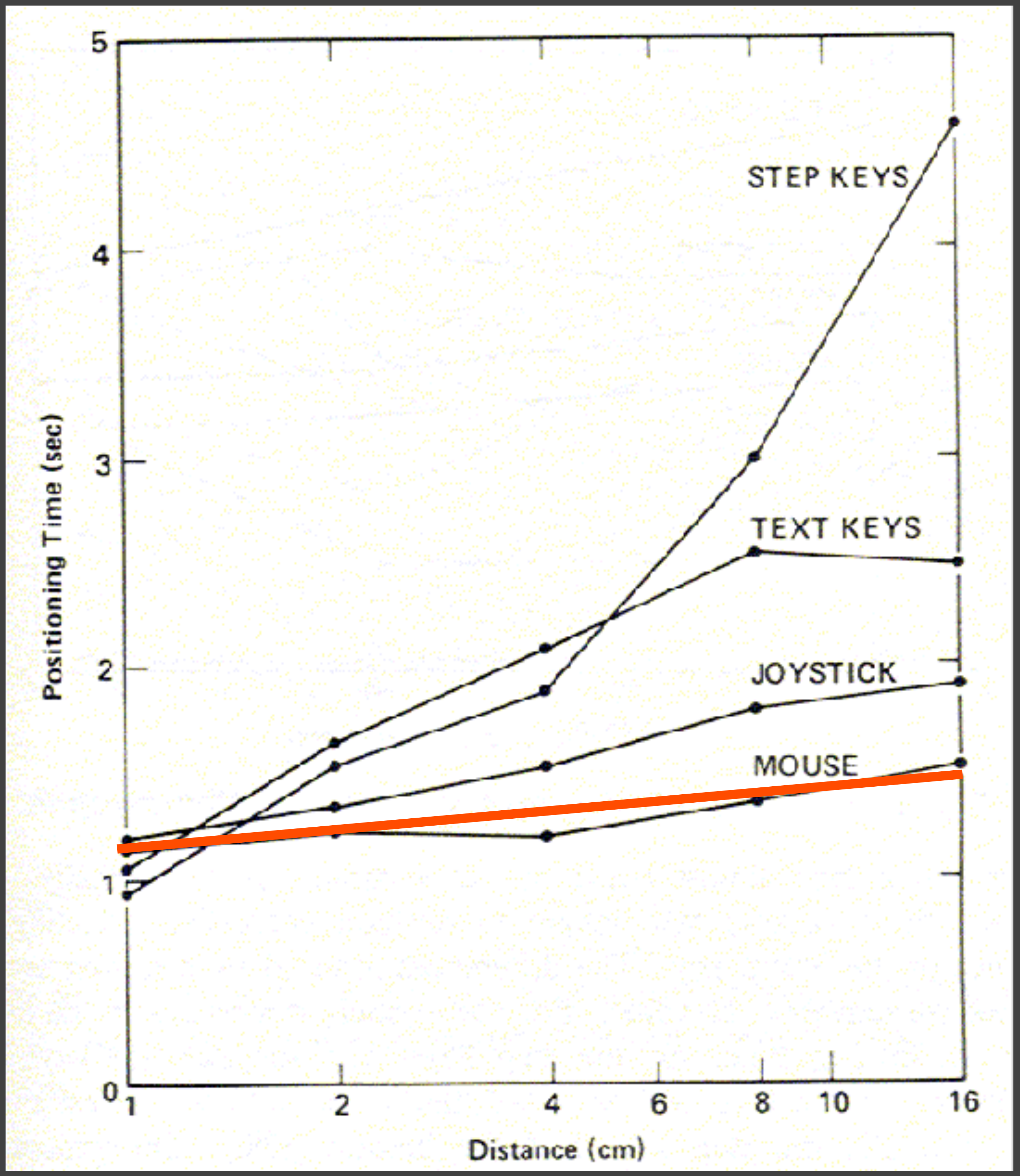
It was inspired by information theory

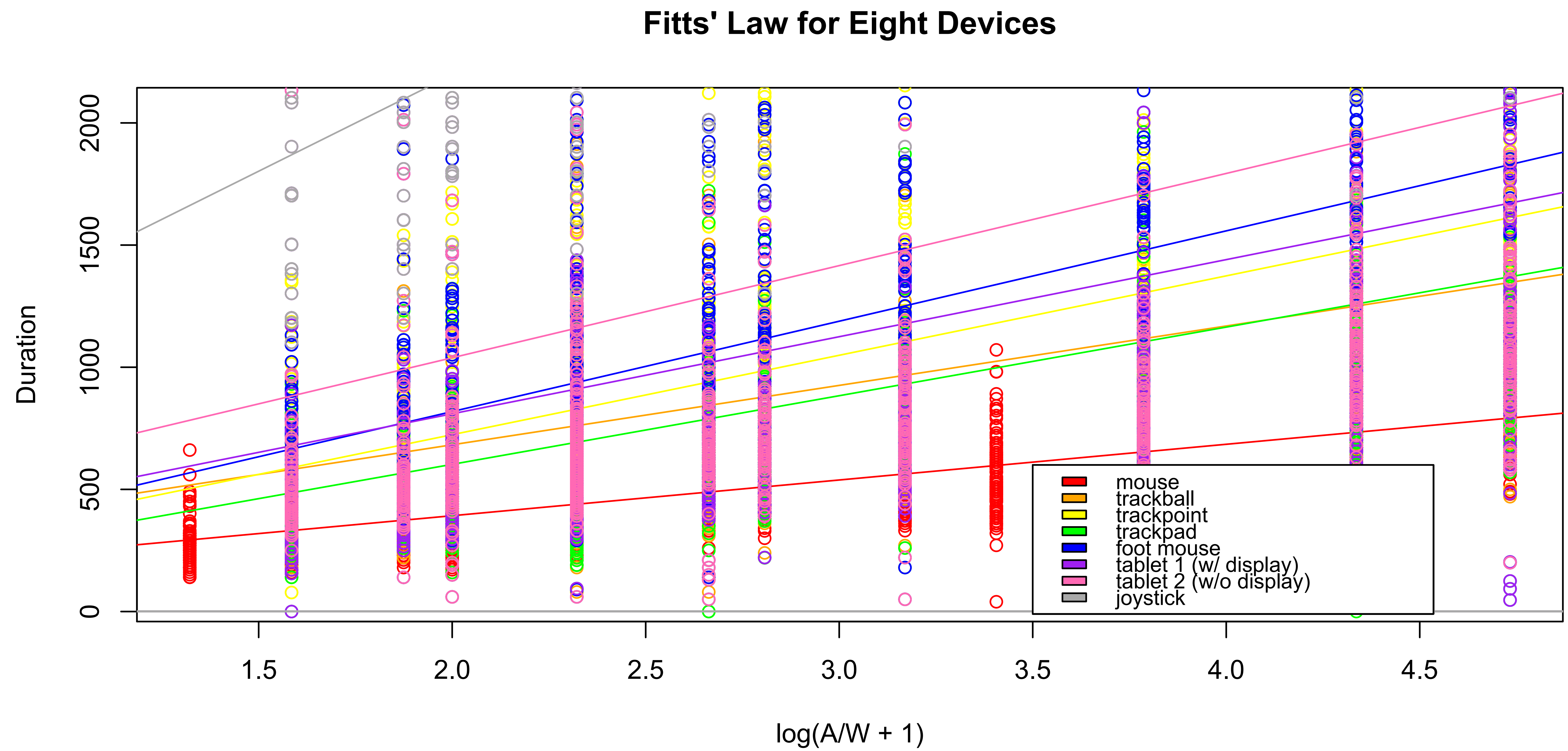
- It treats acquiring a target as specifying a number of bits
- i.e., in the Fitts' worldview, the human motor system is a noisy information channel
- Smaller target? More bits
- Further target? More bits

Experiment

Repeated Tapping

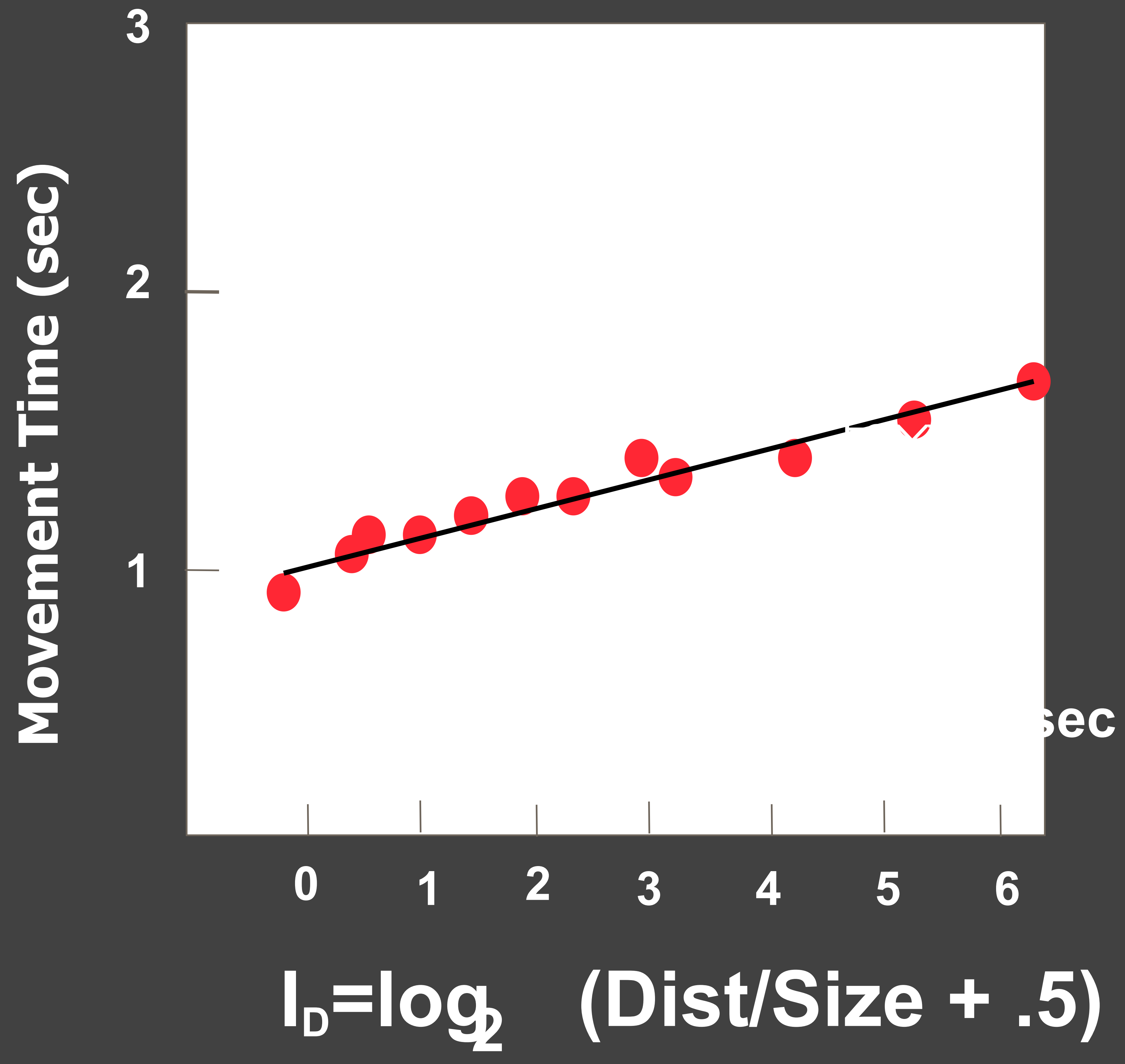
EXPERIMENT: MICE ARE





Fitts' Law for Eight Devices
Duration
0
500
1000
1500
2000
1.5
2.0
2.5
3.0
3.5
4.0
4.5
log(A/W + 1)
mouse
trackball
trackpoint
trackpad
foot mouse
tablet 1 (w/ display)
tablet 2 (w/o display)
joystick

WHY?



Why these results?

Time to position mouse proportional to Fitts' Index of Difficulty I_D.

Proportionality constant = 10 bits/ sec, same as hand.

Therefore speed limit is in the eye-hand system, not the mouse.

Therefore, mouse is a near optimal device.

50 years of data

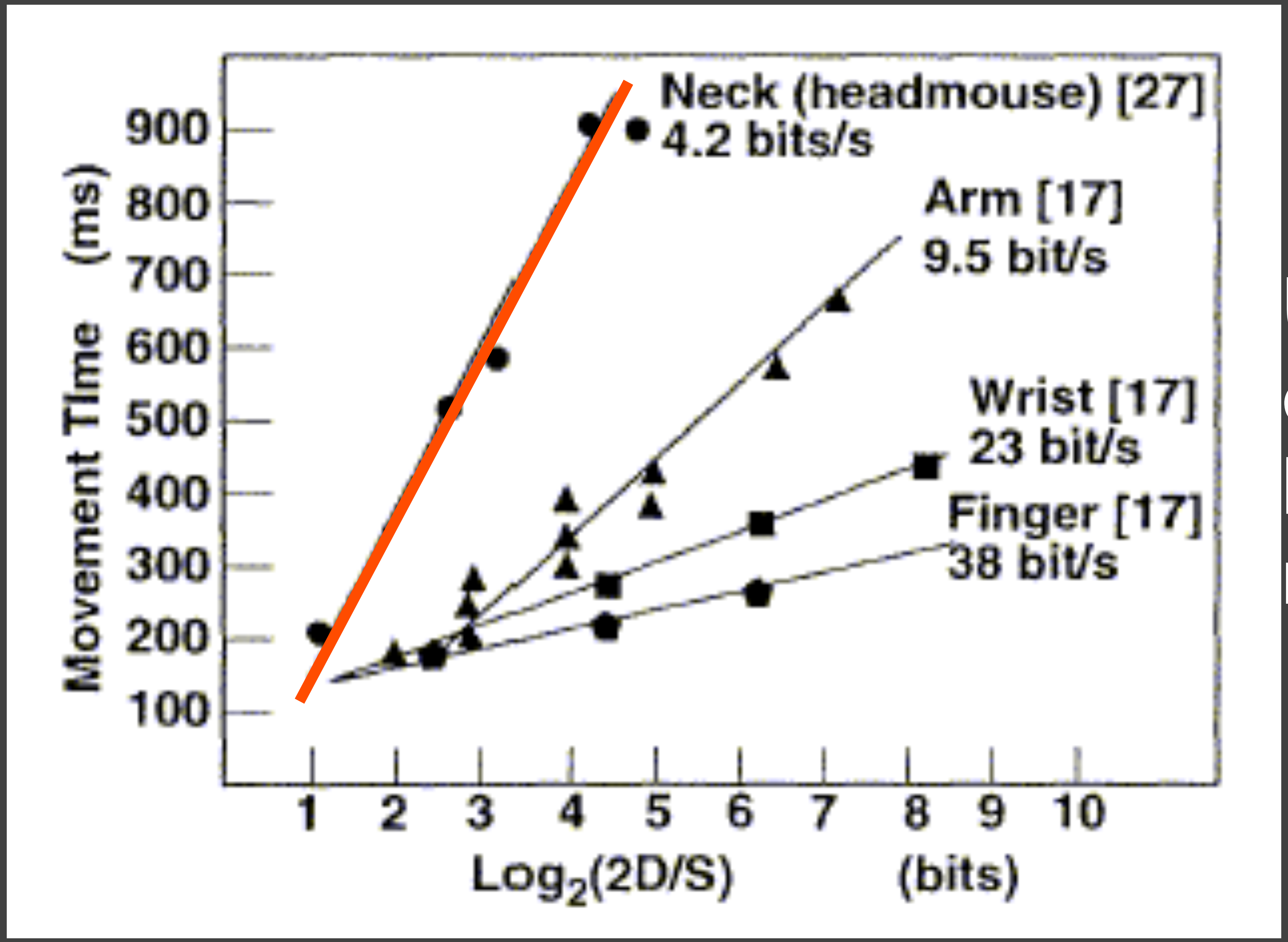
Device	Study	IP (bits/s)
Hand	Fitts (1954)	10.6
Mouse	Card, English, & Burr (1978)	10.4
Joystick	Card, English, & Burr (1978)	5.0
Trackball	Epps (1986)	2.9
Touchpad	Epps (1986)	1.6
Eyetracker	Ware & Mikaelian (1987)	13.7

Reference:
MacKenzie, I. Fitts' Law as a research and design tool in human computer interaction. Human Computer Interaction, 1992, Vol. 7, pp. 91-139

EXAMPLE: ALTERNATIVE DEVICES

Headmouse: No chance to win

ATTACHING POINTING



Use transducer on high bandwidth muscles

Faster Input:
Menu Selection

Faster Input: Menu Selection

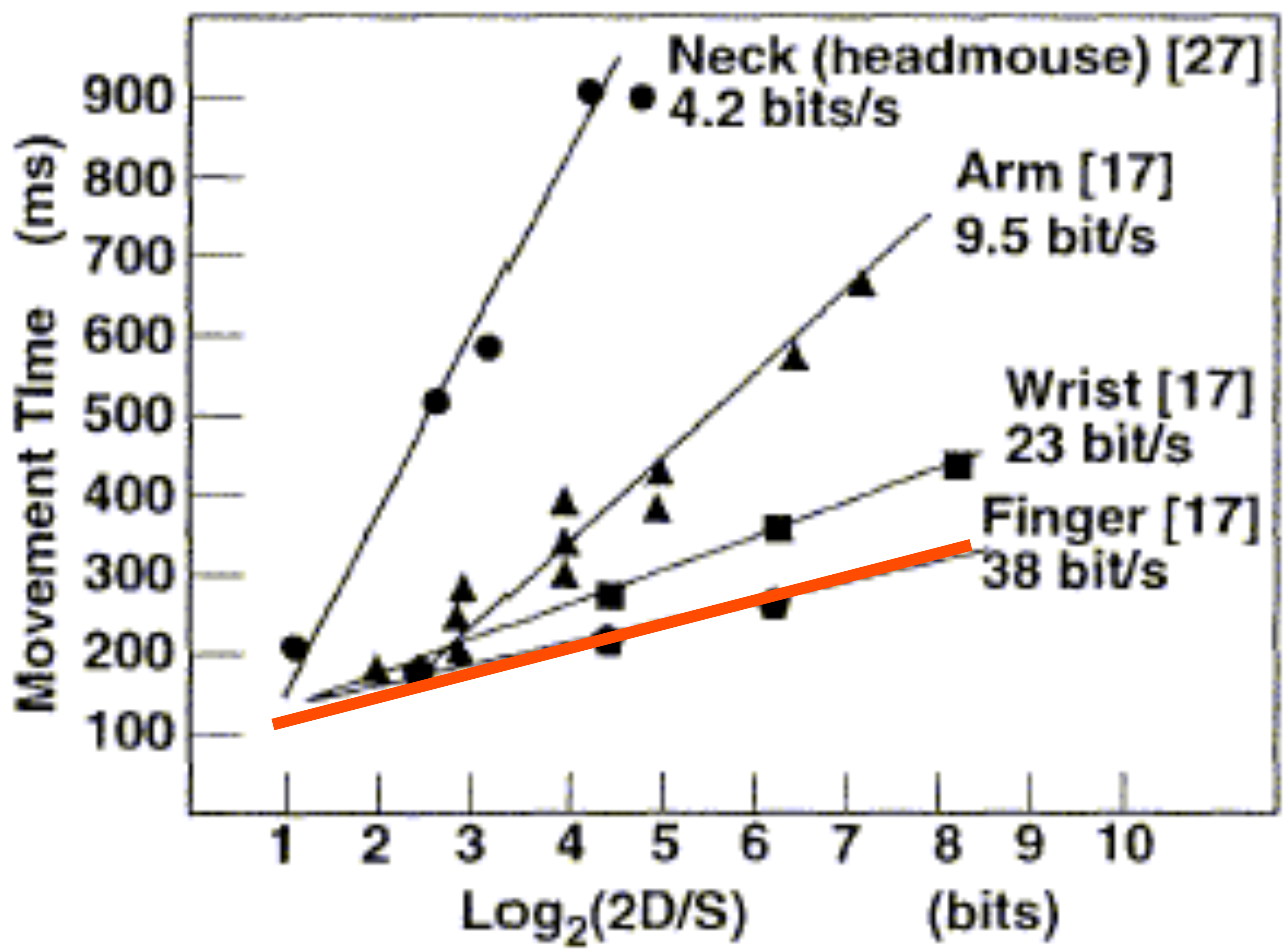
Pop-up Linear Menu

Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday

Try to hit a target without

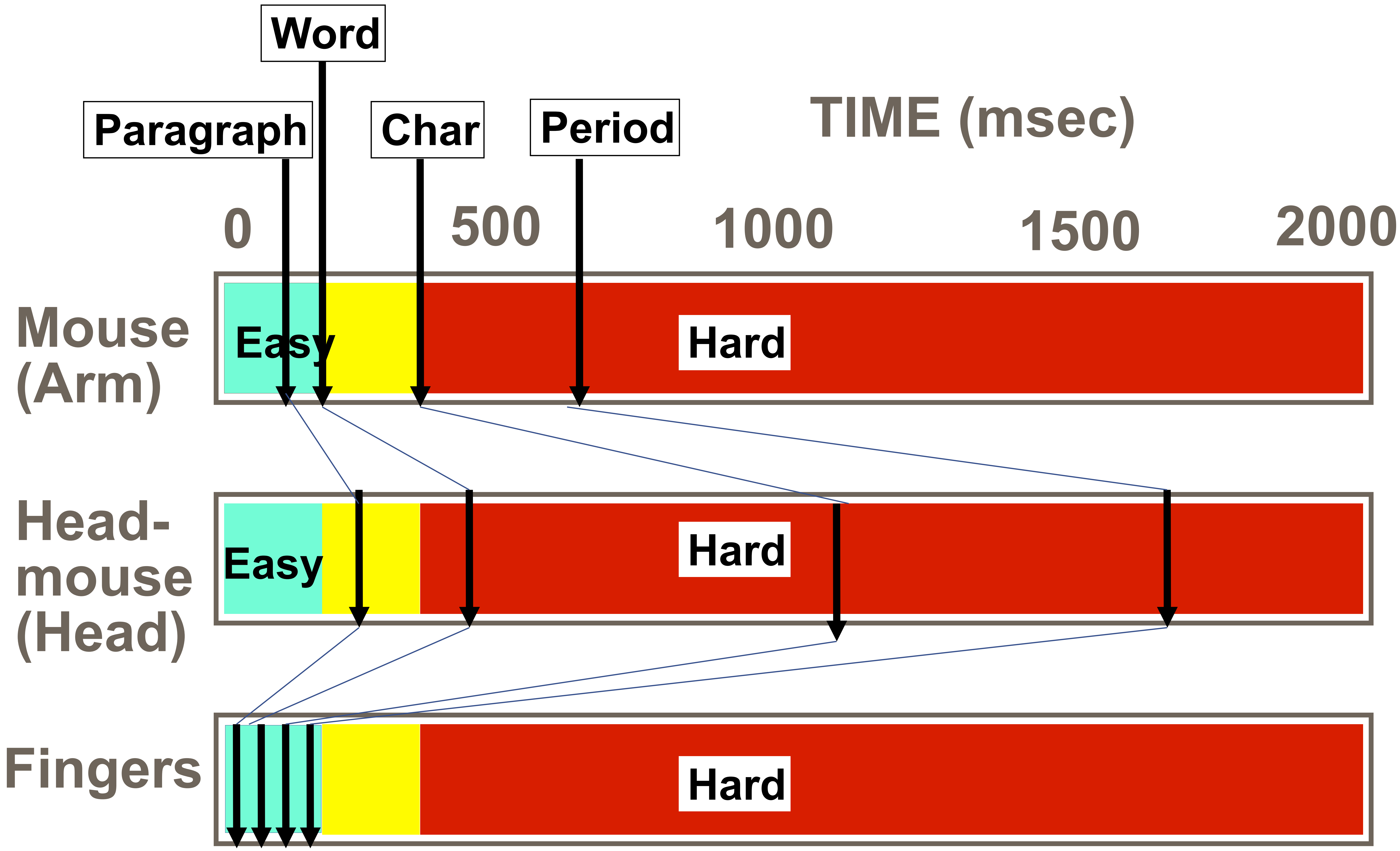
- You can open your eyes after each step
- Then, try it for both a mac-style and windows-style menu bar

EXAMPLE: BEATING THE MOUSE



Use transducer on high bandwidth muscles

EXAMPLE: STRUCTURING THE TASK SPACE BY PROJECTING THE MODEL



What else might we have measured?

- Time on Task -- How long does it take people to complete basic tasks? (For example, find something to buy, create a new account, and order the item.)
- Accuracy -- How many mistakes did people make? (And were they fatal or recoverable with the right information?)
- Recall -- How much does the person remember afterwards or after periods of non-use?
- Emotional Response -- How does the person feel about the tasks completed? (Confident? Stressed? Would the user recommend this system to a friend?)


CORSAIR
Ergonomic Keyboard For Pirates
Avast
!
Shift
R
Enter