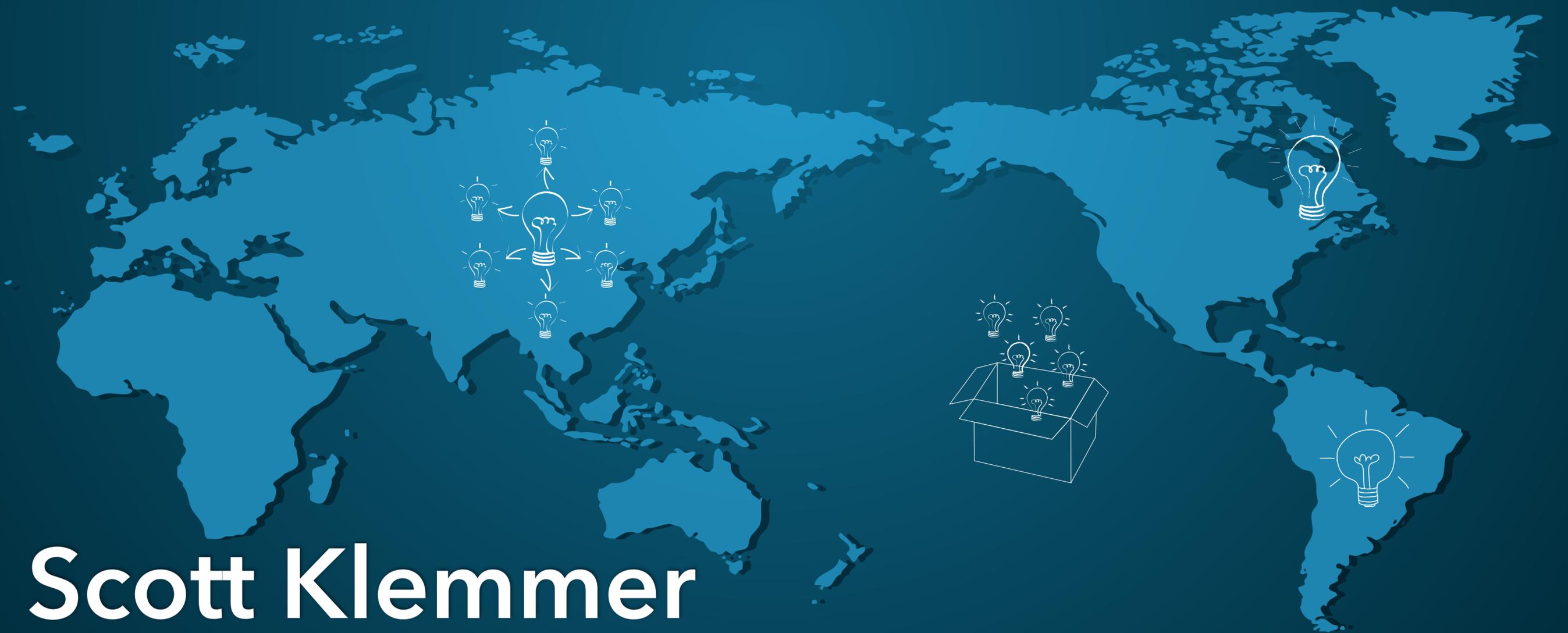


Bring box of devices;
setup Elmo

Input



Scott Klemmer

with materials from Bjoern Hartmann, Stu Card, Pat Hanrahan

A7 Example

<https://a7-mappy.herokuapp.com/>



Select Current Location

Select Destination Gate

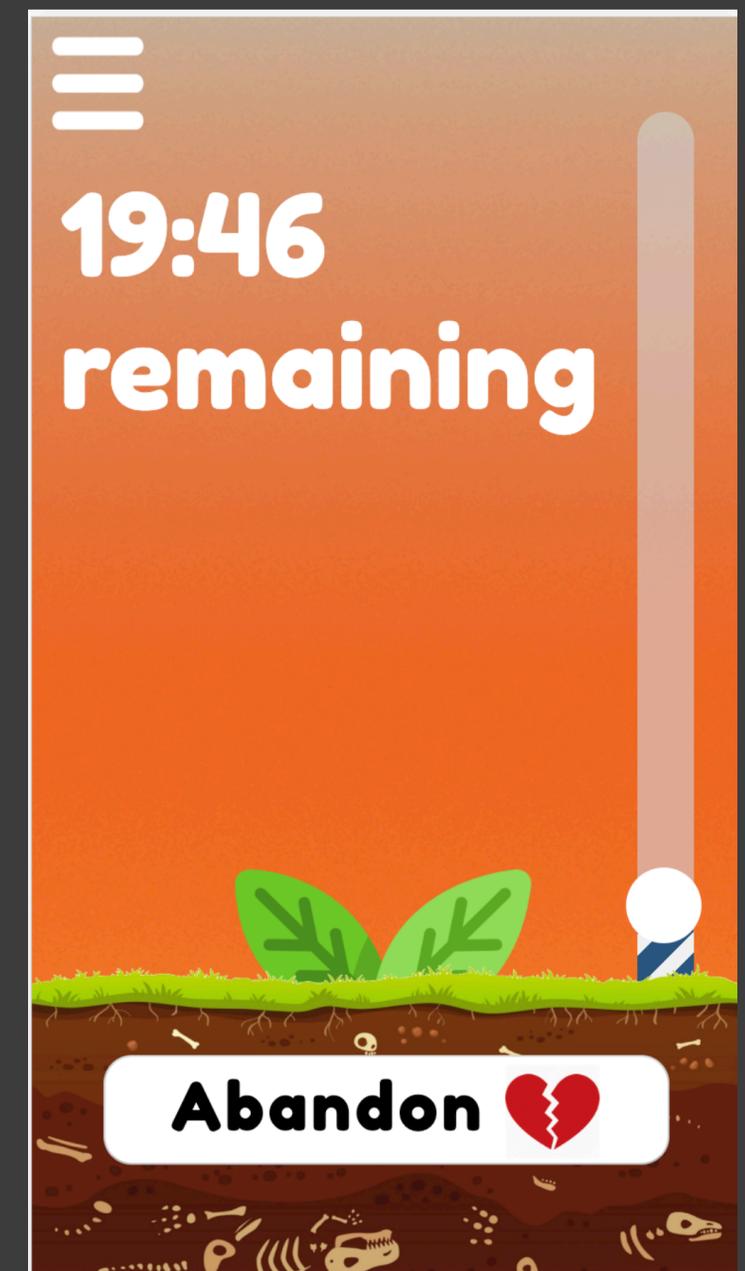
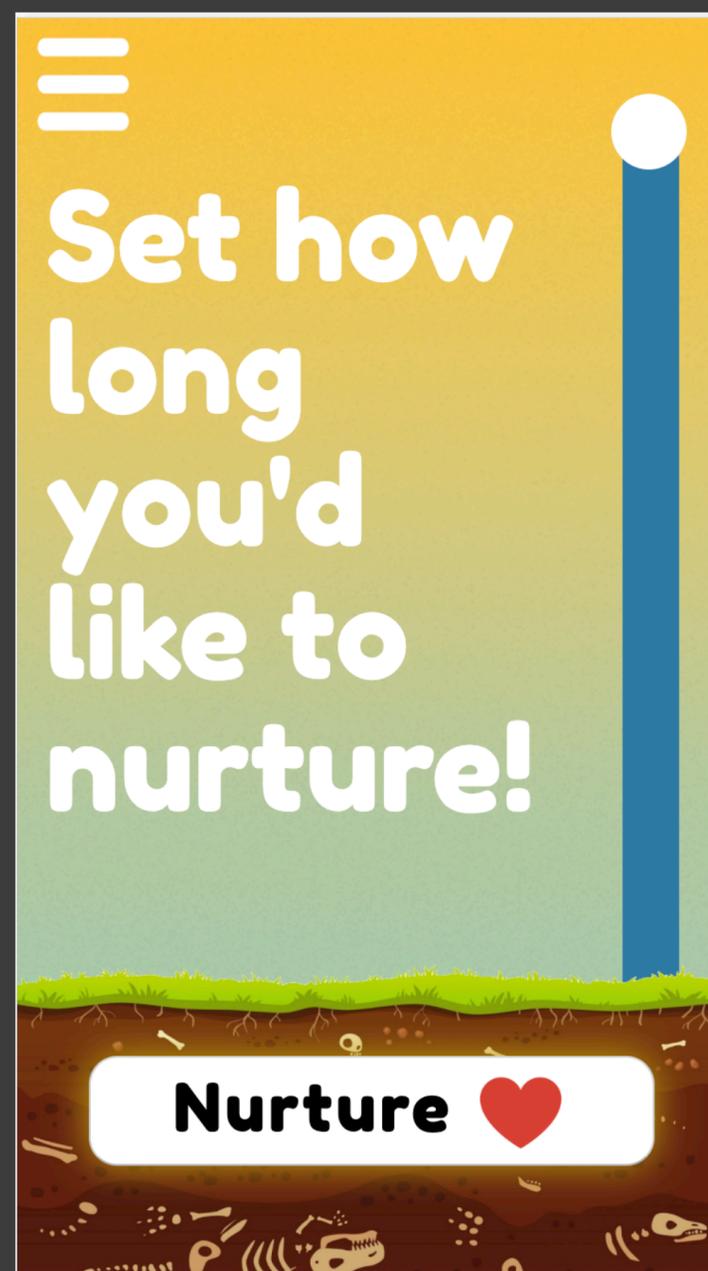
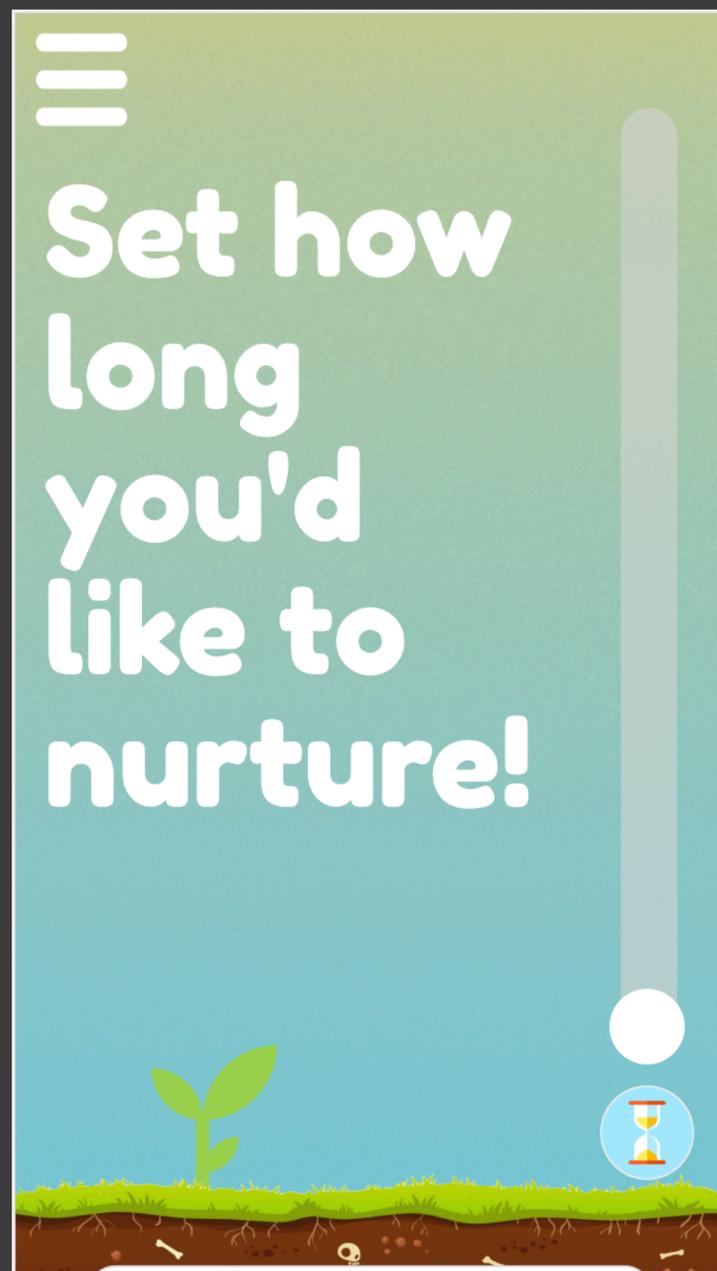
Map Me!

OR

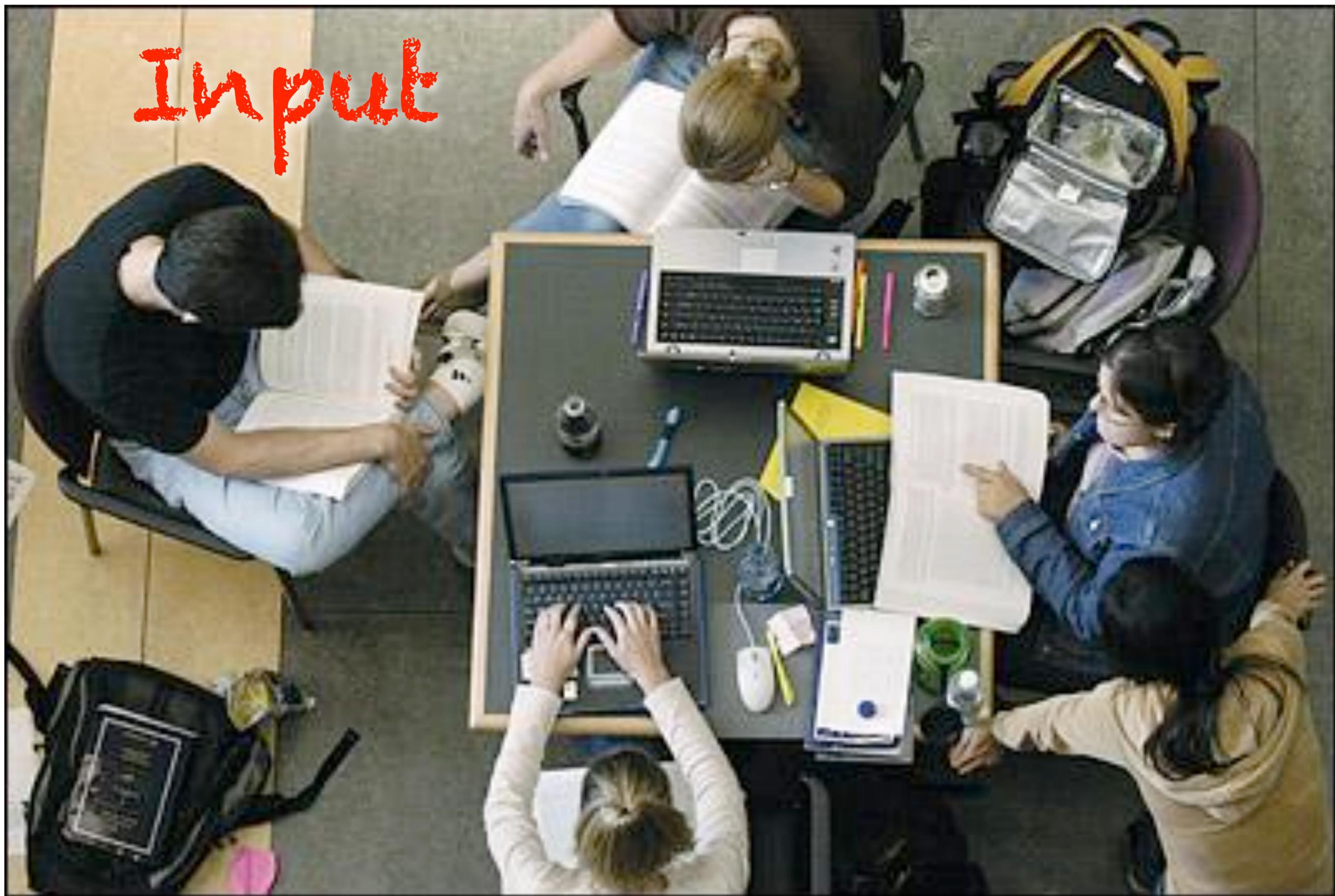
Login with Expedia

A7 Example

<https://a7-nurture.herokuapp.com/>



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

Backspace

Print Screen
Sysrq

Scroll
Lock

Pause
Break

Num
Lock

Insert

Home

Page
Up

Num
Lock

Delete

End

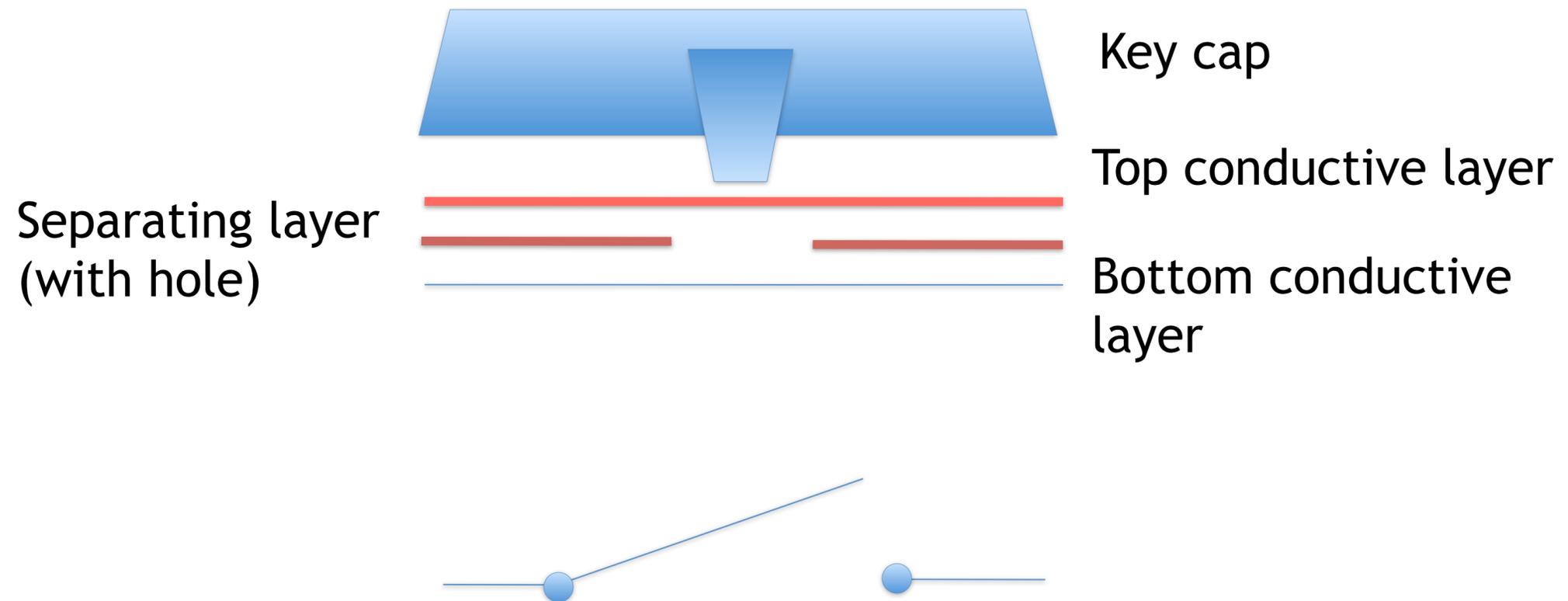
Page
Down

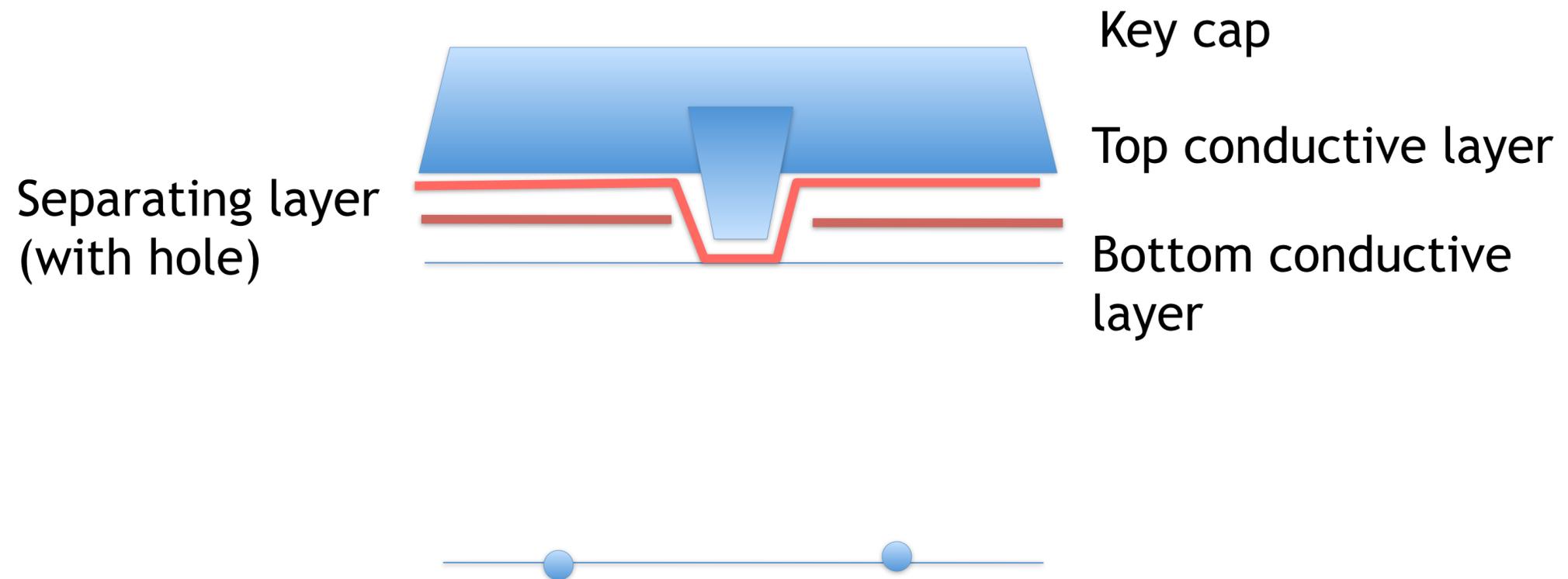
Enter

Shift

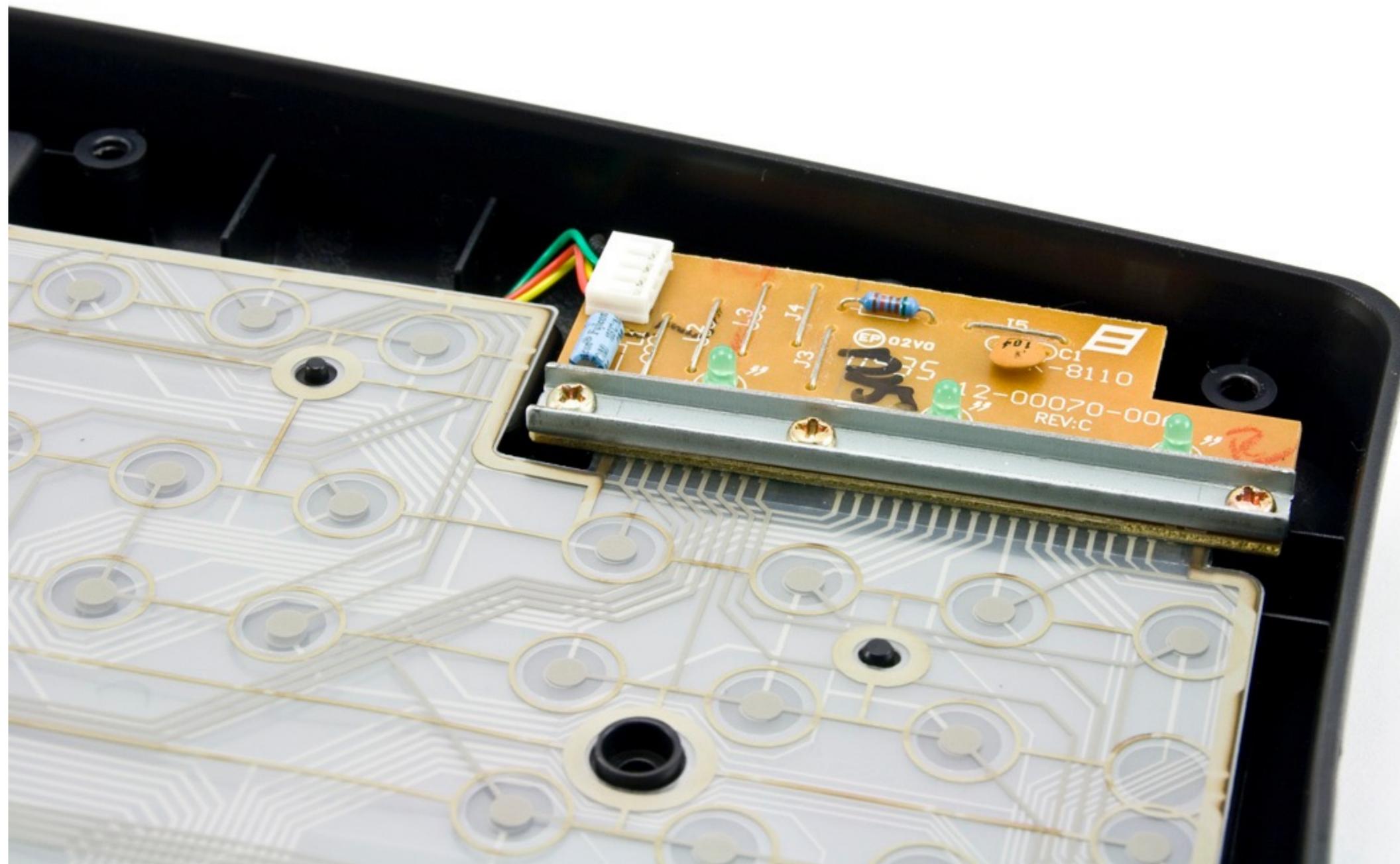
Ctrl

Alt





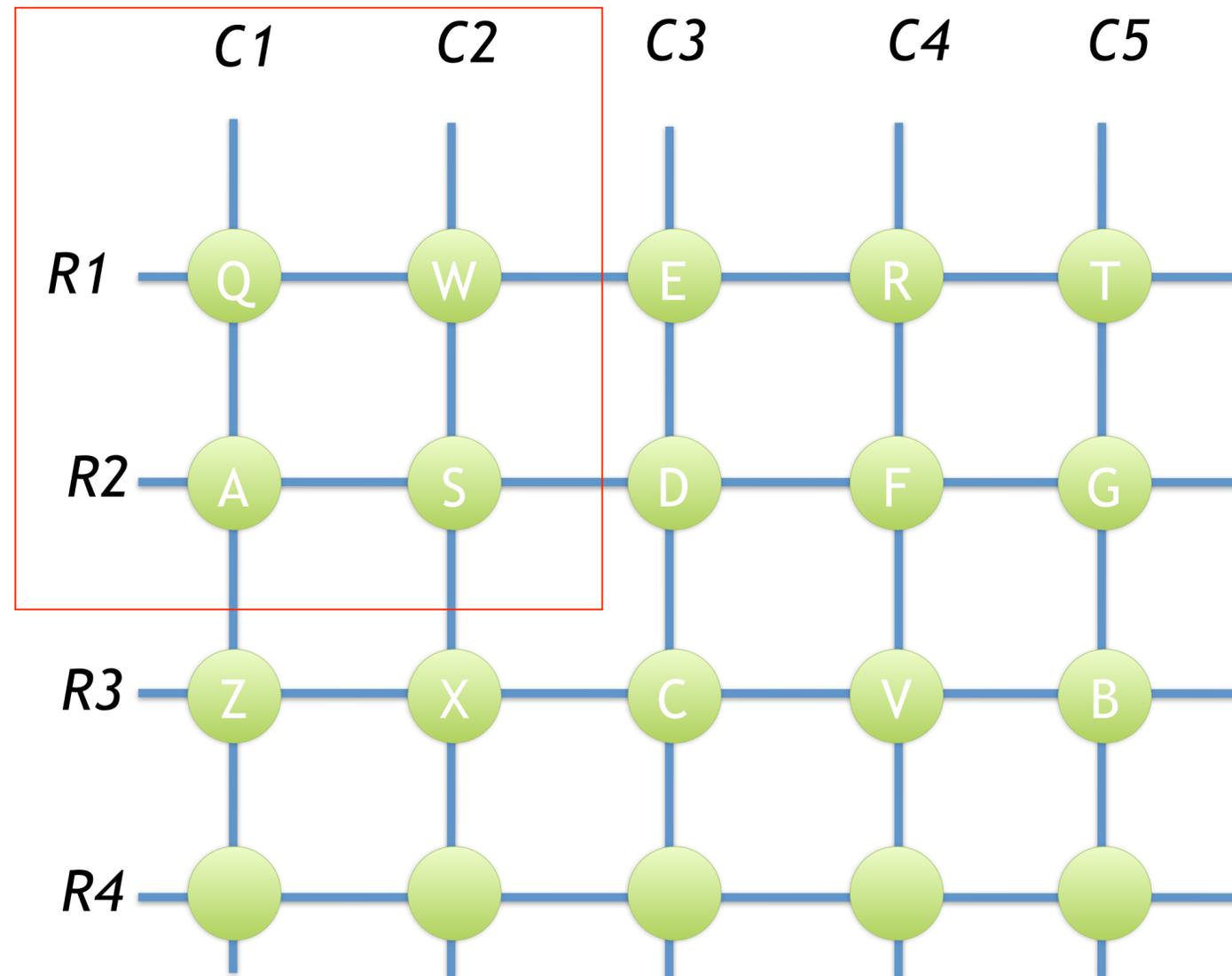
Keyboard Encoder



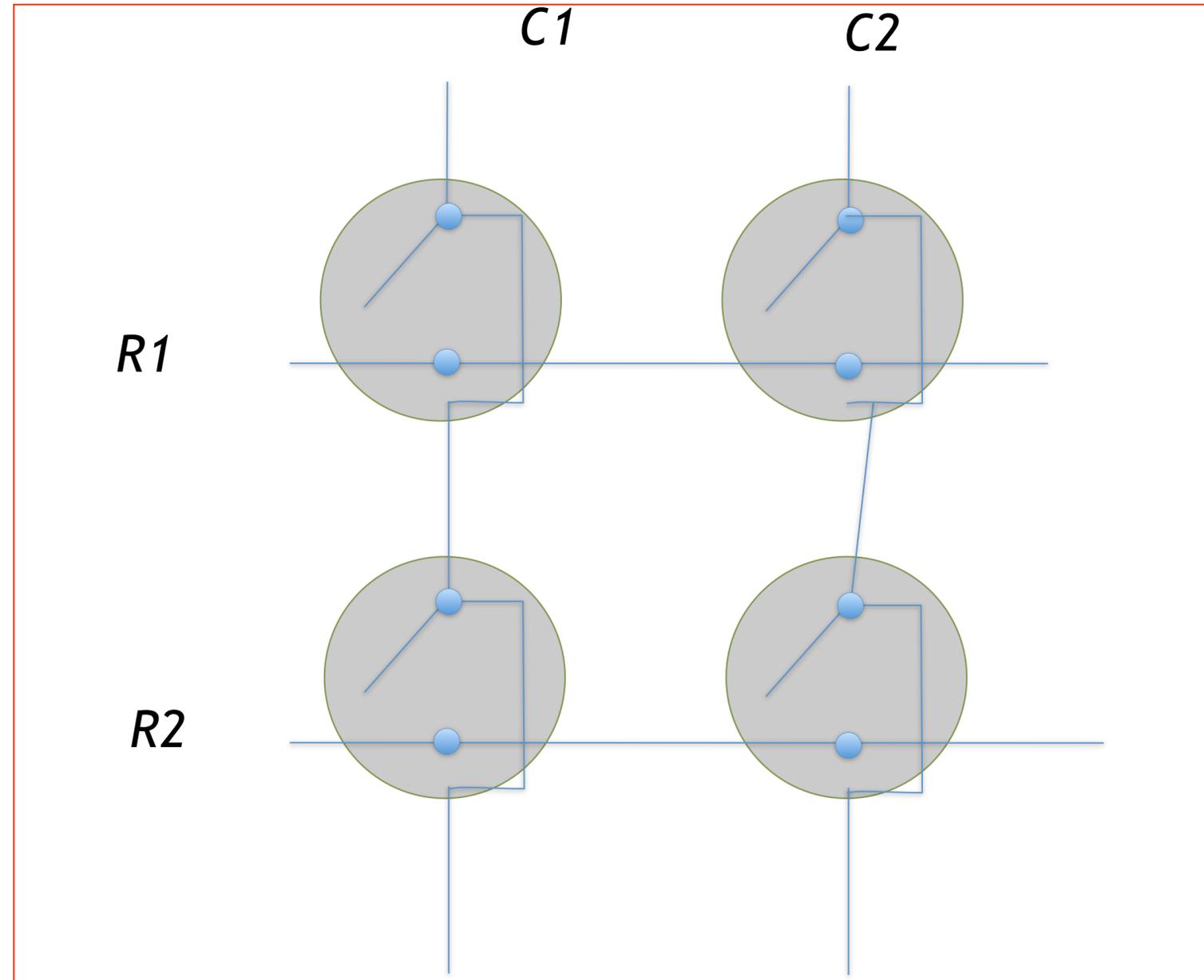
Row/Column Scanning

9 lines

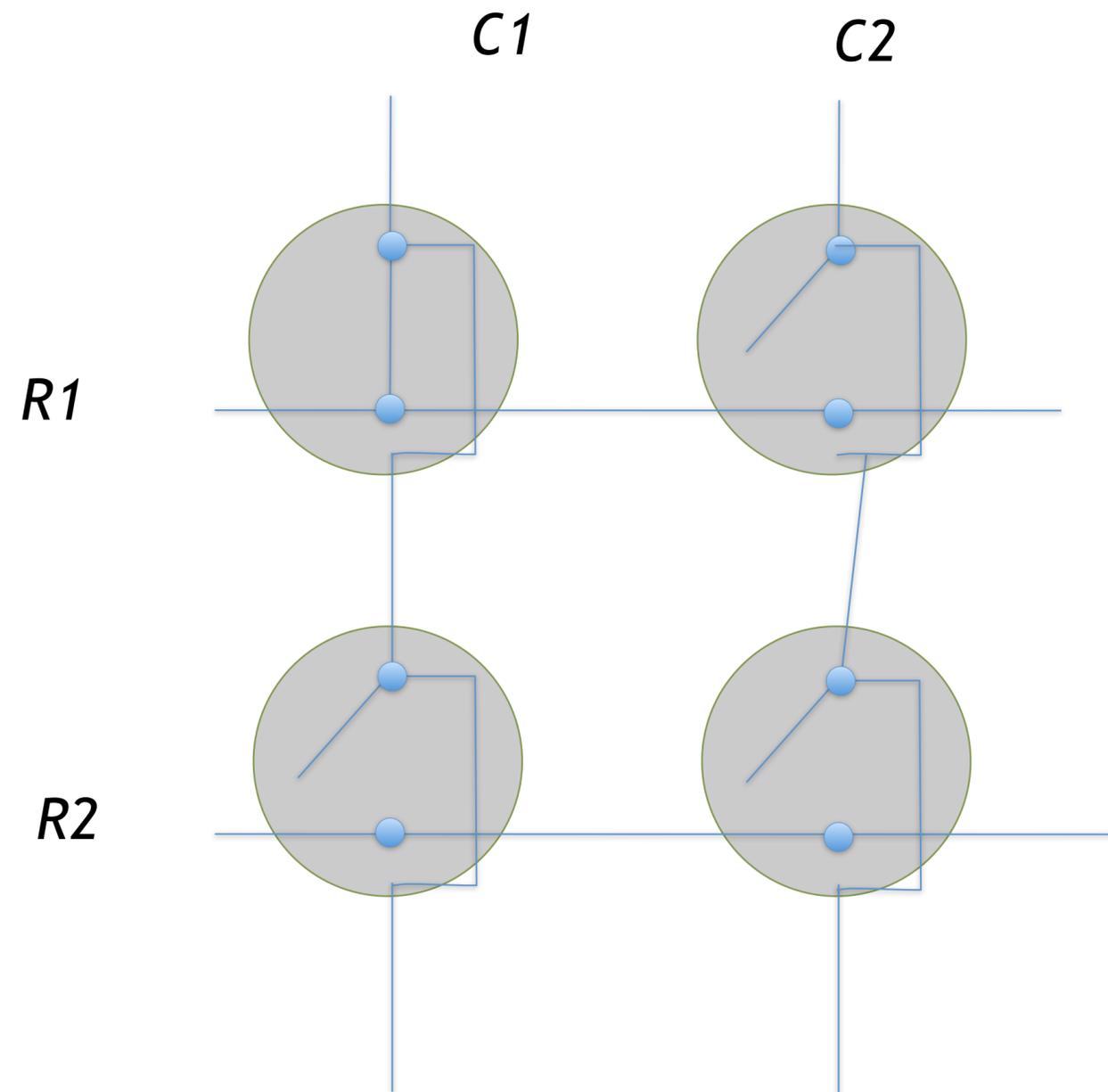
20 keys



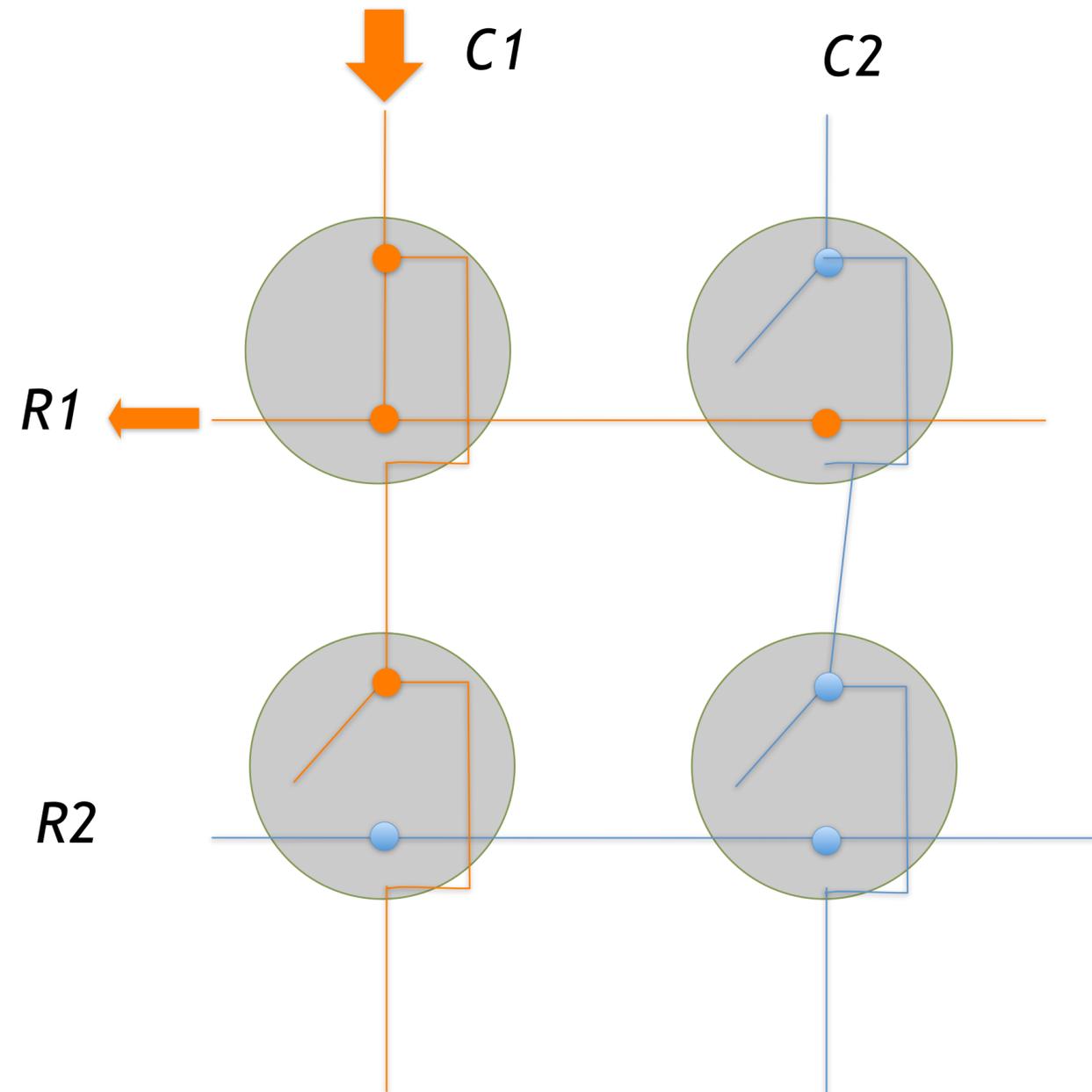
Closeup



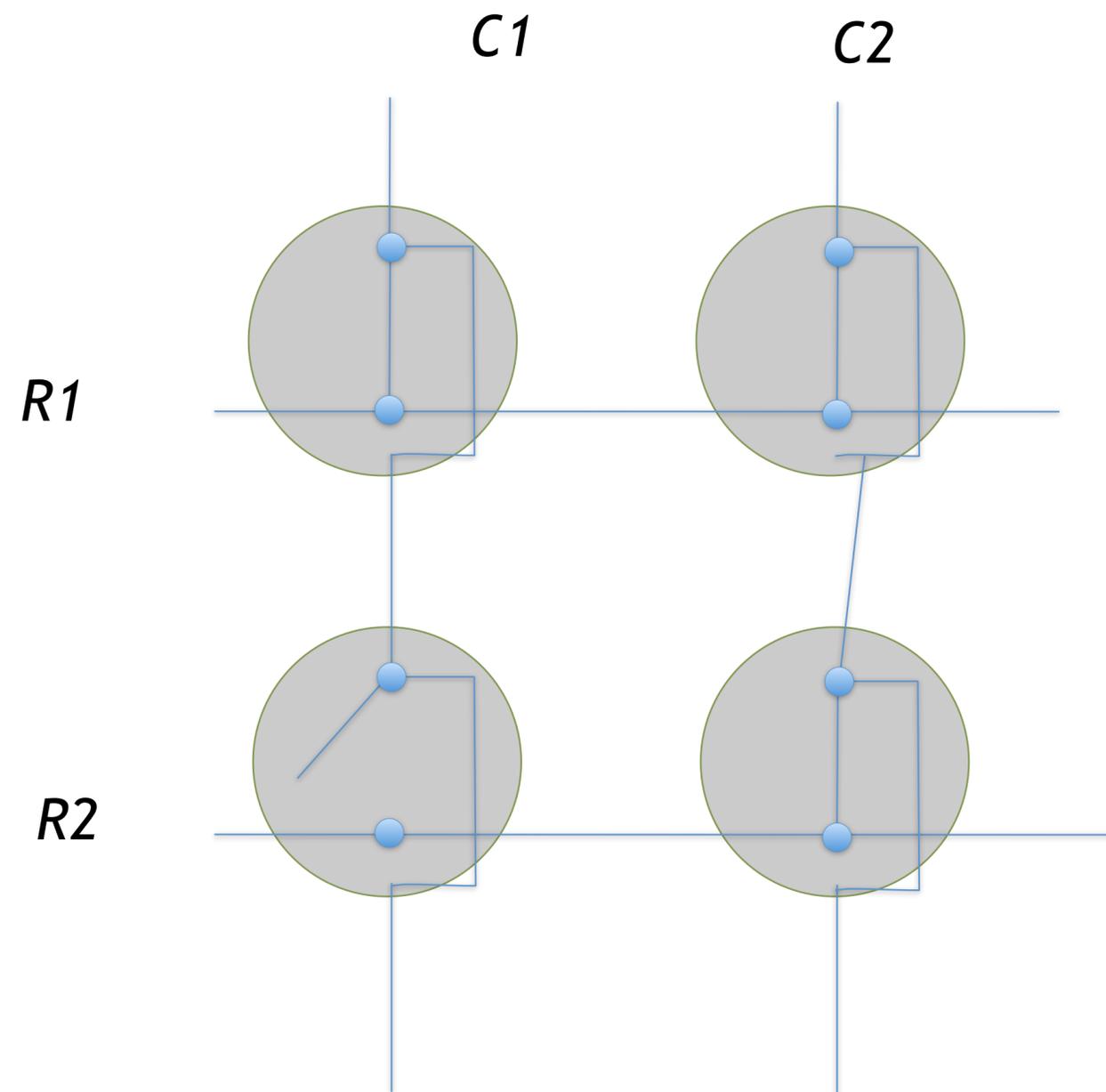
One Key Down



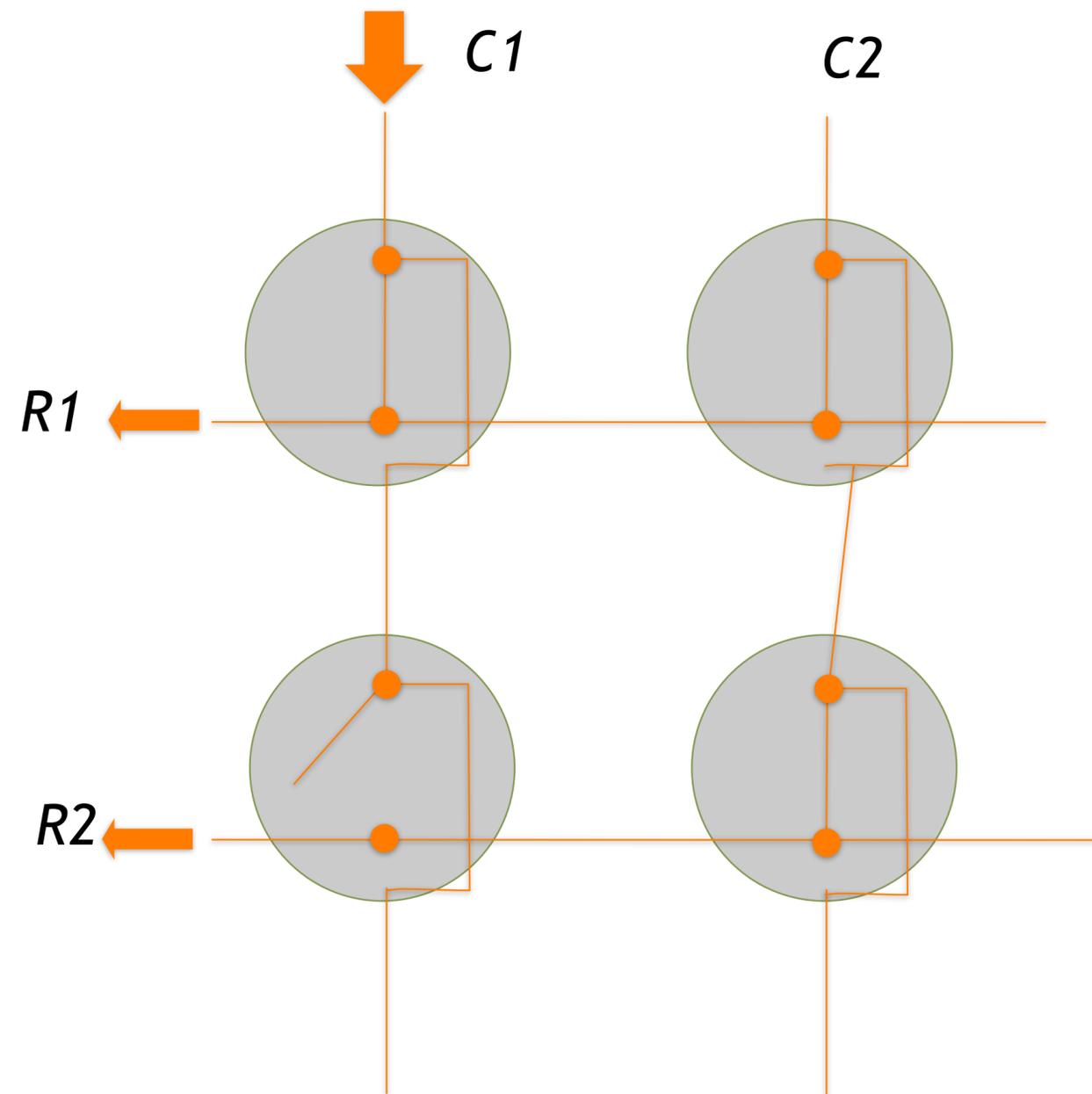
One Key Down



3 Keys Down



3 Keys Down



Keys → Scan Codes



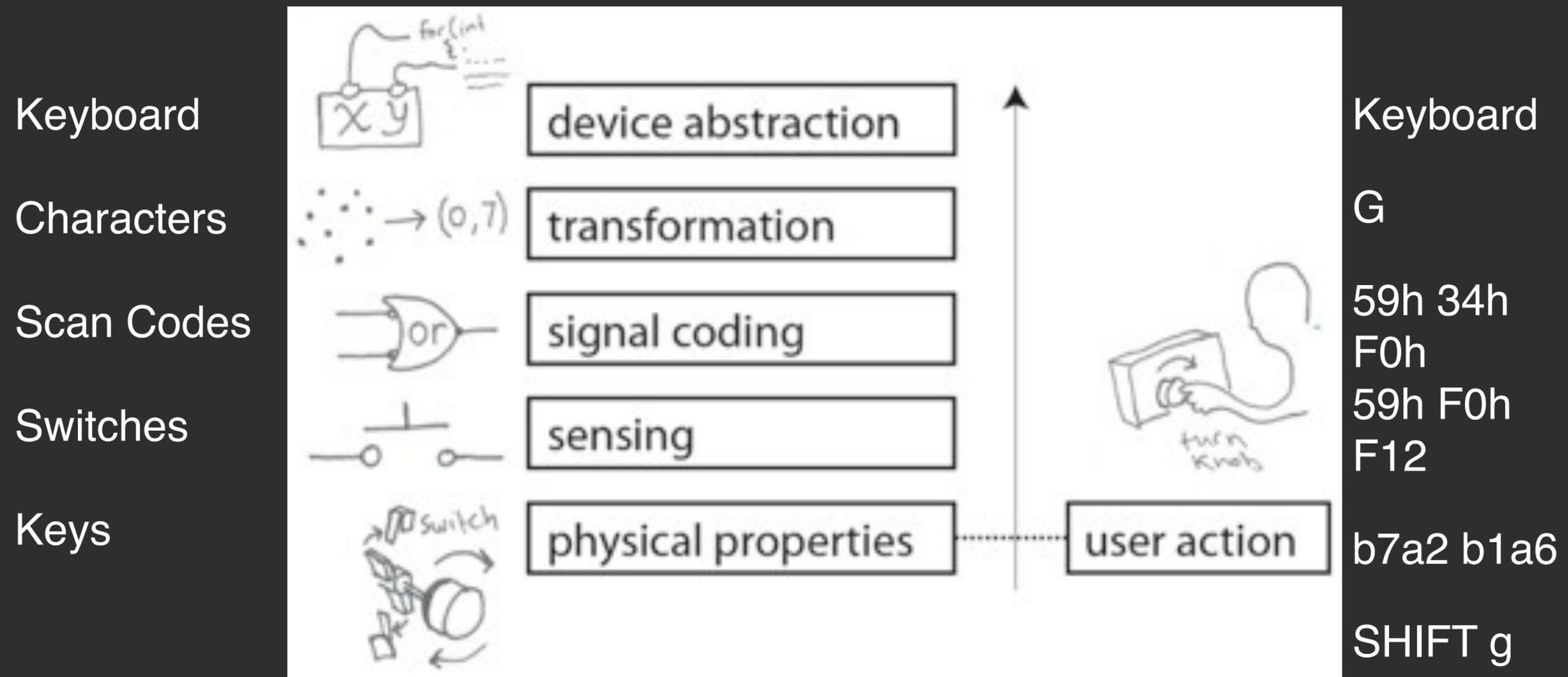
Make (onPress) and Break (onRelease) codes

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

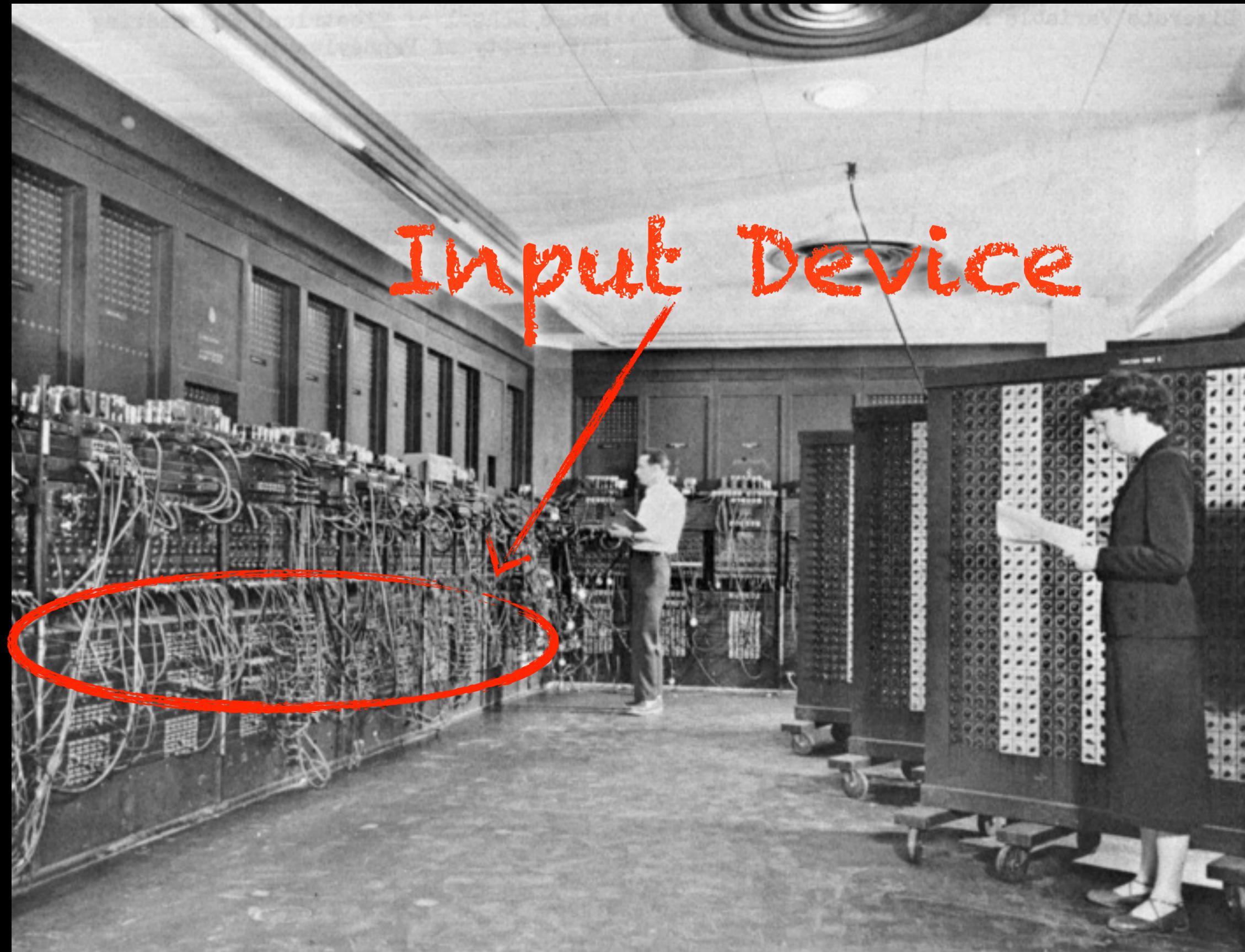
Keys (Scan Codes) != Characters

- 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



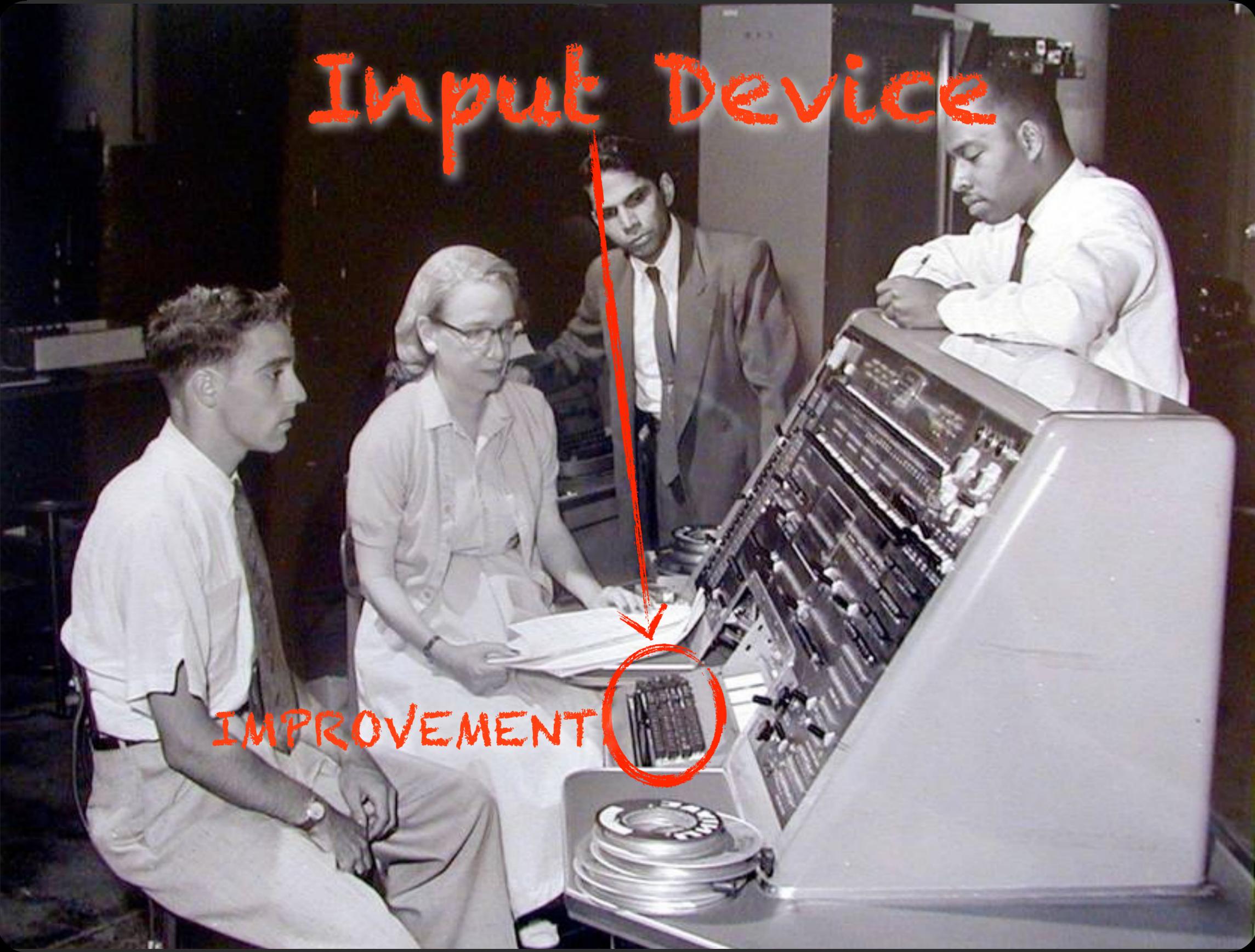
Input Device



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.”



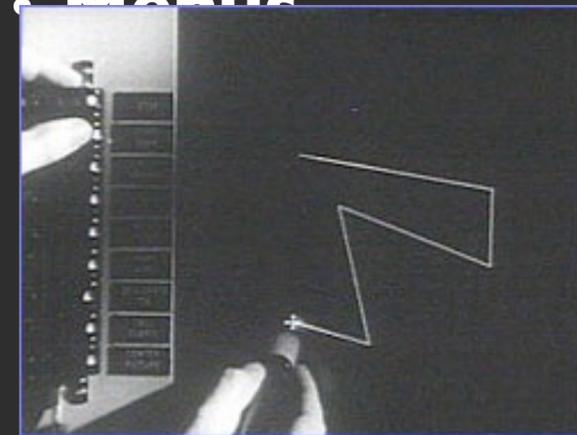
Graphical Direct Manipulation

SKETCHPAD (1963)



TX-2 (MIT, 1959)

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



Changing visual element
part of interaction loop

Lightpen

Point and Click, Hypertext

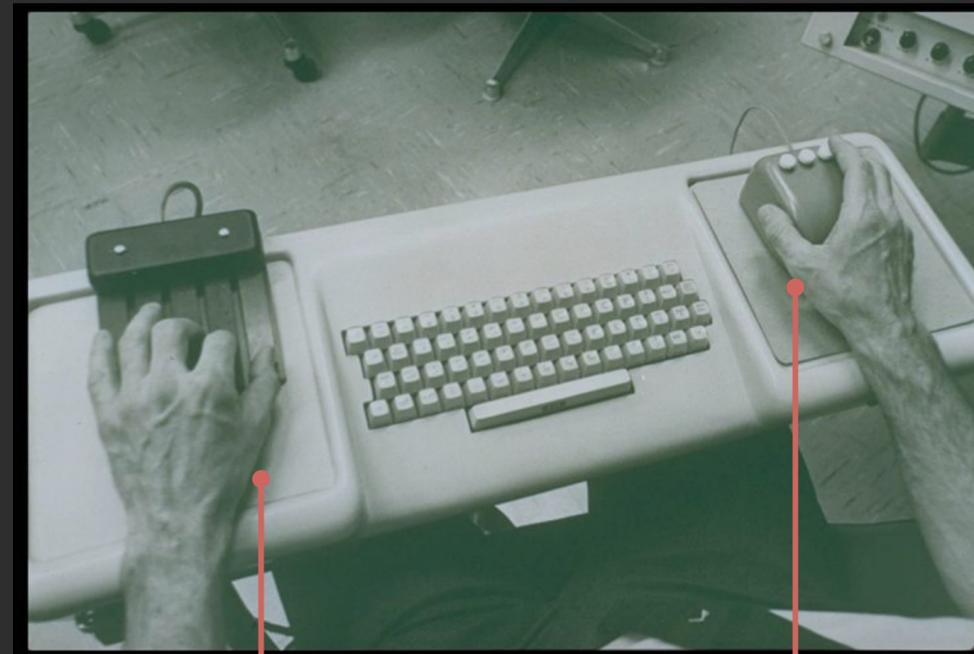
NLS (SRI, 1968)

- 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/>



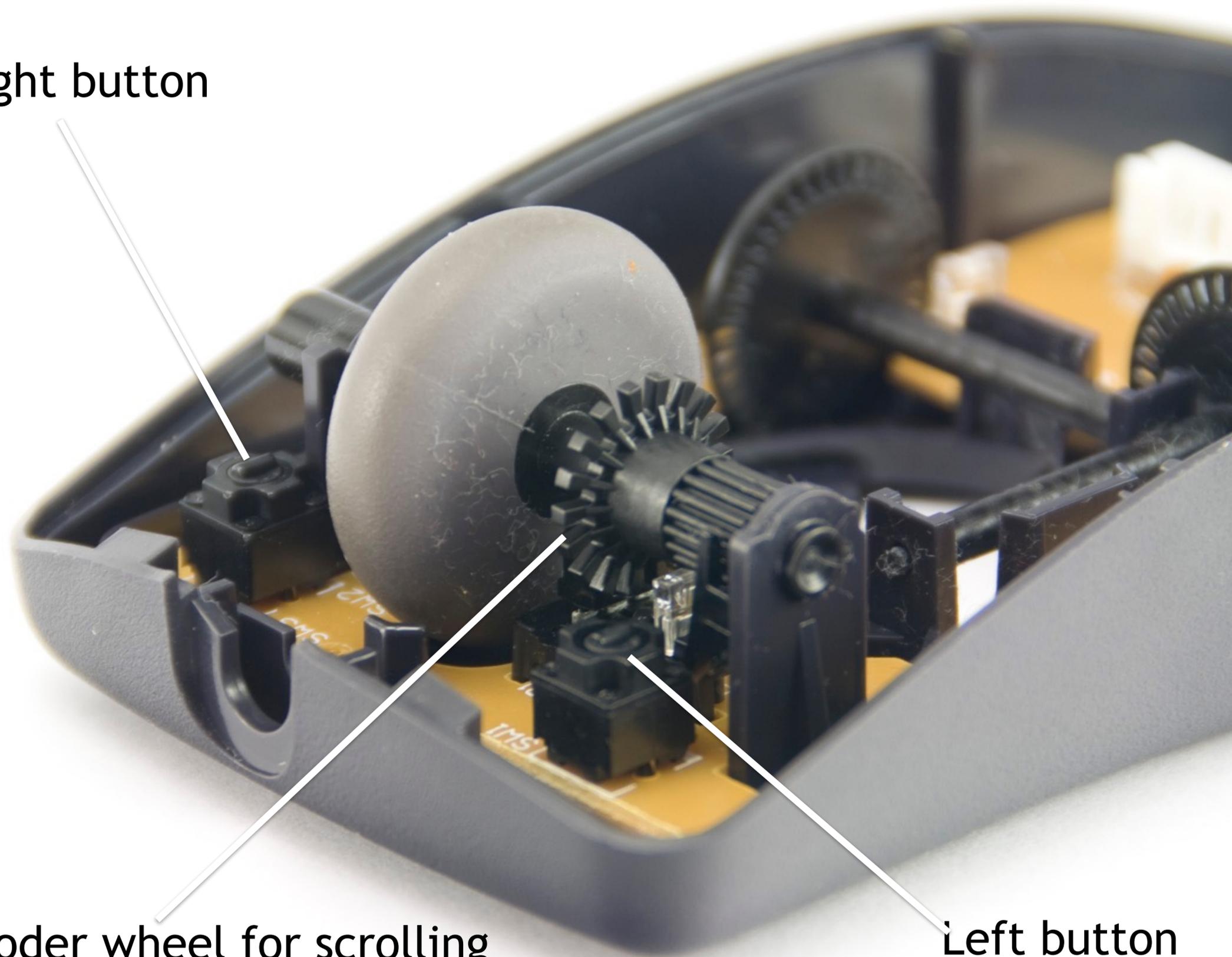




Right button

Encoder wheel for scrolling

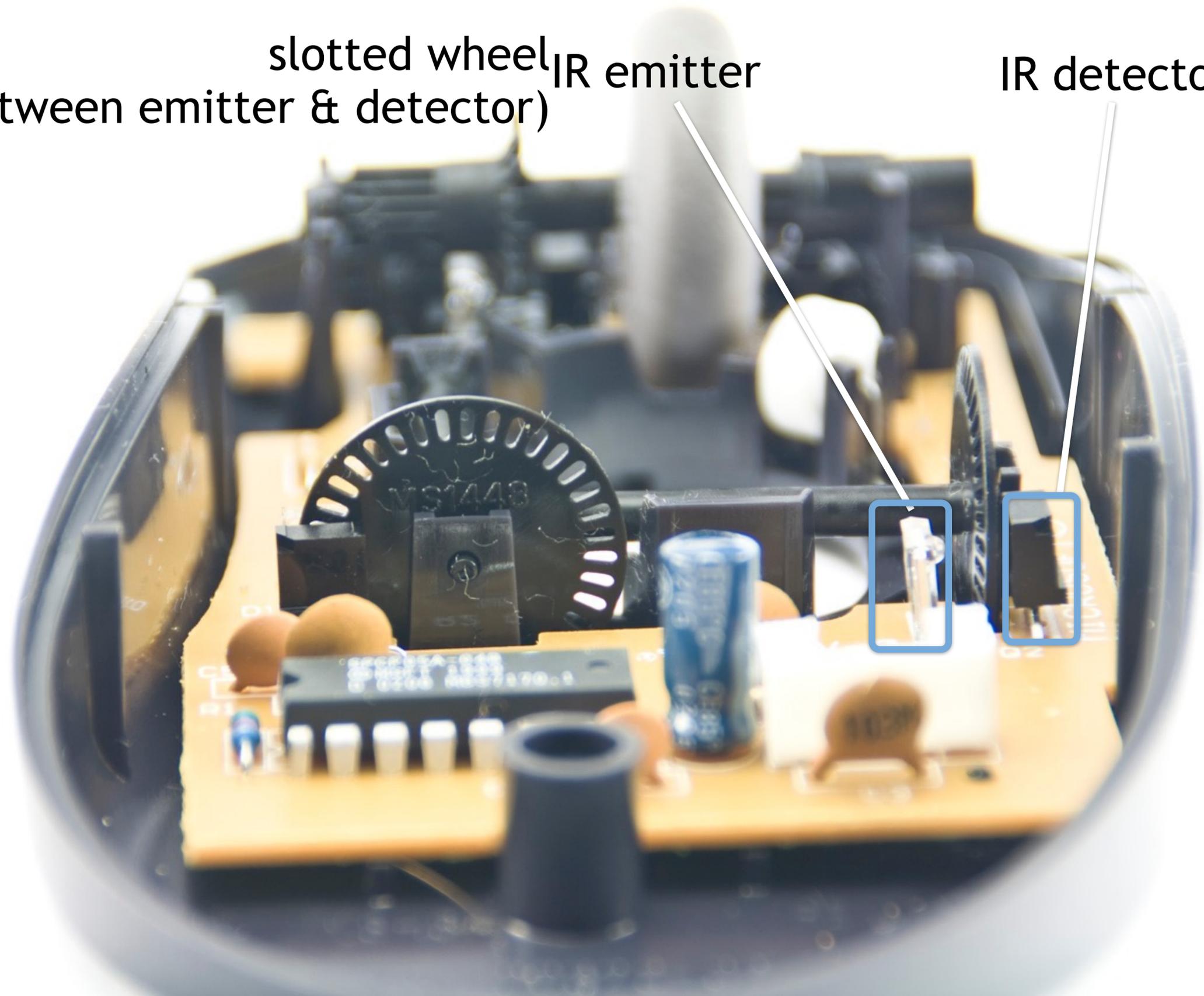
Left button



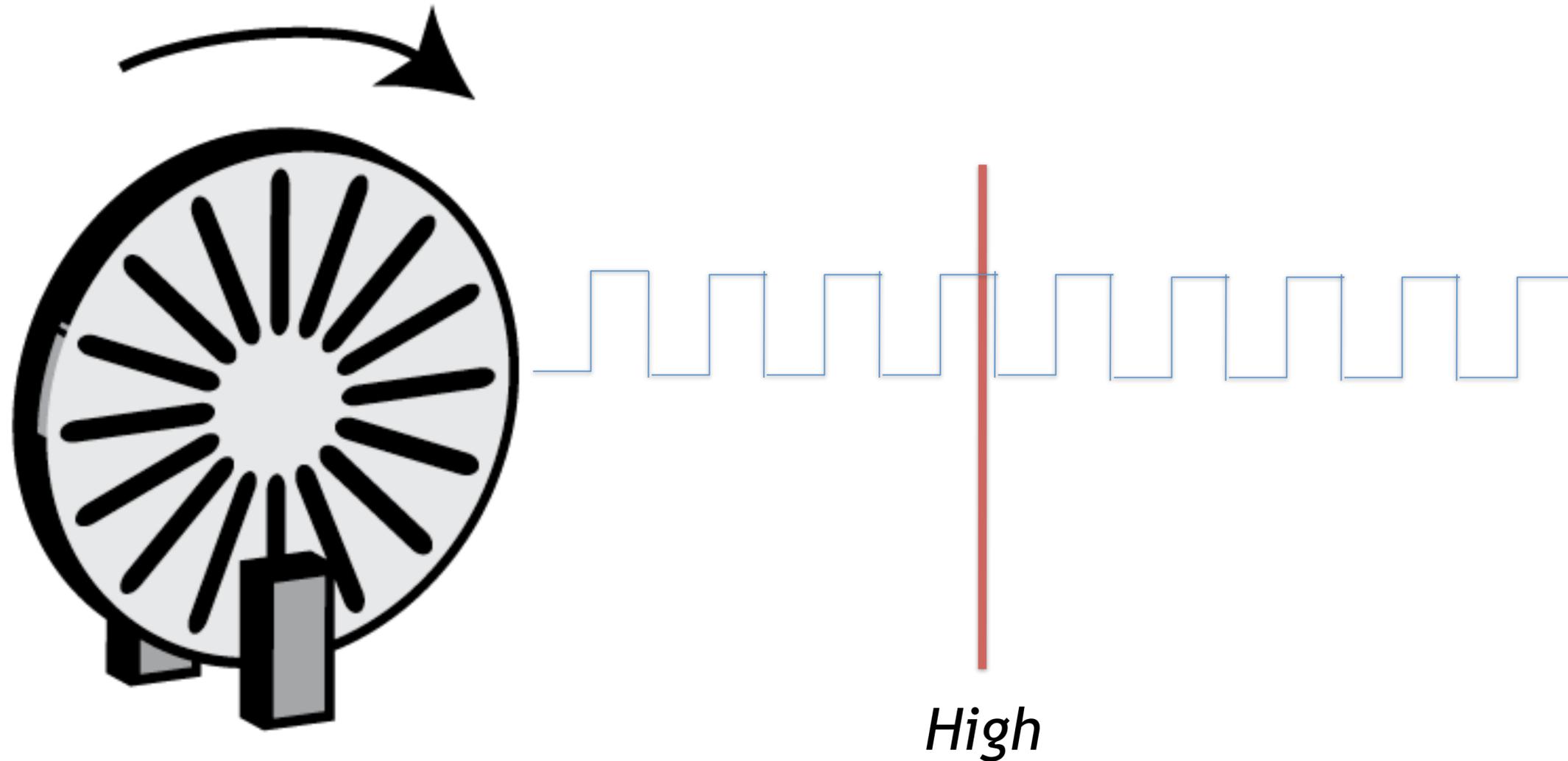
slotted wheel
(between emitter & detector)

IR emitter

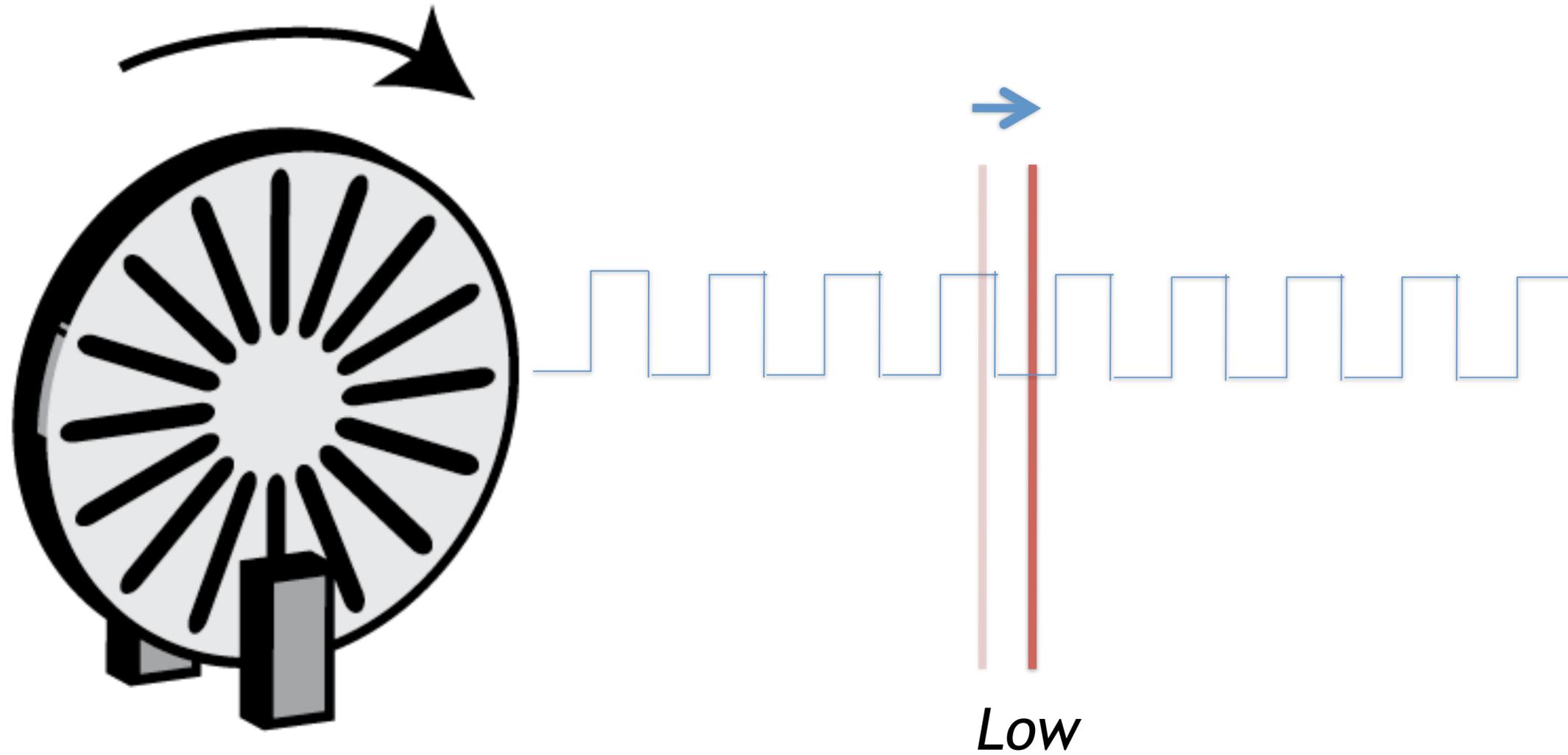
IR detector



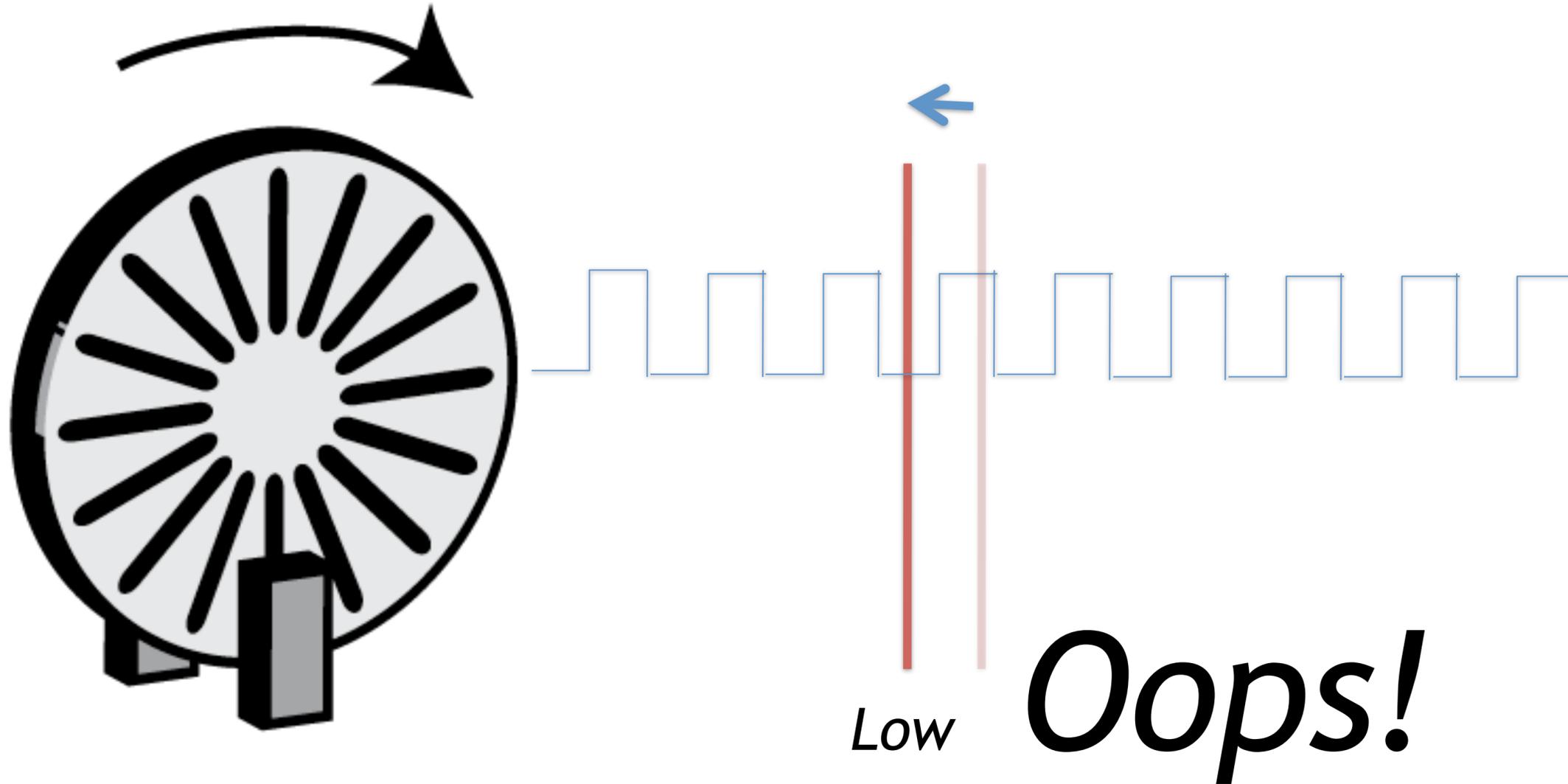
Sensing: Rotary Encoder



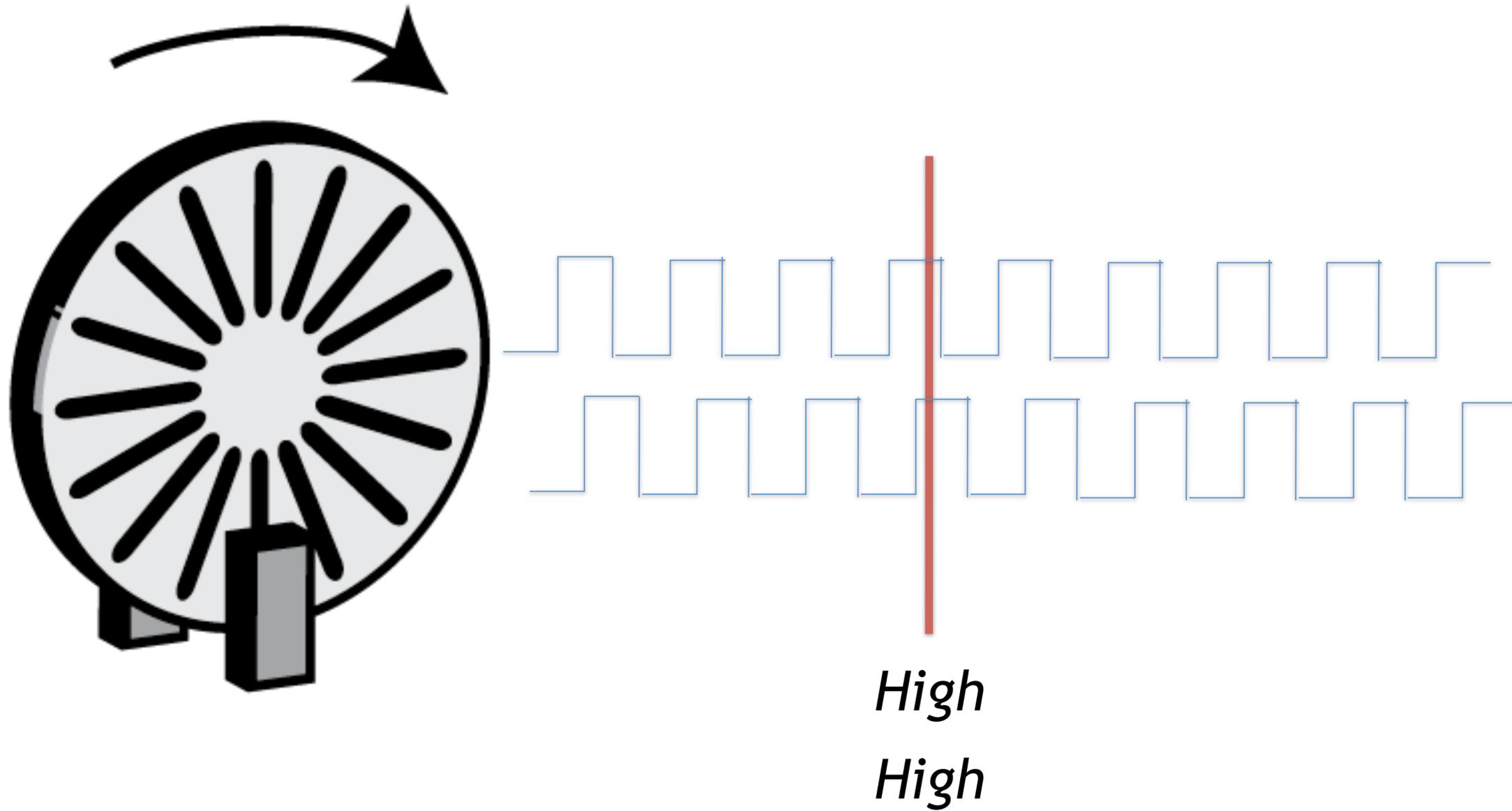
Sensing: Fwd Rotation



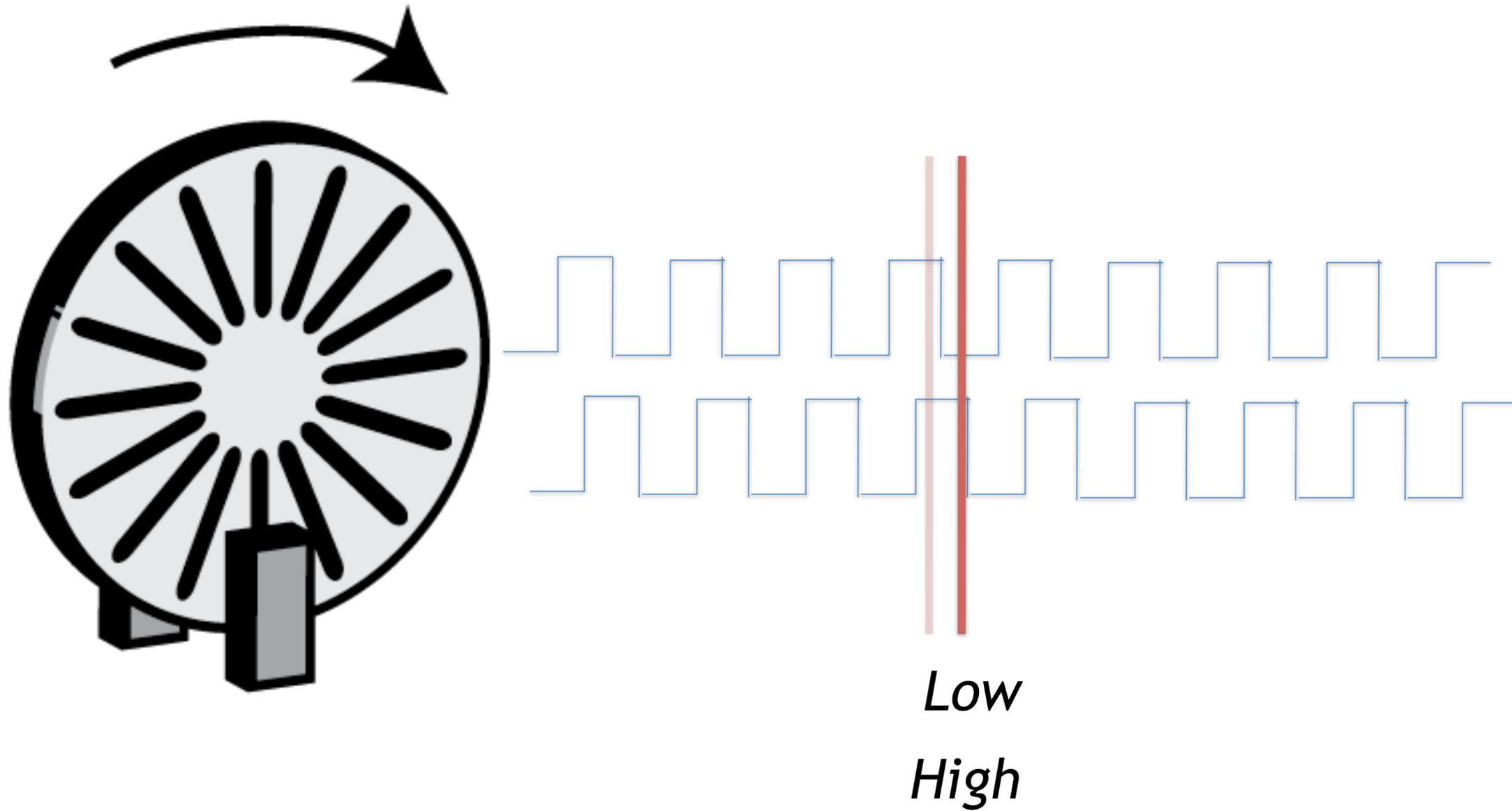
Sensing: Backwd Rotation



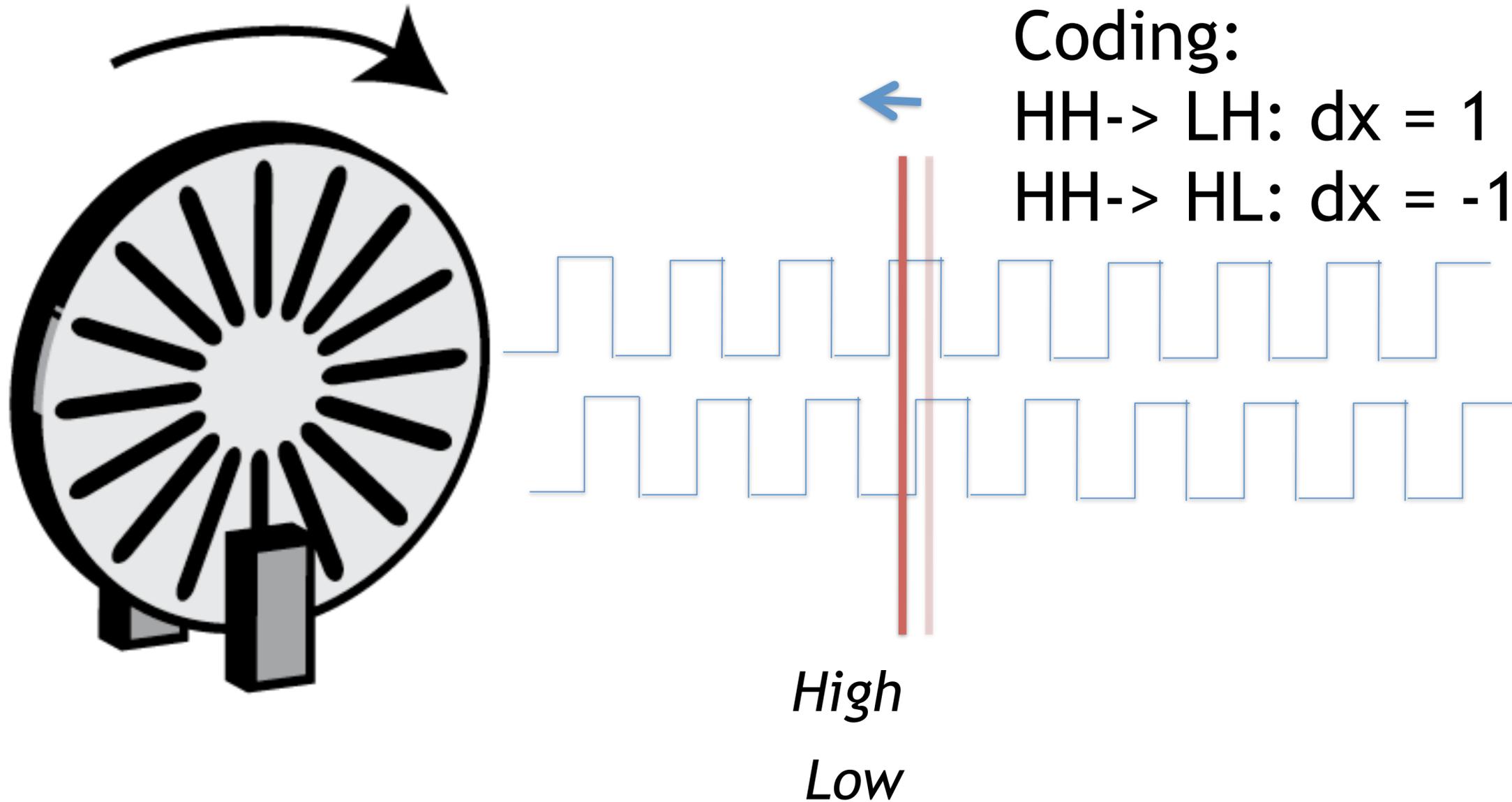
Solution: Use two out-of-phase



Sensing: Rotary Encoder



Sensing: Rotary Encoder



Transformation

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

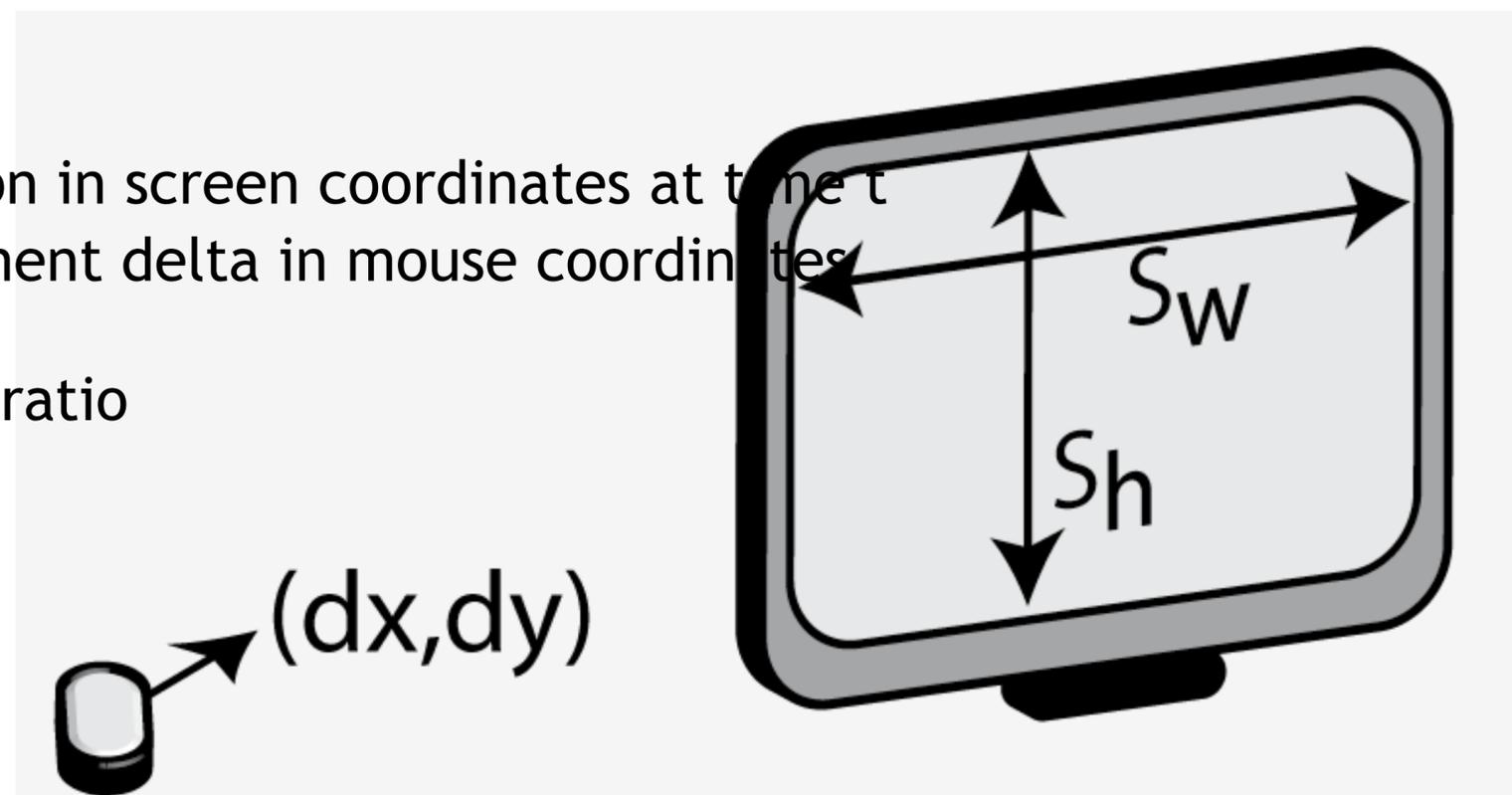
$$cy_t = \dots$$

cx_t : cursor x position in screen coordinates at time t

dx : mouse x movement delta in mouse coordinates

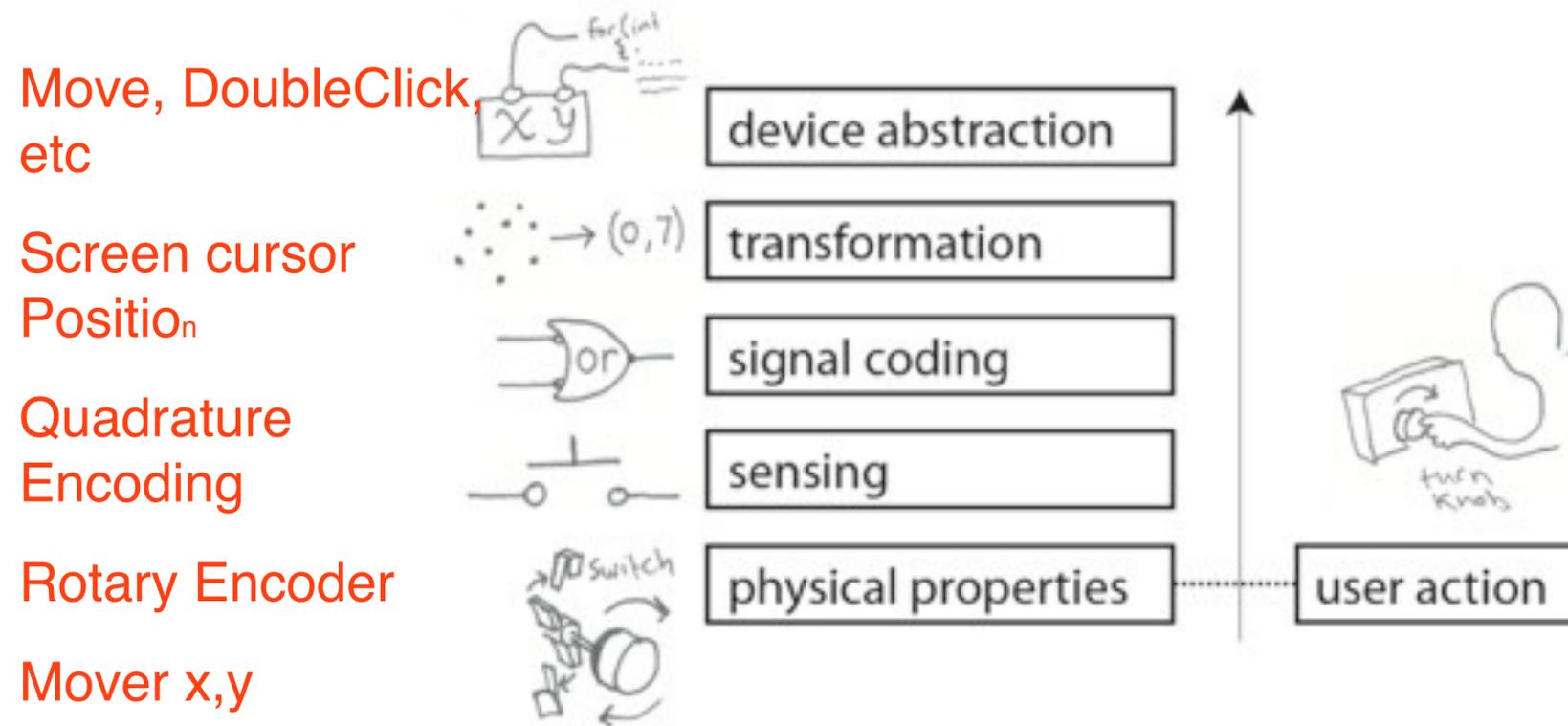
sw : screen width

cd : control-display ratio



Optical Mouse

Layered Model of Input



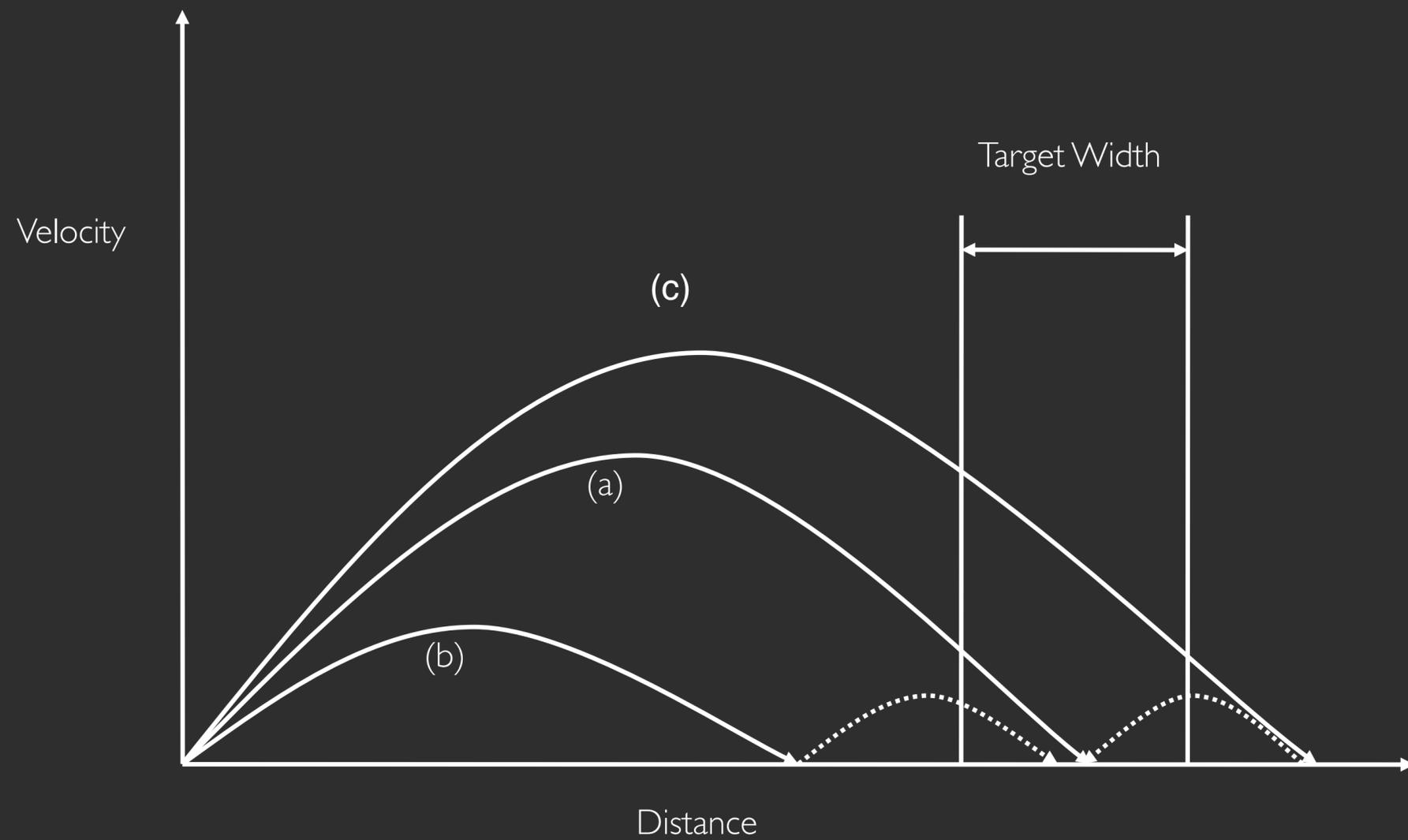
How about People?

Can we model
human performance?

Principles of Operation

- Fitts' Law
 - Time T_{pos} to move the hand to target size S which is distance D away is given by:
 - $T_{pos} = a + b \log_2 (\text{Distance}/\text{Size} + 1)$
 - 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

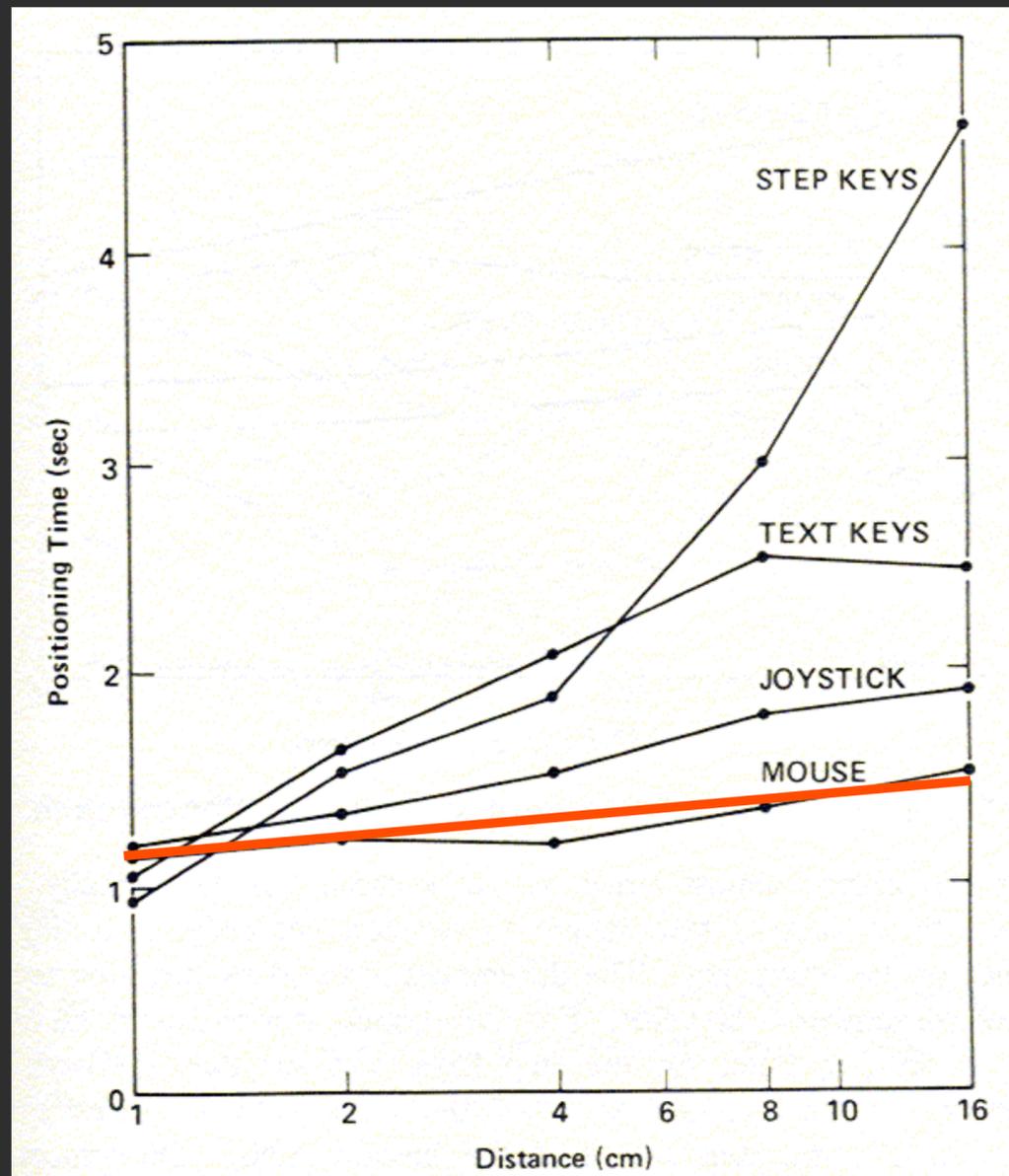
A design space of input

Table I. Physical Properties Used by Input Devices

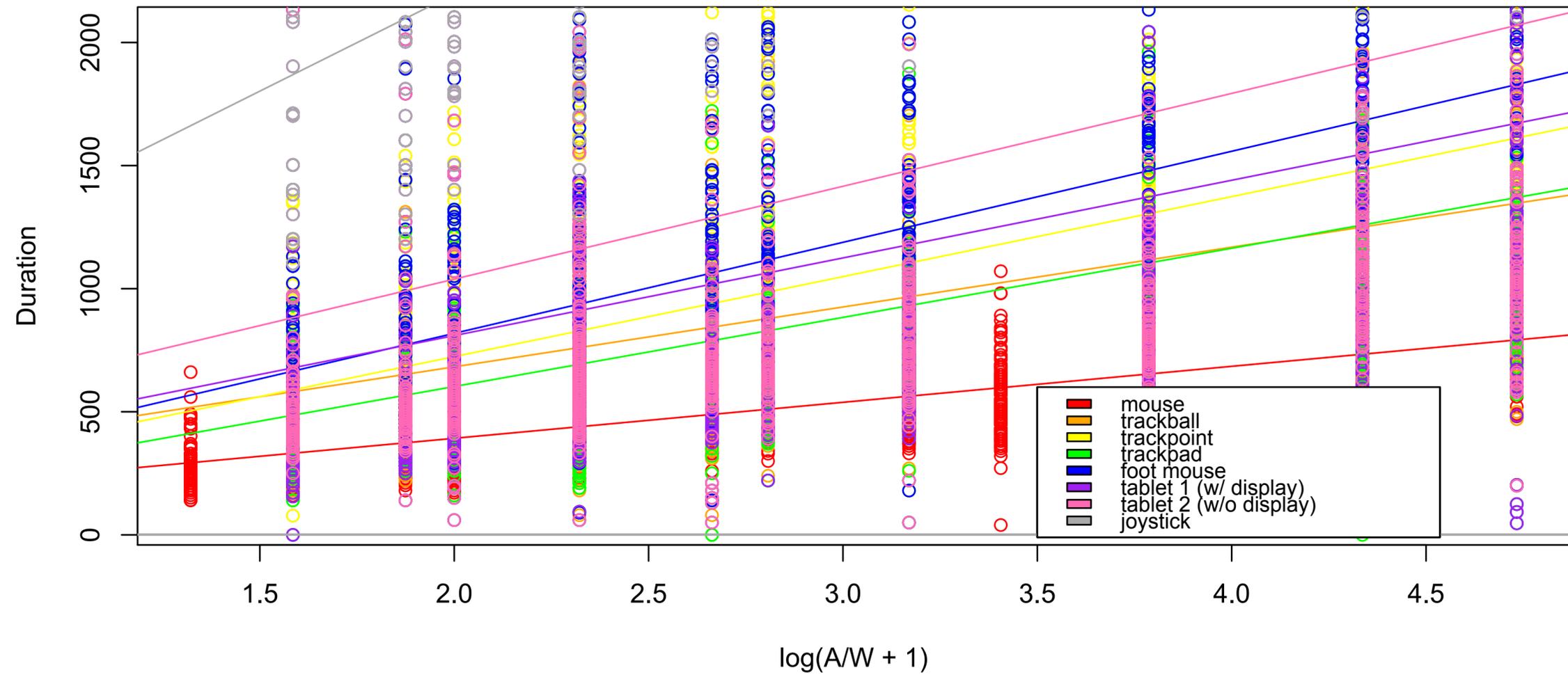
	Linear	Rotary
Position		
Absolute	Position P	Rotation R
Relative	Movement dP	Delta rotation dR
Force		
Absolute	Force F	Torque T
Relative	Delta force dF	Delta torque dT

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

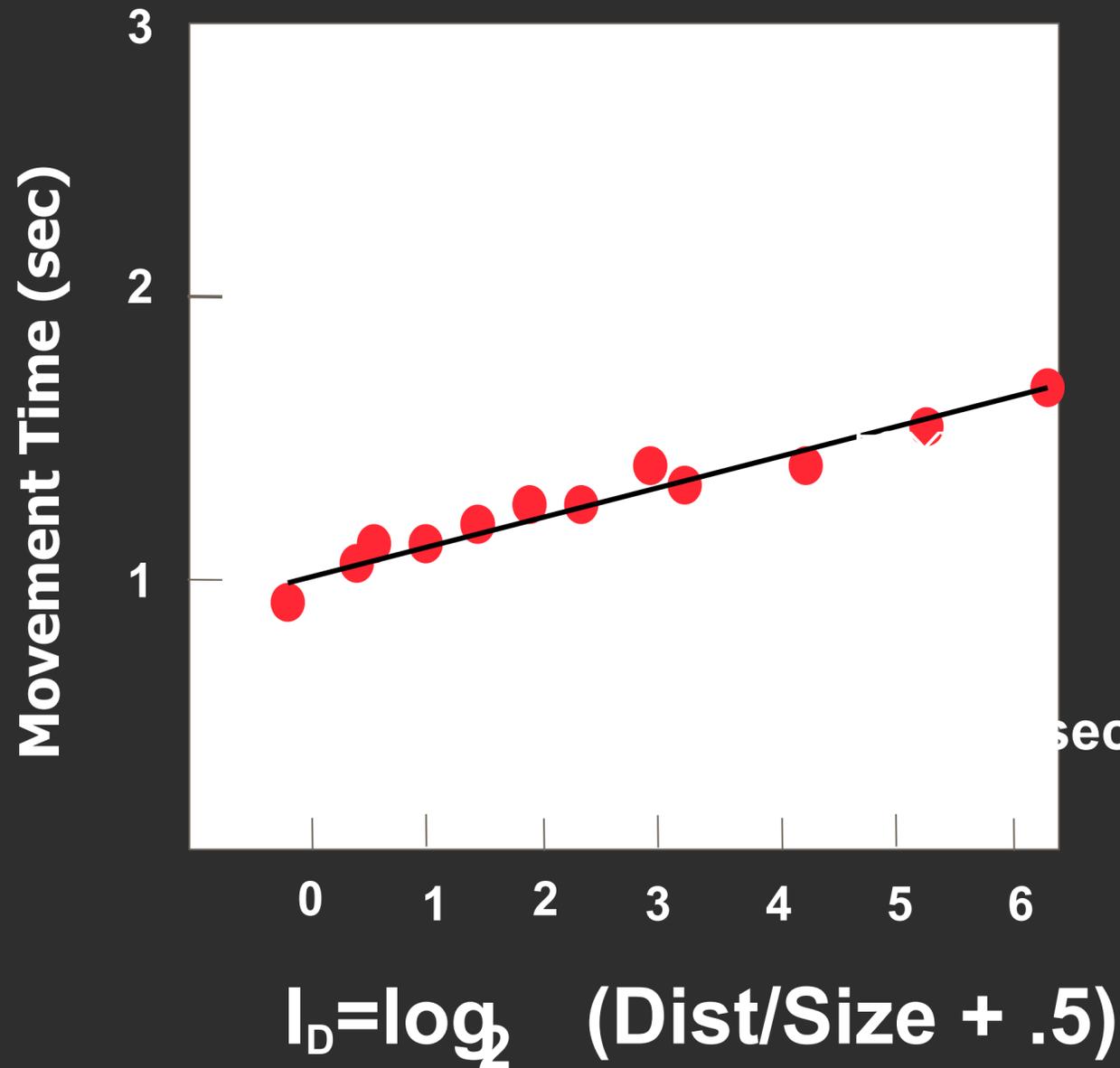
EXPERIMENT: MICE ARE FASTEST



Fitts' Law for Eight Devices



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:

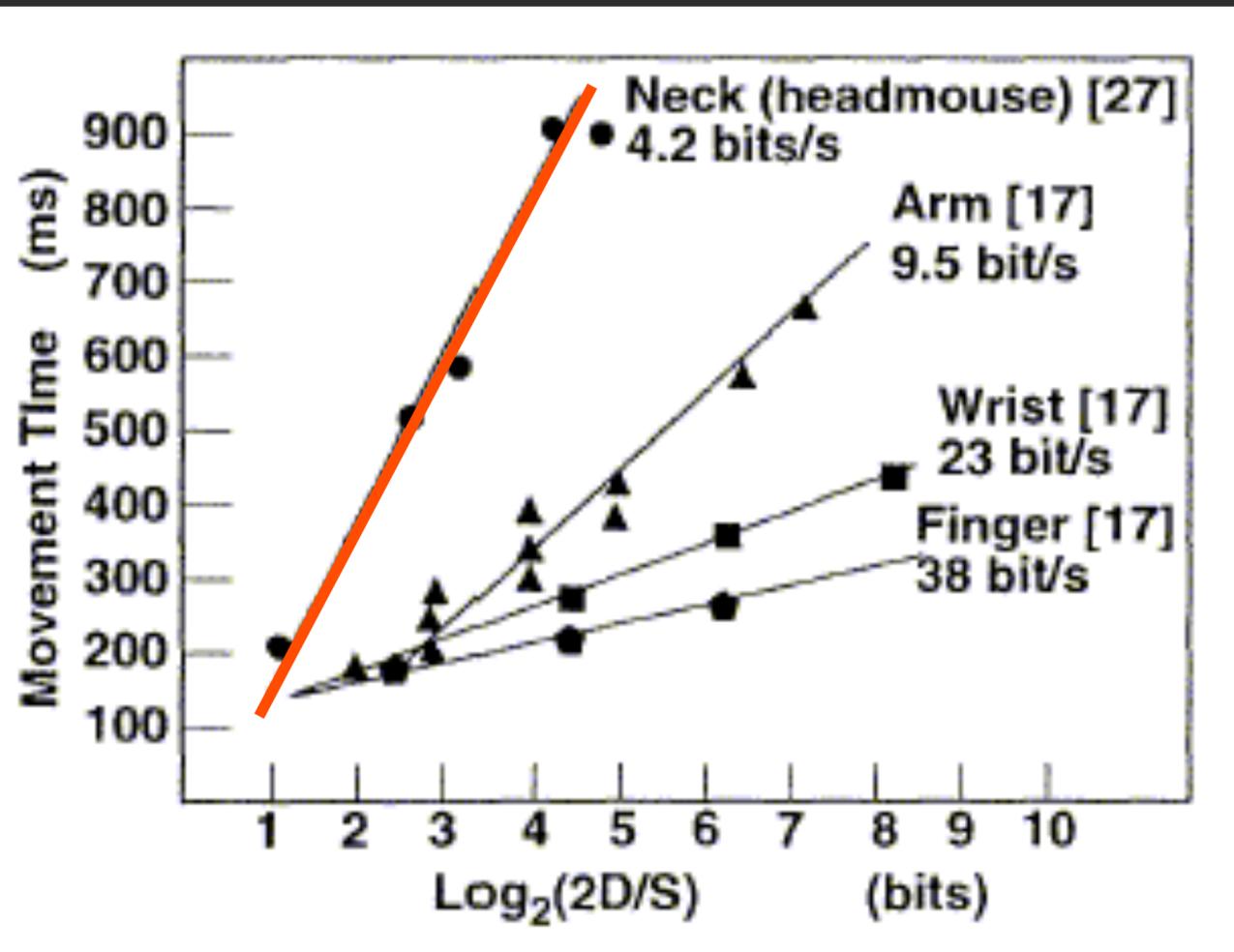
Mackenzie, I. Fitts' Law as a research and design tool in human computer interaction. Human Computer Interaction, 1992, Vol. 7, pp. 91-139

EXAMPLE: ALTERNATIVE DEVICES



**Headmouse: No chance to
win**

ATTACHING POINTING DEVICE



Use transducer on high bandwidth muscles

Faster Input: Menu Selection

Faster Input: Menu Selection

Pop-up Linear Menu

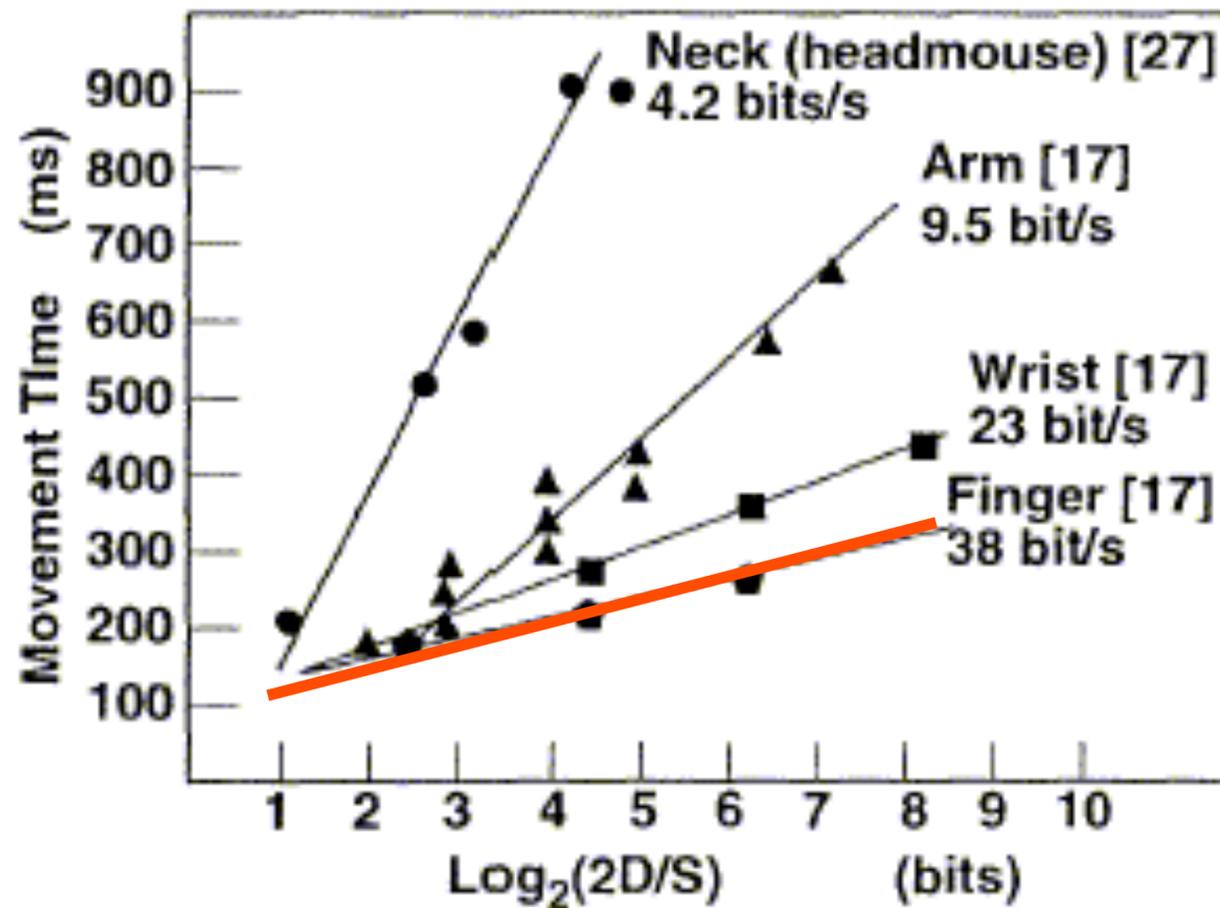
Today
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday



Try To Hit a Target Without Looking

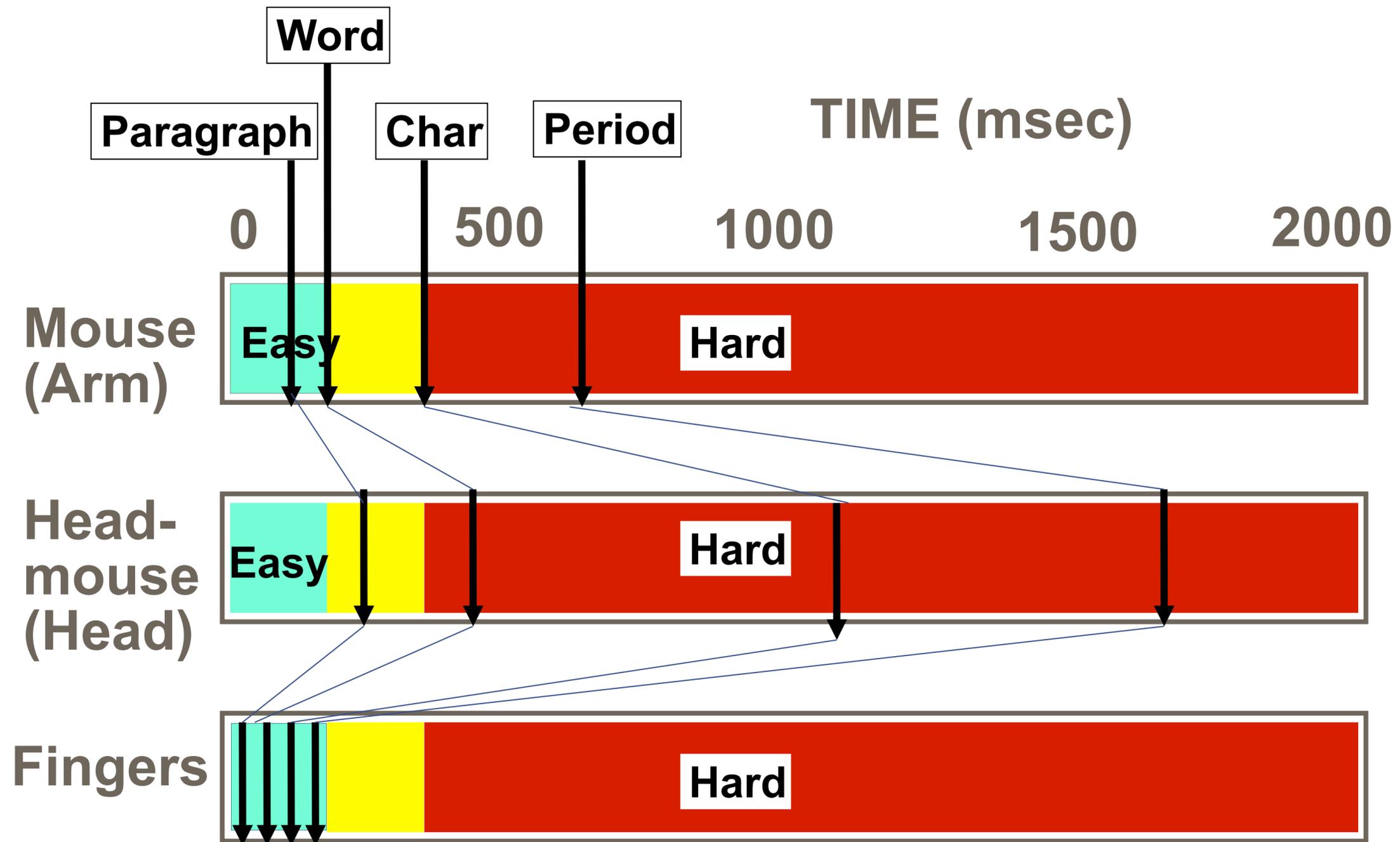
- You can open your eyes after each step
- Then, try it for both a mac-style and windows-style menu bar

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

[Long narrow keycap]