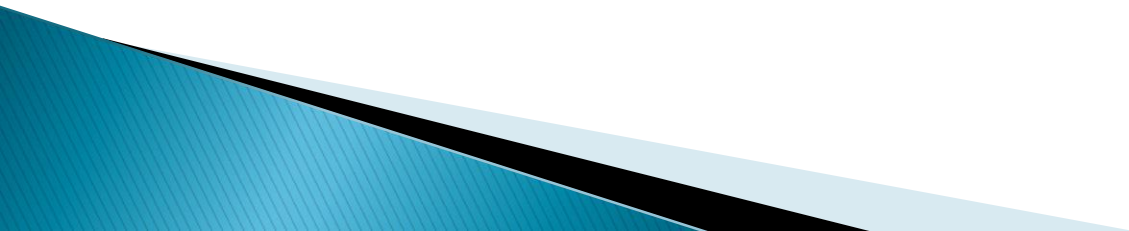Professors d'IDI - UPC

IDI – Interaction Design (I)

Motivation

Already seen:

- Usability & Design Principles
- Perception Laws

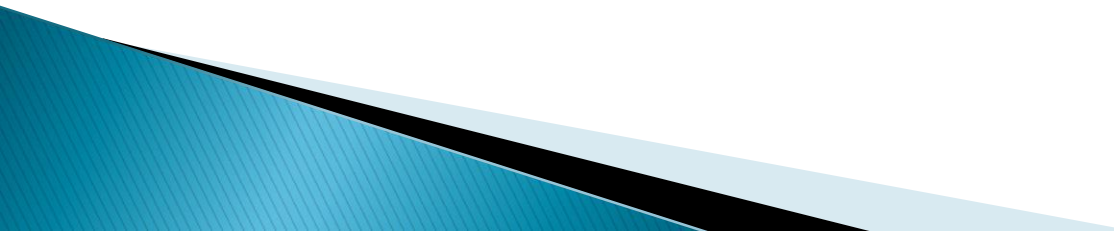Direct Manipulation Interfaces:
- Pointing,
- choice selection

- Interaction Design and Evaluation:
  - Design User Interfaces
  - Measure/Predict performance
  - Design interaction

Outline

Session 1:

- Understanding the fundamentals of basic interaction in UI
- Fitts' Law in UI Design
- Exercises

Session 2:

- Typing & Keyboards
- Pointing Devices
- Mobile Interaction Design
- Exercises

Outline

Session 1:

- Understanding the fundamentals of basic interaction in UI
  - **Background (Information Theory)**
  - Hick–Hyman Law: *Measuring Choice–Reaction Time*
  - Fitts' Law: *Measuring Pointing Time*
  - Crossing and Steering Laws: *Continuous Gestures*
- Fitts' Law in UI Design
  - Applications in UI Design
 - Accelerating Target Acquisition
- Exercises

Background. Basics

▶ **Information Theory**:

◦ Due to <u>Claude E. Shannon</u>

  • *A Mathematical Theory of Communication* (1948)

◦ Based on previous works by Nyquist and Hartley

◦ Analysis of transmission of electrical signals for telegraphic communication

◦ <u>Shannon Entropy measures</u>:

  The amount of information to be transmitted by a message

Background. Basics

▸ Information Theory. Elements (telegraph):
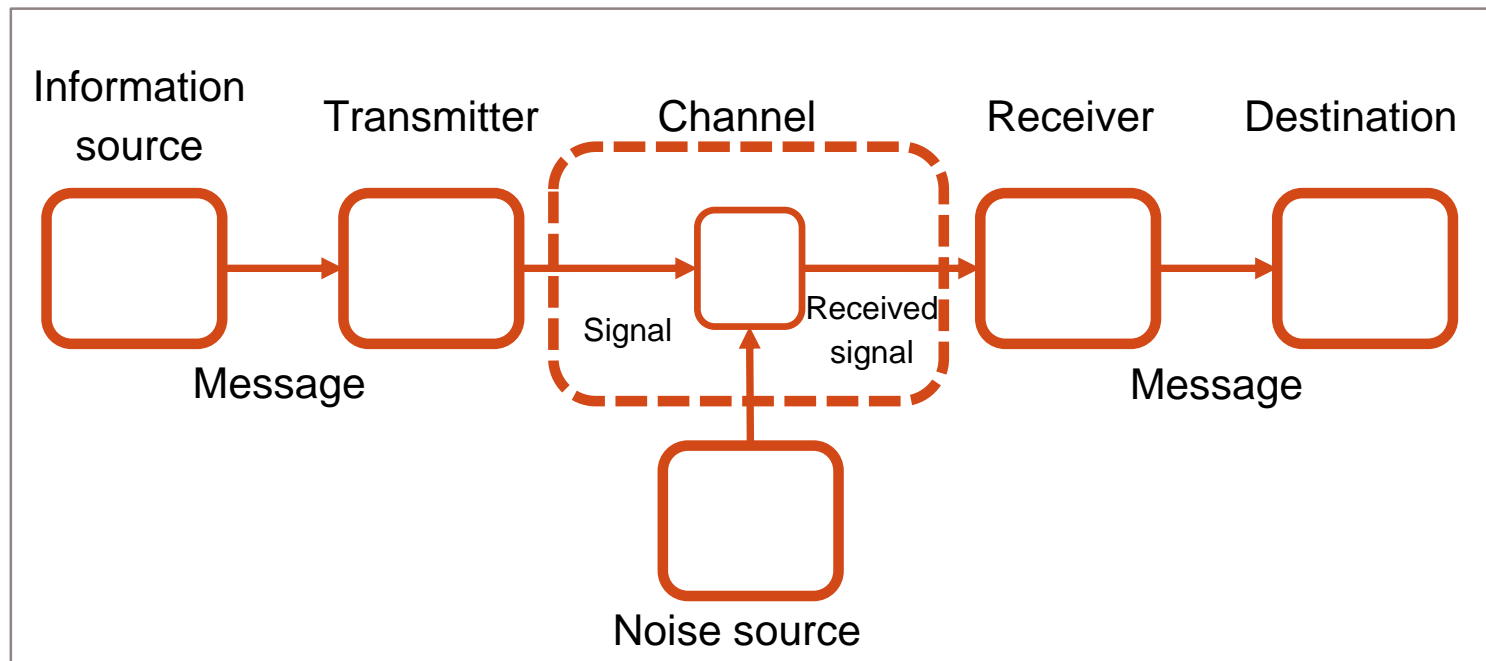
Background. Basics

- Information Theory. Elements (telegraph):
  - **Information source:** The element that produces a message or sequences of message.
  - **Transmitter:** Operates on the message to make it transmissible through a medium.
  - **Channel:** The medium that transmits the message.
  - **Receiver:** The element that reconstruct the message to the destination.

Background. Information measures

▶ Let *d* be a device that produces symbols A, B, C and D with the same probability

  ◦ M = 4 is the total number of symbols

  ◦ Each time a symbol is produced we are <u>uncertain</u> on which symbol is going to be generated

    • This uncertainty is not so big, since there are only four possibilities

  ◦ The <u>probability of a symbol to appear is 1/M : 1/4</u>

▶ The **uncertainty** is measured by $\log_2(M)$ ➜ here $\log_2(4) = 2$ bits

▶ Logarithms are commonly taken in base 2, and the units are bits.

Background. Information measures

- Example 1: Let *d* be a device that produces one single symbol: C
  - **M = 1** is the total number of symbols
  - We have **no uncertainty** and **$\log_2(1) = 0$**
  - The probability of getting the symbol C is 1
  - We previously know which symbol will appear!

- Example 2: Let *d* and *e* be two devices, one with outputs A, B, C, and the second with outputs 1, 2.
  - We combine *words* by concatenating one symbol of device *d* and one with device *e.*
  - We will have 6 different words: A1, A2, B1, B2, C1, C2
  - 6 symbols → uncertainty of $\log_2(6)$ → $\log_2(2) + \log_2(3) = \log_2(6)$.

- The uncertainty of combined the signals of a set of devices is the sum of their uncertainties.

Background. Information measures

- For M symbols with equal probability ➔ each symbol has probability P=1/M

  - Rewriting the uncertainty

$$\log_2(M) = \log_2\left(\left(\frac{1}{M}\right)^{-1}\right) = \log_2\left(P^{-1}\right) = -\log_2(P)$$
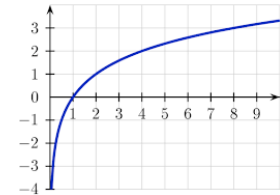
  - $-log_2(P)$ is called the **surprise** or *surprisal* of finding a certain symbol

  - We will use p_i from now on for the probability of a symbol i

- For M symbols that have different probabilities, we may have a different p_i for each, provided that

$$\sum_{i=1}^{M} p_i = 1$$

Background. Information measures

- **Information is the reduction of <u>uncertainty</u> or <u>average surprise</u> of a set of symbols**
  - ◦ Measuring the surprise for an *infinite* set of N symbols (produced by a device) ➔ the frequency of each symbol transforms to the probability.
  - ◦ Shannon Entropy measures the amount of information:

$$\mathrm{H} = \sum_{i=1}^{N} p_i \log_2 \left(\frac{1}{p_i} \right) = -\sum_{i=1}^{N} p_i \log_2 p_i$$

  - • *N* is the number of alternatives
  - • p_i is the probability of the *i*th alternative.
  - • H is the entropy of the message that is to be transmitted,

    ➔ the amount of information expected to be received (no noise).

Background. Information measures

- **Example 1: Source with two equiprobable symbols: A and B**
  - p(A)=0.5, p(B)=0.5
  - H= −0.5 $\log_2$ (0.5) − 0.5 $\log_2$(0.5) =− $\log_2$(0.5)=− $\log_2$(2^{-1})=1

→ The source requires an average of 1 bit per symbol.

- **Example 2: Source with two symbols: A and B**
  - p(A)=0.1, p(B)=0.9
  - H= −0.1 $\log_2$ (0.1) − 0.9 $\log_2$(0.9) = 0,332 + 0,137=0,47

→ The source requires an average of 0,47 bit per symbol.

Background. Information measures

p(A)=0.1, p(B)=0.9

H=0,47 bits → Is it possible? We can achieve it using a smart codification of the information. For instance:

| Symbols	Codification	Probability	Bits	Weighted bits
AA = 00	000	0,1*0,1=0,01	3	0,03
AB = 01	001	0,1*0,9=0,09	3	0,27
BA = 10	01	0,1*0,9=0,09	2	0,18
BB = 11	1	0,9*0,9=0,81	1	0,81
		1		1,29bits in average to send 2 symbols
				0,645 bits per symbol

Background. Information measures

▸ Information Theory. Shannon entropy:

  ◦ There is interference: Not all information will reach the receiver

  ◦ Average information faithfully transmitted (R):

$$R = \mathrm{H}(x)\text{-}\mathrm{H}_y(x)$$

  ◦ $H_y(x)$ is the equivocation or conditional entropy of x when y is known. Measures the information required to quantify the error.
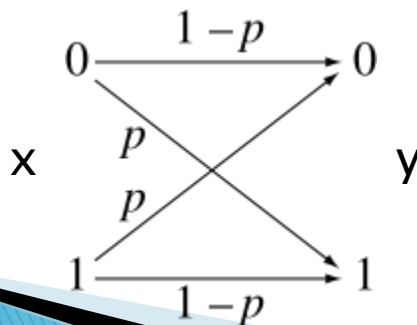
$$H_y(x) = \sum_{i=0}^{N} \sum_{j=0}^{N} p(x_i, y_j) \cdot log_2(p(x_i|y_j))$$


p: error probability

Outline

Session 1:

- Understanding the fundamentals of basic interaction in UI
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  - Fitts' Law: *Measuring Pointing Time*
  - Crossing and Steering Laws: *Continuous Gestures*
- Fitts' Law in UI Design
  - Applications in UI Design
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- Exercises

Hick–Hyman Law

▸ Hick–Hyman Law:
  ◦ Initially stated by William E. Hick (1951)
  ◦ Describes human decision time as a function of the information content conveyed by a visual stimulus
  ◦ It takes longer to respond to a stimulus when it belongs to a large set as opposed to a smaller set of stimuli
  ◦ Extended by Ray Hyman (1952)
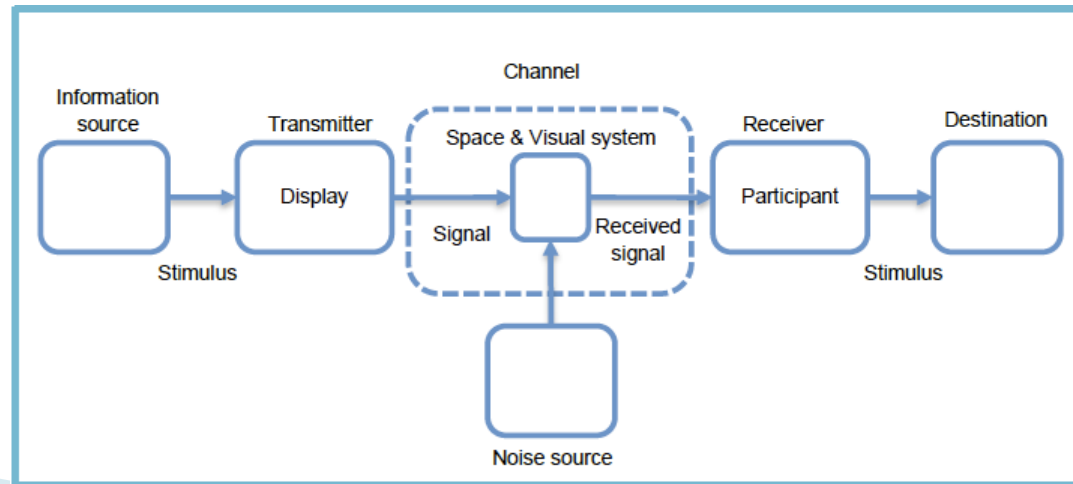
Hick–Hyman Law

▸ Time to make a decision (Reaction Time):

$$RT = a + bH_T$$

◦ *a*, *b* constants
◦ H_T transmitted information

Hick–Hyman Law

- Hick–Hyman Law:
  - H_T: Transmitted information:

$$H_T = \log_2(n+1)$$

  - n are the equiprobable alternatives
  - original formulation did not have the "+1"
   attends for the uncertainty whether to respond or not

  - Time to answer is the Reaction Time:

$$RT = a + b\log_2(n+1)$$

Hick–Hyman Law
Experimental assessment

▸ Hick's initial experiment:

- ◦ 10 pea lamps are arranged in an irregular circle
- ◦ One random lamp is lit every 5 seconds
- ◦ User has to press the correct key corresponding to the lamp that is lit
- ◦ Stimulus and response encoded in a moving paper in binary code
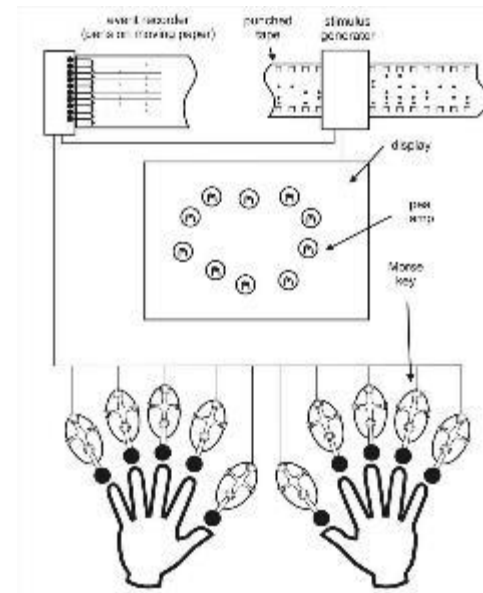
Hick-Hyman Law
Experimental assessment

- Time to answer. Reaction Time is a linear function of stimulus information

$$RT = a + b \log_2 (n + 1)$$

- Hyman [Hyman53] found that it also holds for not equiprobable alternatives

- Experiment:
  - 8 lights (whose names were *Bun, Boo, Bee, Bore, By, Bix, Bev,* and *Bate*)
    - The users had to name the one lit
    - A microphone attached to the throat detected the voice and stopped the timer
    - First with equal probabilities
    - Then, with varying probabilities

Hick-Hyman Law
Evidences

▸ **Evidences of Hick-Hyman Law**

◦ Performance *in hierarchical full-screen menu selections* is well described by Hick-Hyman [Landauer85]

◦ Selection times decay logarithmically with menu length for frequently selected items, but linearly with infrequent ones [Sears94].

  ➢ Learnt locations (most frequent) fit Hick-Hyman decision times
  ➢ Non-learnt locations fit a linear search

◦ Novice users search linearly while experts decide upon item location and fit a Hick-Hyman curve [Cockburn2008]

Outline

Session 1:

▸ Understanding the fundamentals of basic interaction in UI

◦ Background (Information Theory)

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◦ **Fitts' Law: *Measuring Pointing Time***

◦ Crossing and Steering Laws: *Continuous Gestures*

▸ Fitts' Law in UI Design

◦ Applications in UI Design
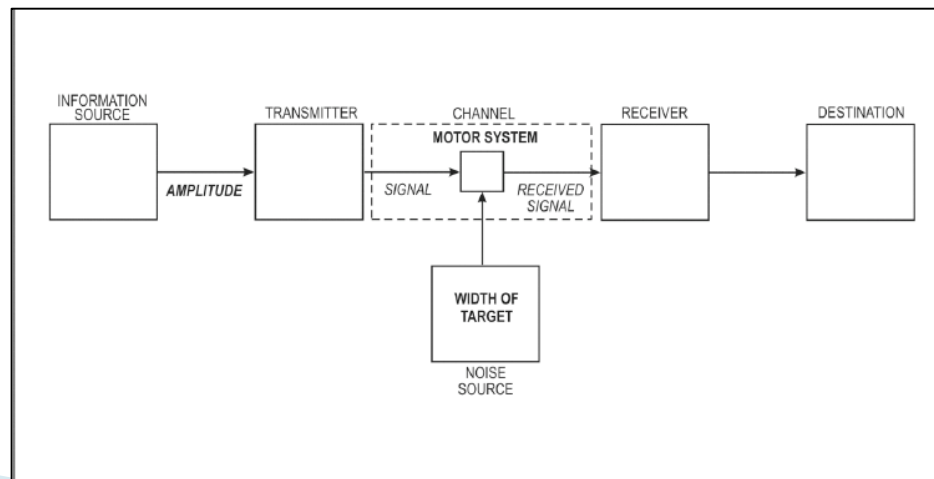
◦ Accelerating Target Acquisition

▸ Exercises

Fitts' Law
Original Formulation

- States a **linear relationship between the movement time (MT) and task difficulty**

$$MT = a + b\ ID$$

- Formulation is also based on Information Theory
  - Amplitude of movement is the *signal*
  - Human motor system is the communication *channel*
  - Target width is the *noise*

Fitts' Law
Original Formulation

▸ **Task difficulty:**

$$ID = \log_2 \left(\frac{2A}{W} \right)$$

- ◦ *ID:* Index of difficulty
- ◦ *A:* Amplitude of movement
- ◦ *W:* Target width

➢ The larger the amplitude the higher the difficulty
➢ The larger the target the lower the difficulty

Fitts' Law
Original Formulation

- **Movement Time:** Time to point a certain objective (target)

$$MT = a + b\ ID$$

- ◦ *a* start/stop times in seconds
- ◦ *b* inherent speed of the device

$$ID = \log_2\left(\frac{2A}{W}\right)$$

- ◦ A: Amplitude of movement
- ◦ W: Target width

Fitts' Law
Experimental Evidences

Fitts' Law. Original experiments:

▸ <u>Experiment 1: Reciprocal tapping</u>:

- Participants used a metal-tipped stylus:
    - Two experiments with two different stylus: ~ 28.35 and 453.6 gr
- Tap two strips of metallic targets of width from ~ 0.635 to 5.08 cm
- At distance 5.08 to 40.64 cm
- Participants instructed to be accurate!
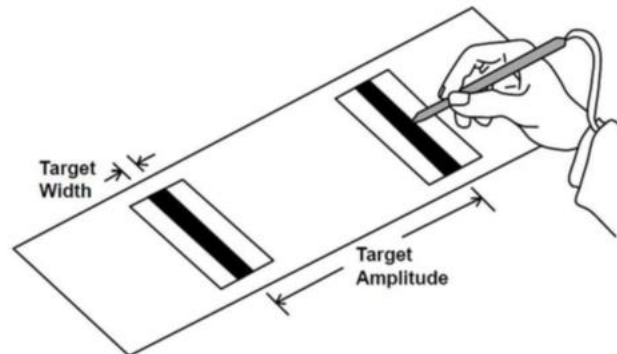
Fitts' Law
Experimental Evidences

Fitts' Law. Original experiments:

- Experiment 2: Disk transfer

  ◦ Participants had to transfer stack round plastic disks (with holes drilled trough the middle) from one pin to another
  ◦ Holes of different sizes and pins of different diameters used

- Experiment 3: Pin transfer

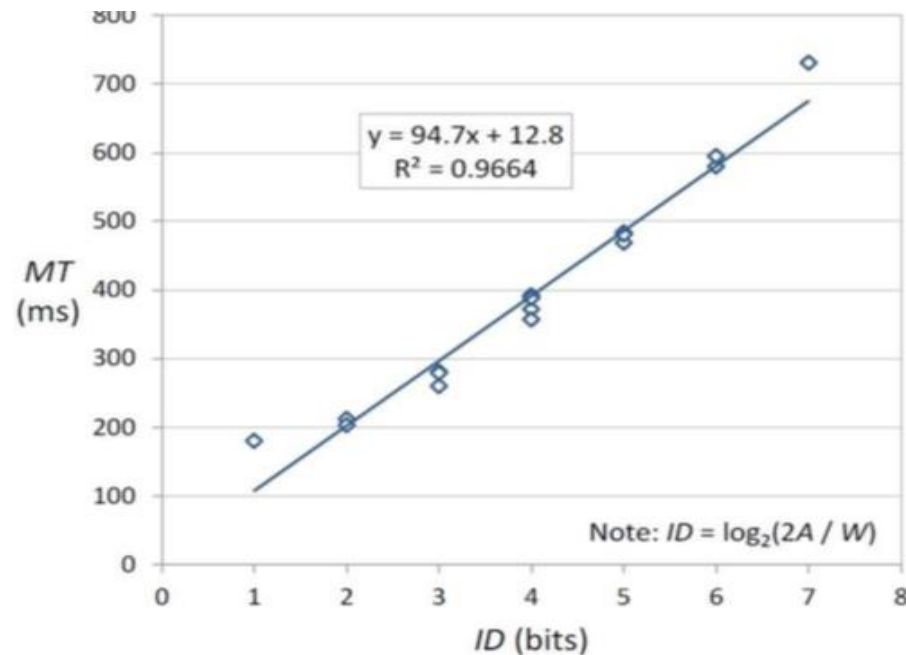 ◦ Participants had to transfer pins of different diameters from a set of holes to another set of holes

Fitts' Law
Experimental Evidences

$$ID = \log_2\left(\frac{2A}{W}\right)$$

▸ Fitts' Law. Results.

MT = 12.8 + 94.7 ID

Note: $ID = \log_2(2A / W)$

$y = 94.7x + 12.8$
$R^2 = 0.9664$
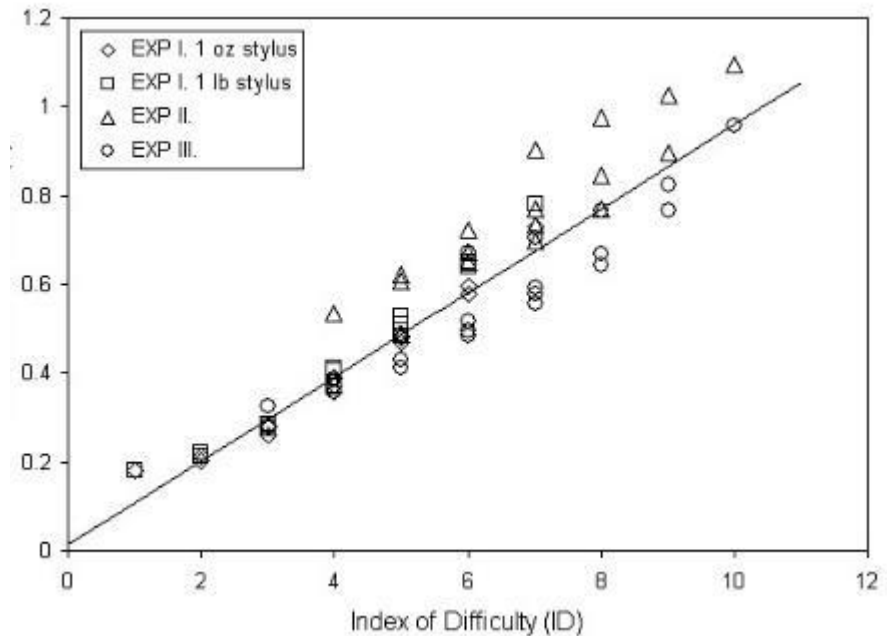
➢ Results show that there is a linear relationship between MT and ID
➢ *Most difficult condition: Smaller W and largest A*
➢ Only valid for the experiments carried out
   ◦ One curve per experiment fits better (different a and b values)

Fitts' Law Variants

- Original formulation fits well to the original experiments
  - But it might fit better
- Other researchers have found different formulations that better model the experimental data
  - Including the experimental data by Fitts
- Welford [Welford68]:

$$MT = a + b \log_2 \left(\frac{D + 0.5W}{W} \right)$$

- D is the distance of movement
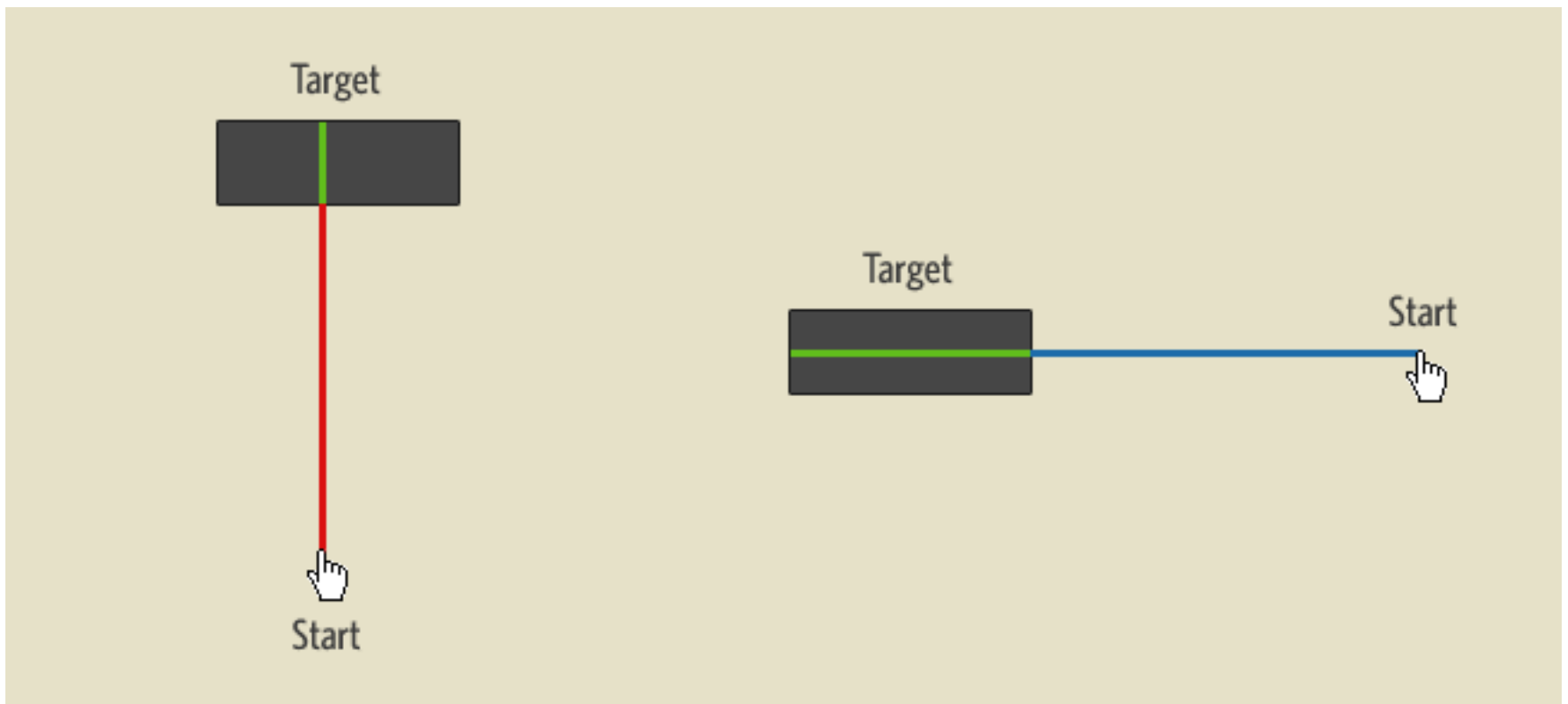- W is the width of the target

Fitts' Law Variants

- **MacKenzie's** approach [MacKenzie92] is one of the most accepted:

$$MT = a + b\log_2\left(\frac{D}{W} + 1\right)$$

  ○ D is the distance of movement
  ○ W is the width of the target

Fitts' Law Variants

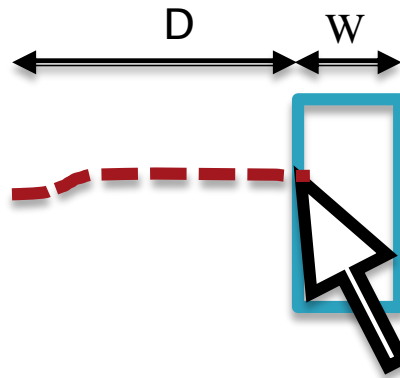▸ Vertical and horizontal movements can be treated equally

Fitts' Law Extensions

- Main application of Fitts in HCI is evaluation/design of UI and interaction

- Today's interfaces are much more complex
  - Variety of sizes
  - 2D movements
  - Use of fingers

Fitts' Law Extensions

▸ Use in UI design or evaluation:

◦ D is the distance the pointer (mouse) covers to reach the target (button)
◦ W is the width of the target (button)

Fitts' Law
Extensions 2D

- Fitts' Law is designed for 1D movements
  BUT…most movements in a UI are 2D
- Vertical and horizontal movements can be treated equally… or not?
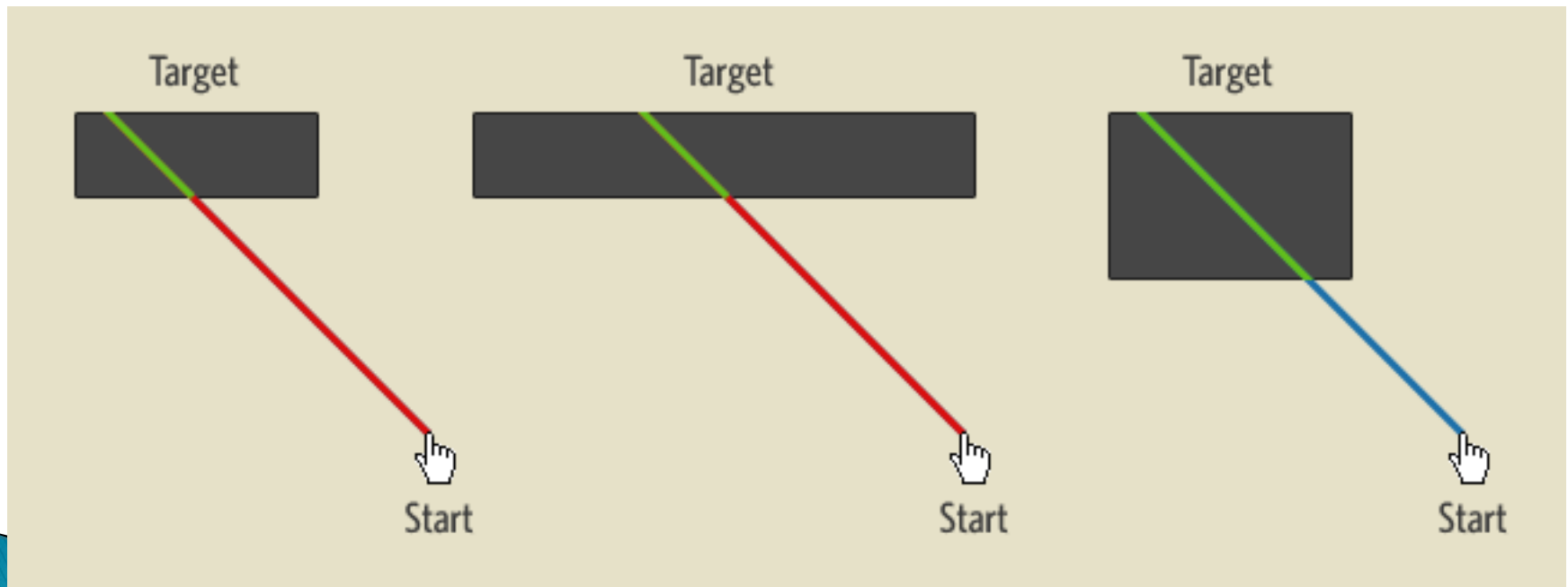
Fitts' Law
Extensions 2D

- **Several extensions deal with 2D movements**
  - Mimicking Fitts' Law, but changing some of the parameters

  - [Crossman83]:

$$MT = a + b\log_2\left(\frac{2D}{W}\right) + c\log_2\left(\frac{2D}{H}\right)$$

  - [Accot97]:

$$MT = a + b\log_2\left(\sqrt{\left(\frac{D}{W}\right)^2 + \eta\left(\frac{D}{H}\right)^2} + 1\right)$$

Fitts' Law
Extensions: Precision Pointing

- Fitts Law does not model properly very small targets:
  - Extra time devoted to fine adjustment
  - Increase of errors
  - …
- Very small targets yield a lower fit of the regression curve of the MT function
- Touchscreens also modifies the timing we require to point targets.

Fitts' Law
Extensions: Precision Pointing

Extension of Fitts' Law by analyzing the behavior both in tactile screens and small targets ([Sears91]):

- Named FFitts (**Finger Fitts**), also PPMT (Precision Pointing Movement Time) by some other authors :

$$FFits = a + bID + dID_2$$

$$FFitts = a + b\left[\log_2\left(\frac{cD}{W}\right)\right] + d\left[\log_2\left(\frac{e}{W}\right)\right]$$

> The higher number of freedom degrees, the easier to fit in a regression curve

Fitts' Law
Extensions: Precision Pointing

▶ **FFitts:**

$$FFitts = a + b\left[\log_2\left(\frac{cD}{W}\right)\right] + d\left[\log_2\left(\frac{e}{W}\right)\right]$$

- ◦ the first logarithmic factor measures *the time to place the finger on the screen initially*
- ◦ the second factor measures *the time to position the cursor*
- ◦ *D* is the distance, measured in three dimensions, from the original hand location to the location of first contact
- ◦ If the task consists of iteratively clicking targets: *D* is the distance from one target to the next one
- ◦ W is some measurement of target size
- ◦ *a*, *b*, *c*, *d*, and *e* must be determined for each specific case

Fitts' Law
Assessed Results

- Validation of Fitts' Law may not extrapolate to outside the experiments carried out

  - *Validity Fitts* ➔ *Experimentation*

- Fitts' Law have been formulated in a number of ways, however its prediction is consistent:
  - "the ID to acquire a target is function of the distance to and the size of the target"

Fitts' Law
Assessed Results

- Fitts' Law has shown its validity in multiple setups and devices:
  - Mouse, joystick, finger, stylus…
  - Different screen types of varying sizes…
  - **But the results cannot be extrapolate to data outside the experiment.** *Validity Fitts* ➤ *Experimentation*
- Fitts' law is a really good predictive model of human movement.
- Precued targets lead to more efficient and precise pointing movements than for non-precued targets [Hertzum2013].
  - Most common case: we know the buttons' positions in advance.
  - The benefit of precuing is larger for the mouse than the touchpad
    - Maybe movement preparation is more effective if the device is more demanding

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  - **Crossing** and **Steering** **Laws:** *Continuous Gestures*
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Law of Crossing

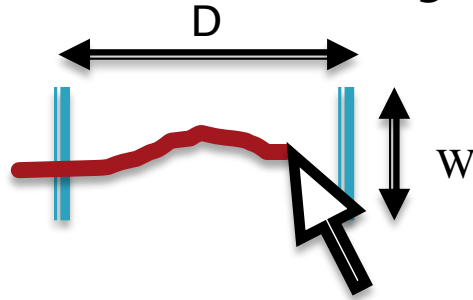- Crossing movement as compared to pointing
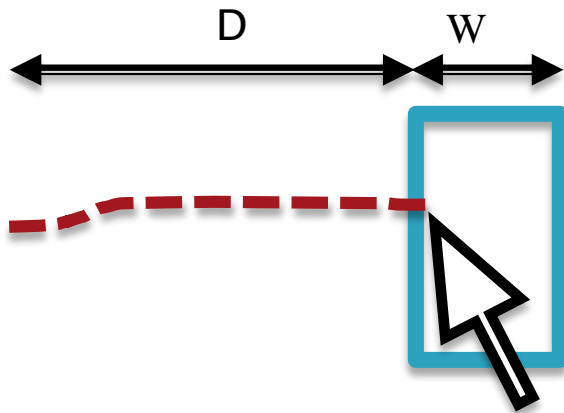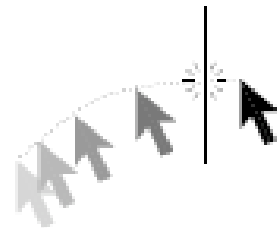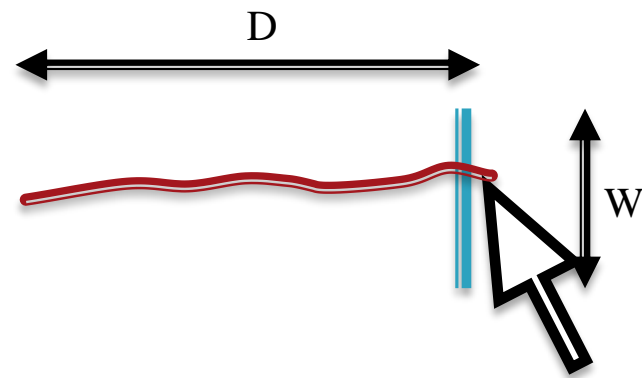
(a) Pointing a target   (b) Crossing a goal

Law of Crossing

- Crossing configurations:
  - Discreteness vs continuity of the movement:
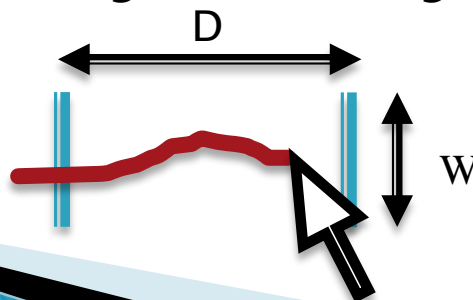   - Landing and lifting off the stylus

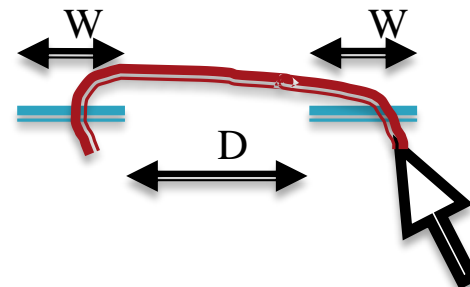*Continuous crossing*   *Discrete crossing*

D   D

W   W
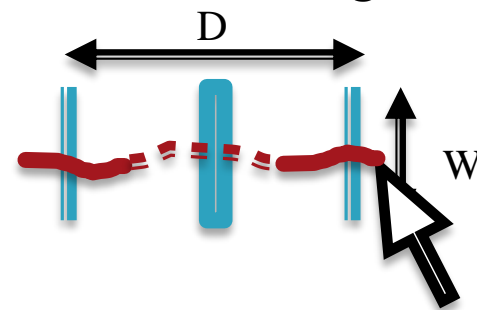
  - Direction of the targets vs direction of the movement:
    - If parallel, the trace will be larger

Orthogonal crossing   *Collinear crossing*

D   W   W

W   D

Law of Crossing

- Stylus or fingers naturally lead to crossing gestures
  - Especially useful in tactile devices
  - Crossing an object is easier than <u>double-clicking</u>.
    - Drag & drop, multiple selections
  - ➢ crossing can be a good alternative for users who have difficulties with clicking or double-clicking.
- Several objects can be crossed at the same time within the same <u>gesture</u>

Multi-links extension for Chrome (LinkClump)

Law of Crossing

▸ **Crossing performance across two goals** [Accot99,Zhai2002]:

○ Follows the same characterization than the Fitts' Law:

$$T = a + b \log_2 \left(\frac{D}{W} + 1 \right)$$

- T is the average moving time between passing the two goals.
- *D* is the distance between the two goals
- *W* is the width of each goal
- *a* and *b* are constants to be determined

Law of Crossing

▸ Results of the experiments:

◦ Crossing-based interfaces achieve similar (or faster) times than pointing.

◦ The error rate in crossing is smaller than in pointing.

◦ Discrete crossing becomes more difficult if the distance between the targets is small.

Law of Crossing

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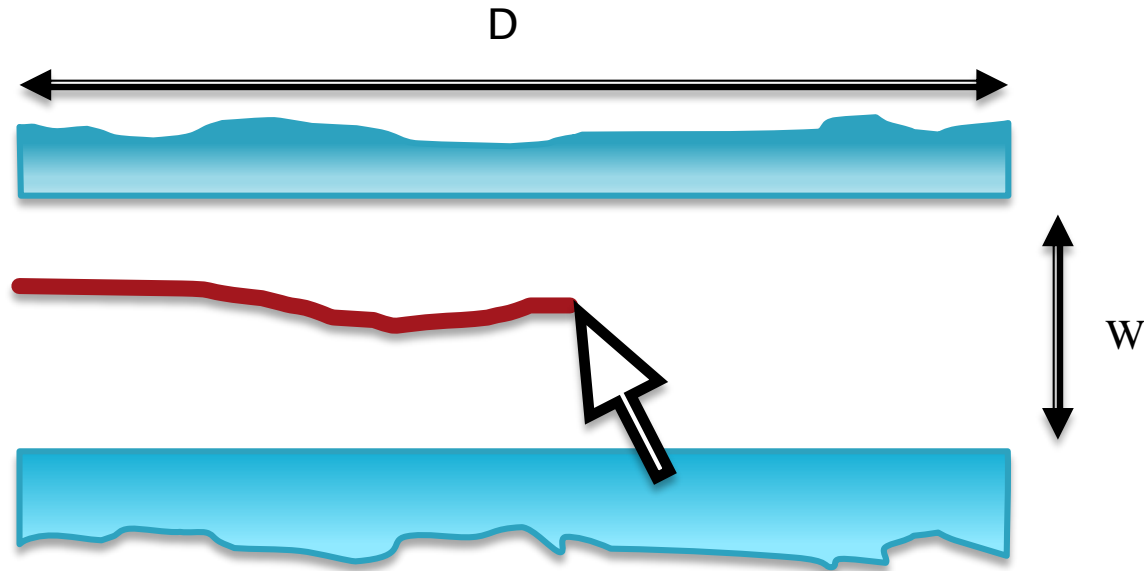 - Accelerating Target Acquisition
- Exercises

Steering Law

- Navigating through a constrained path is an useful operation in modern UIs
  - Navigating through nested menus
  - 3D navigation
  - Dragging elements
  - Free-hand Sketching/Drawing
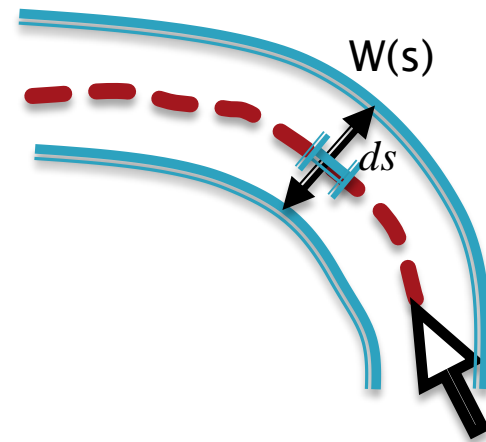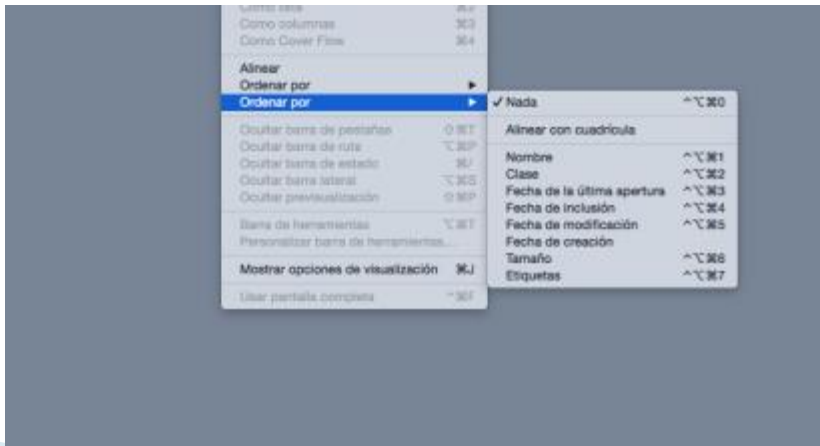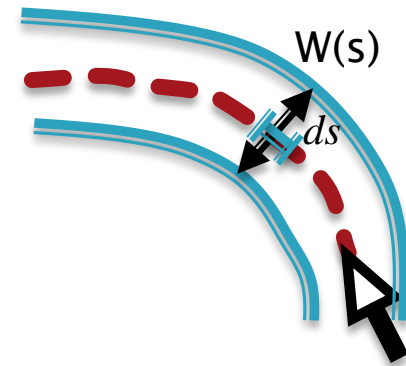
Steering Law

▸ Steering through a **straight path**:

Steering Law

- Navigating through a **generalized path** can be expressed as infinite crossings [Accot97]

- Movement time across the path T_s:

$$T_s = a + bID_s \qquad\qquad T_s = a + b \int_C \frac{ds}{W(s)}$$

  - C is the length of the path
  - $W(s)$ is the path width at point s

Steering Law

- Time to navigate through a **straight path** (tunnel) T_p [Accot97]:

$$T_s = a + b \int_C \frac{ds}{W(s)} \qquad T_P = a + b\frac{D}{W}$$

  - ◦ D is the length of the path/tunnel
 - ◦ W is the width of the path/tunnel

- Applying Fitts' formatting:

$$T_P = a + b\, IDP \qquad ID_P = \frac{D}{W}$$

  - ◦ Which also applies to circular paths of constant width

Steering Law

▸ Results [Accot97, Zhai2004] show that the steering law is applicable to different configurations:

  ◦ Different path shapes: cone, spiral, straight

  ◦ Works with different devices, works in VR…

  ◦ Can be used to analyse navigation through nested menus, compare menu designs…
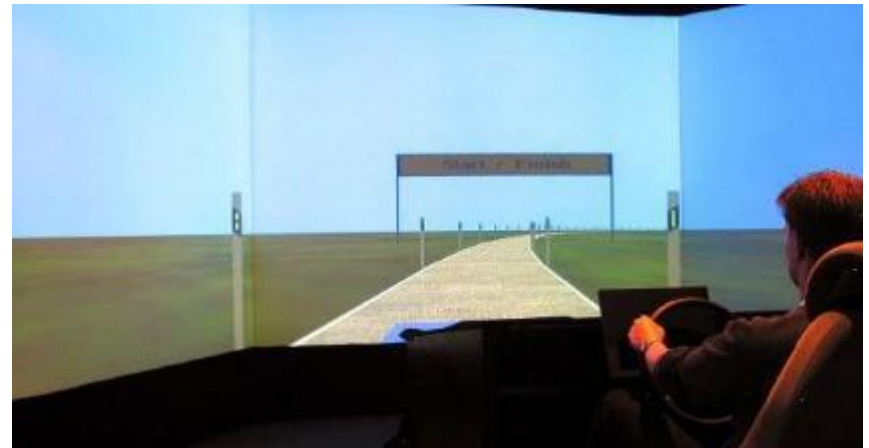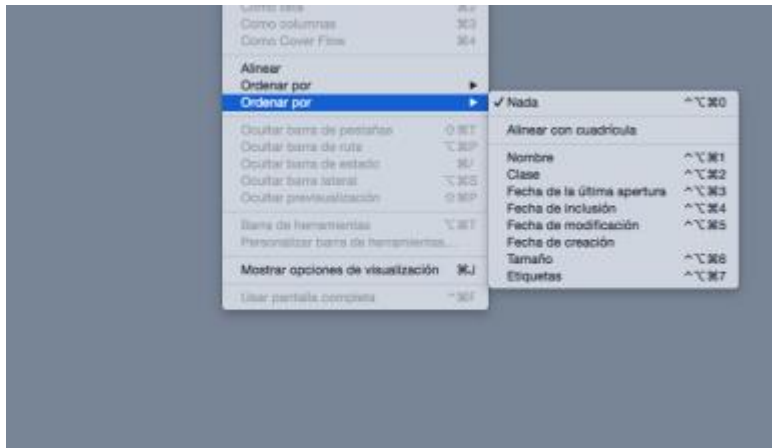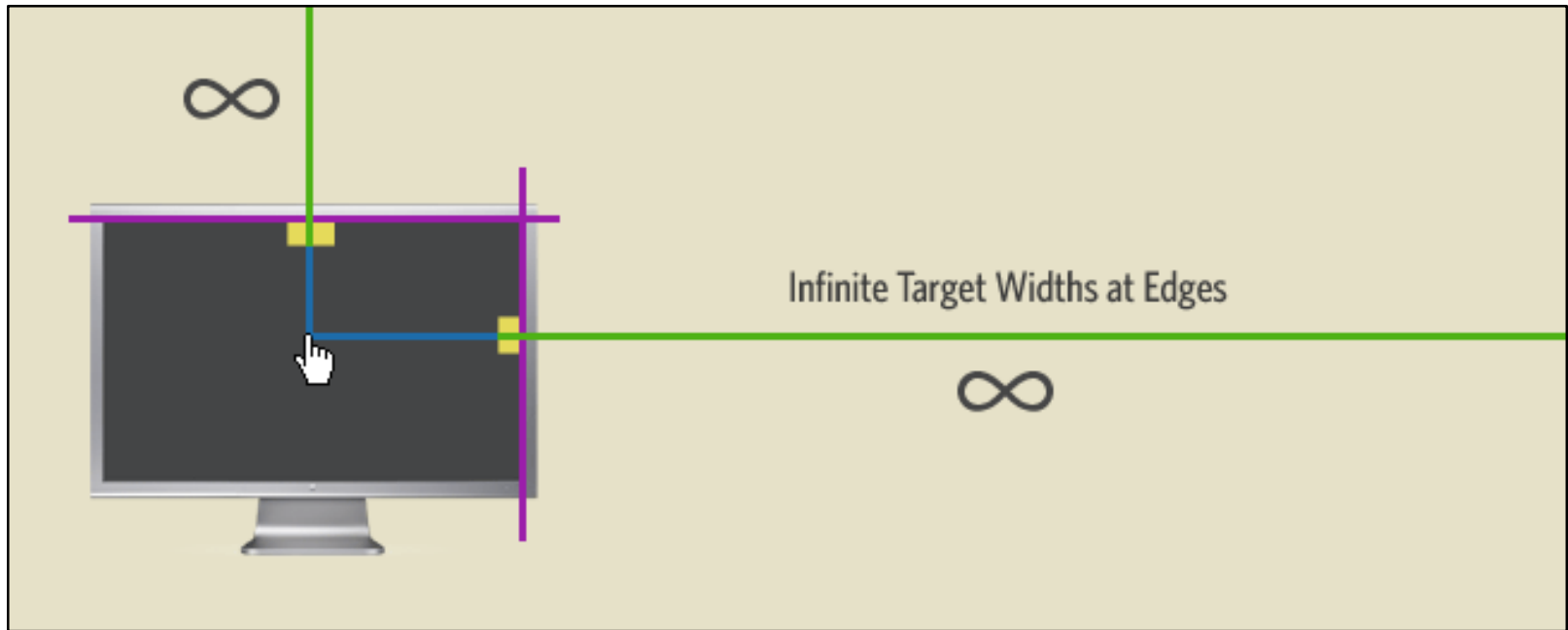
Outline

Session 1:

- Understanding the fundamentals of basic interaction in UI
  - Background (Information Theory)
  - Hick–Hyman Law: *Measuring Choice–Reaction Time*
  - Fitts' Law: *Measuring Pointing Time*
  - Crossing and Steering Laws: *Continuous Gestures*
- **Fitts' Law in UI Design**
  - **Applications in UI Design**
  - Accelerating Target Acquisition
- Exercises

Fitts' Law in UI Design Applications

- Fitts' Law accurately predicts **pointing** movement
  - Further distance ➔ Harder to select
  - Larger target ➔ Easier to select

- If improvement required, it can help us modify our UI
  - Change target width:
    - Increase size for faster reach
  - Change de "virtual distance" or pointer movement:
    - Increase speed, pop-up menus,….

- But <u>visual stimuli must also be taking into account</u>…
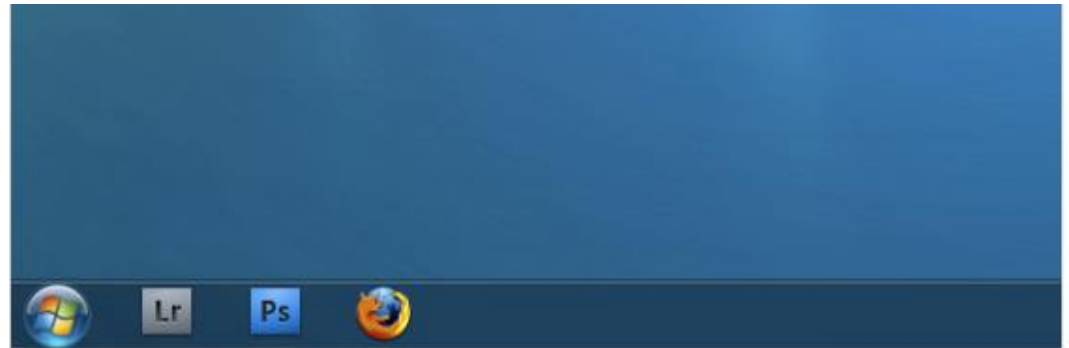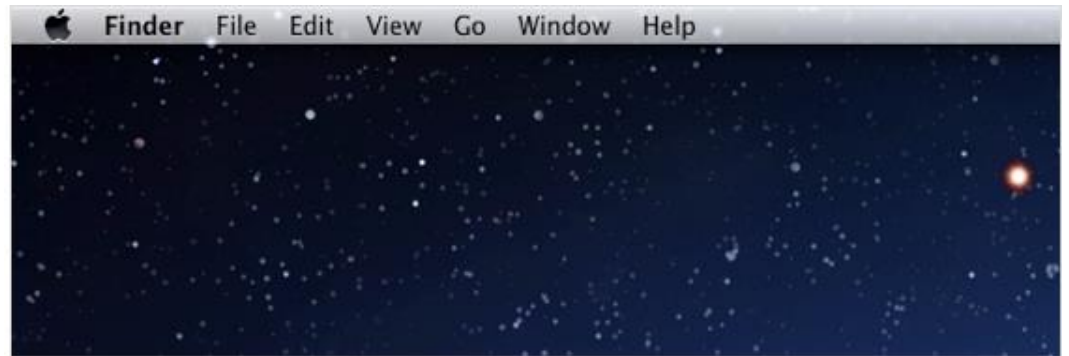
Fitts' Law in UI Design Applications
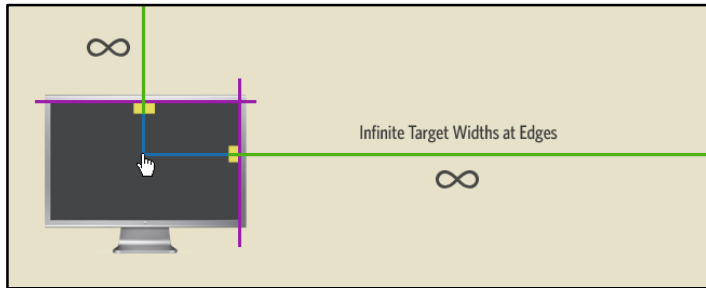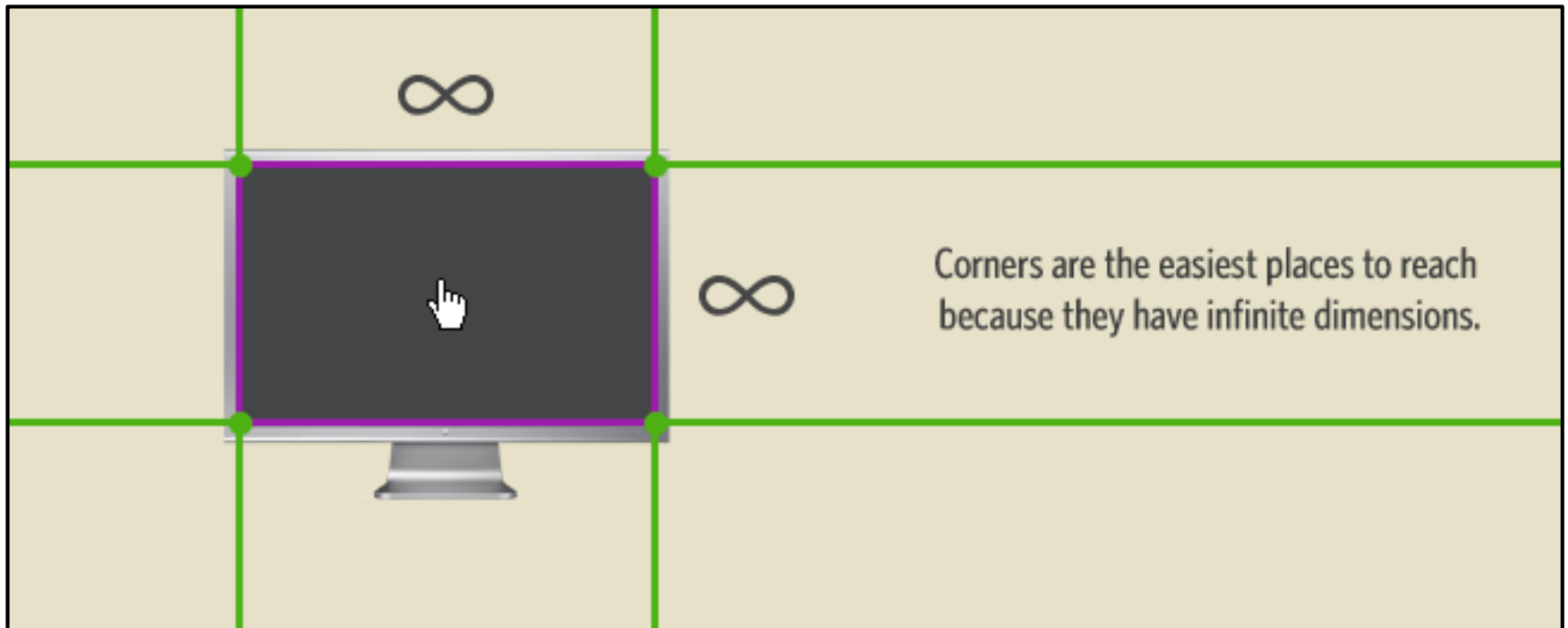
▸ **The outer edges and corners**

Infinite Target Widths at Edges

$$MT = a + b\log_2\left(\frac{D}{W} + 1\right)$$

Fitts' Law in UI Design Applications

∞

Infinite Target Widths at Edges

∞

Finder   File   Edit   View   Go   Window   Help

Lr   Ps

Fitts' Law in UI Design
Applications

Corners are the easiest places to reach because they have infinite dimensions.
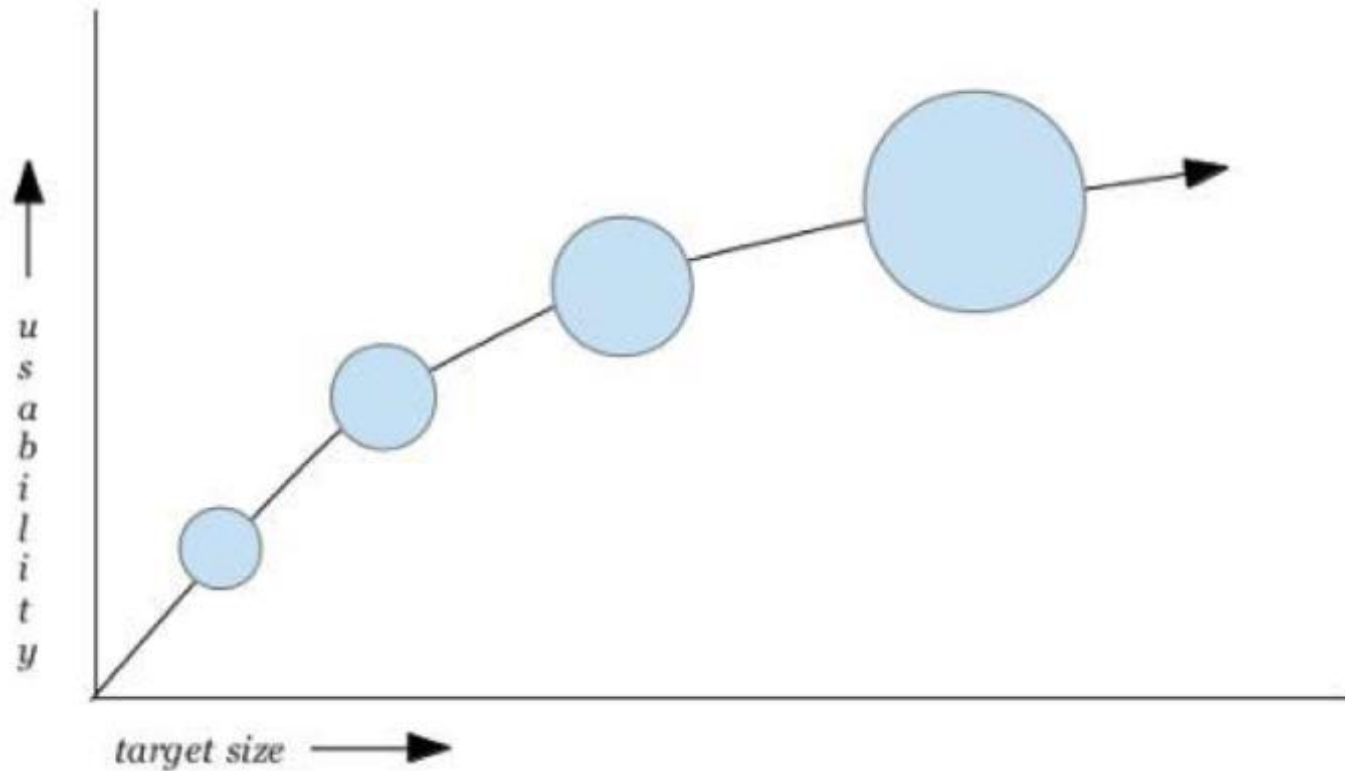
Fitts' Law in UI Design
Applications

Web sites do not have edges or corners of infinite width.

:(

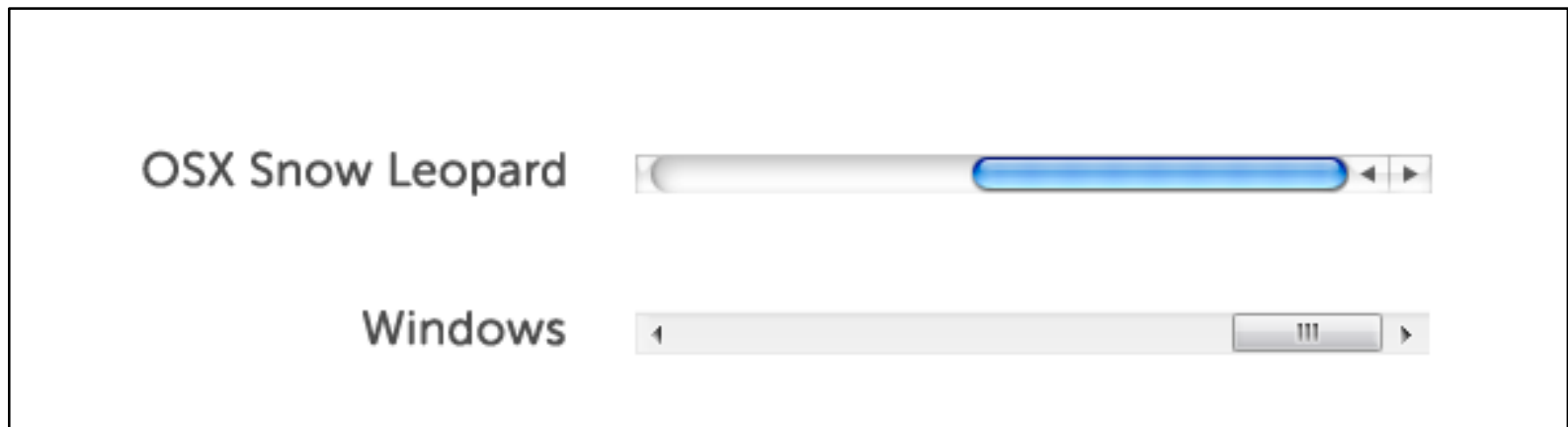# Fitts' Law in UI Design Applications

▸ **Create larger target size**

Fitts' Law in UI Design Applications

▸ **Keep related things close**

◦ Filters should be placed close to the search field

Fitts' Law in UI Design Applications

- **Keep related things close**
  - ◦ Mac OS scrolls are faster to navigate

OSX Snow Leopard

Windows

Fitts' Law in UI Design Applications

▸ **Keep related things close** and **Opposite Elements Far**

  ◦ These buttons should be placed far away from each other
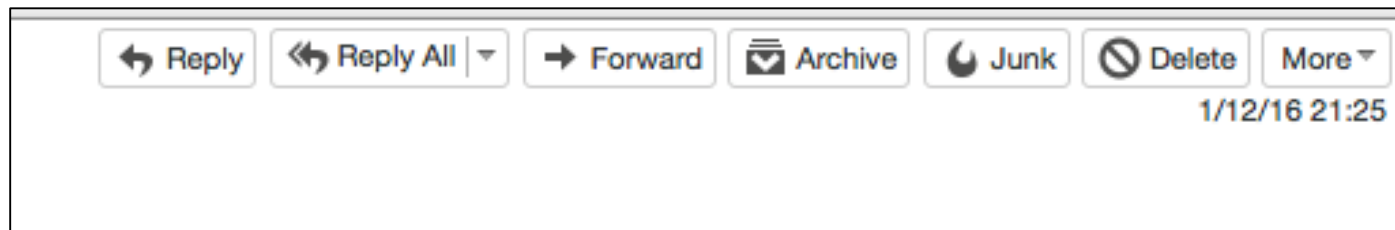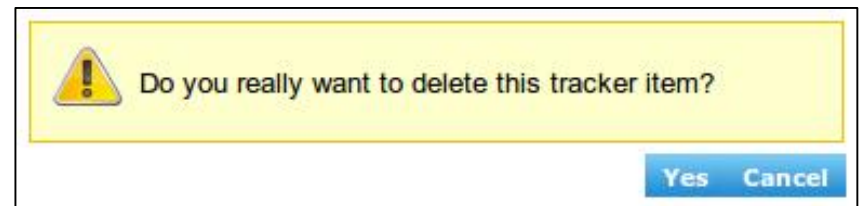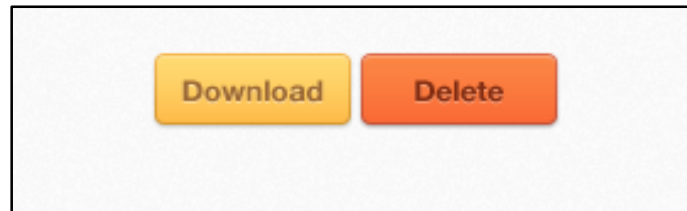
But...don't forget the usability principles!!!

Fitts' Law in UI Design Applications

- **Pop-up menus**: Reduce travelling distance
- **Improve two aspects:**
  - Reduction of distance to travel (Fitts)
    - The option is close to the menu emerging place
  - Frequency-enabled may improve the time to pick an option:
    - Based on Hick-Hyman:

      Recall that *users are able to point faster objects that are known*

- Only used by experts!
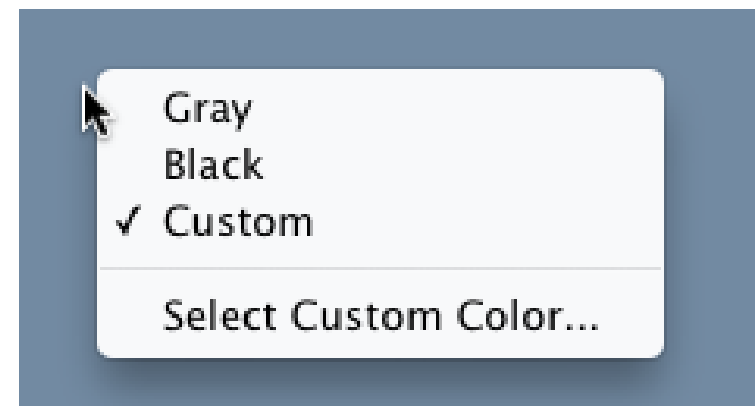
Fitts' Law in UI Design Applications

▸ *What about pie menus?*
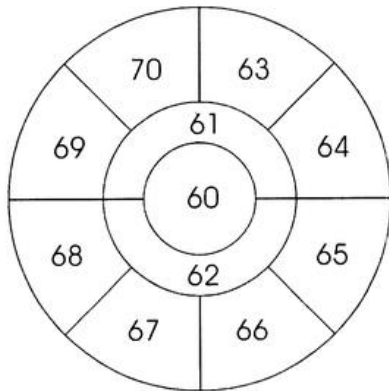
Fitts' Law in UI Design Applications

- *What about pie menus?*
  - Sort of contextual menu
    - Needs to be created on demand
    - Needs some room!
  - Should not have occlusions
    - On mobile half-pie menus better than fully circular

Fitts' Law in UI Design Applications

- *What about pie menus?*
  - Difficult to design!
    - Second layer changes the size and distance
    - Organizing by frequency may be a problem (learning)

Fitts' Law in UI Design Applications

+ **Perception**: Grouping things may improve over distance

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  - **Accelerating Target Acquisition:**
    - Dynamic Expanding Targets
    - Target Moving
    - Control–Display Ratio
- Exercises

Accelerating Target Acquisition
Expanding Targets

- **Increase the size of targets close to the pointer**

  Two implementation approaches:
  - Size-enlargement and position-changing icons
  - Enlarged icons overlap over their neighbours

Accelerating Target Acquisition
Expanding Targets

▸ **Increase the size of targets close to the pointer**

Exemple1: Implemented in Mac OSX Dock:
◦ Mix of target size increase and moving target

Accelerating Target Acquisition
Expanding Targets

- Enlarged icons overlap over their neighbours

Dynamic Scaling (DS)

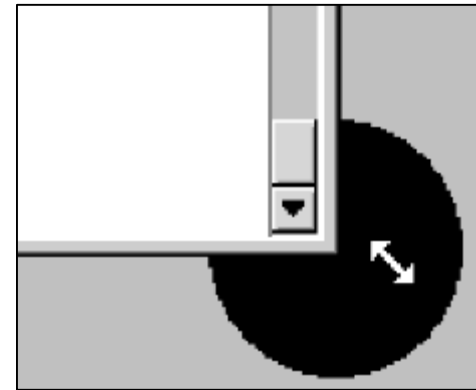Objects near the selection ray are dynamically scaled

Accelerating Target Acquisition
Expanding Targets

- **Bubble targets:**
  - Increase selectable region around target
    - Only when the mouse is close
    - Improves selection times
  - Issues:
    - Bubble appearing may distract users
    - Overlapping targets:
      Close selection points may generate several bubbles
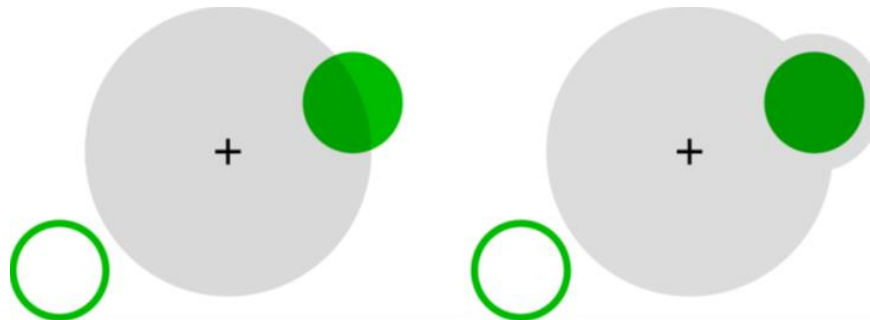
Accelerating Target Acquisition
Expanding Targets

▸ **Bubble cursor** [Grossman2005] ➜

   Reduction of amplitude movement

◦ Cursor size increases when it is close to objectives

◦ It may even grow to *absorb the* closer target when it is not completely inside the main cursor bubble.

   • Based on position, no speed

   • In experiments Control-Display ratio fixed to 1

Accelerating Target Acquisition
Expanding Targets

▶ **Dynamic Bubble cursor** [Chapuis2009]:
  ◦ Based on the Bubble cursor idea
  ◦ It takes into account the speed of the mouse
    • Area increases according to speed and position
    • Visual cues to indicate the captured target: the target closer to the cursor center.

Symbol	Legend
+	Cursor Center
(gray circle)	Activation Area
(red circle)	Captured Target
(white circle)	Uncaptured Target
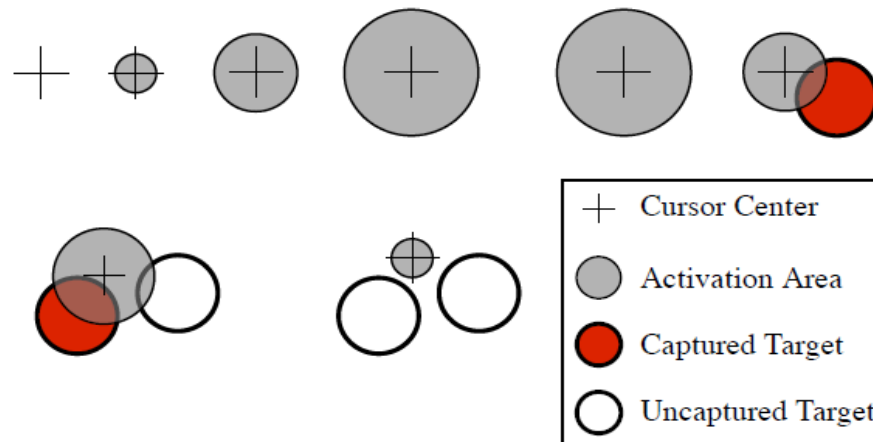
Accelerating Target Acquisition Target Moving

▶ **Move targets to the user:**

▶ **Generate targets next to the user: pop-up menus**

Accelerating Target Acquisition Target Moving

- **Sticky targets:**
  - Attract pointer
    - When the pointer is close to a selectable area
    - May reduce selection time
      - Precision not required
    - Users adapt easily

Accelerating Target Acquisition Control-Display Ratio

▶ Relation between the amplitude of movements of the user's real hand and the amplitude of movements of the virtual cursor

- Moves in real world (physical move) mapped to moves in virtual desktop (cursor move)

- Different strategies:
  - Constant
  - Dependent on mouse speed
  - Dependent on cursor position

- Interpretation according to Fitts Law:
  - *Dynamic C-D ratio adaptation can be interpreted as dynamic change of physical motor space*

Accelerating Target Acquisition Control-Display Ratio

- Mac OSX and Windows both use mouse acceleration
  - When mouse moves fast, it is accelerated
    - Reducing the amplitude of movement to cover large distances
  - When mouse moves slow, it is decelerated
    - Magnifying amplitude of movement to improve precision

- No clear how the mapping affects perception and productivity
  - Some studies say it is not intuitive
  - Some studies say it improves some pointing tasks

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◦ Applications in UI Design

◦ Accelerating Target Acquisition

▸ **Exercises**

Exercicis

5. Donades les constants a = 400 ms, b = 200 ms/bit i un objectiu de mida 2.1 cm a una distància de 10.5 cm. Marca la resposta correcta assumint que fem els càlculs amb la versió de McKenzie de la llei de Fitts.

a. ID ≈ 3.4.
b. 2 < ID < 3.
c. ID ≈ 4.3.
d. MT està entre 1100 i 1200 ms.

$$MT = a + b \log_2 \left(\frac{D}{W} + 1 \right)$$

6. La llei de Hick-Hyman:

a. Modela el temps de decisió com una funció de la informació transmesa.
b. Modela el temps de selecció d'un element com a funció de la distància a recórrer i la mida de l'element.
c. Modela el temps de decisió com una funció de la distància a recórrer i l'entropia dels elements a seleccionar.
d. Utilitza l'entropia de Shannon per a mesurar la distància del recorregut mínim.

Exercicis

- Els *expanding targets*:
  a. Es basen en la llei de Hick-Hyman.
  b. Pretenen reduir el temps d'accés als elements basant-se en el fet que, segons la llei de Fitts, el temps d'accés es redueix si s'augmenta la longitud del desplaçament.
  c. Si es combinen amb el moviment dels objectius poden causar confusió a l'usuari.
  d. Cap de les anteriors.

Exercicis

▸ **Ens han encarregat fer un disseny d'una interfície per a un sistema tipus desktop en la qual hi haurà botons i menús drop-down.**

a. Podem predir la dificultat d'accedir als botons utilitzant la llei de Fitts i la dificultat de recórrer els menús amb la llei de crossing.

b. Podem analitzar el nombre d'elements a posar en un menú utilitzant la llei de steering i en funció dels digrams.

c. Podem analitzar el nombre d'elements a posar en un menú utilitzant la llei de Fitts.

d. Podem analitzar la dificultat de recórrer els menús utilitzant la llei de steering.

Exercicis

‣ **La llei de** *steering*:

    a.   No es pot derivar a partir de la llei de *crossing*.

    b.   Serveix per modelar el temps necessari per recórrer un camí de forma arbitrària.

    c.   Diu que hi ha una relació logarítmica entre l'índex de dificultat de creuar un objectiu i el temps que requerit per a fer-ho.

    d.   Diu que l'índex de dificultat de creuar un objectiu és D/W.

Exercicis

▸ Dos elements T1 i T2 a distàncies *D1 = 10 cm i D2 = 8 cm* en direcció horitzontal i d'amplades *5 cm i 2 cm*, respectivament. Per a T1 emprem un dispositiu amb *a1= 200 ms i b1 = 200 ms/bit*. Per a T2 utilitzem un dispositiu amb *a2 = 200 ms i b2 = 100 ms/bit*. Assumint la formulació original de la llei de Fitts:

   a.   ID1 > ID2.

   b.   ID1 = ID2.

   c.   MT1 = MT2.

   d.   MT2 < MT1.

Professors d'IDI - UPC

IDI – Interaction Design (I)