

COMBINING TABLETS WITH SMARTPHONES FOR DATA ANALYTICS

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L'AVENIR EST AUX VALEURS SÛRES

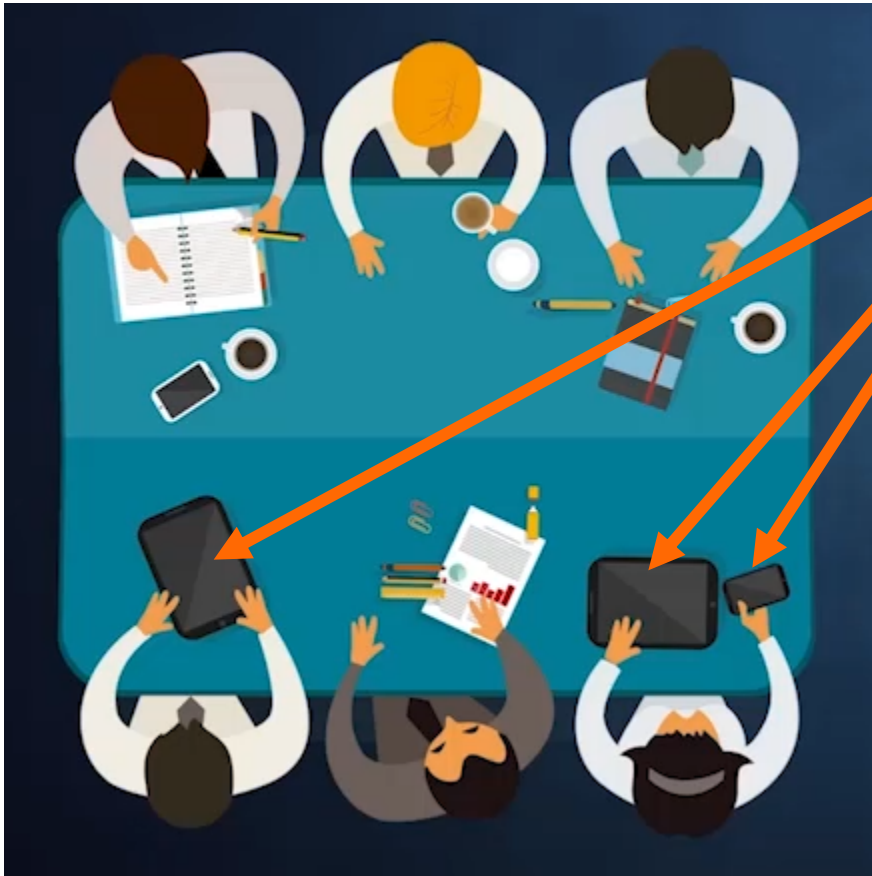


Institut de Recherche
en Informatique de Toulouse



- Berger-Levrault:
 - ➔ Leader in the software development for French public administration
 - ➔ Developing an ambitious strategy serving digital and societal transformations

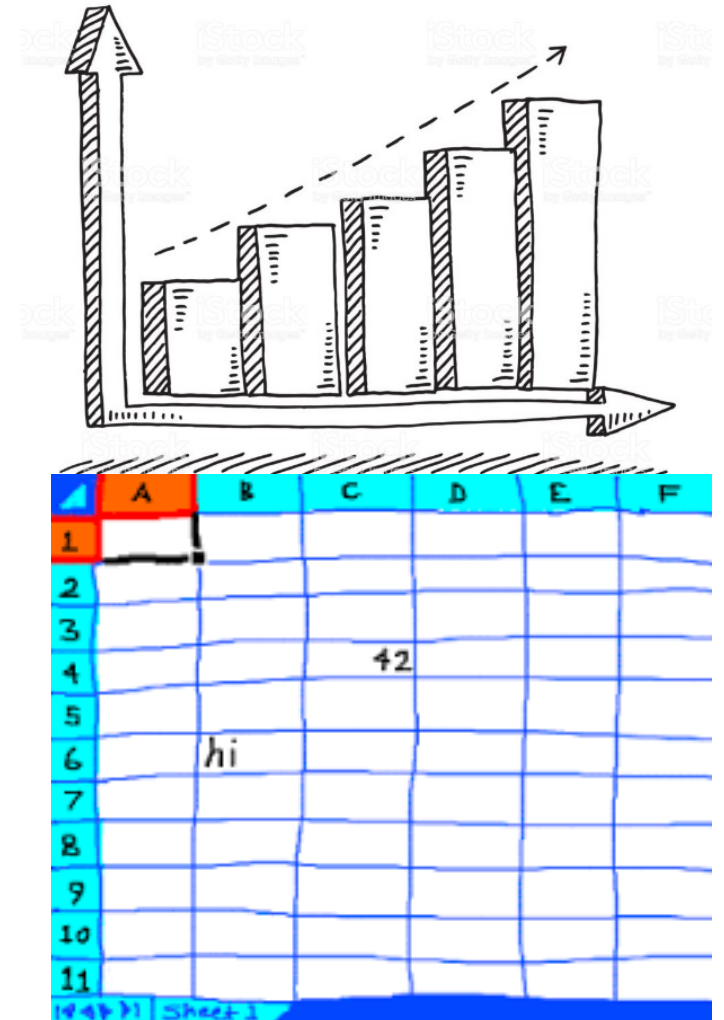




- Take advantage of small, portable devices that become professional computing platforms
- Make sense of data anywhere and anytime
- Could even use them in close contact with citizens (i.e. in the street)

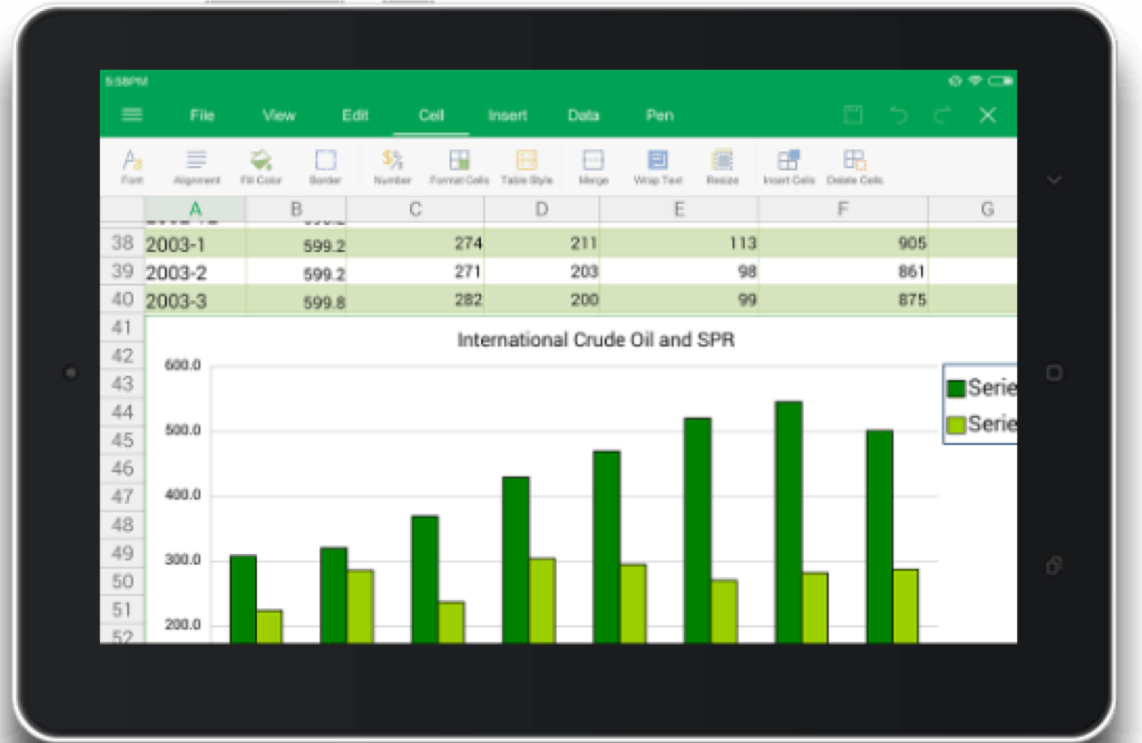
REQUIREMENTS: INTERVIEWS WITH LOCAL AUTHORITIES

- Goal : Identifying typical data analysis tasks
- Interview protocol
 - 8 elected officers : small and large cities
 - Semi-guided interviews
 - Duration : approx. 1 hour
- Main results
 - Huge need to create / manipulate graphical representation
 - Spreadsheet is the major tool used
 - Representation mainly prepared off-line because of interaction limitations during meetings



- Limited output display size: occlusion or pan required

- Limited input vocabulary: menus or combination of input required





GOAL



Data inquiry during meeting

Providing an interaction technique facilitating data manipulation (especially graphic) on mobile devices

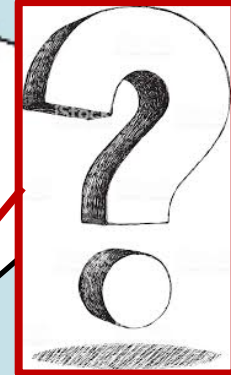


Chart visualization

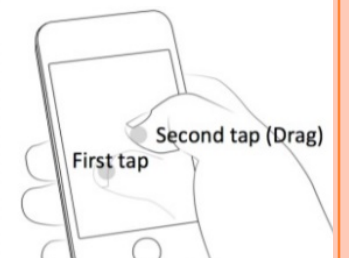
EXISTING SOLUTIONS: MULTIMODAL APPROACHES

- Consecutive Taps
 - Gestures Around the Smartphone
 - Hand
 - Thumb

- Pen
 - Rolling / tilting
 - Combined with thumb

➔ **Output capabilities not extended**

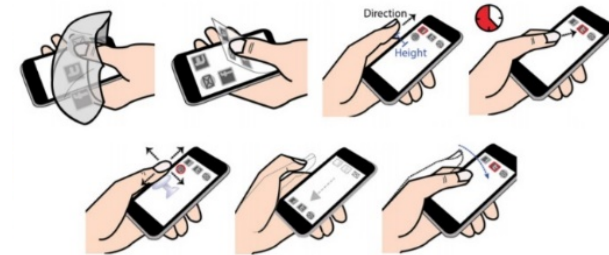
➔ **Dedicated device required to be differentiated from a finger touch**



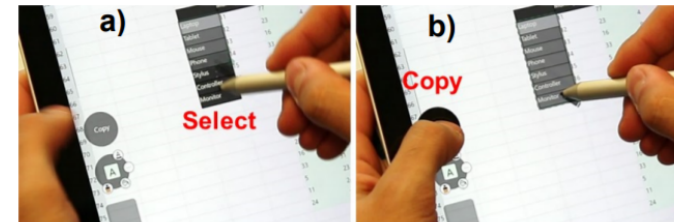
Consecutive taps
[Heo 2014]



Ad-binning [Hasan 2013]



Thumbs-Up [Hasan 2016]



Thumb + pen [Pfeuffer 2017]



Pen rolling
[Moscovich 2008]

EXISTING APPROACHES: MULTI-DISPLAY APPROACHES

- Data and command distribution over multiple spatially aware tablets

➔ **Need for an external tracking system**



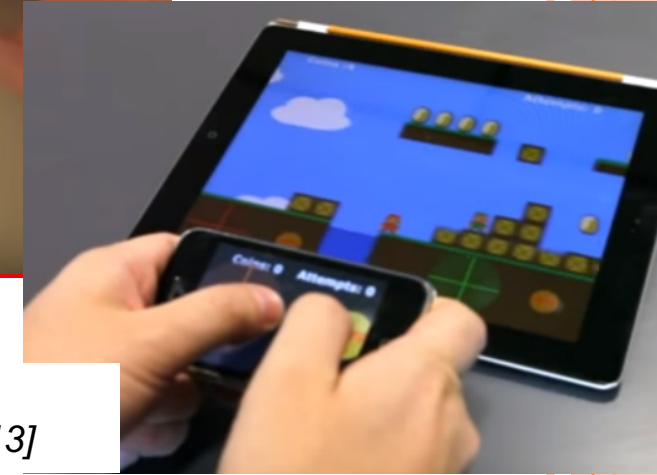
VisTile
[Langner 2018]

- Display stacking

- Satellite view and orthogonal view

➔ **Offer concrete solutions**

➔ **Need for more systematic exploration of the stacking design space**



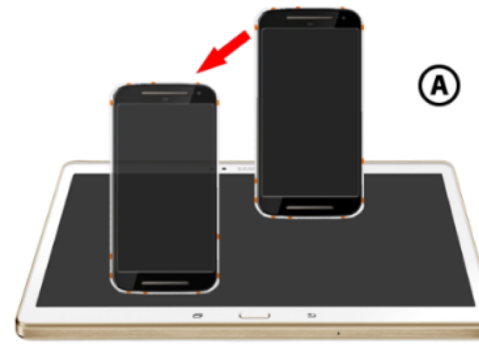
BatMan
[Piazza 2013]



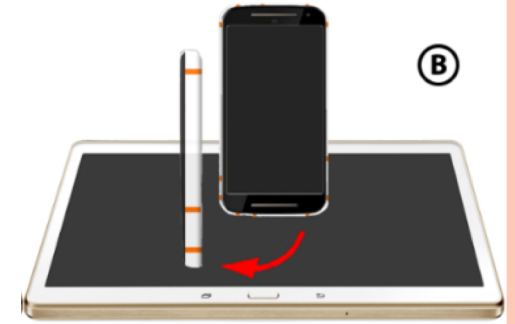
ACTUI
[Li 2015]



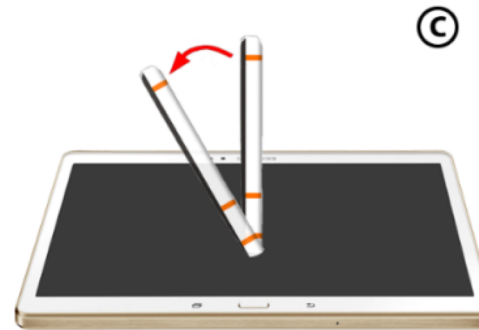
STACKING: OUR APPROACH



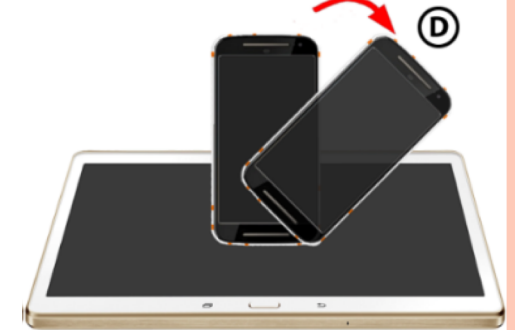
Translation



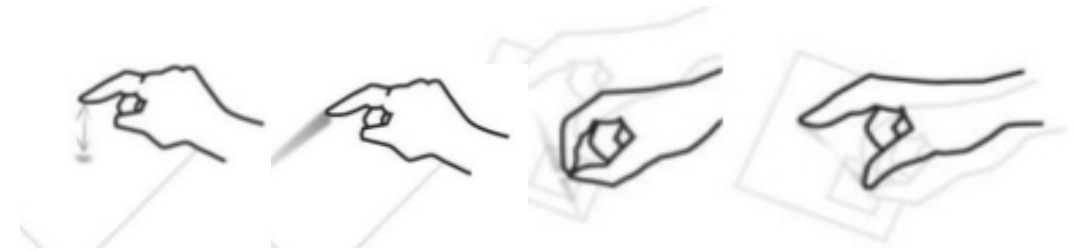
Flat Rotation



Tilt



Corner Rotation



Tap

Drag/Pan

Pinch

Spread

Tactile contact of one edge of the smartphone with the tablet display

Physical and/or tactile gesture applied to the Smartphone in contact with the tablet



EXPLORING THE USABILITY OF STACKING

- Case study: ubiquitous data analysis
 - Editing Pivot Table in Spreadsheets

C	D	E	F	G	H	I	J	K	L
Worldwide_Gross	Production_Budget	Date de sortie	MPAA_Rating	Distributor	Source	Major_Genre	Creative_Type	Director	IMDB_Rating
390525	39	30		MGM	Based on Boo Drama		Historical Fiction	George Cukor	8.2
28202	27	30		Warner Bros.	Based on Boo Musical		Fantasy	Ingmar Bergman	8.3
7900	120	60	-13	United Artists	Original Screen Western		Historical Fiction	John Wayne	5.9
5322	50	60	-13	Paramount Pictures	Original Screen Western		Historical Fiction	John Wayne	8.8
111721	110	60	-13	MGM	Based on Boo Drama		Historical Fiction	Francis Ford Coppola	8
78800	315	70		MGM	Based on Boo Action		Historical Fiction	Francis Ford Coppola	8.6
470700	120	70		Universal	Based on Boo Horror		Contemporary Fiction	Steven Spielberg	8.3
300200	550	70		Warner Bros.	Based on Con Adventure		Super Hero	Richard Donner	4.9
139000	350	70		Paramount Pictures	Based on TV Adventure		Science Fiction	Robert Wise	6.2
402500	120	70		Warner Bros.	Based on Boo Horror		Contemporary Fiction	William Friedkin	8.1
203631	90	70		20th Century Fox	Original Screen Horror		Science Fiction	Jerry Bruckheimer	8.5
206005	60	70		Paramount Pictures	Based on Mut Musical		Historical Fiction	Richard Linklater	7
54243	700	80	-13	20th Century Fox	Original Screen Action		Science Fiction	James Cameron	7.6
276665	200	80		Paramount Pictures	Original Screen Action		Contemporary Fiction	John Wood	6.1
33140	280	80		Warner Bros.	Based on Boo Thriller/Suspens		Science Fiction	Jerry Bruckheimer	8.3
9929	150	80		Universal	Original Screen Black Comedy		Fantasy	John Wood	8
411349	350	80	-13	Warner Bros.	Based on Con Action		Super Hero	John Wood	7.6
84970	120	80		Sony/Columbia	Based on Boo Drama		Historical Fiction	Olfgang Petersen	4.3
792911	105	80		Universal	Original Screen Drama		Science Fiction	Steven Spielberg	7.9
125213	140	80		Orion Pictures	Based on Boo Action		Contemporary Fiction	Richard Linklater	7.4
291632	300	80		Sony Pictures	Original Screen Comedy		Science Fiction	John Wood	6.8
12900	160	80		20th Century Fox	Original Screen Action		Fantasy	Michael Bay	7.2
10161	90	80	-13	Goldwyn Entertainment	Based on Play Action		Historical Fiction	John Wood	7.9
15717	220	80	-13	Universal	Based on Boo Adventure		Contemporary Fiction	Michael Bay	6.9
183316	170	80		20th Century Fox	Original Screen Action		Science Fiction	James Cameron	7.5
51973	180	80		Warner Bros.	Based on Play Drama		Dramatization	John Wood	8.4
25698	100	80	-13	Warner Bros.	Based on Boo Drama		Historical Fiction	Francis Ford Coppola	7
23380	180	80		Warner Bros.	Based on Real Drama		Dramatization	John Wood	8.4
386800	200	80		Paramount Pictures	Original Screen Adventure		Historical Fiction	Steven Spielberg	8.7

Champs de tableau croisé d... x

Choisissez les champs à inclure dans le rapport :

- Title
- US_Gross
- Worldwide_Gross
- Production_Budget
- Date de sortie
- MPAA_Rating
- Distributor
- Source
- Major_Genre
- Creative_Type
- Director
- IMDB_Rating

Faites glisser les champs dans les zones voulues ci-dessous:

FILTRES

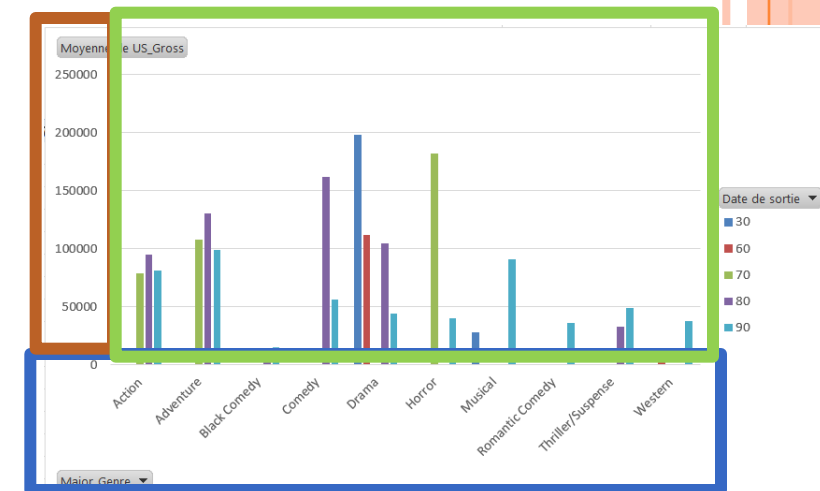
COLONNES
Date de sortie

LIGNES
Major_Genre

VALEURS
Moyenne de US_Gross

Étiquettes de colonnes

	30	60	70	80
Action				
Adventure			108238	130375
Black Comedy				992
Comedy				16196
Drama	198680	111721		104432.285
Horror			181854.6667	
Musical	28202		305	
Romantic Comedy				3265
Thriller/Suspense			6611	
Western				
Total général	113441	41647.66667	120163.5714	100773.333

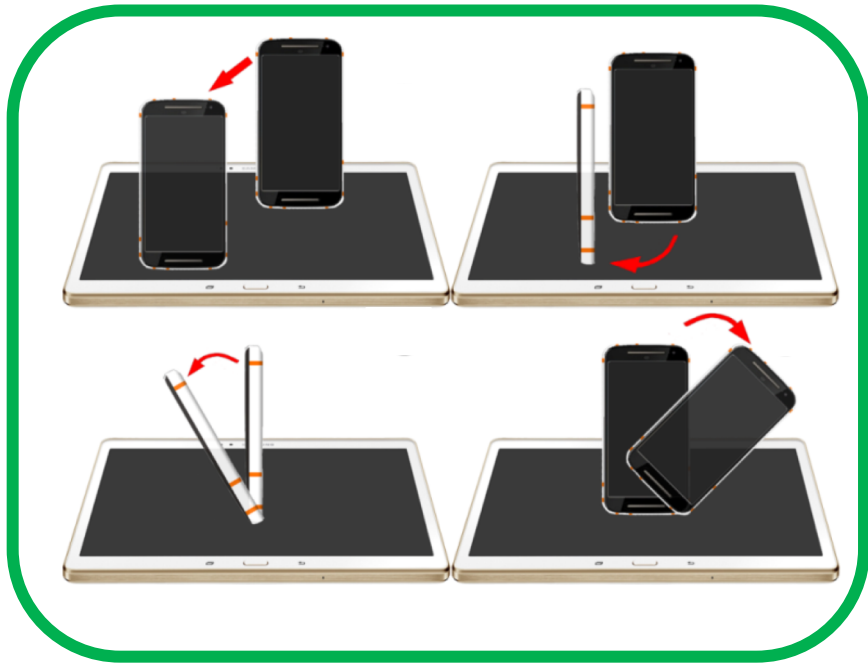


○ Three steps process

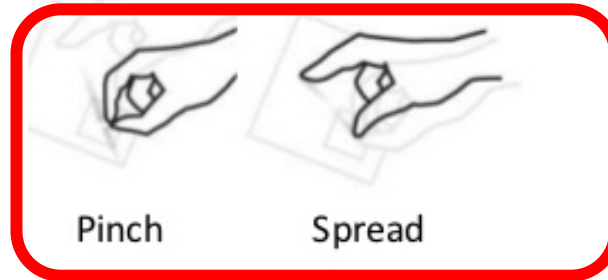
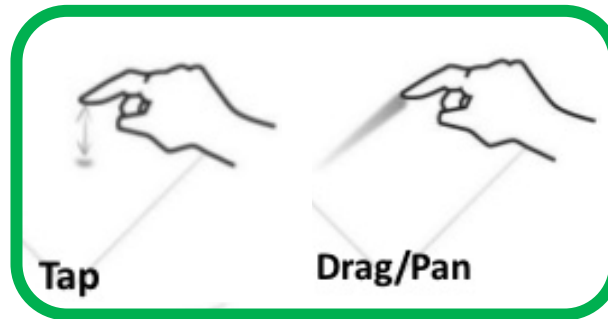
- Studying the comfort of stacking gestures **Step 1: preliminary study**
- Designing Interaction techniques for Pivot Table manipulation
 - Cell Range selection **Step 2: study 1**
 - Pivot Table Wizard edition **Step 3: study 2**

- Goal: identifying the **most uncomfortable gestures** after stacking the Smartphone on the Tablet

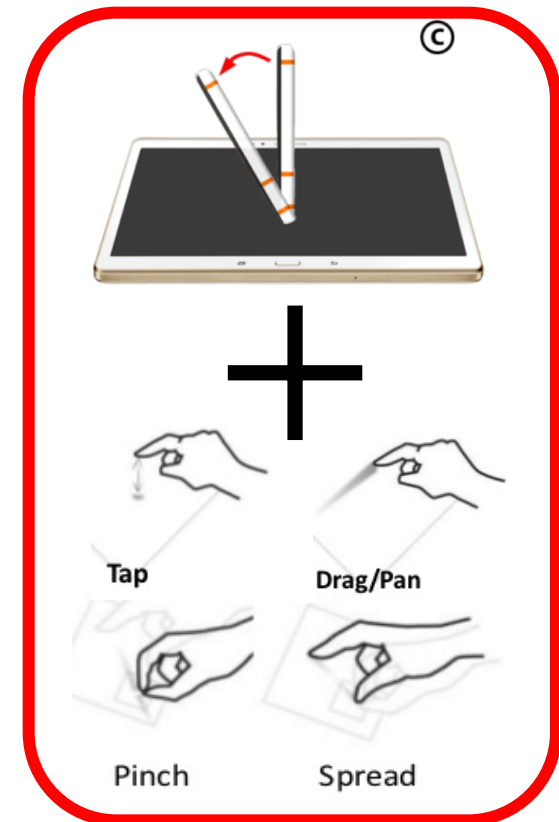
Physical Gestures



Tactile Gestures



Compound gestures



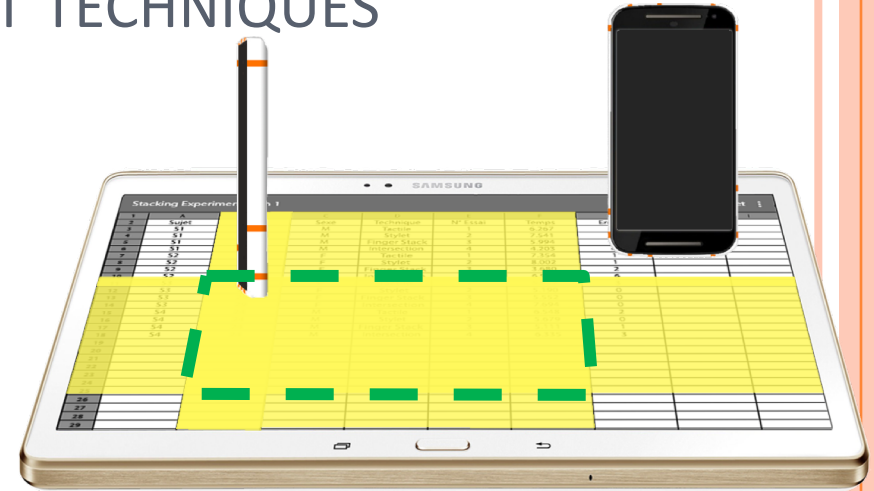


STUDY 1, CELL RANGE SELECTION: 4 DIFFERENT TECHNIQUES



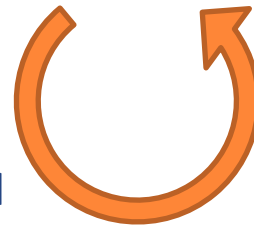
Tactile

One hand



Intersection

Two stacking gestures

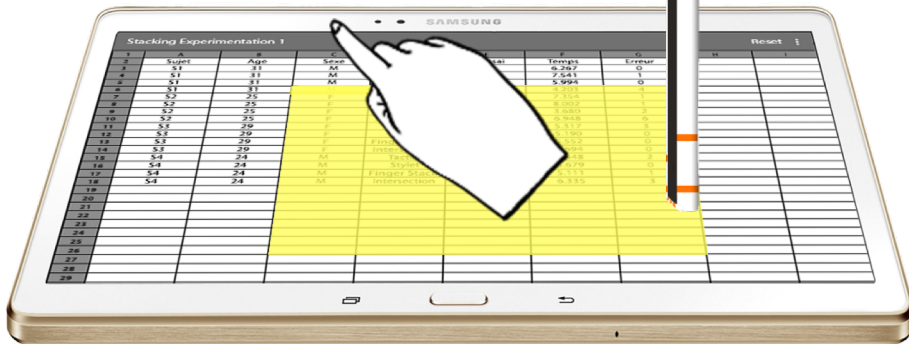


One hand

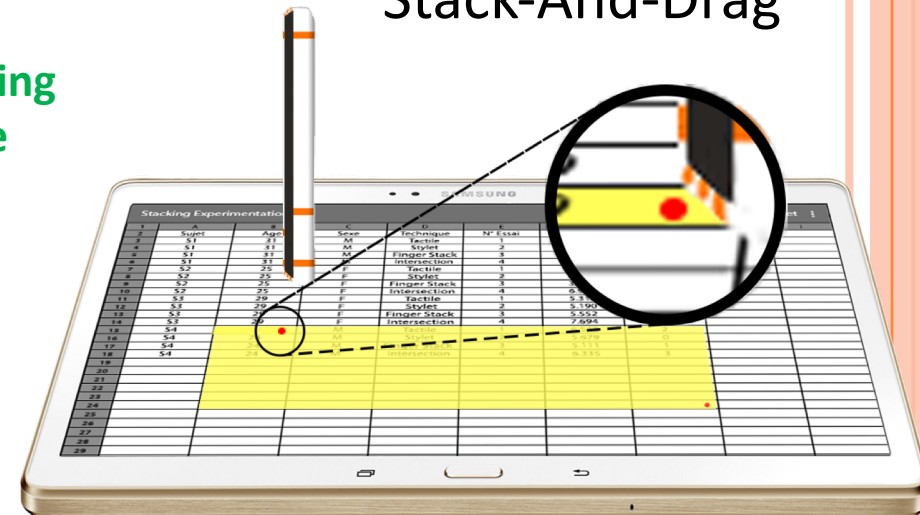
One stacking gesture

One stacking gesture

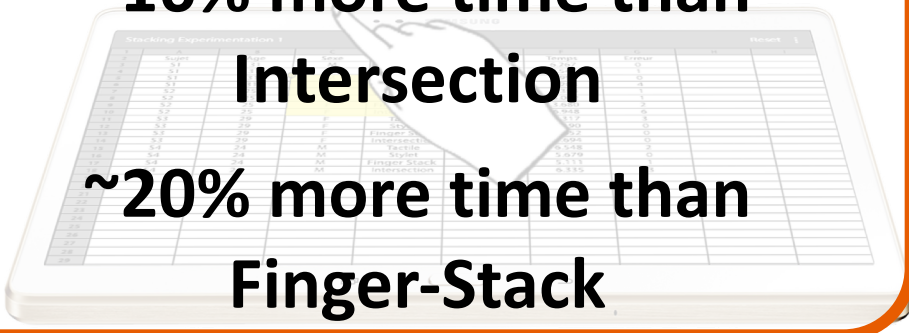
Finger-Stack



Stack-And-Drag

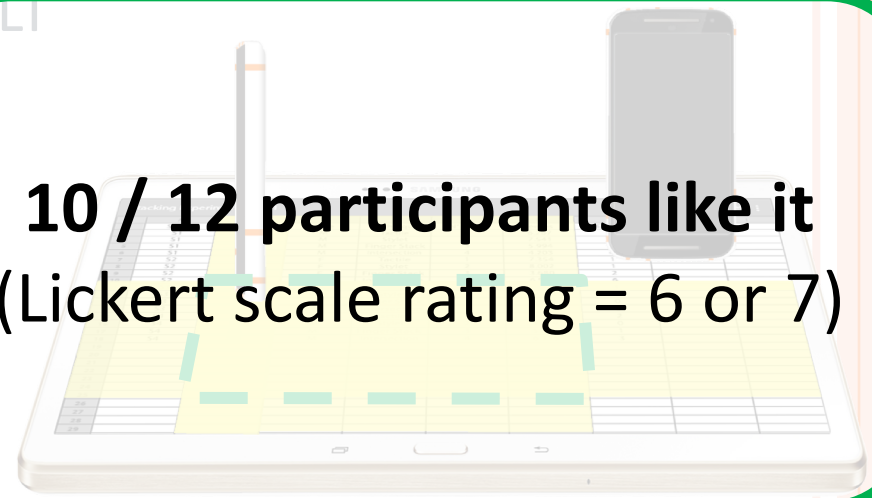


~16% more time than Intersection
~20% more time than Finger-Stack



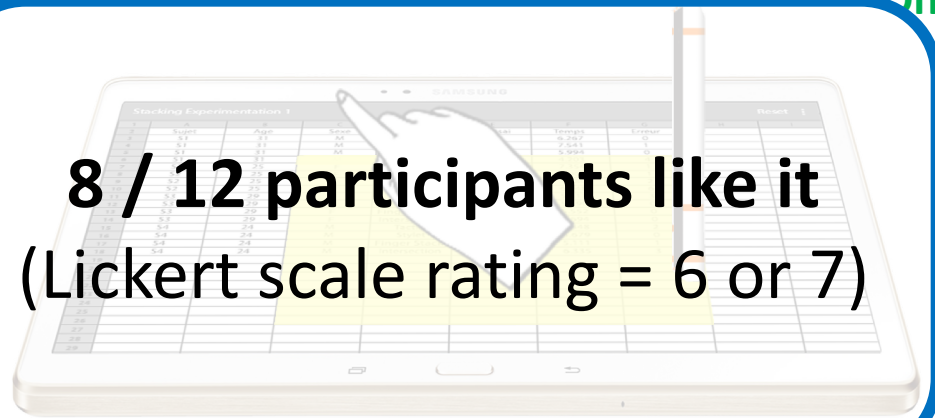
Tactile

10 / 12 participants like it
(Lickert scale rating = 6 or 7)



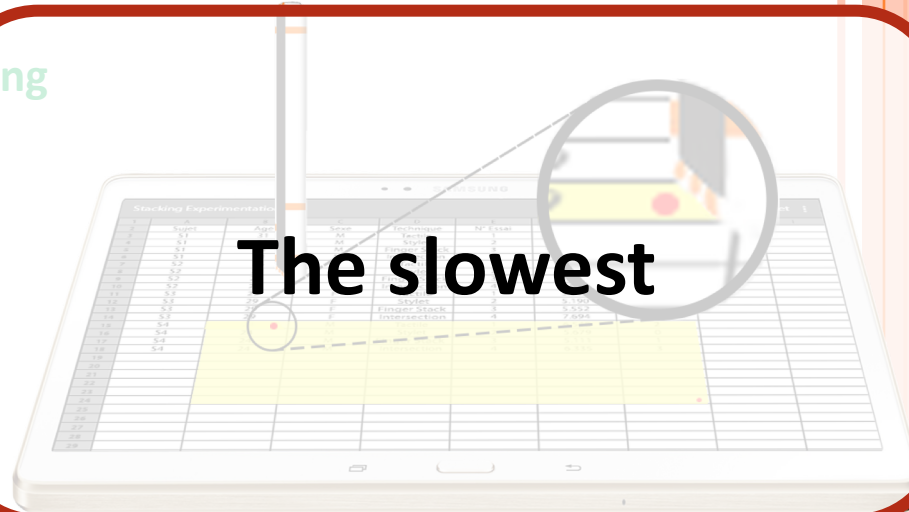
Intersection

8 / 12 participants like it
(Lickert scale rating = 6 or 7)



Finger-Stack

The slowest



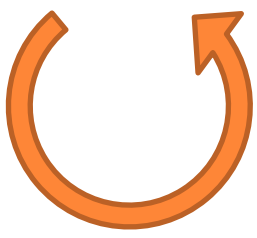
Stack-And-Drag

One hand

Two stacking gestures

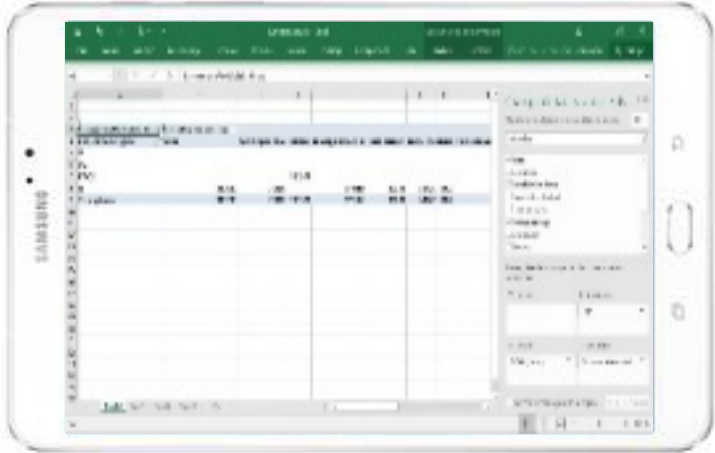
One hand
One stacking gesture

One stacking gesture



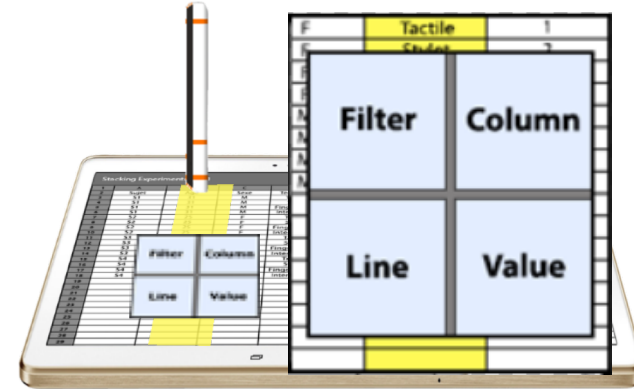


STUDY 2, PIVOT TABLE EDITION: 3 DIFFERENT TECHNIQUES



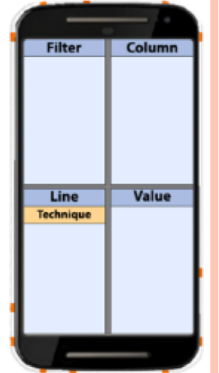
One device
Two touch gestures

Tactile



Two stacking gestures

Stack-and-Translate

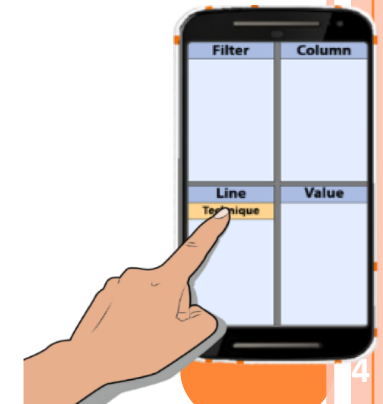
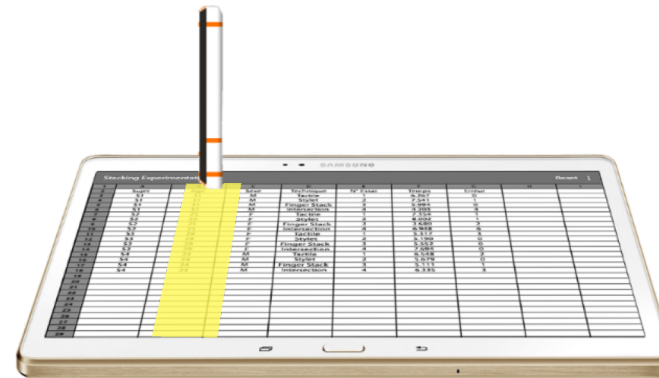


Two touch gestures

One touch gesture
One stacking gesture

Stack-and-Touch

Dual-Screen Touch



The slowest:
→ ~15% more time for selection
→ up to 30% more time for assignation

Tactile

Dual-Screen Touch

Higher error rate during assignation

Smallest time for assignation
(time gain >12% wrt other stacking TI)
Best SUS score (90)
Best subjective evaluation

Stack-and-Translate

Stack-and-Touch

Lower SUS score than the other stacking TI (73)

One device

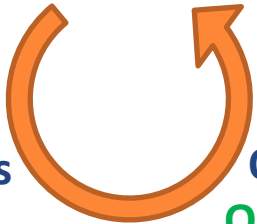
Two touch gestures

Two stacking gestures

Two touch gestures

One touch gesture

One stacking gesture



- Design of different Stacking-Based interaction techniques for spreadsheet manipulation on mobile device
 - Cell-Range selection
 - Pivot table edition
- Based on a conductive case
 - 3D printed
 - Aluminium
- Stacking-Based approaches are faster than tactile approaches
 - Enlarge display space
 - Enrich input vocabulary
 - Speed-up the access to specific commands

