INTERACT 2019

Combining Tablets with Smartphones for Data Analytics

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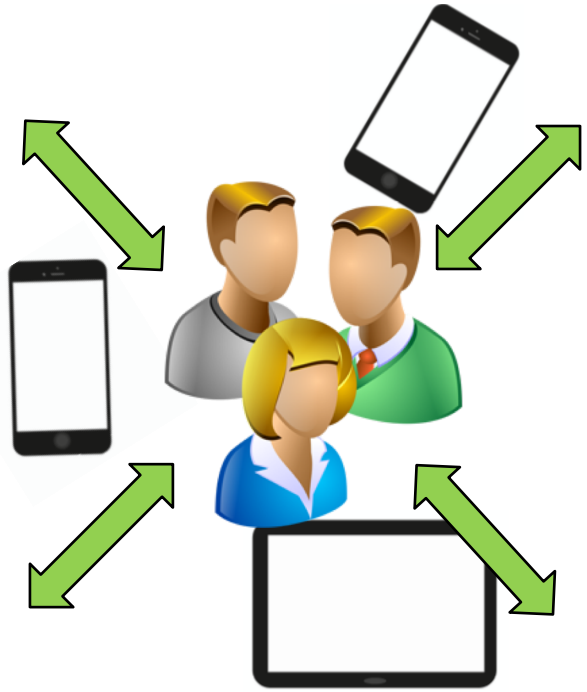
Context: Berger-Levrault and local elected officers

- Berger-Levrault:

➔ Leader in the software development for French public administration

➔ Developing an ambitious strategy serving digital and societal transformations



Towards ubiquitous analytics for elected officers

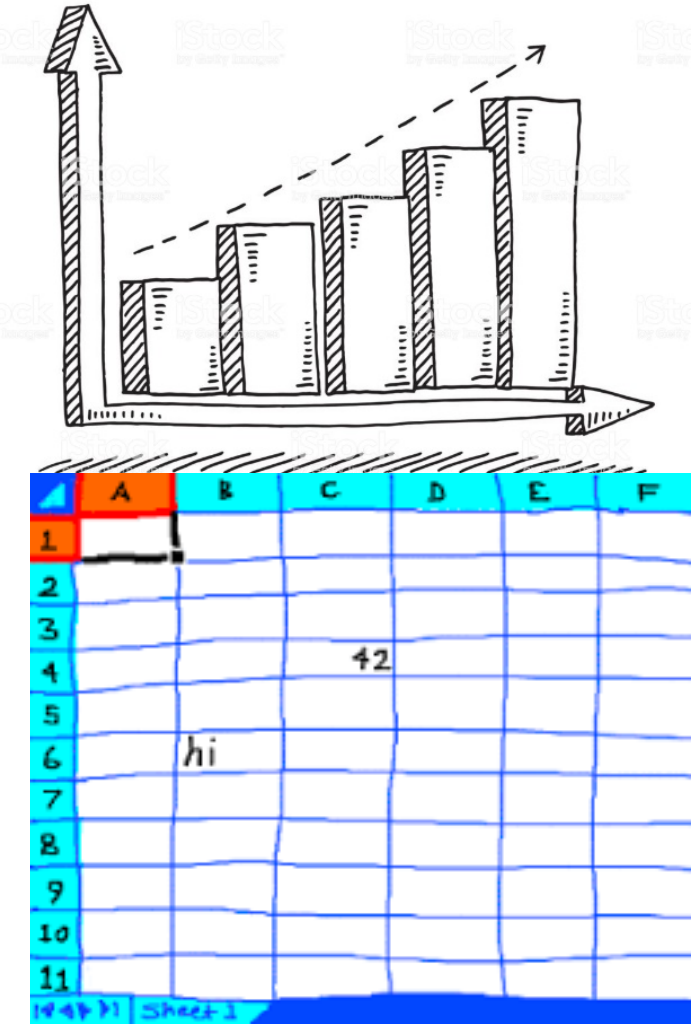
- Take advantage of small, portable devices that become professional computing platforms
- Make sense of data anywhere and anytime
- Could even use them in close contact with citizens (i.e. in the street)

Requirements: interviews with local authorities

- Goal : Identifying typical data analysis tasks

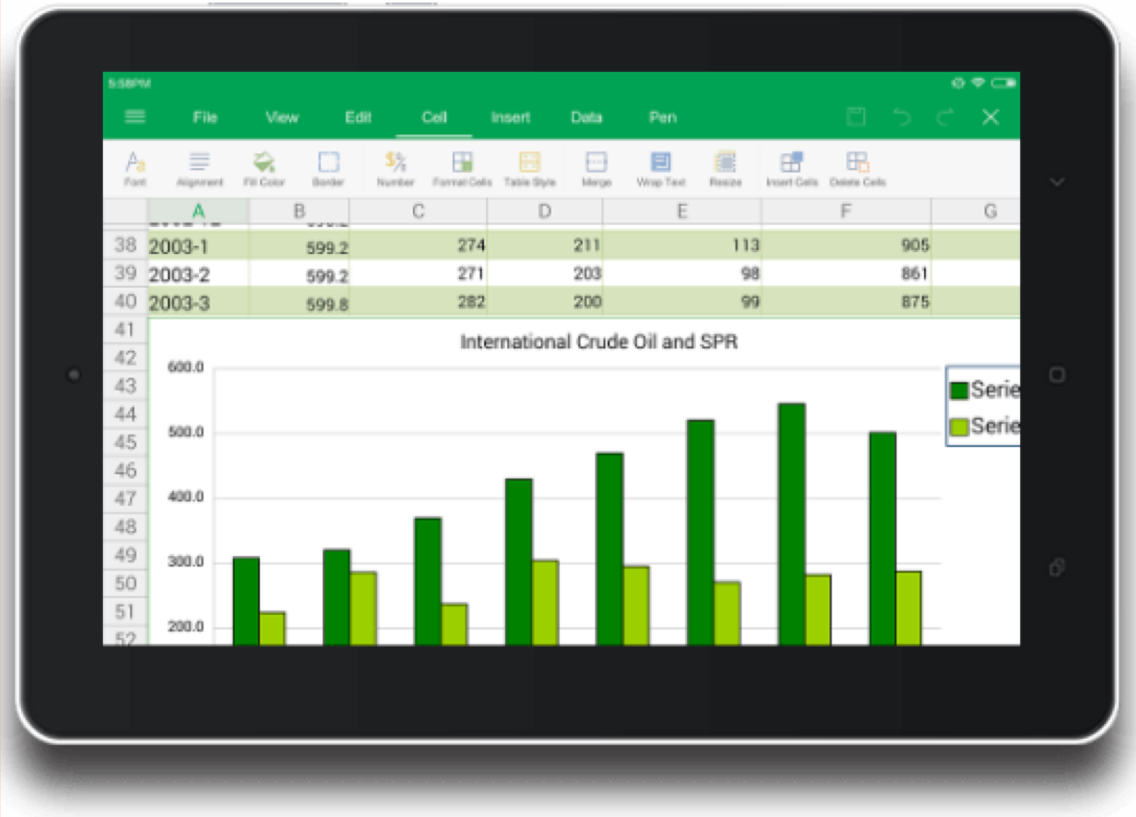
- Interview protocol
  - 8 elected officers : small and large cities
  - Semi-guided interviews
  - Duration : approx. 1 hour

- 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

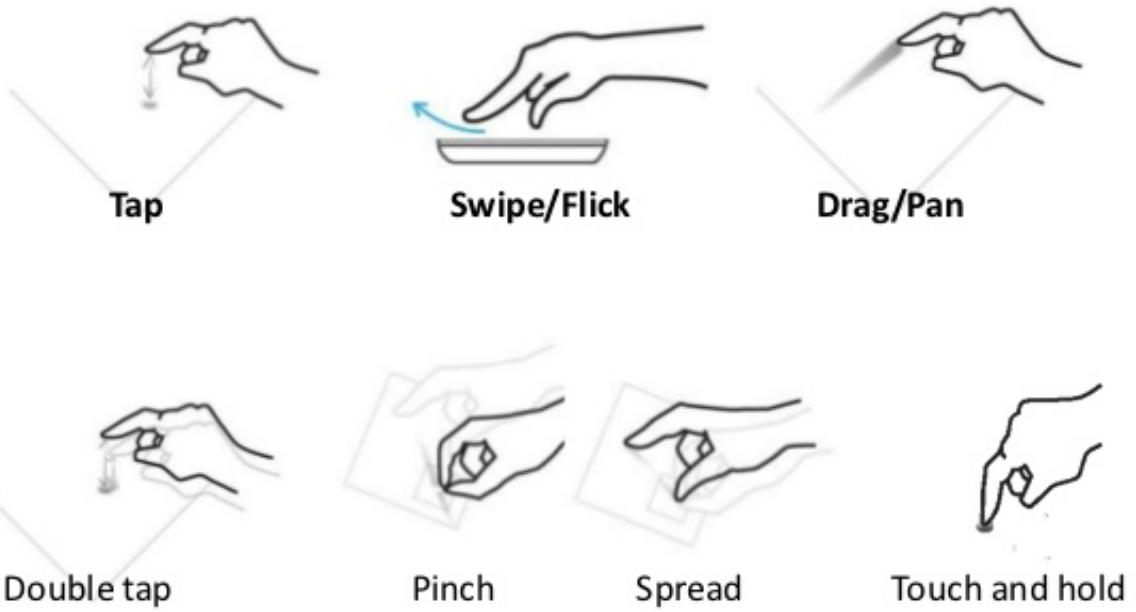


LIMITATIONS

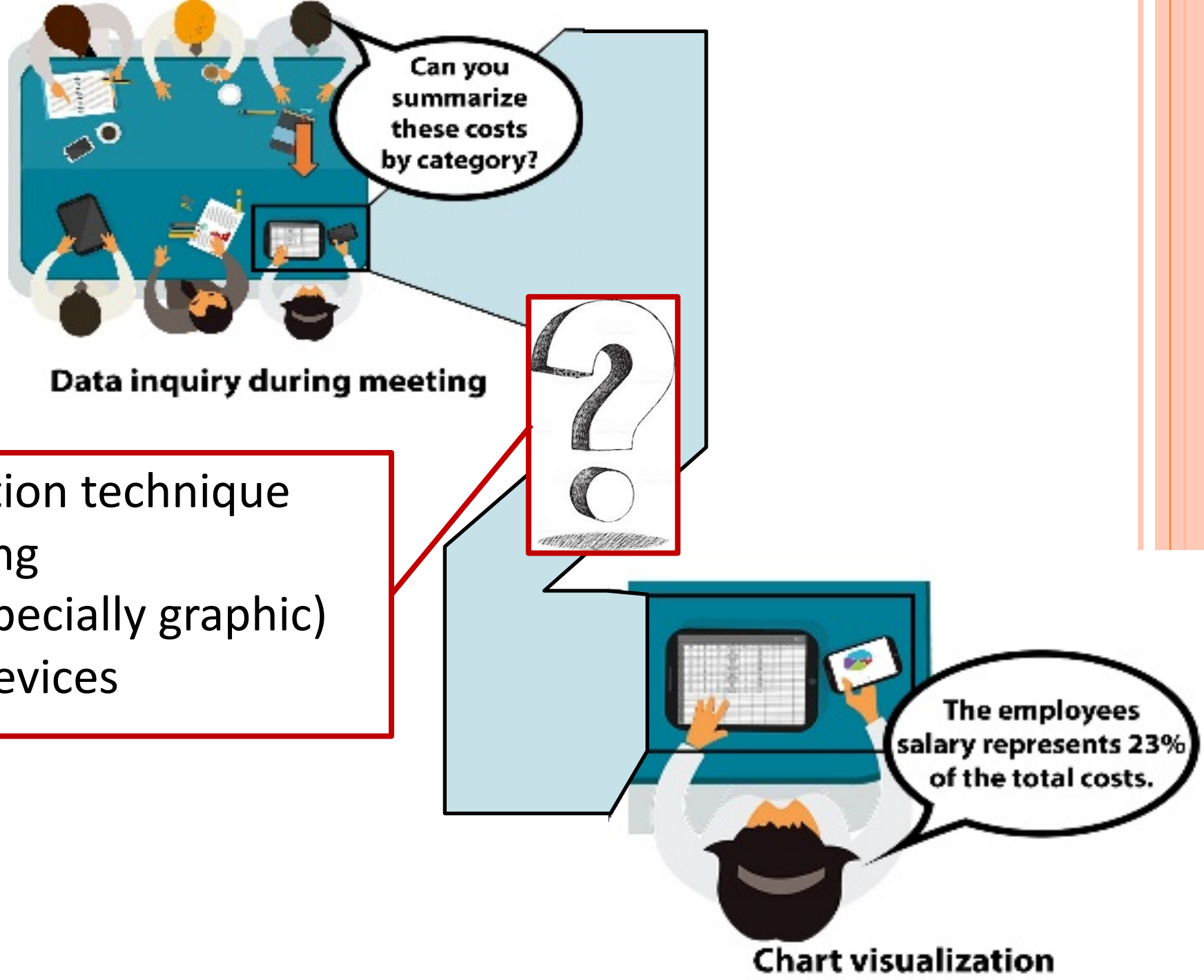
- Limited output display size: occlusion or pan required



- Limited input vocabulary: menus or combination of input required



GOAL



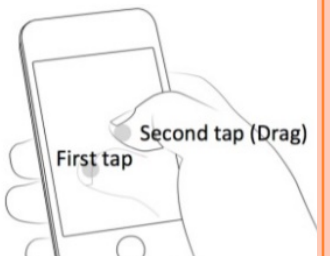
Providing an interaction technique facilitating
data manipulation (especially graphic)
on mobile devices

EXISTING SOLUTIONS: MULTIMODAL APPROACHES

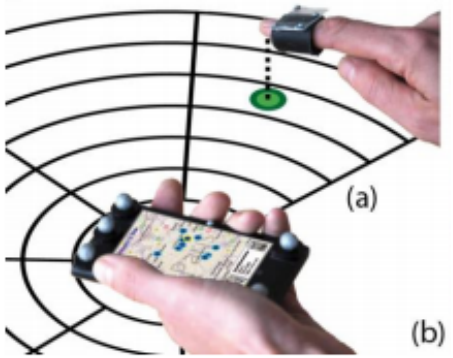
- Consecutive Taps
- Gestures Around the Smartphone
  - Hand
  - Thumb
- Pen
  - Rolling / tilting
  - Combined with thumb

➔ **Output capabilities not extended**

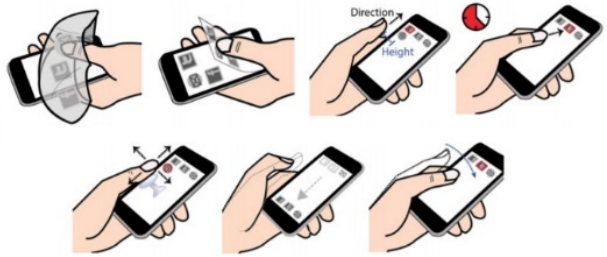
➔ **Dedicated device required to be differentiated from a finger touch**



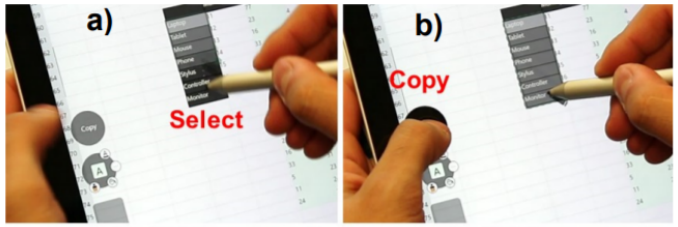
Consecutive taps [Heo 2014]



Ad-binning [Hasan 2013]



Thumbs-Up [Hasan 2016]



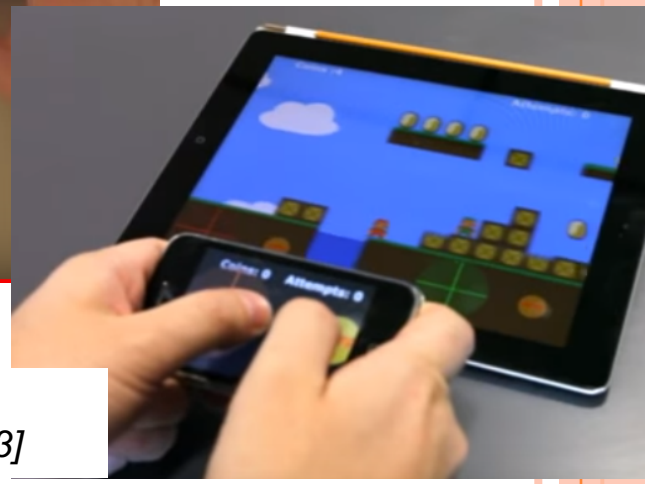
Thumb + pen [Pfeuffer 2017]

Pen rolling [Moscovich 2008]

Existing approaches: multi-display approaches

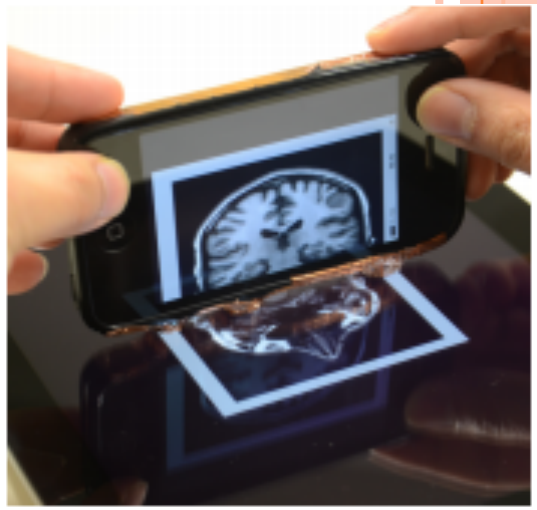
VisTile
[Langner 2018]

- Data and command distribution over multiple spatially aware tablets
  - ➔ **Need for an external tracking system**



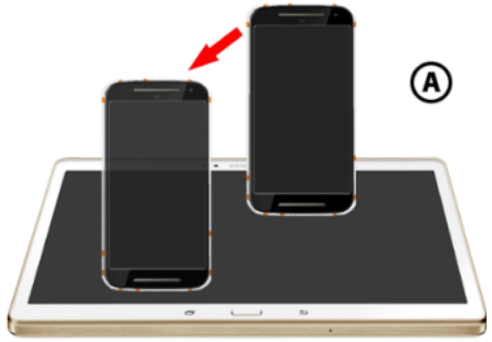
BatMan
[Piazza 2013]

- Display stacking
  - Satelite view and orthogonal view
    - ➔ **Offer concrete solutions**
    - ➔ **Need for more systematic exploration of the stacking design space**

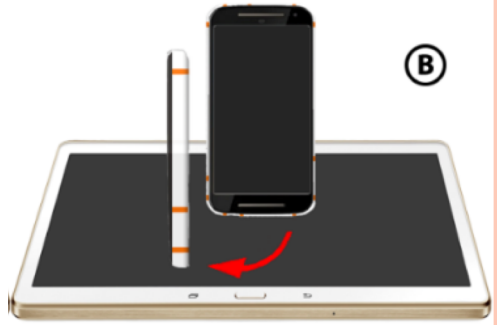


ACTUI
[Li 2015]

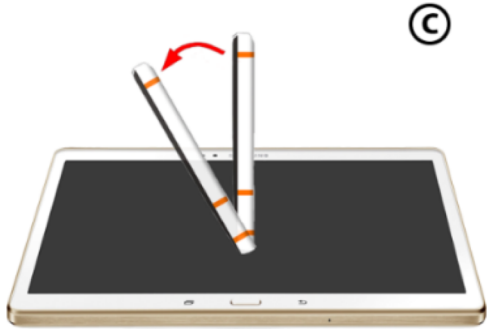
STACKING: OUR APPROACH



Translation

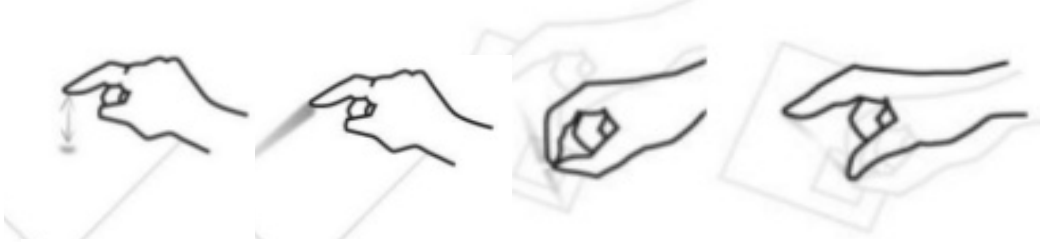


Flat Rotation



Tilt

Corner Rotation



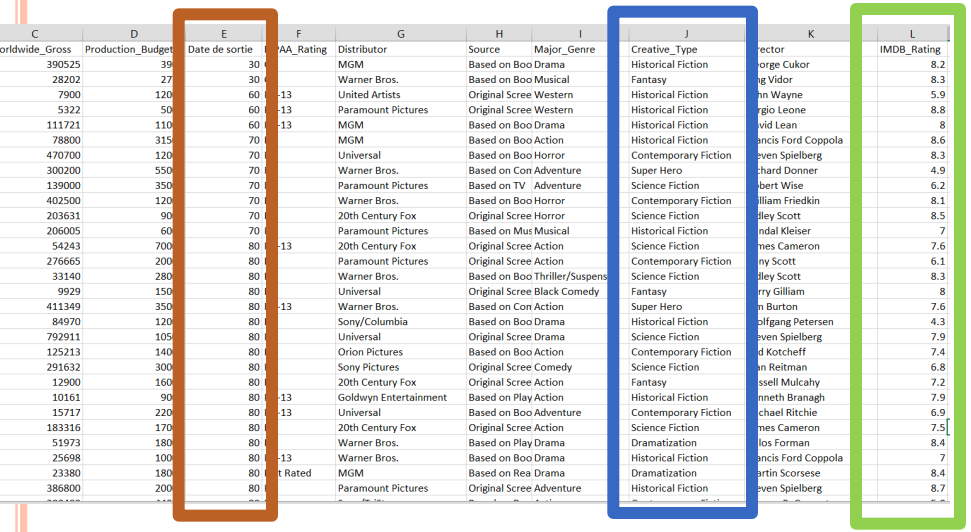
Tap Drag/Pan Pinch Spread

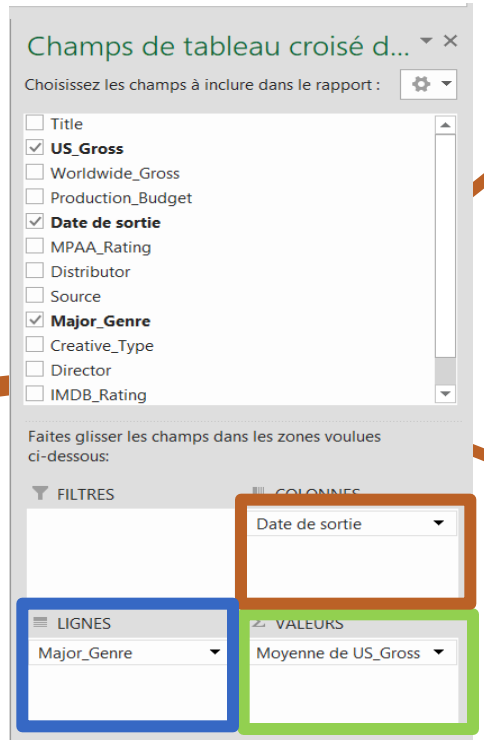
Tactile contact of one edge of the smartphone with the tablet display

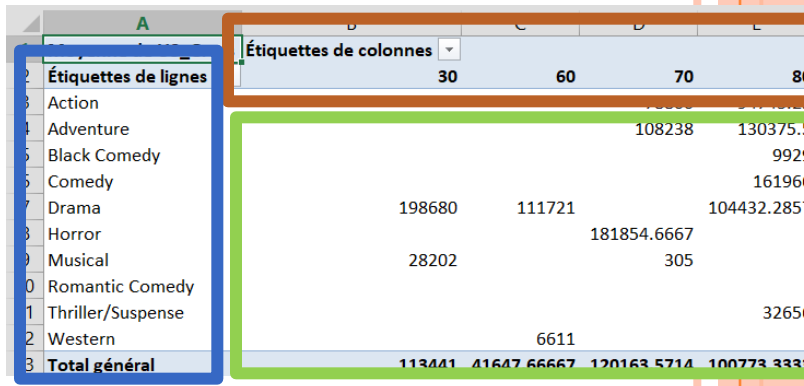
Physical and/or tactile gesture applied to the Smartphone in contact with the tablet

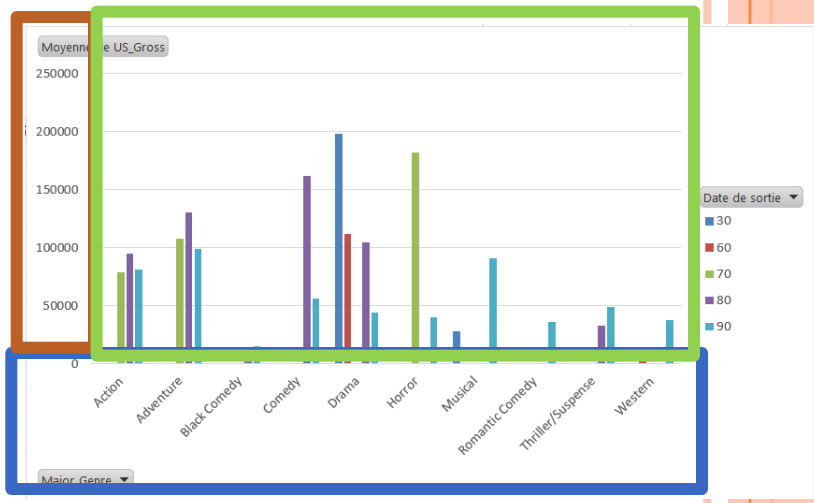
Exploring the usability of Stacking

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







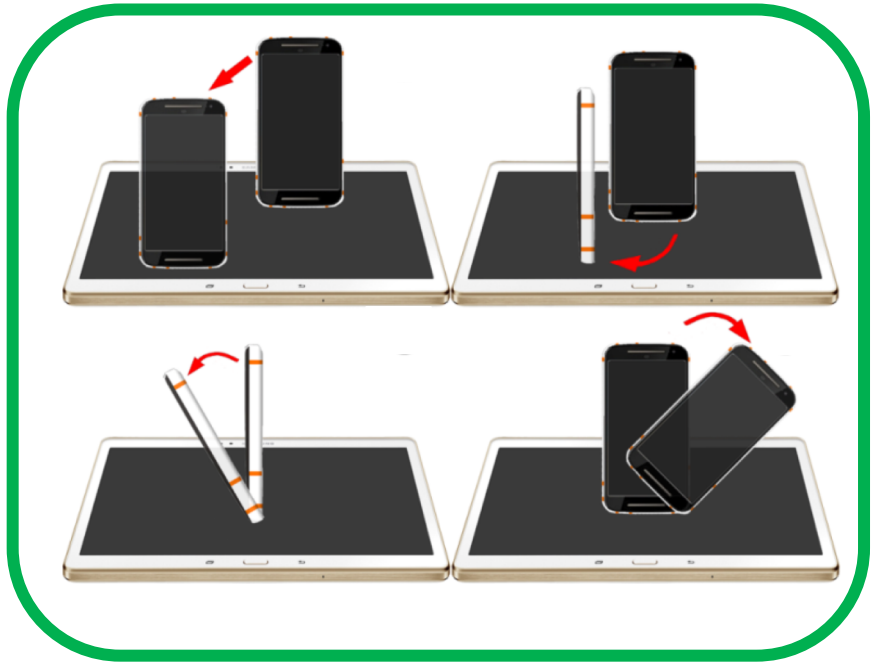


- Three steps process
  - Studying the comfort of stacking gestures ..... **Step 1: preliminary study**
  - Designing Interaction techniques for Pivot Table manipulation
    - Cell Range selection ..... **Step 2: study 1**
    - Pivot Table Wizard edition ..... **Step 3: study 2**

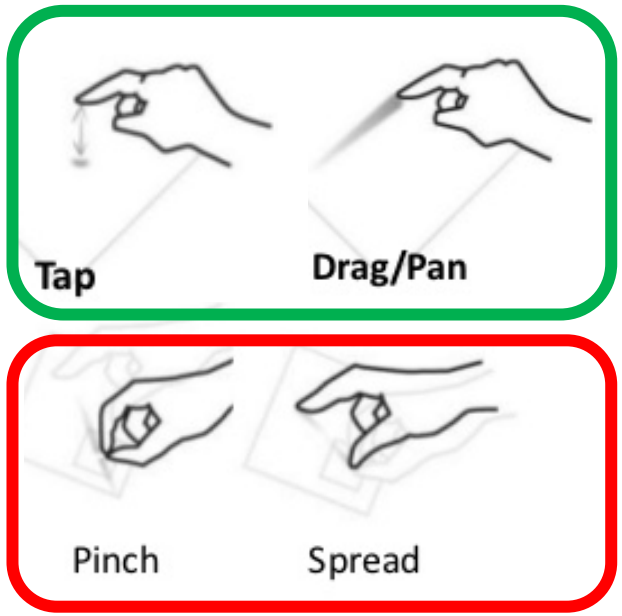
Preliminary study: main results

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

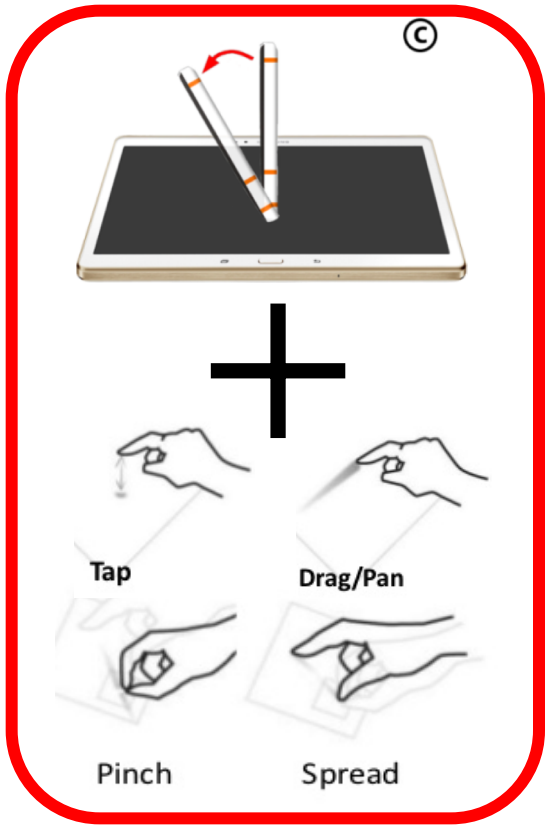
Physical Gestures



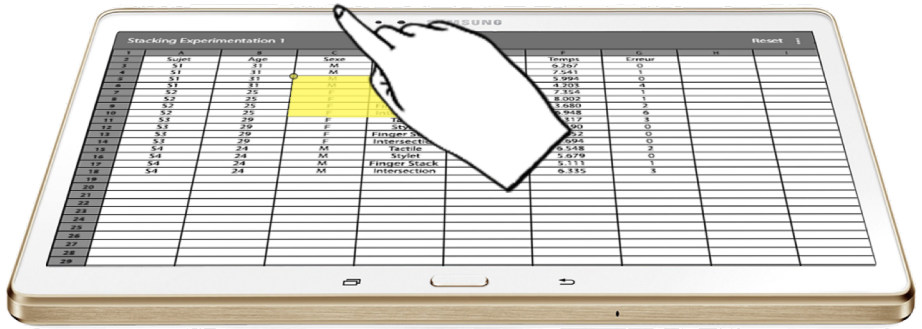
Tactile Gestures



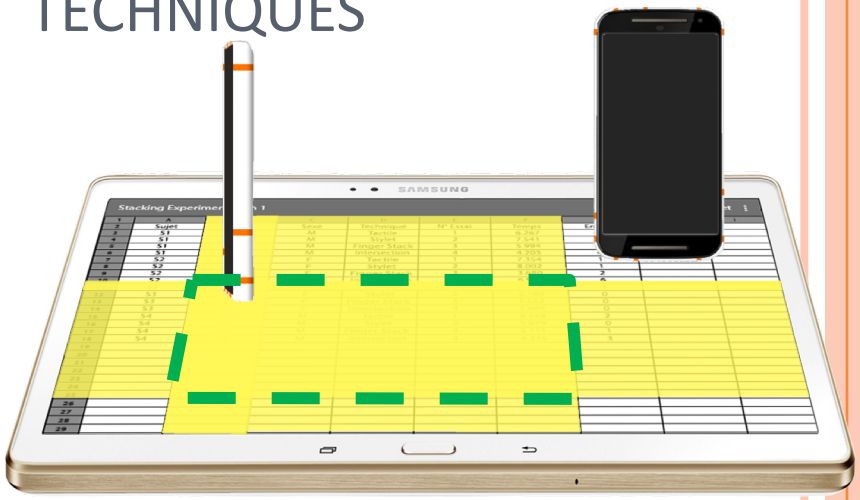
Compound gestures



Study 1, cell range selection: 4 different techniques



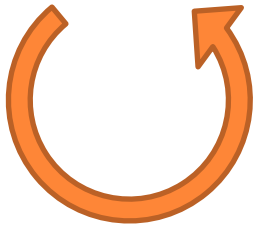
Tactile



Intersection

One hand

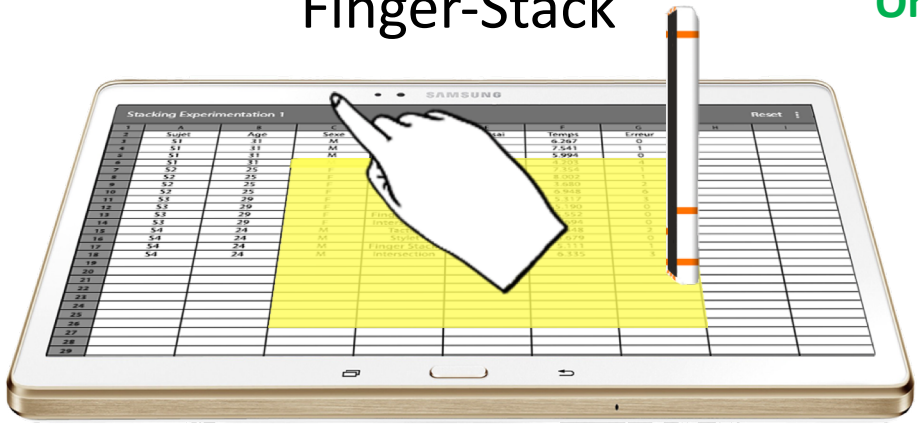
Two stacking gestures



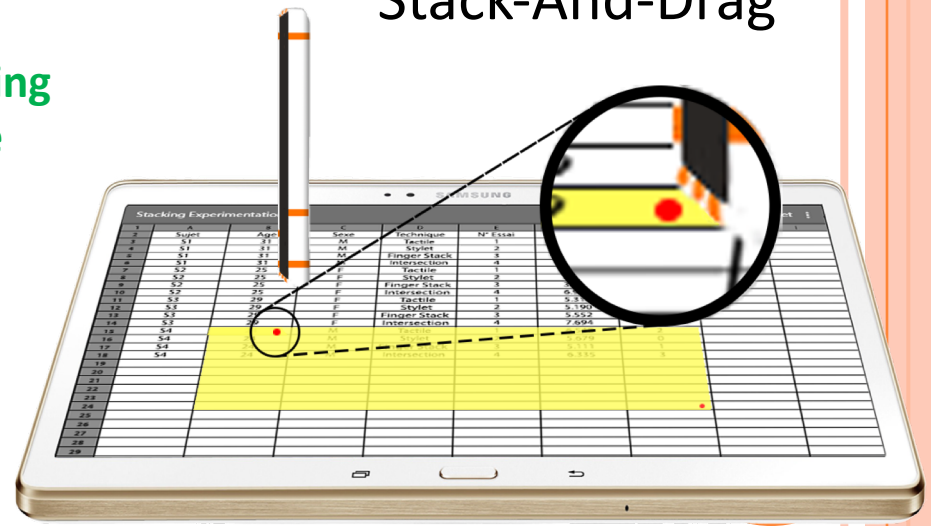
One hand
One stacking gesture

One stacking gesture

Finger-Stack



Stack-And-Drag



Study 1, cell range selection: Main result

~16% more time than Intersection

~20% more time than Finger-Stack

Tactile

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

Intersection

One hand

Two stacking gestures

One hand
One stacking gesture

One stacking gesture

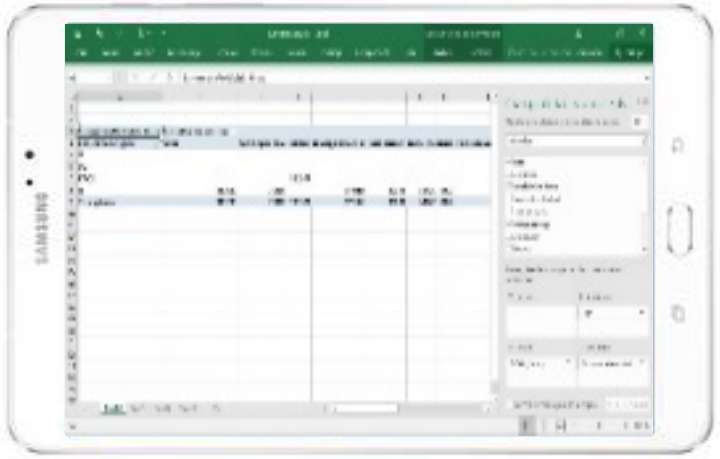
Finger-Stack

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

Stack-And-Drag

The slowest

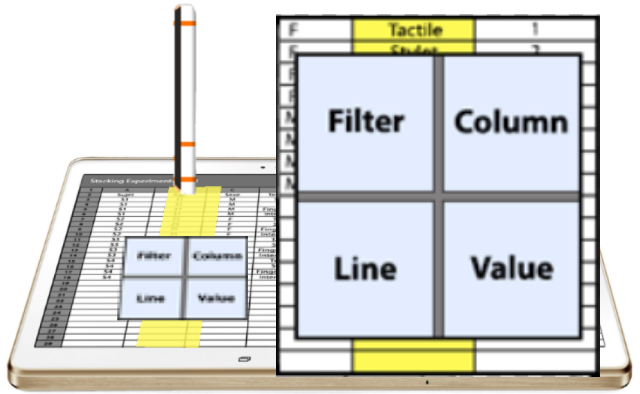
Study 2, pivot table edition: 3 different techniques

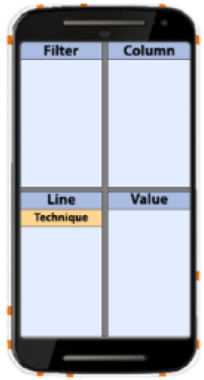


One device

Two touch gestures

Tactile





Two stacking gestures

Stack-and-Translate

Two touch gestures

Dual-Screen Touch

One touch gesture

One stacking gesture

Stack-and-Touch

Study 2, pivot table edition: main results

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

Tactile

One device
Two touch gestures

Two stacking gestures

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

Stack-and-Translate

Two touch gestures

One touch gesture
One stacking gesture

Dual-Screen Touch

Higher error rate during assignation

Stack-and-Touch

Lower SUS score than the other stacking TI (73)

Conclusion

- 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 that tactile approaches
  - Enlarge display space
  - Enrich input vocabulary
  - Speed-up the access to specific commands