Physical Activity in SPACE:
Collecting, processing and linking accelerometry, GPS and GIS data

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SPACE

SUPPORTIVE ENVIRONMENTS FOR PHYSICAL & SOCIAL ACTIVITY, HEALTHY AGEING & COGNITIVE HEALTH

This work was supported by **UK Research and Innovation** [ES/V016075/1]

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RESEARCH AIMS

Aim

Using more granular measures, to investigate the possible mechanistic pathways by which the urban environment influences cognitive health.

Objective

By collecting new data on a subgroup of 1,000 older people including more in-depth measures of brain health and better measures of physical activity, using sensors worn around the waist. This will allow us to explore how the urban environment influences our brain health.

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PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR IN OLDER ADULTS

- Measure levels of physical activity
  - Light, moderate and vigorous
- Measure sedentary time
- Need measures that provide detail relating to:
  - Day – weekday versus weekend day
  - Time of day – morning, noon, afternoon, evening
  - Intensity – sedentary, light, moderate, vigorous
  - Duration – minutes, hours

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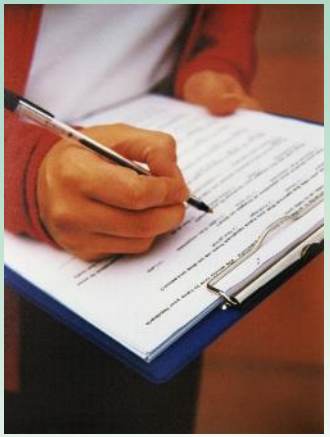
WHY USE ACCELEROMETRY IN OLDER ADULT RESEARCH

- Accelerometry provides:
  - Objectively measures physical activity and sedentary time
  - Reduces burden for participants
  - Avoids self-report limitations such as
    - Visual impairments
    - Writing difficulties
    - Recall limitations
    - Questions that are not designed for older adult activities
    - Classification of activity by domain and/or intensity
  - Enables researchers to adapt the processing criteria for the specific population



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ACCELEROMETRY

- Actigraph GT3X+
- Worn on an elasticated waist band on right hip
  - Easy to wear
  - No skin contact
  - Non-invasive

- Seven days of consecutive wear (weekday and weekend)
- Removed for water-based activities and sleep
- Charged and initiated before delivery

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ACCELEROMETRY PROCESSING

- Download accelerometer data (raw files)
- Using Actilife software
- Monitors then recharged, initiated and back into the field
- All data stored securely

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ACCELEROMETRY PROCESSING

- Need to decide on processing criteria:
  - Non-wear: 20, 60, 90 or 120 minutes
  - Valid day: 8, 10 and 12 hours
  - 3, 4, 5 days wear
  - Cut points, multiple variations:
    - Pre-school
    - Children
    - Adults
    - Older adults

OUTPUT

- **Minutes of:**
  - **Light, moderate and vigorous**
  - **Total physical activity**
  - **Sedentary time**

By day
By time of day
Weekly

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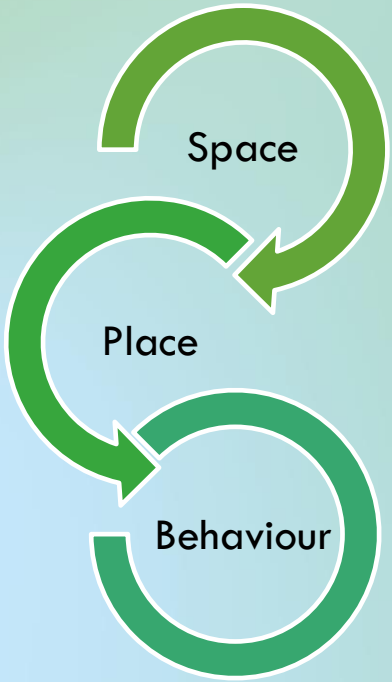
GLOBAL POSITIONING SYSTEM (GPS)

- Satellite-based navigation system
- Allows researchers to measure participants access and exposure to specific environments, amenities, facilities etc.



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GPS

- Device: Qstarz BT-1000XT
- Worn on a belt with accelerometer (GPS device on left hip)
  - Easy to wear
  - No skin contact
  - Non-invasive
- Seven days of consecutive wear
- Removed for water-based activities and sleep
- Charged and initiated before delivery but requires charging every night
- Software: Qtravel

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ETHICAL CONSIDERATIONS

- Monitoring is not “live” – black box device
- From the outset participants should be made aware of what data is being collected and for what purpose
- Participants are free to withdraw at any stage even after the data has been collected
- Non-identifiable outputs should be used

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OUTPUTS

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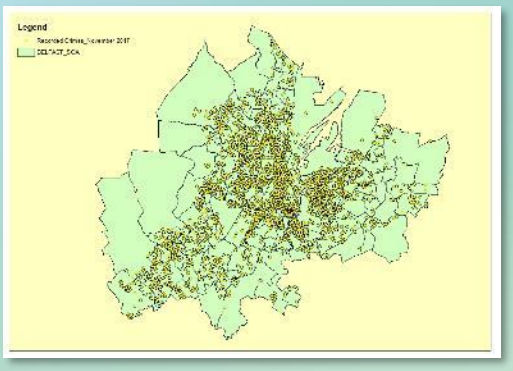
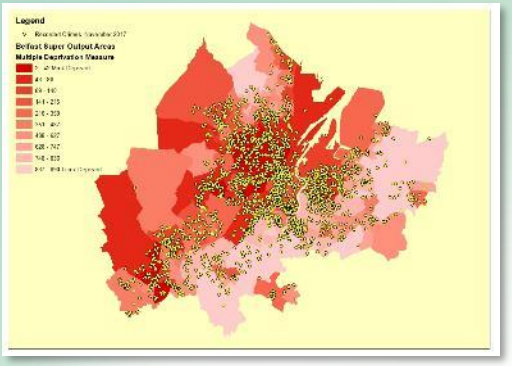
GEOGRAPHICAL INFORMATION SYSTEM (GIS)

- Spatial mapping and visualisation of:
  - Geographical phenomena
  - Statistical data
- Highlights patterns and distributions across space
- Generates new information by combining and synthesising information from existing layers
- Widespread use in research and by private/public organisations





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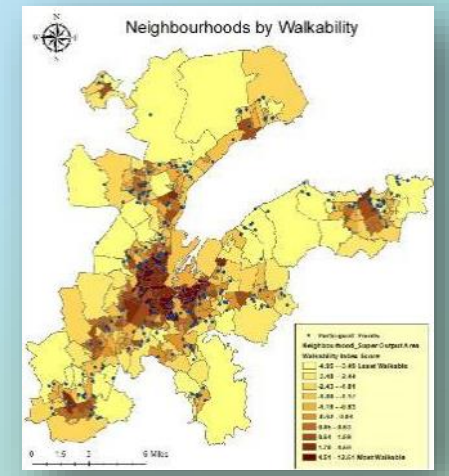
GIS



- GIS can be used as:
  - **A visualisation tool** - Inter- and Intra-city comparisons

  - **A sampling tool** – Recruitment of participants by neighbourhood (e.g., varying by walkability, income etc.)

  - **A spatial analytical tool** - Creation of objective environmental data to integrate and analyse with other sources of data

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USING GIS TO MEASURE ENVIRONMENTS

- GIS used to measure built environment characteristics. Such as:
  - Residential density
  - Commercial/Retail
  - Civic and Institutional
  - Entertainment
  - Recreational
  - Food-Related and Restaurant
  - Intersection Density
  - Public Transportation
  - Private Recreation Facilities
  - Public Parks

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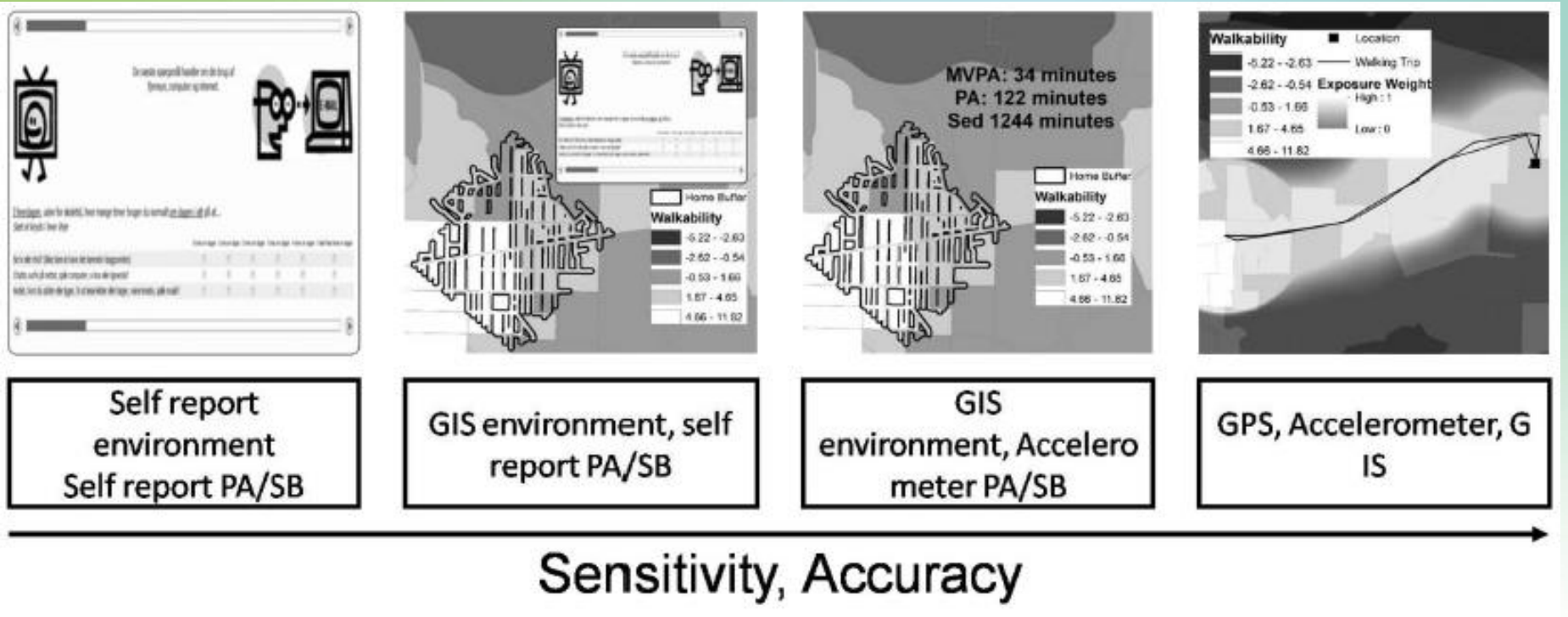
DATA INTEGRATION



Jankowska et al. (2015) A framework for using GPS data in physical activity and sedentary behavior studies. Exerc Sport Sci Rev. 43(1):48-56

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DATA INTEGRATION

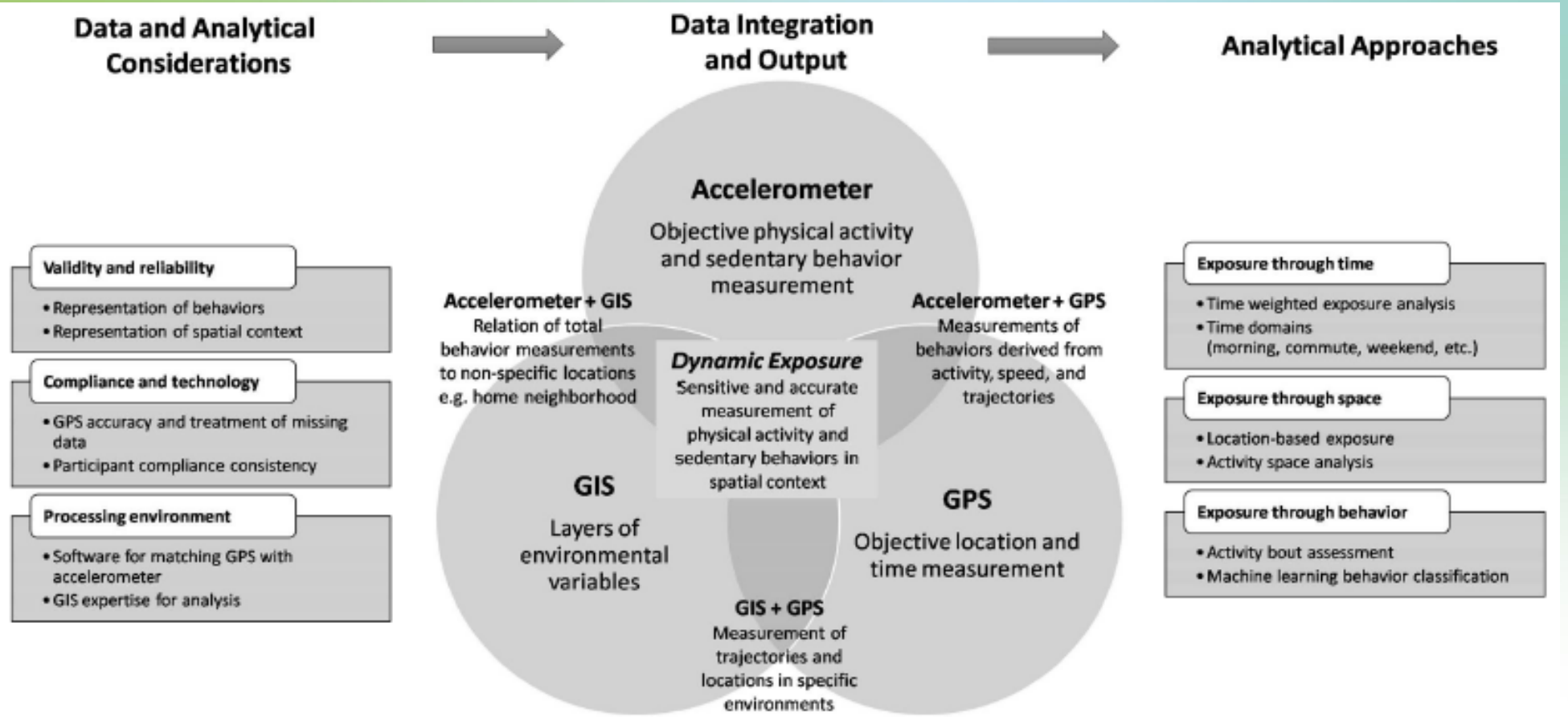

Figure 2.
Framework for integration of GPS, accelerometer, and GIS technology.

Jankowska et al. (2015) A framework for using GPS data in physical activity and sedentary behavior studies. Exerc Sport Sci Rev. 43(1):48-56

SOFTWARE USED FOR DATA INTEGRATION

We use 3 opensource software to analyse and integrate accelerometer, GPS and GIS data

1. GGIR – Analysing accelerometer data
2. PALMSpy – Combining accelerometer and GPS data
3. Palmsplusr – Putting PA in geographical context

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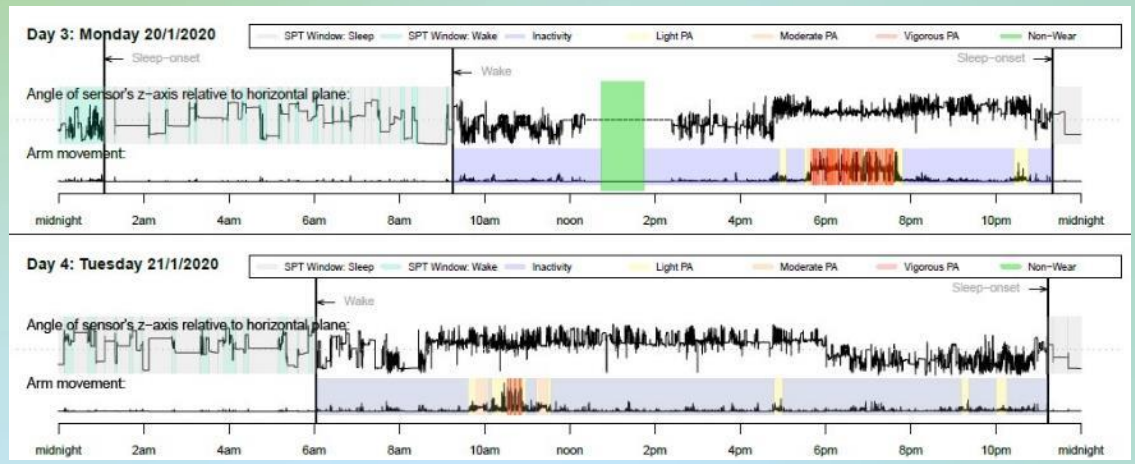
SOFTWARE USED FOR DATA INTEGRATION

GGIR – Analysing accelerometer data

- Input: Raw accelerometer data
- Output: Summary metrics of PA & SB in time intervals
  - Person summary
  - Day summary
  - Data quality



Source: https://cran.r-project.org/web/packages/GGIR/vignettes/GGIR.html

Migueles JH, Rowlands AV, et al. GGIR: A Research Community–Driven Open Source R Package for Generating Physical Activity and Sleep Outcomes From Multi-Day Raw Accelerometer Data. Journal for the Measurement of Physical Behaviour. 2(3) 2019. doi: 10.1123/jmpb.2018-0063.

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SOFTWARE USED FOR DATA INTEGRATION

PALMSpy – Combining accelerometer and GPS data

- Input: Accelerometer activity counts, GPS
- Output: Metrics of PA & SB in points in time and space
  - For each timestamp: distance, speed, activity intensity, activity bouts, trips and travel modes
  - It can be visualized on map using maps in SPACE Geoportal!

Emiliano Molinaro, & marodseg. (2021). emolinaro/PALMSpy: PALMSpy v1.9.6 (1.9.6). Zenodo. https://doi.org/10.5281/zenodo.5588126

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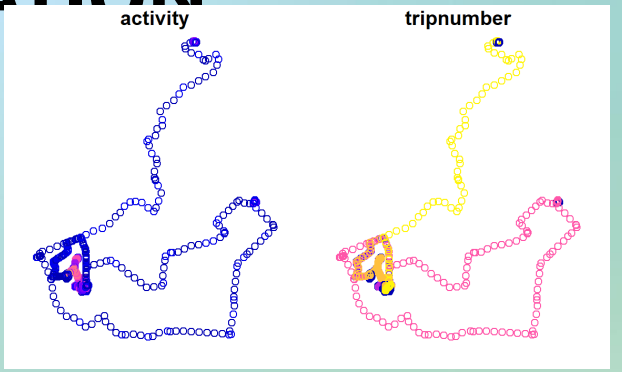
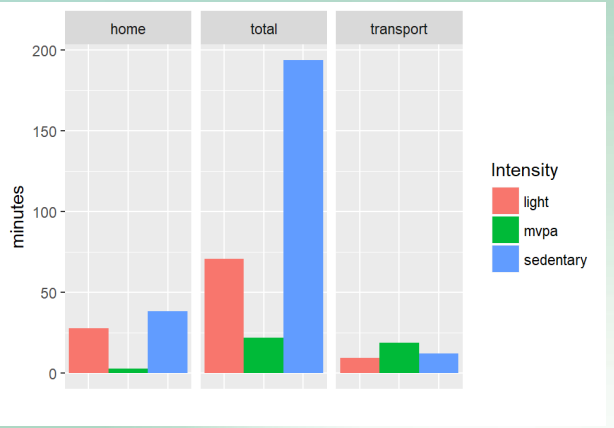
SOFTWARE USED FOR DATA INTEGRATION

Palmsplusr – Putting PA in geographical context

- Input: PALMSpy output and GIS shapefiles
  - SPACE Geoportal offers a wide range of shapefiles!
- Output: Metrics of PA & SB within defined locations
  - MVPA in greenspaces
  - Sedentary time during vehicular travel
  - etc.





Source: https://thets.github.io/palmsplusr/articles/article-1-getting-started.html

Stewart T, Snizek B, Schipperijn J. PALMSplus for R. https://thets.github.io/palmsplusr/

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Thank you!

Contact:

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