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Measuring Device-Specific Physical Activity Trackability in Multi-Device Environments

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***Abstract*—Wrist-worn wearables such as smartwatches and fitness trackers have become widely used with smartphones in recent years. Interestingly, both types of devices support physical activity tracking, but that is only available when users wear or carry their devices, and thus, trackability is heavily influenced by user contexts. To analyze physical activity trackability in a multi-device environment, this paper explores *device-specific coverage* measures based on activity bouts.**

***Keywords*-Wearables, Smartphones, Physical Activity, Device Coverage**

I. Motivation

With the widespread use of mobile devices, it is now common to track daily physical activities for individuals, known as the quantified-self movement, and this data has been widely adopted in research in the health domain [1]. In general, two types of mobile devices–smartphones and wrist-worn wearables–are widely used for tracking physical activity. Due to the difference in their usage (i.e., wearing wrist wearables vs. carrying smartphones), missing data can be related to user contexts and characteristics. However, despite the fact that missing data is one of the main issues with physical activity tracking [2], there is a lack of analysis on how missing data can be related to user contexts. In this study, to lay the foundation for an analysis of trackability, we proposed a method to quantify physical activity trackability. We want to assess physical activity trackability in uncontrolled everyday situations by multiple devices.

II. Activity Bouts and Device-specific Coverage

We first defined the unit of a step count as a *bout*, which represents each discrete movement by averaging minute-by-minute step count data. Instead of using the step count collected in minutes directly, this was done because 1 minute is susceptible to device-related data collection errors, and movement can easily exceed 1 minute. When a bout is detected by both wearables and smartphones, the average step count can be used to calculate size.

There are three types of bouts based on the device that detects them: phone-only, wearable-only, and both. These categories are used to define a physical activity trackability metric, or *device-specific relative coverage*, coverage in short, to identify the relative step count differences between smartphones and wearables. To be precise, the relative coverage of each bout type is calculated as the ratio of the number of steps occupied by each bout type to the total number of steps occupied by all bout types. Even though coverage does not include step count when the user does not have any devices, it would be sufficient to compare trackability between smartphones and wearables.

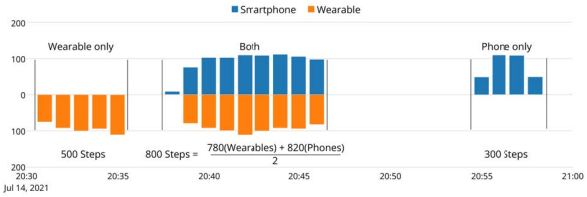

Figure 1. Step counts along with timeline

For example, the interval illustrated in Figure 1 can be divided into three bouts, defined as wearable-only, both, and phone-only types, and the size can be defined using each step count. Thus, both coverage was 50.0%, wearable-only coverage was 31.2%, and phone-only coverage was 18.7%.

III. Conclusion and Future Work

This study investigates device-specific coverage to quantify physical activity tractability in multi-device environments. Our metric lays the groundwork for analyzing trackability in environments where multiple devices, such as wrist-worn wearables and smartphones, are used for tracking. We plan to collect a large-scale dataset in the wild to analyze device-specific coverage and evaluate device-specific coverage patterns, as well as contextual factors influencing physical activity tractability such as activity intensity and location.

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REFERENCES

[1] S Goya Wannamethee and A Gerald Shaper. 2001. Physical Activity in the Prevention of Cardiovascular Disease An Epidemiological Perspective. Sports medicine 31, 2 (2001), 101–114.

[2] Eric E Wickel. 2014. Reporting the reliability of accelerometer data with and without missing values. PloS one 9, 12 (2014), e114402.