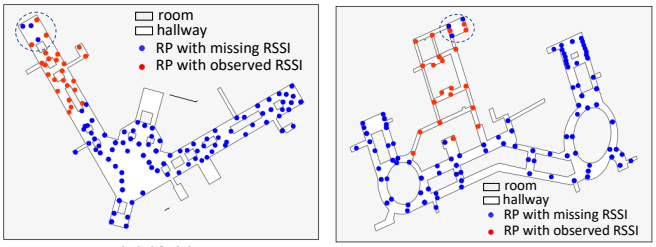
Supplementary Materials to: Data Imputation for Sparse Radio Maps in Indoor Positioning

I. Example of MAR and MNAR RSSI

As shown in Figure 1 below, we selected an AP in each venue and its deployment location is roughly within the dashed circle. For an RP, if all fingerprints collected at that RP have observed the selected AP, the RP is marked as red; otherwise, some of its fingerprints have missed the selected AP, and that RP is marked as blue. Clearly, most RPs that are far away from the selected AP are blue, indicating that the selected AP is unobservable at these RPs and the corresponding missing events are classified as Missing Not At Random (MNAR). On the other hand, most of the RPs near the dashed circle are red but there are several blue RPs that sometimes miss the selected AP's signals. The missing events in these RPs are incident and should be classified as Missing At Random (MAR).



(a) Kaide (b) Wanda

Fig. 1: Observability of a selected AP's signals at different reference points (RPs).

II. Binarization Process

The Binarization process is to generate an **AP profile** for each observed RP, as shown in Algorithm 1. It constructs a D-dimensional binary vector $\mathbf{b}_i$ for the RP $\mathbf{l}_i$'s fingerprint $\mathbf{f}_i$ such that $\mathbf{b}_i[d] = 1$ if the dth AP is observed at $\mathbf{l}_i$, and $\mathbf{b}_i[d] = 0$, otherwise.

Algorithm 1 Binarization (an RP $\mathbf{l_i}$'s fingerprint $\mathbf{f}_i$)

1: binary vector $\mathbf{b}_i \leftarrow \mathbf{1}^D$
2: **for** $d = 1$ to D **do**
3: **if** $\mathbf{f}_i[d]$ is `null` **then** $\mathbf{b}_i[d] \leftarrow 0$
4: **return** $\mathbf{b}_i$

III. Experiments on Bluetooth Fingerprinting Data

To test if our proposals are still effective in other application scenarios and other indoor venues, we complement experiments on Bluetooth fingerprinting data in a different indoor venue, i.e., Longhu. The description of the new venue as well as the created radio map from Bluetooth dataset are shown in Table I:

TABLE I: Statistics of Venues and Created Radio Maps

Venue	Longhu
Floor Area (m^2)	6504.1
RP density (per 100 m^2)	3.11
# of fingerprints	4617
# of RPs	202
# of APs (i.e., # of fingerprint dimension)	330

A. Experimental Results

The APE results with Bluetooth dataset in Longhu are shown in Table II. As we can see, *-BiSIM still outperform other data imputation methods with significant advantage, which demonstrates that our proposed imputation framework is able to generalize to different fingerprinting scenarios.

TABLE II: APE on Bluetooth Data (unit: meter)

	CD	LI	SL	MICE	MF	BRITS	SSGAN	D-BiSIM	T-BiSIM
KNN	22.65	17.99	20.42	57.41	19.57	7.52	6.67	6.28	**5.95**
WKNN	22.76	16.14	18.7	57.27	19.68	7.33	6.74	6.24	**5.86**
RF	23.21	17.69	20.7	63.37	20.36	9.49	8.31	7.13	**6.29**