Transferring Positioning Model for Device-free Passive Indoor Localization

Kazuya Ohara*，Takuya Maekawa
（Graduate School of Information Science and Technology, Osaka University）

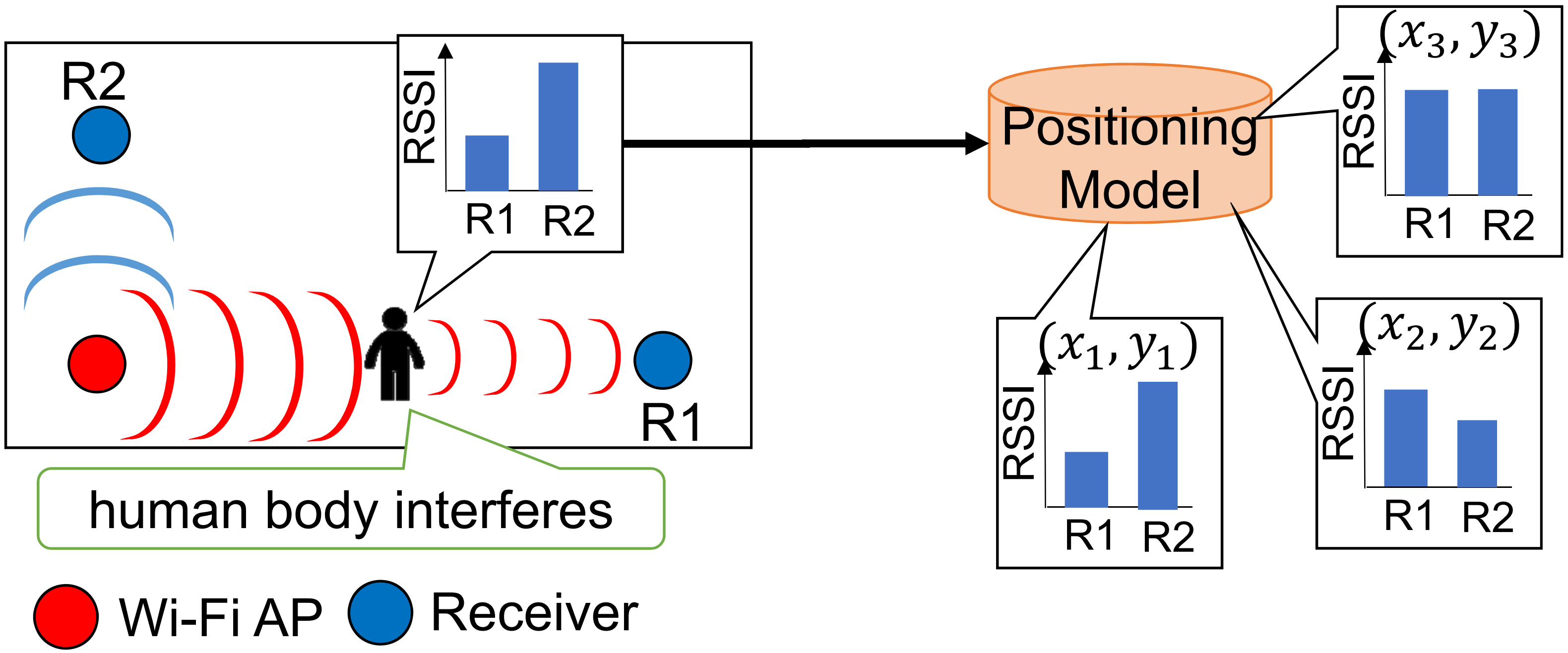
Yasue Kishino, Yoshinari Shirai, Futoshi Naya
（NTT Communication Science Laboratories）

Research Background

Device-free passive indoor positioning

- ➢ Estimate position of person in indoor environment
- ➢ Need not to carry any device

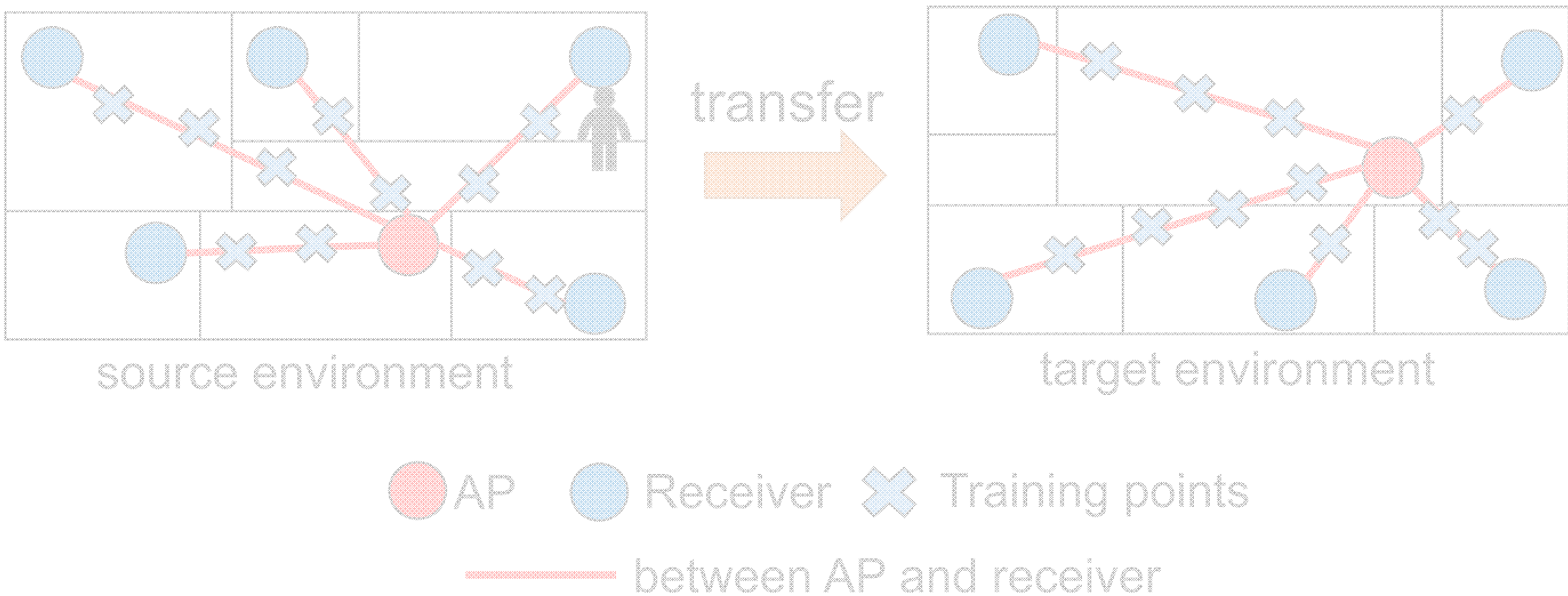
- surveillance of elderly person
- smart homes automation



Research Purpose

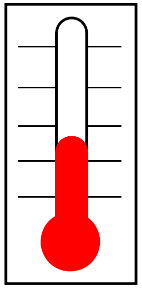
Issue Collecting labeled training data at many positions in the target environment is costly

Purpose Construct an indoor positioning model by transferring training data from other environments (source environments)

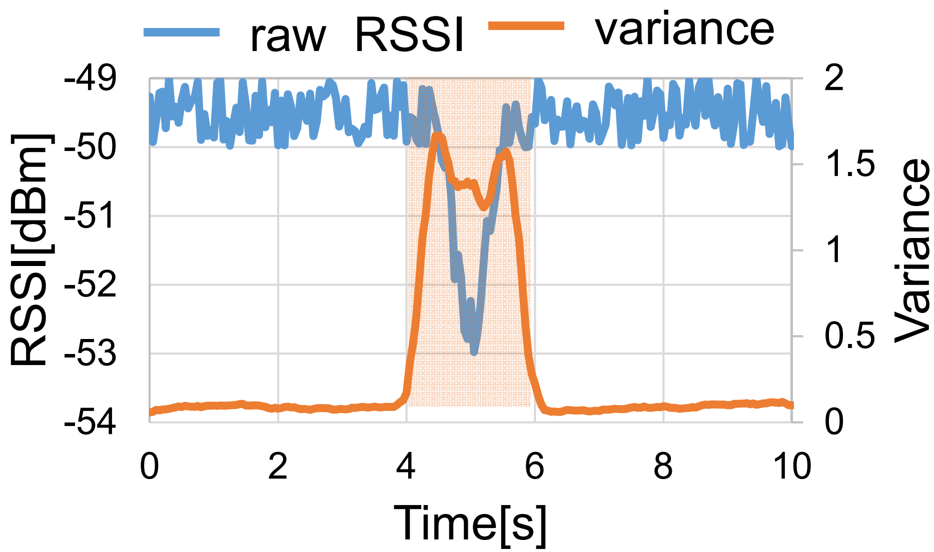


Approach

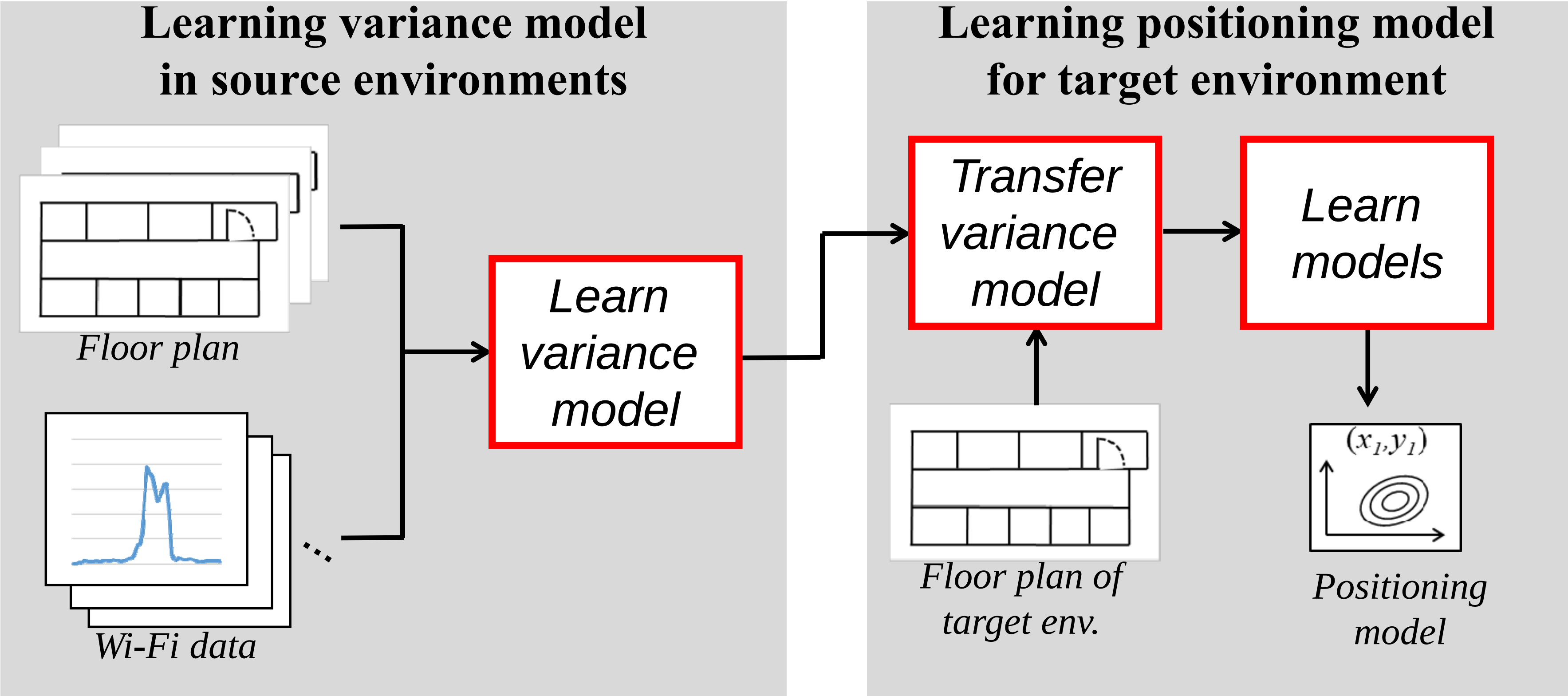
~~raw signal strength~~



variance of signal strength
to track the person

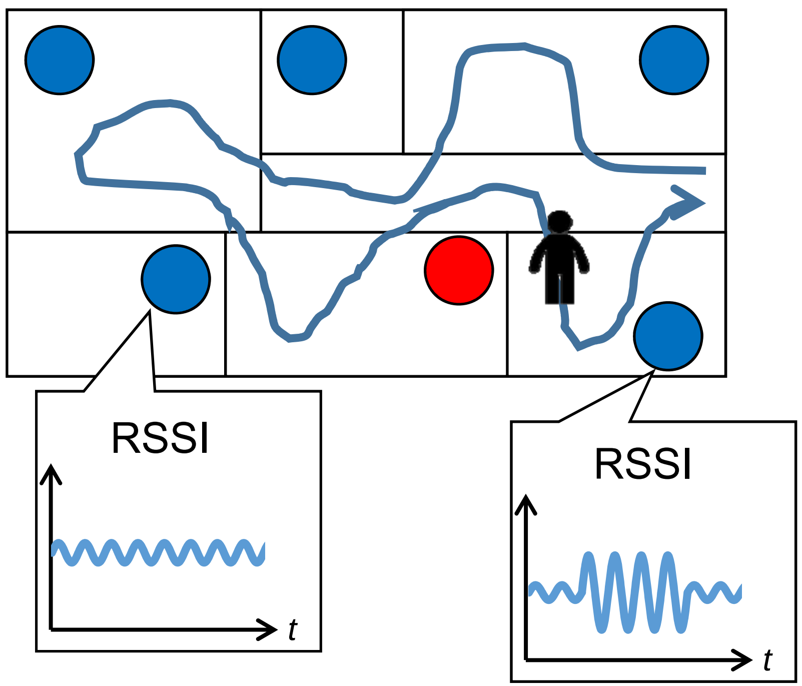


Overview of proposed method



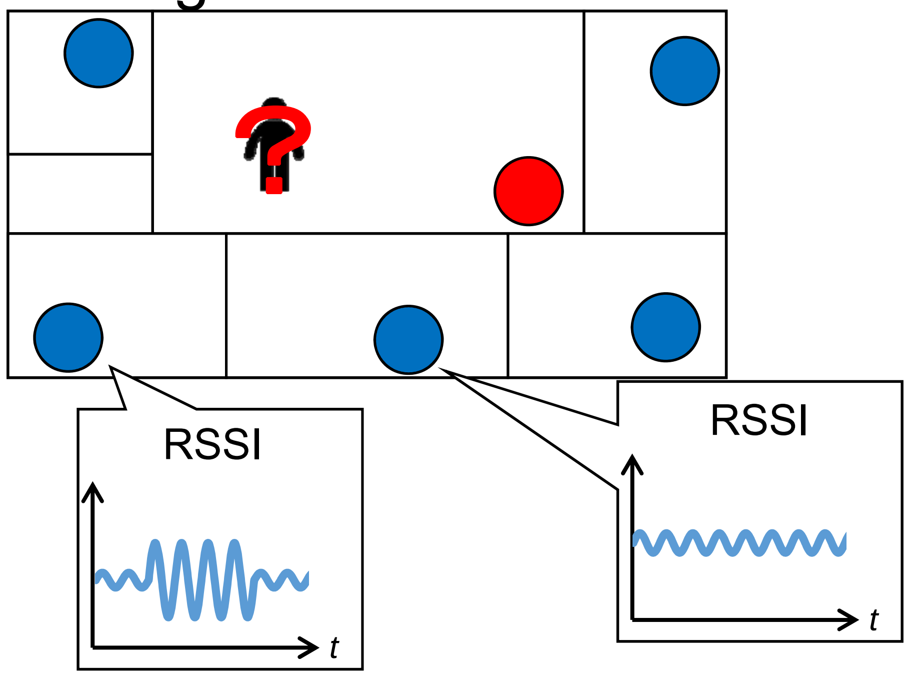
Proposed method (Necessary information)

source environment



- Floor plans (layout of walls)
- RSSI when there is no person
- <u>Labeled RSSI</u>
  e.g. by video recording

target environment

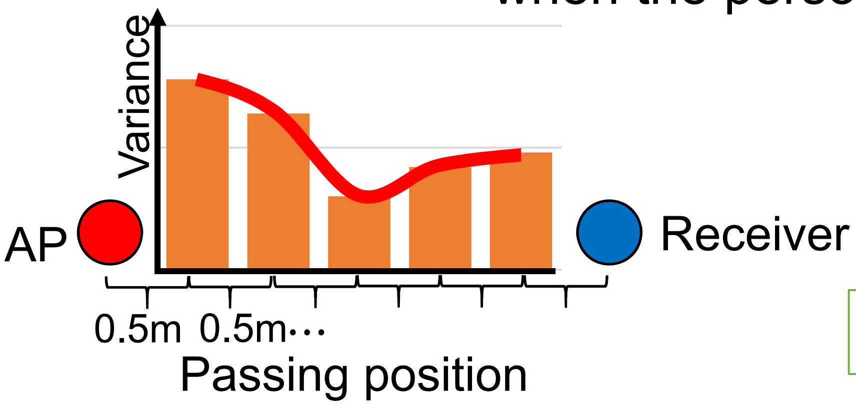


- Floor plans (layout of walls)
- RSSI when there is no person
- <u>Unlabeled RSSI</u>

Learning variance model

Example data

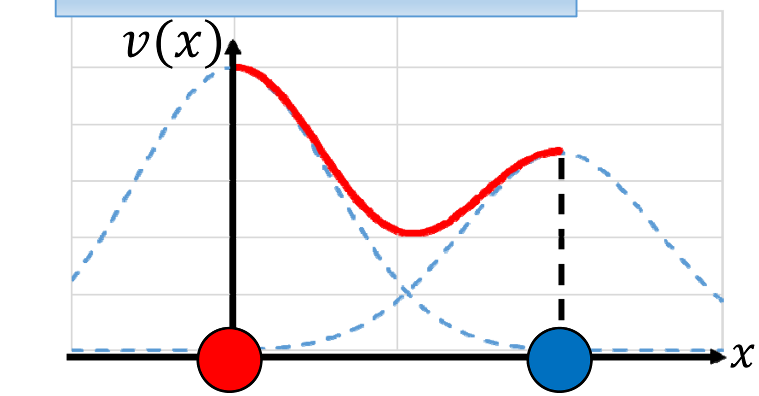
signal strength variance values
when the person passed each position



Become larger as the path becomes closer to device

Human body interferes signal more

Variance model



Bimodal model

- Largest at AP and Receiver
- mixture of 2 Gaussian functions

x : passing point, $v(x)$: variance value

Learning variance model

Example data

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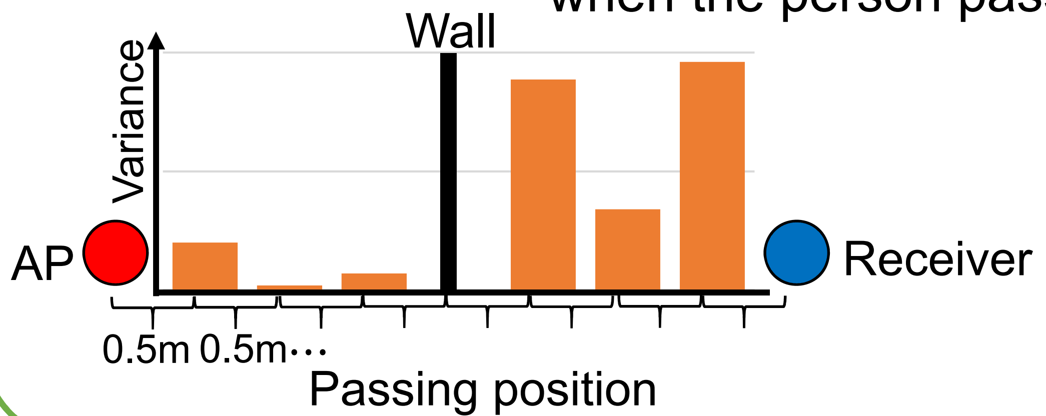
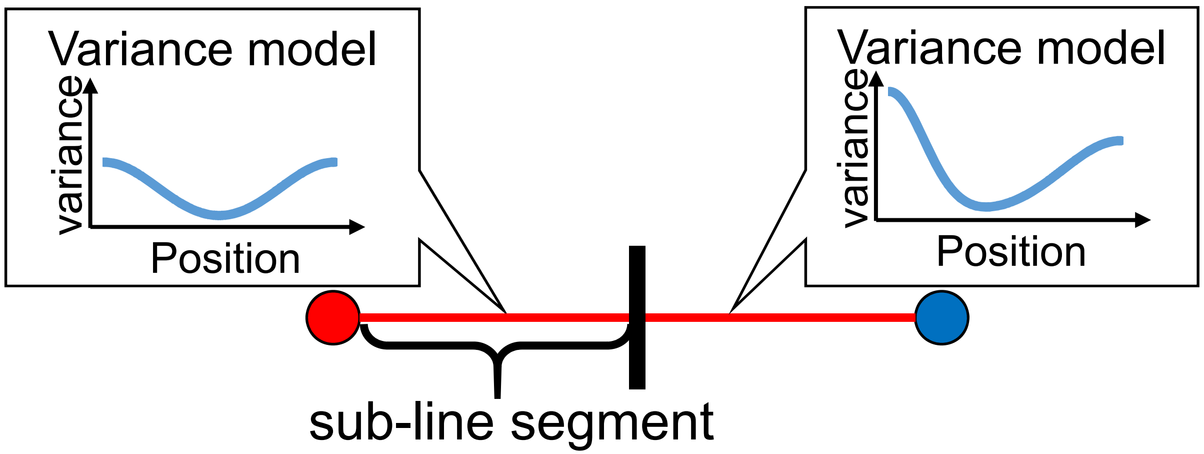
when the person passed each position



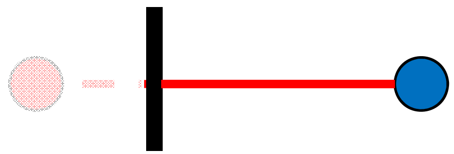
Feature depends greatly on the area divided by walls

Variance model

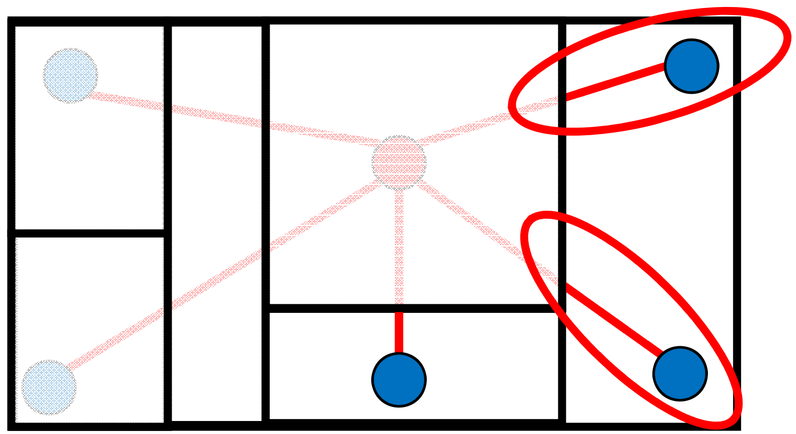


Transferring variance model

1. Find top-k similar source sub-line segments
   i. the same end points of sub-line segment
   ii. the same number of walls
   iii. kNN search according to three criteria



target sub-line segment



source environment

2. Transferring variance model

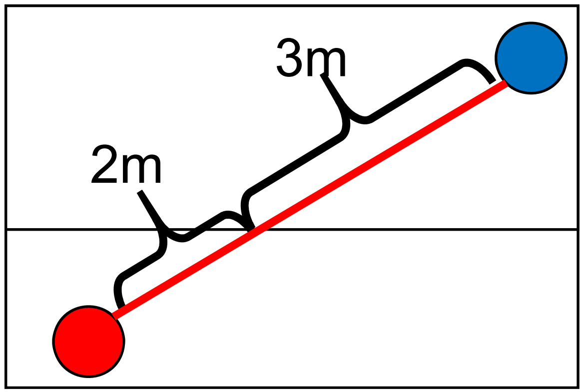
Averaging parameters of top-k source models

→ target model parameter

Transferring variance model

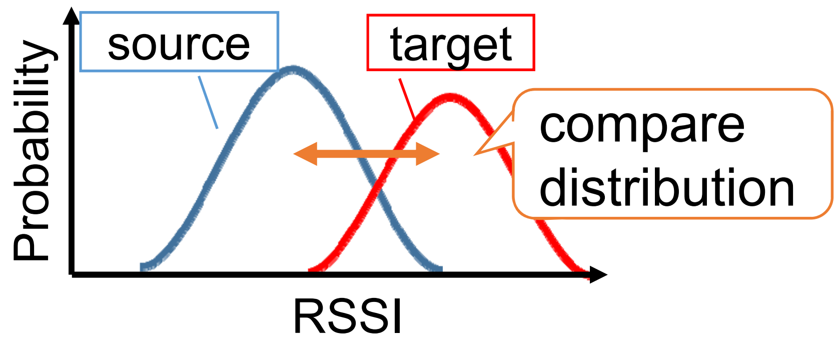
Criteria used for selecting source sub-line segments with *k*NN search

1. Length of sub-line segment

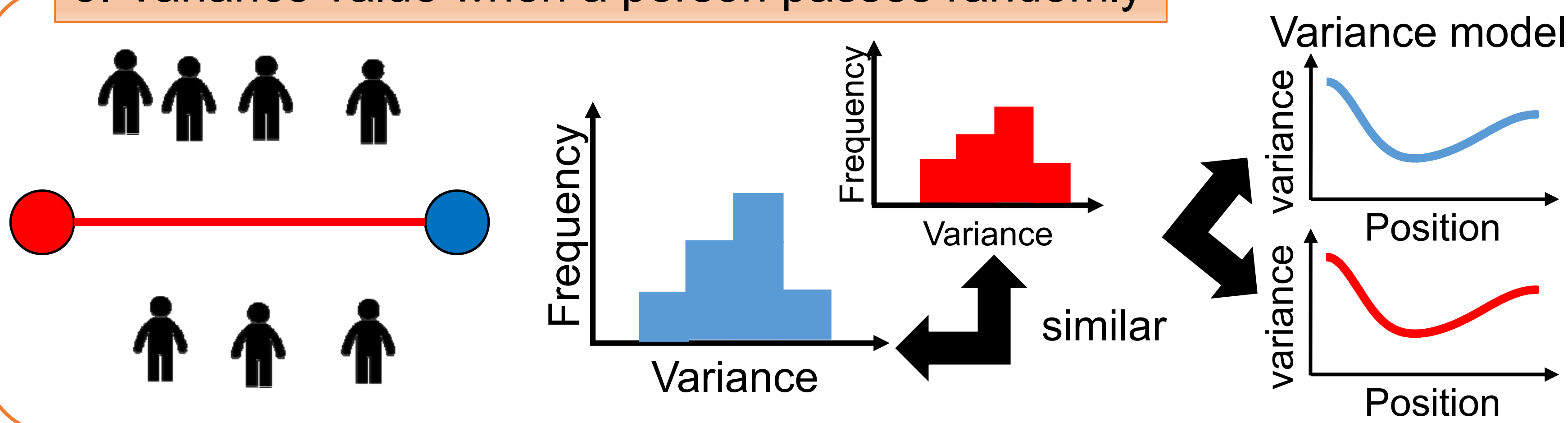


2. Signal strength when there is no person

materials on segments are similar



3. Variance value when a person passes randomly



Transferring variance model

Criteria used for selecting source sub-line segments with *k*NN search

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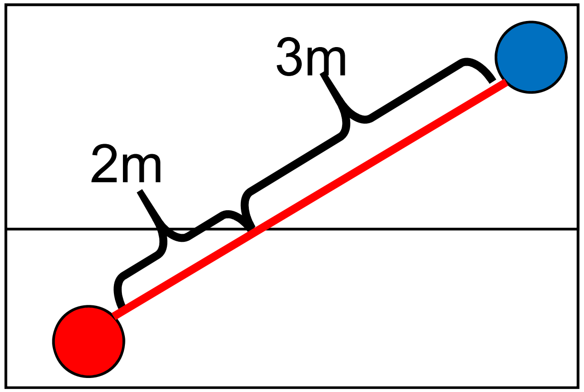

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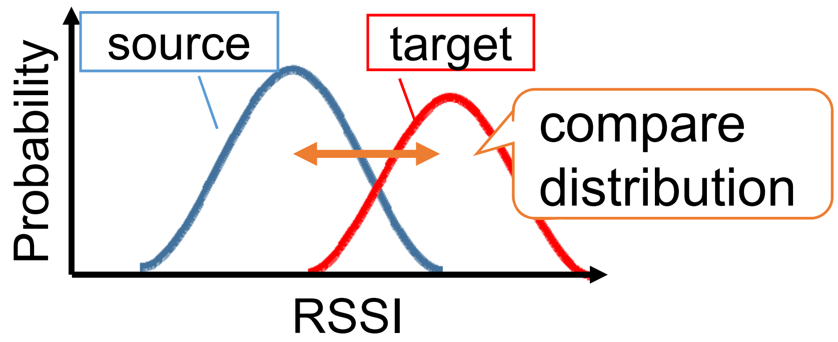
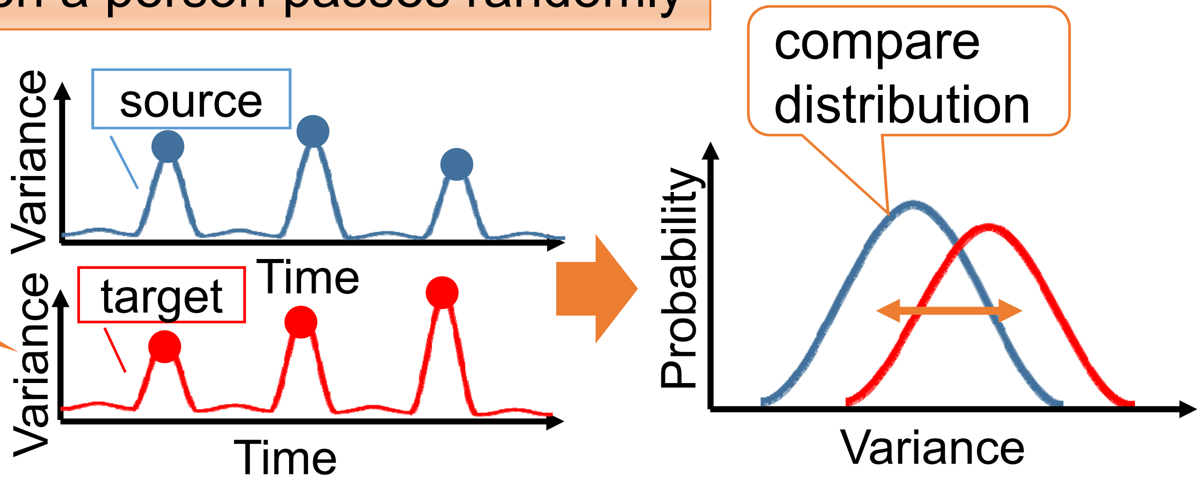


3. Variance value when a person passes randomly

From unlabeled data

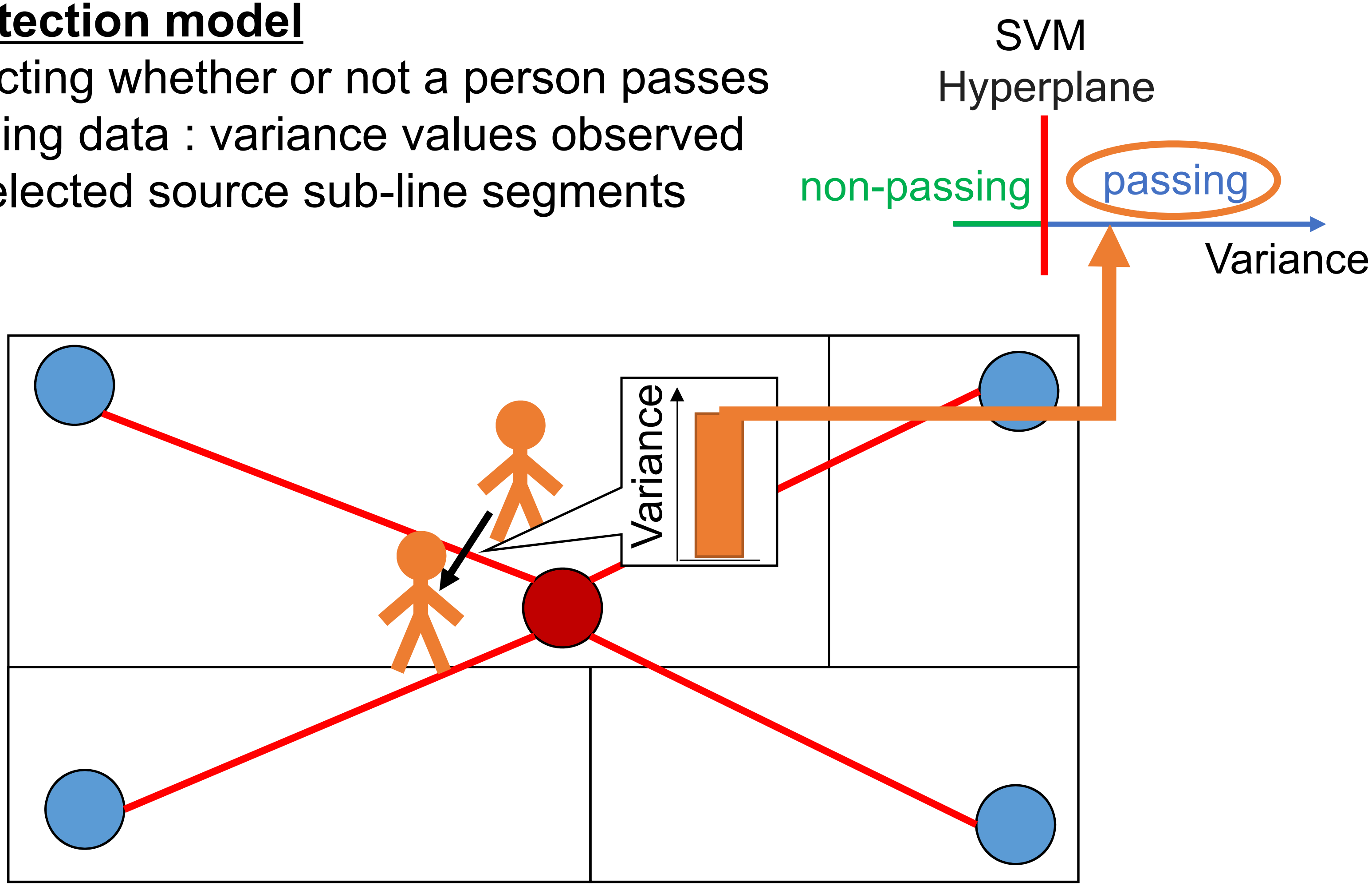
outlier detection



Learning models

<u>Passing detection model</u>

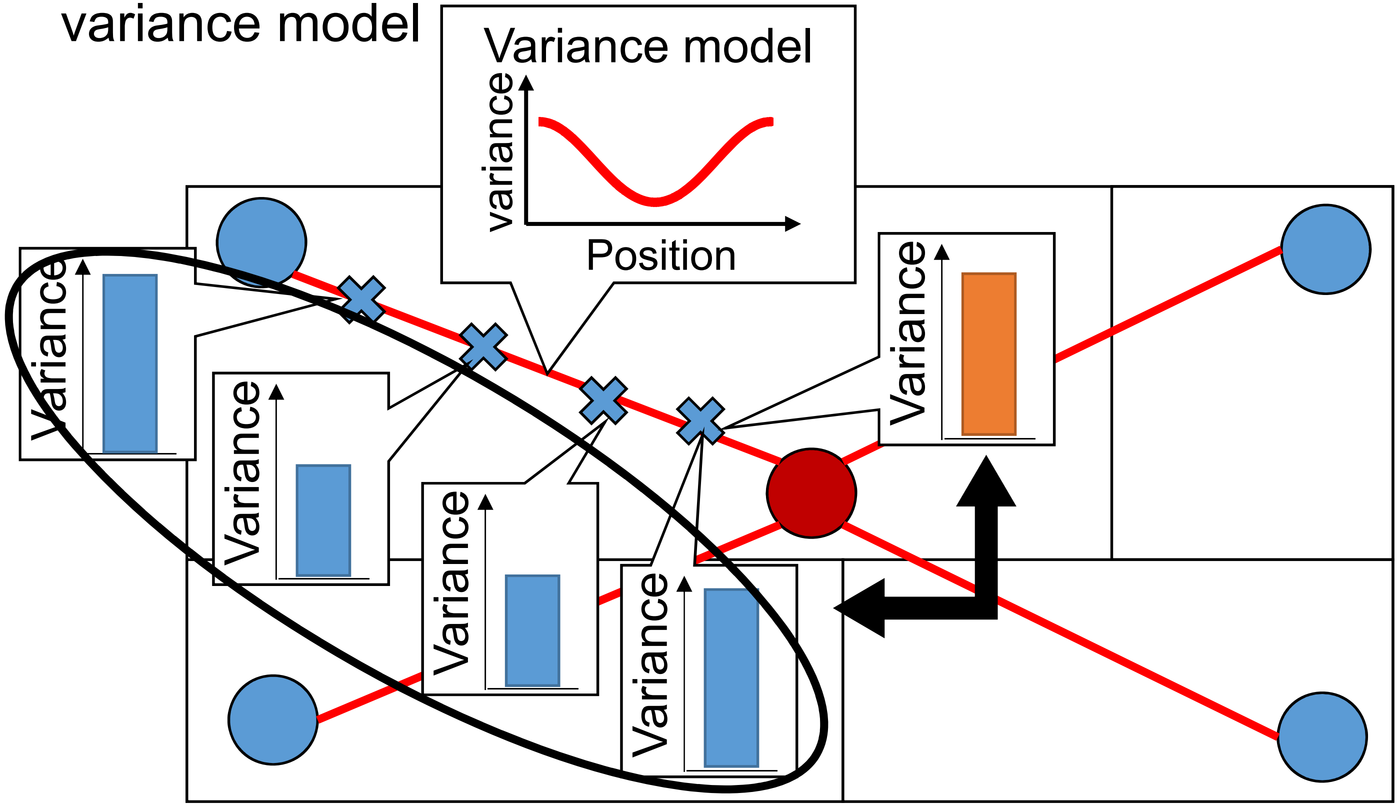
- Detecting whether or not a person passes
- Training data : variance values observed by selected source sub-line segments



Learning models

<u>Positioning model</u>

- Estimate position of a person when passing is detected
- Compute variance values at some points from a transferred variance model

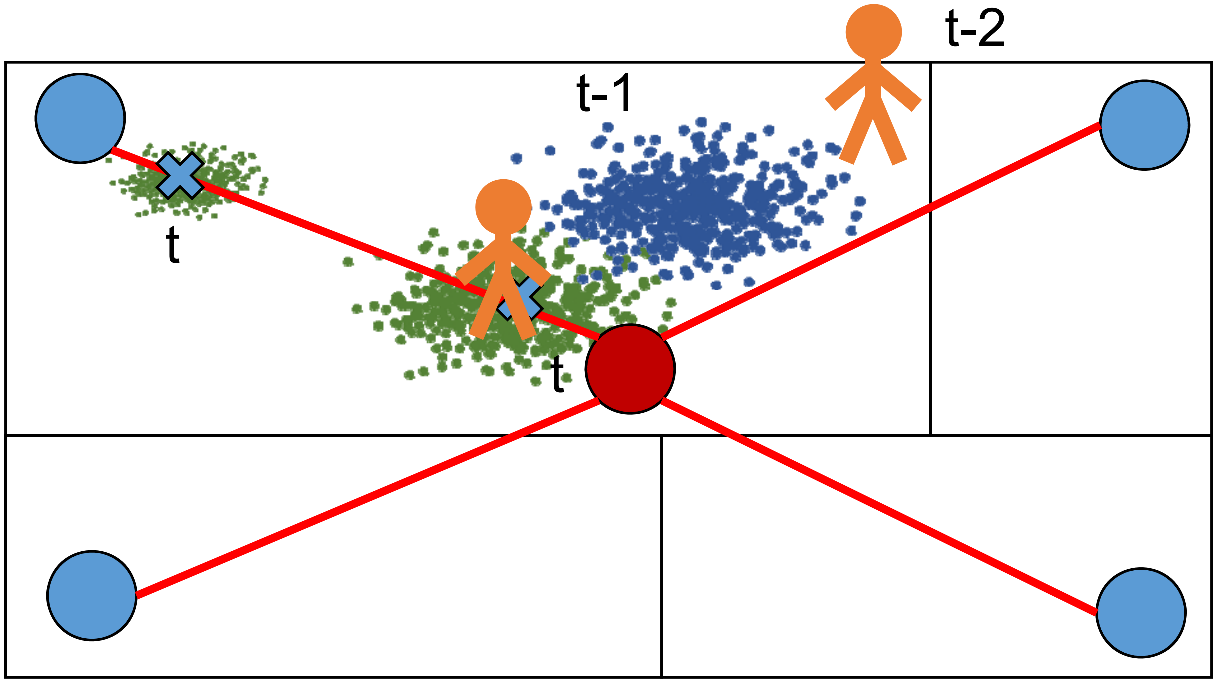


Two positions match → Tracking by using particle filter

Tracking by using particle filter

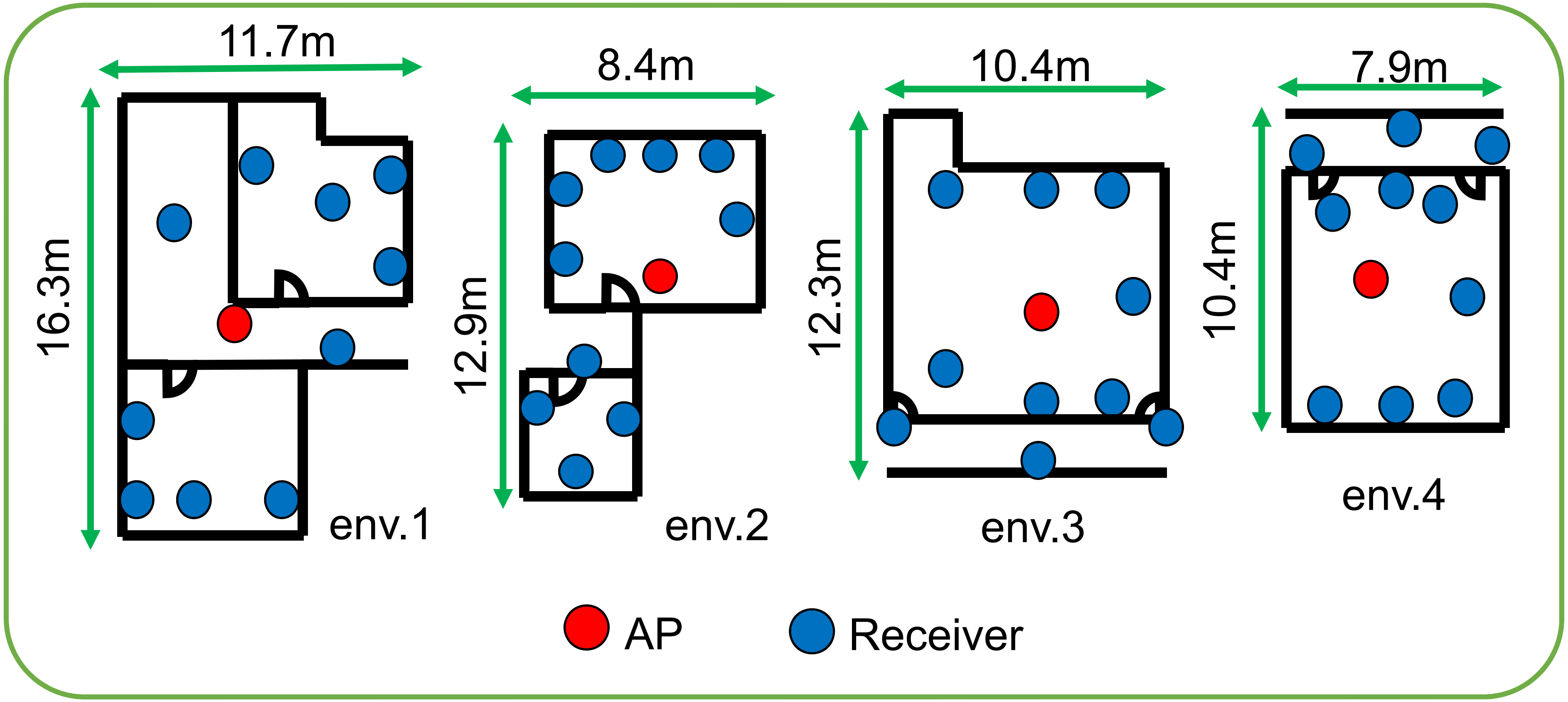
Particle filter

- Particle : position of a person
- High density particles
  - ⇨ High probability that the person is there



Evaluation (Environments)

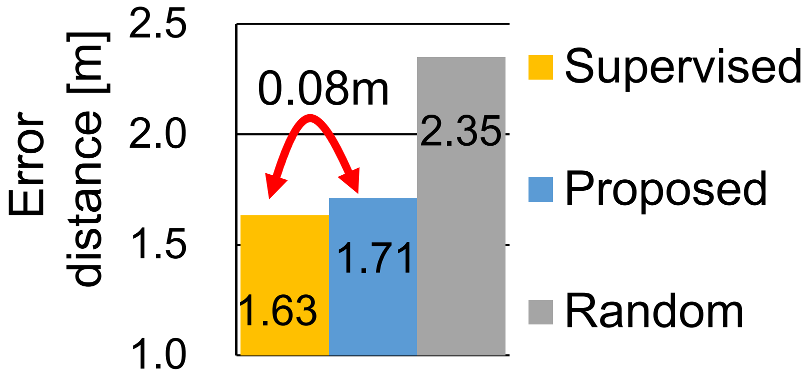
- 1 Wi-Fi AP and 10 receivers
- Walk around for 20 minutes in each environment
- Leave-one-out cross-validation evaluation



Evaluation (Results)

Evaluating proposed method

Supervised・・・trained on labeled data obtained in the same environment
Random・・・select randomly *k sub-line* segments while transferring variance model



- Performance of random was poorer than with proposed method

Conclusion

- We proposed a new method that enables us to construct a positioning model for device-free passive indoor localization with little effort
- As a part of our future work, we plan to automatically obtain unlabeled data in an end user's daily life to reduce burdens imposed on the user