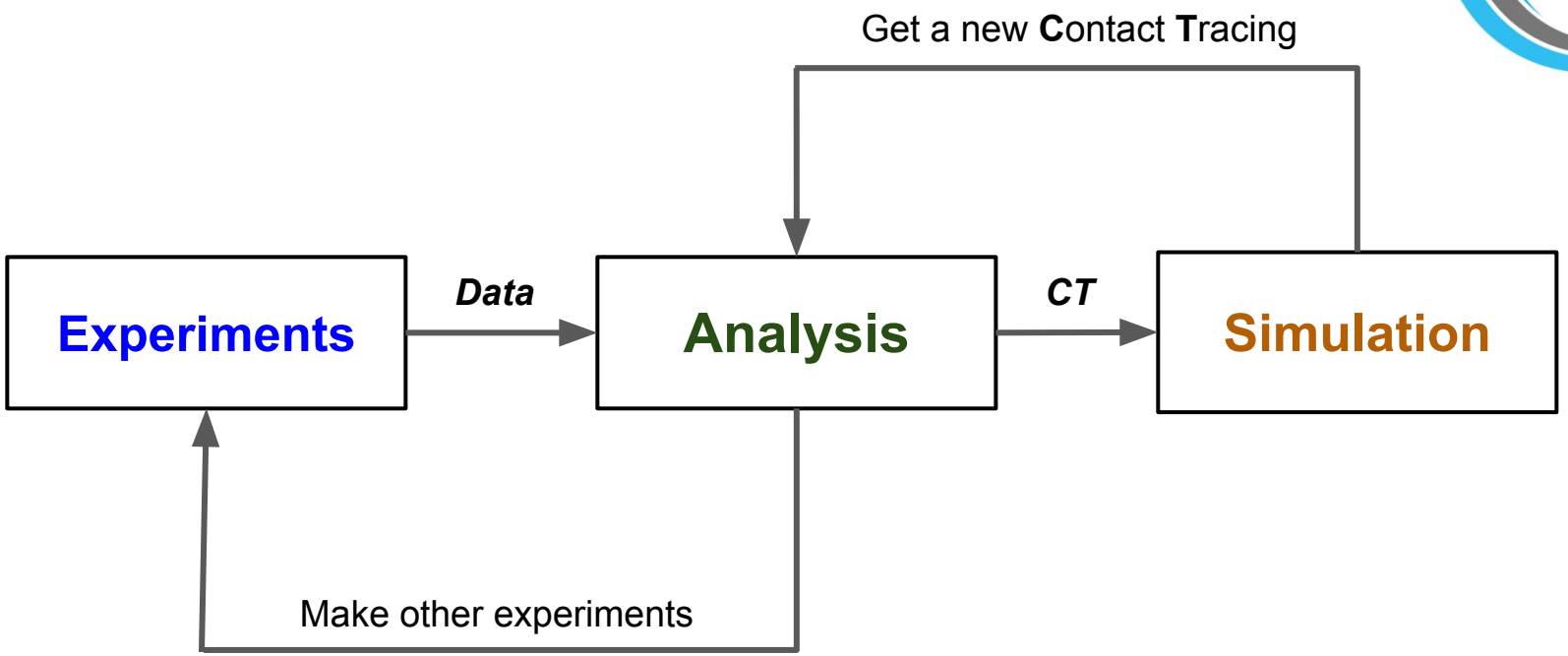
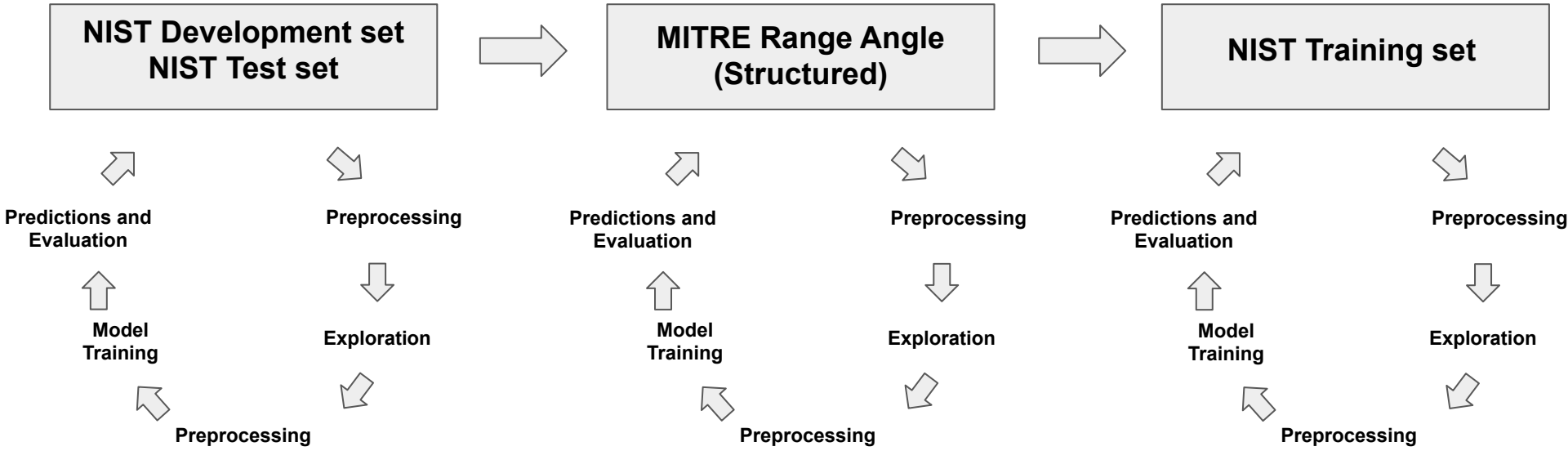
Digital Communications Lab - Team: LCD

UNC Universidad Nacional de Córdoba

Our Project: ContactAR



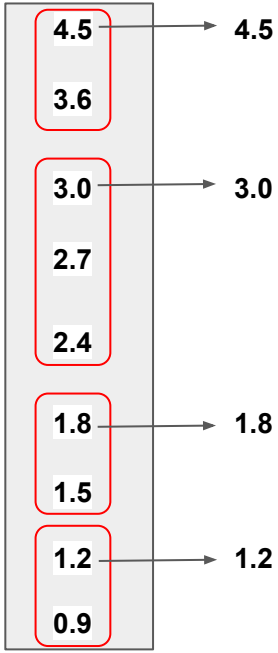
TC4TL: Our Roadmap



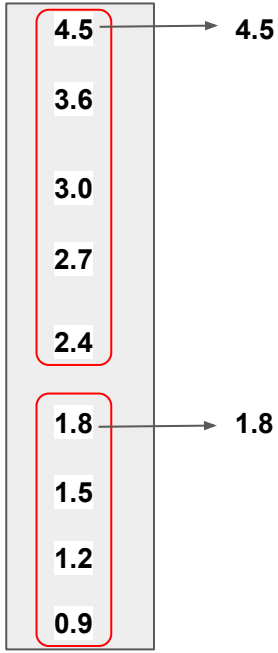
TC4TL Datasets

NIST Development set
NIST Training set
NIST Test set

Distance in a range [m]
(**fine_grain**)

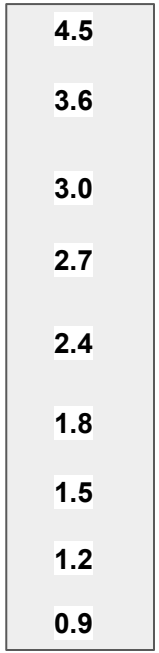


Distance in a range [m]
(**coarse_grain**)



MITRE Range Angle (Structured)

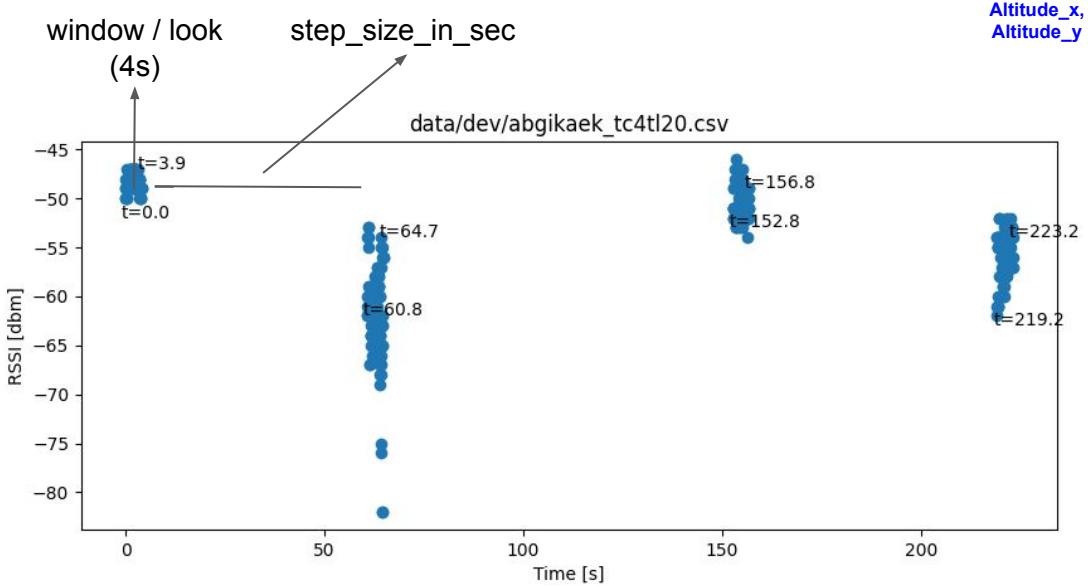
Exact Distance [m]



NIST Development set

```
TXDevice,iPhone11
TXPower,8
RXDevice,iPhone11_Pro_max
TXCarry,hand
RXCarry,hand
RXPose,sitting
TXPose,sitting
0.000,Bluetooth,-58
0.001,Bluetooth,-58
0.040,Bluetooth,-61
0.041,Bluetooth,-61
0.075,Bluetooth,-62
0.076,Bluetooth,-63
0.109,Bluetooth,-61
0.117,Accelerometer,0.0168914794921875,-0.46905517578125,-0.8700714111328125
0.118,Gyroscope,0.19825583696365356,-0.09077224880456924,0.11583206057548523
0.119,Attitude,0.5437021367318535,-0.01124289648294017,-2.979732885421364
0.120,Gravity,-0.009621461853384972,-0.5173078179359436,-0.8557453155517578
0.120,Magnetic-field,-16.0982666015625,-22.49454116821289,-38.31756591796875,high
0.186,Bluetooth,-60
0.188,Bluetooth,-59
0.220,Bluetooth,-60
0.221,Bluetooth,-61
0.248,Bluetooth,-61
0.249,Bluetooth,-61
0.289,Bluetooth,-58
0.290,Bluetooth,-58
0.358,Bluetooth,-61
0.359,Bluetooth,-60
0.366,Accelerometer,-0.0174713134765625,-0.52325439453125,-0.82757568359375
0.367,Gyroscope,0.1287342756986618,-0.04999179393053055,-0.0866885557770729
0.368,Attitude,0.5577016928192643,0.01568146465130259,-3.021383655995540 3
0.369,Gravity,0.013304765336215496,-0.5292375683784485,-0.8483694195747375
0.369,Magnetic-field,-14.394622802734375,-23.38714599609375,-37.67650604248047,high
0.400,Bluetooth,-60
0.437,Bluetooth,-61
0.438,Bluetooth,-61
0.506,Bluetooth,-55
0.507,Bluetooth,-55
0.546,Bluetooth,-60
0.546,Bluetooth,-60
0.576,Bluetooth,-58
0.577,Bluetooth,-57
0.607,Bluetooth,-53
0.608,Bluetooth,-53
```

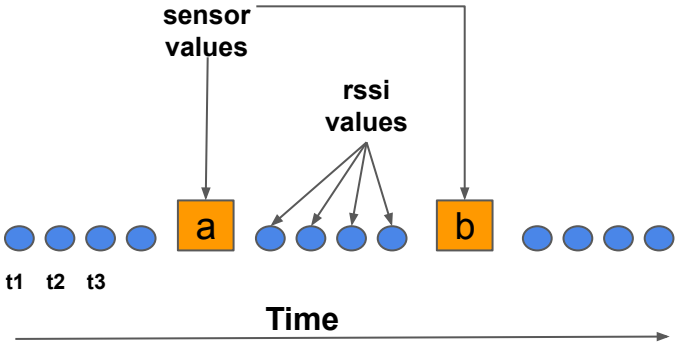
Accelerometer_x
Accelerometer_y
Accelerometer_z
Gyroscope_x
Gyroscope_y
Gyroscope_z
Attitude_pitch
Attitude_roll
Attitude_yaw
Gravity_x
Gravity_y
Gravity_z
Magnetic_field_x
Magnetic_field_y
Magnetic_field_z
Altitude_x,
Altitude_y



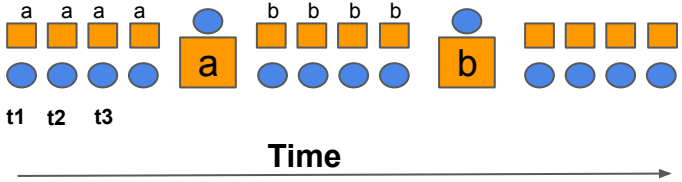
Data Preprocessing (Python-Pandas)

1 Large Data file

Time	feature 1 (rssi)	feature 2 (acceleration_x)	feature 3 (acceleration_y)	feature 4 (acceleration_z)	feature 5 (gyroscope_x)	feature 6 (...)
t1	rssi(t1)					
t2	rssi(t2)					
t3	rssi(t3)					



Imputation method
Back-fill



Data Preprocessing (Python-Pandas)

Features added as columns →

File | TXPower | TXDevice, TXCarry, TXPose | window_number | attenuation | coarse_grain | distance_in_meters

RXDevice, RXCarry, RXPose → One Hot Encoding → TXCarry

TXCarry →

TXCarry_hand	TXCarry_pocket	TXCarry_unknown
1	0	0
0	1	0
0	0	1

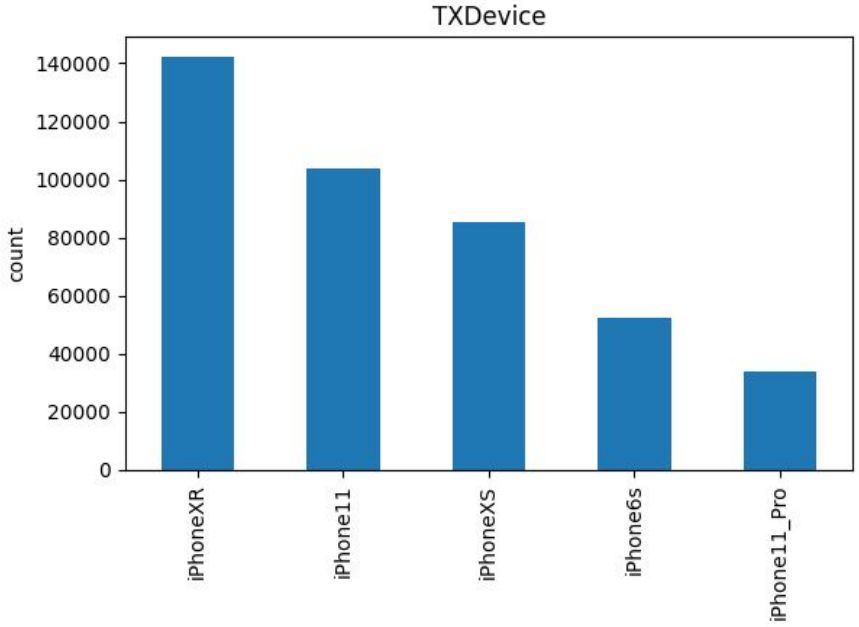
coarse_grain → One Hot Encoding

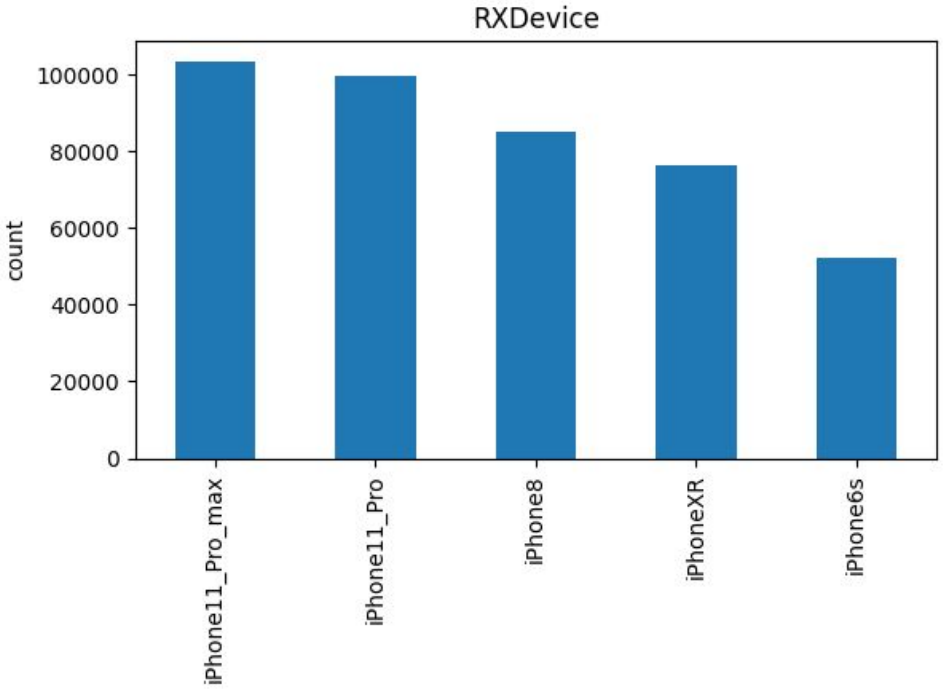
attenuation → TXPower - 41 - RSSI

RSSI > 0 were removed

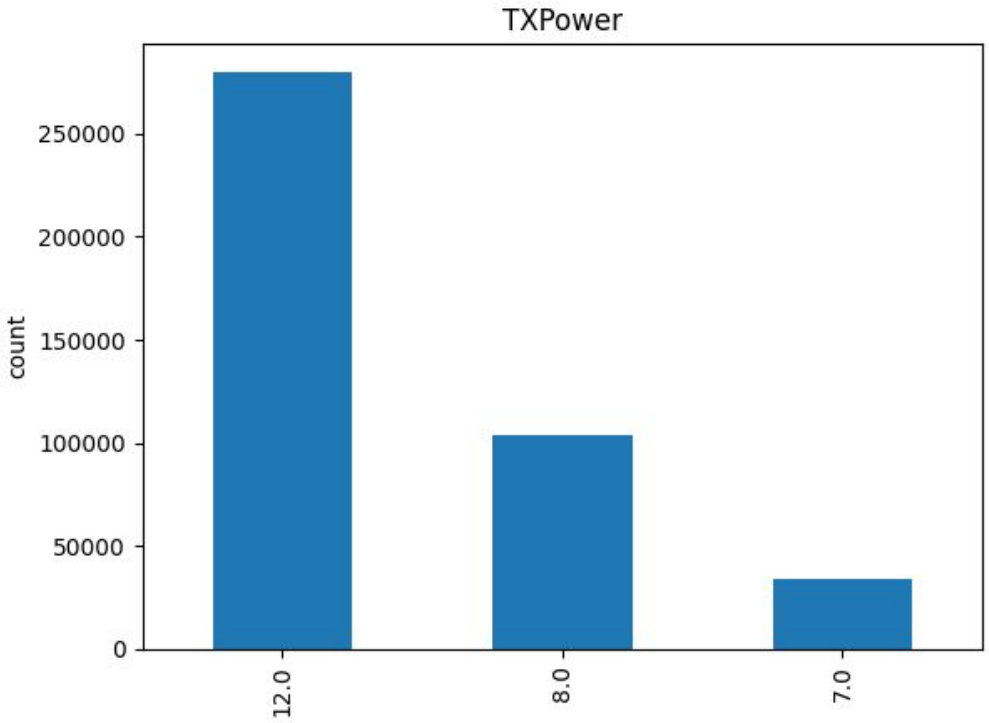
step_size_in_sec = Inf were removed

Dataset Exploration

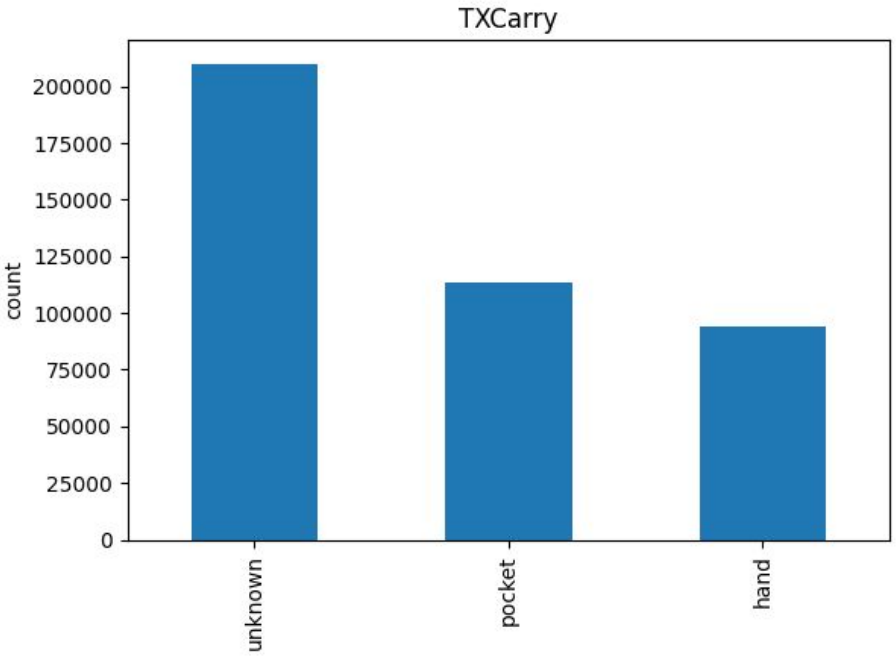


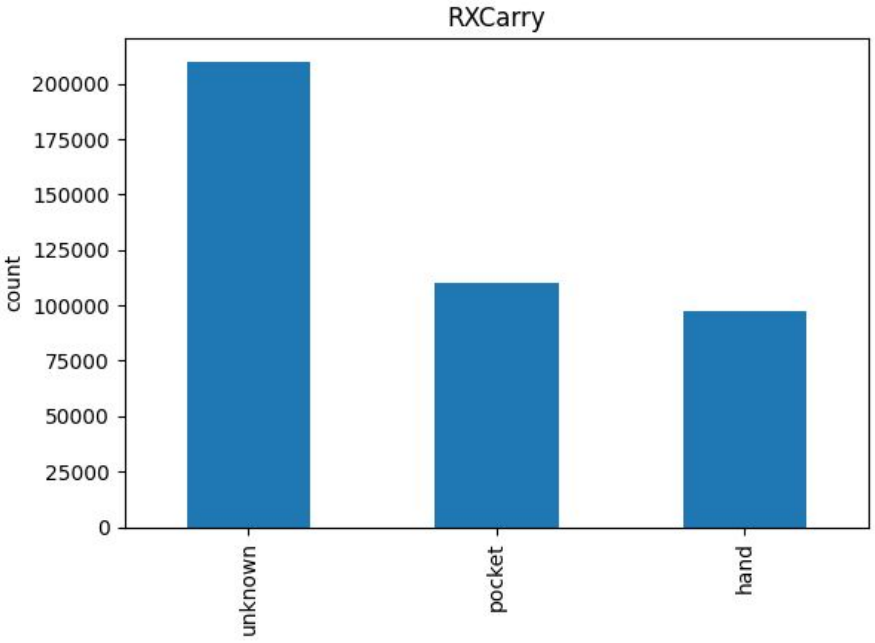


Dataset Exploration

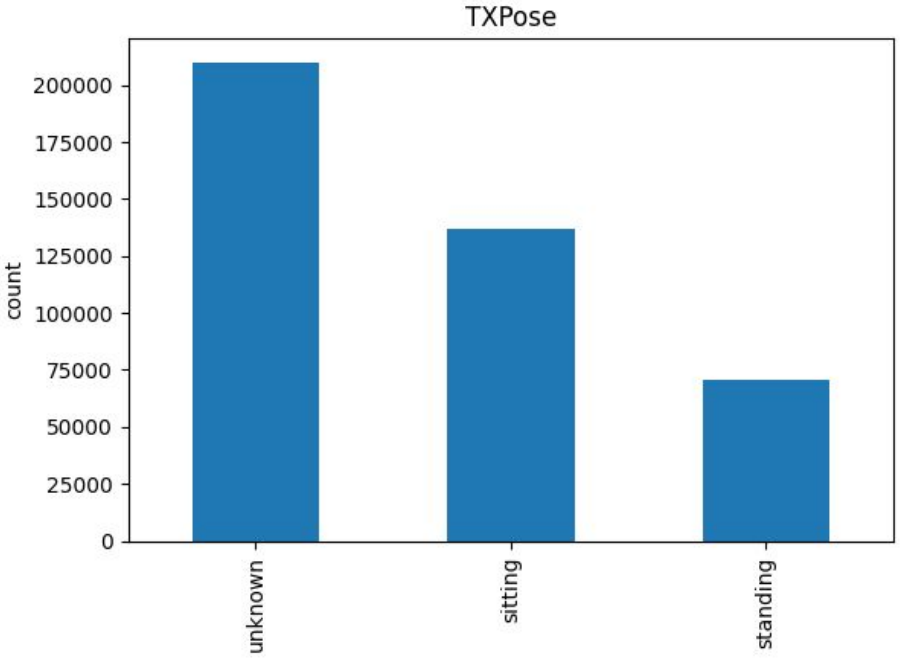


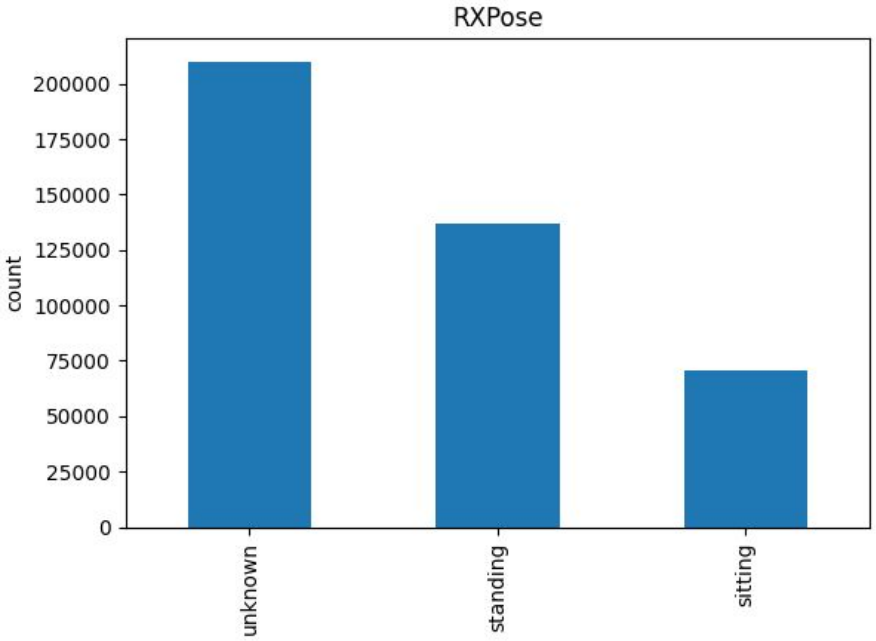
Dataset Exploration



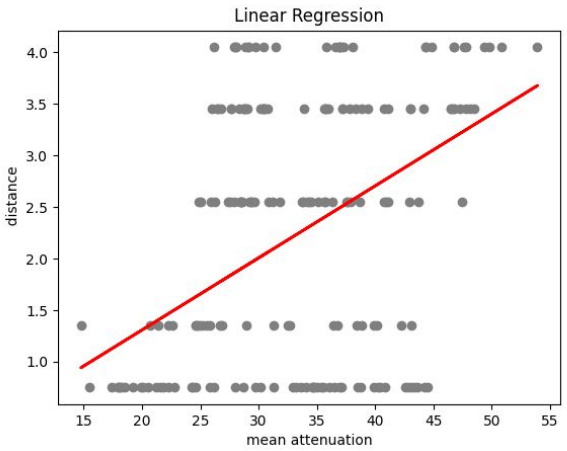


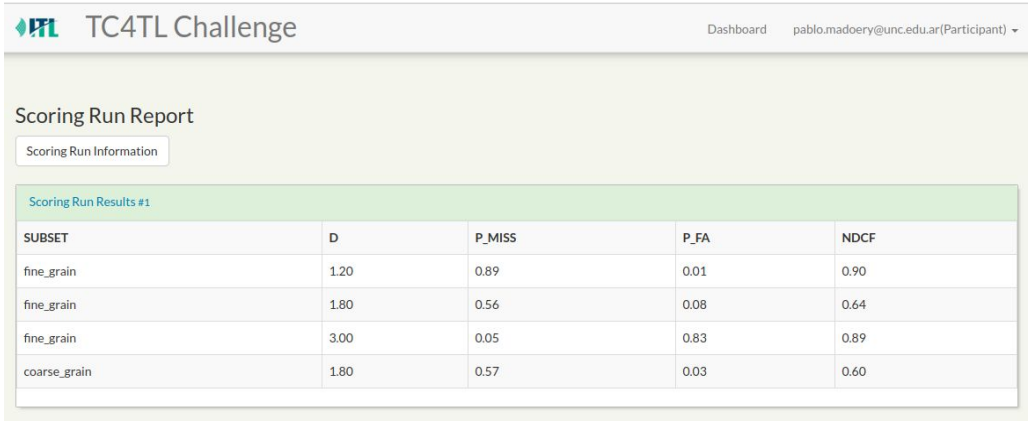
Dataset Exploration





Simple Linear Regression





TC4TL Challenge

Dashboard pablo.madoery@unc.edu.ar(Participant)

Scoring Run Report

Scoring Run Information

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.89	0.01	0.90
fine_grain	1.80	0.56	0.08	0.64
fine_grain	3.00	0.05	0.83	0.89
coarse_grain	1.80	0.57	0.03	0.60

1 Feature: attenuation

each point is the mean attenuation value of 1 window

Several Linear Regressions

split in scenarios

TXCarry_RXCarry_TXPose_RXPose_coarsegrain

hand_hand_sitting_sitting_Y
hand_hand_sitting_sitting_N
hand_hand_standing_sitting_Y
hand_hand_standing_sitting_N
……..

1 Model / scenario

(1 Feature: attenuation)

M1
M2
M3
M4
M...

Score comparison

TC4TL Challenge

Dashboard pablo.madoery@unc.edu.ar(Participant)

Scoring Run Report

Scoring Run Information

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.89	0.01	0.90
fine_grain	1.80	0.56	0.08	0.64
fine_grain	3.00	0.05	0.83	0.89
coarse_grain	1.80	0.57	0.03	0.60

TC4TL Challenge

Dashboard pablo.madoery@unc.edu.ar(Participant)

Scoring Run Report

Scoring Run Information

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.75	0.03	0.78
fine_grain	1.80	0.44	0.10	0.54
fine_grain	3.00	0.04	0.86	0.90
coarse_grain	1.80	0.43	0.12	0.55

Simple Linear Regression

↓

Several Linear Regressions

RandomForestRegressor

GridSearch + Cross Validation

All features: mean values / window

```
# Import the model we are using
from sklearn.ensemble import RandomForestRegressor

# model
rf = RandomForestRegressor(warm_start=True, random_state = 42, n_jobs = -1)

#Grid Search
from sklearn.model_selection import GridSearchCV
grid_values = {'n_estimators': [100, 200, 500],'max_depth':[8, 10, 12, 14], 'min_samples_split':[2,3,4], 'min_sample
grid_rf = GridSearchCV(rf, param_grid = grid_values, verbose=10)
grid_rf.fit(train_features, train_labels)
```

Score comparison

TC4TL Challenge

Dashboard pablo.madoery@unc.edu.ar(Participant)

Scoring Run Report

Scoring Run Information

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.75	0.03	0.78
fine_grain	1.80	0.44	0.10	0.54
fine_grain	3.00	0.04	0.86	0.90
coarse_grain	1.80	0.43	0.12	0.55

TC4TL Challenge

Dashboard pablo.madoery@unc.edu.ar(Participant)

Scoring Run Report

Scoring Run Information

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.04	0.20	0.23
fine_grain	1.80	0.11	0.10	0.21
fine_grain	3.00	0.15	0.08	0.23
coarse_grain	1.80	0.02	0.02	0.04

Several Regressions

↓

RandomForestRegressor

Feature Importance Analysis

using: RSSI & attenuation

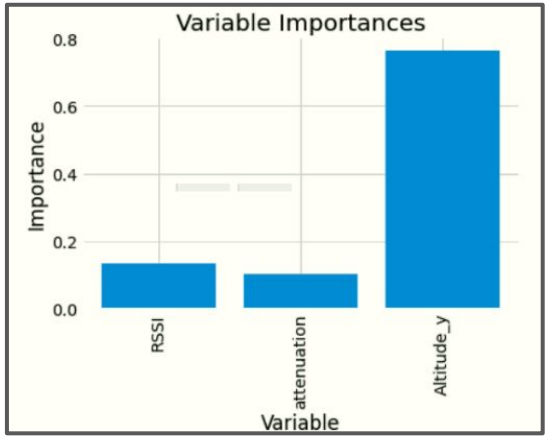
Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.86	0.00	0.87
fine_grain	1.80	0.85	0.00	0.85
fine_grain	3.00	0.00	0.96	0.96
coarse_grain	1.80	0.89	0.00	0.89

using: RSSI & attenuation & Altitude_y

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.17	0.20	0.37
fine_grain	1.80	0.15	0.13	0.28
fine_grain	3.00	0.18	0.22	0.40
coarse_grain	1.80	0.12	0.10	0.22



Omid's hypothesis

Place **A** -> Experiment 1 -> Distance 1

Altitude 1

Train Data 1	Test Data 1

Place **B** -> Experiment 2 -> Distance 2

Altitude 2

Train Data 2	Test Data 2

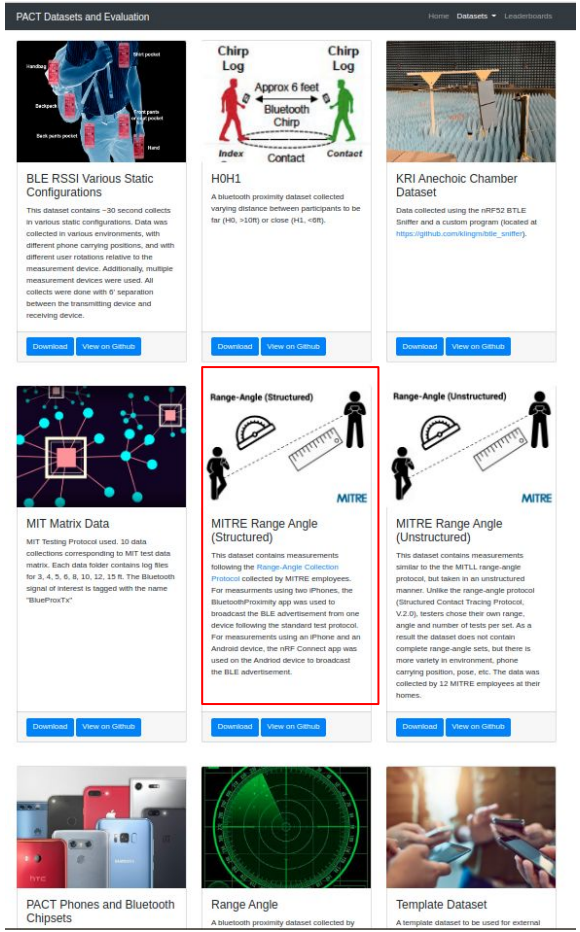
Place **C** -> Experiment 3 -> Distance 3

Altitude 3

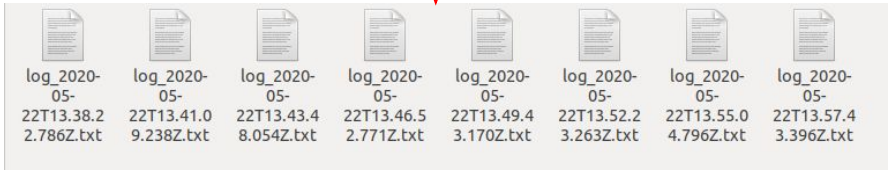
Train Data 3	Test Data 3

MITRE Range Angle (Structured)

https://mitll.github.io/PACT/datasets.html#datasets-submit



Data Preprocessing



Range 3	Range 4	Range 5	Range 6	Range 8	Range 10	Range 12	Range 15
Angle 0	Angle 0	Angle 0	Angle 0	Angle 0	Angle 0	Angle 0	Angle 0
Angle 45	Angle 45	Angle 45	Angle 45	Angle 45	Angle 45	Angle 45	Angle 45
Angle 90	Angle 90	Angle 90	Angle 90	Angle 90	Angle 90	Angle 90	Angle 90
Angle 135	Angle 135	Angle 135	Angle 135	Angle 135	Angle 135	Angle 135	Angle 135
Angle 180	Angle 180	Angle 180	Angle 180	Angle 180	Angle 180	Angle 180	Angle 180
Angle 225	Angle 225	Angle 225	Angle 225	Angle 225	Angle 225	Angle 225	Angle 225
Angle 270	Angle 270	Angle 270	Angle 270	Angle 270	Angle 270	Angle 270	Angle 270
Angle 315	Angle 315	Angle 315	Angle 315	Angle 315	Angle 315	Angle 315	Angle 315

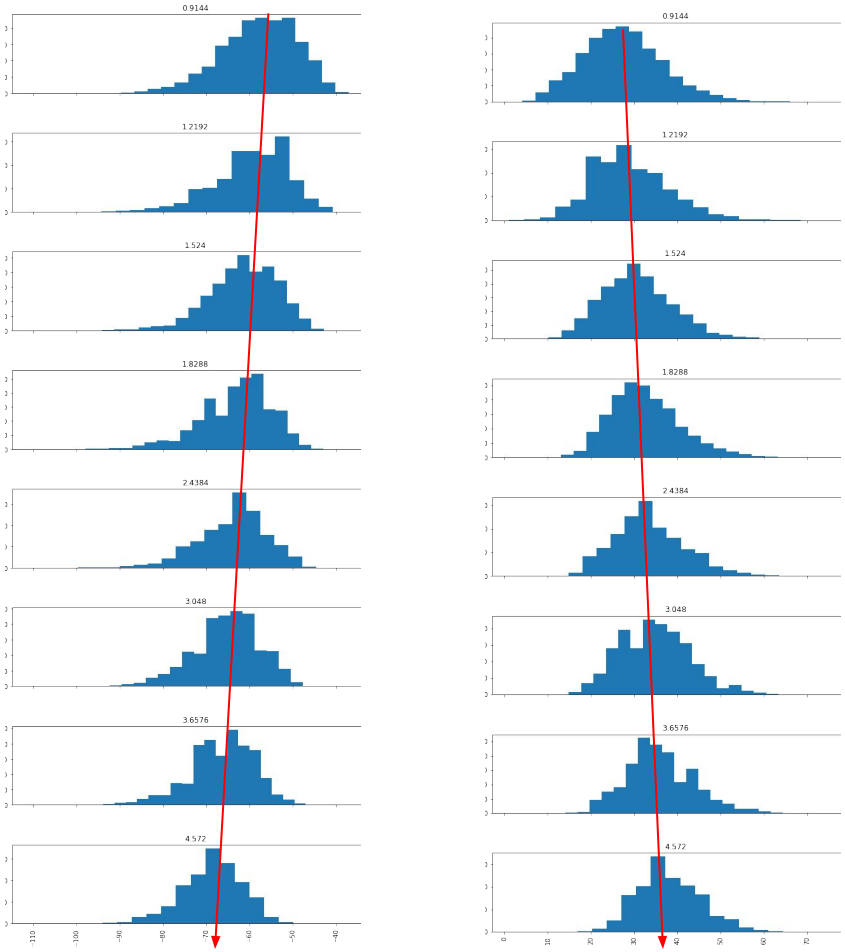
0.9 m → 4.5 m

~~coarse_grain~~

exact distance

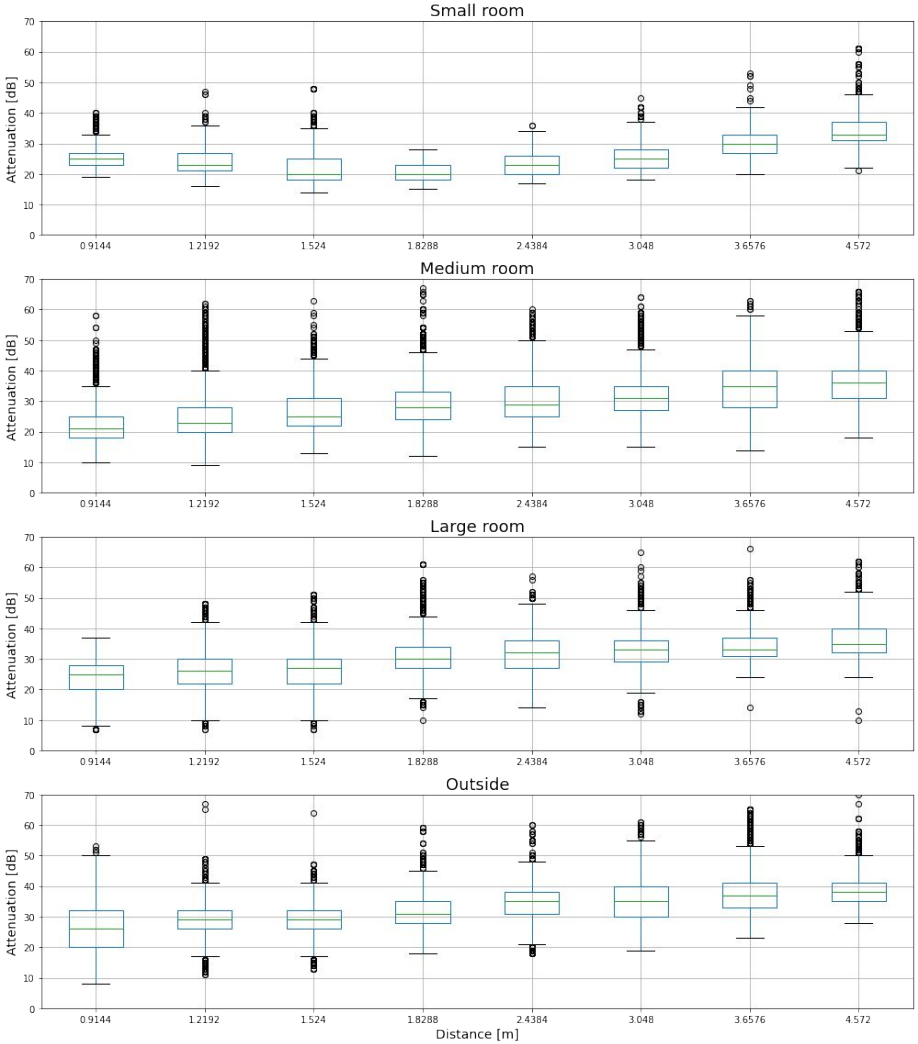
Data Exploration

Distance	RSSI	attenuation
0.9144 m		
1.2192 m		
1.524 m		
1.8288 m		
2.4384 m		
2.7432 m		
3.048 m		
3.6576 m		
4.572 m		



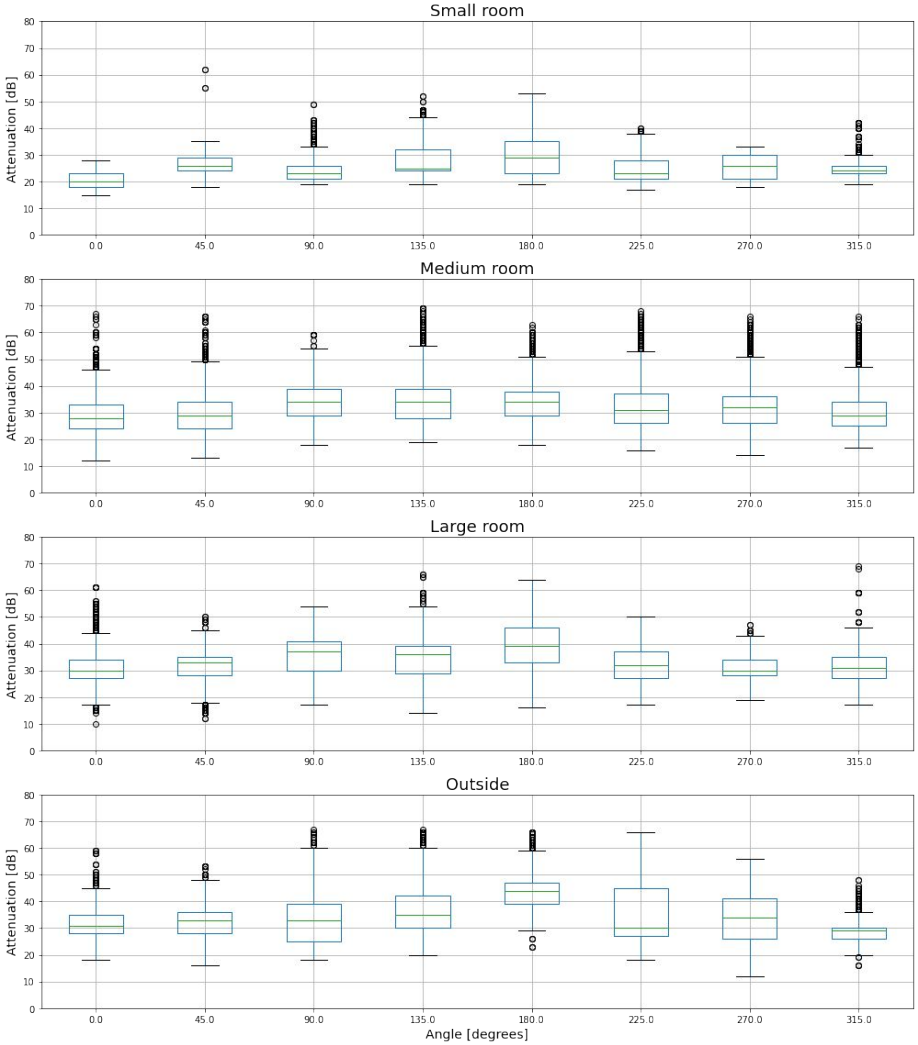
Data Exploration

(Varying **Distance** in each environment)

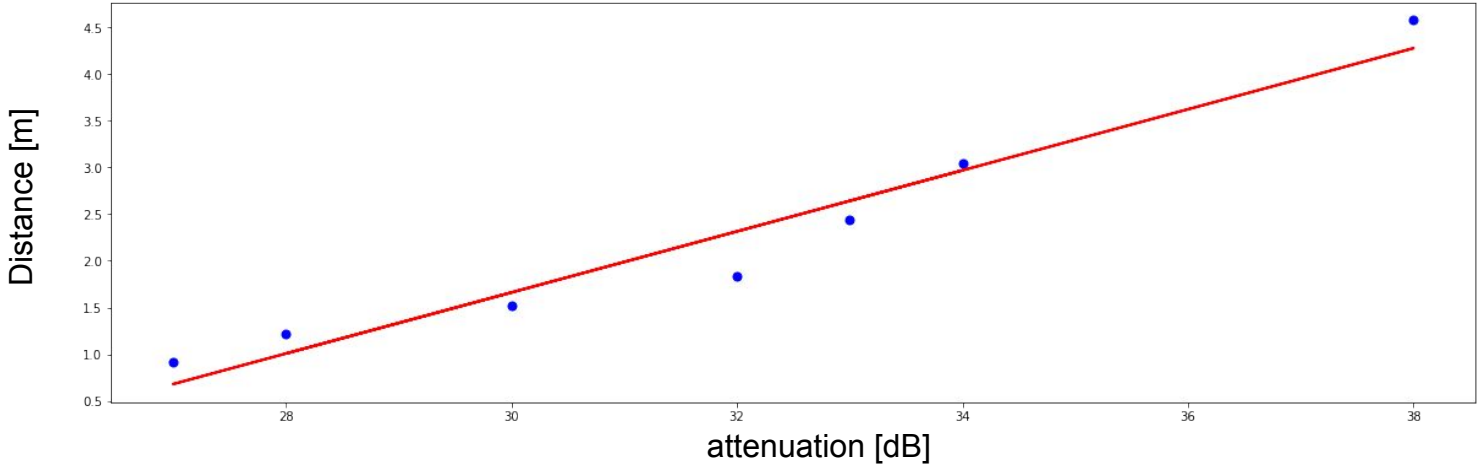


Data Exploration

(Varying **Angle** in each environment)



Simple Linear Regression



Scoring Run Results #1

UBSET	D	P_MISS	P_FA	NDCF
ne_grain	1.20	0.49	0.32	0.81
ne_grain	1.80	0.46	0.35	0.81
ne_grain	3.00	0.36	0.49	0.86
parse_grain	1.80	0.47	0.33	0.80

NIST Training set:
Multiple RandomForestRegressors

Scoring Run Results #1

SUBSET	D	P_MISS	P_FA	NDCF
fine_grain	1.20	0.53	0.16	0.69
fine_grain	1.80	0.45	0.38	0.83
fine_grain	3.00	0.10	0.80	0.90
coarse_grain	1.80	0.44	0.37	0.81

What we have left to do

- **Try different aggregation techniques per file**
- **Try other Regression/Classification Algorithms**
- **Feature engineering with sensors data**

Thank you !!!

BACKUP

15500 files

10 files

TXCarry_RXCarry_TXPose_RXPose

hand_hand_sitting_sitting
hand_hand_sitting_standing
hand_hand_standing_sitting
hand_hand_standing_standing
pocket_hand_sitting_standing
pocket_hand_standing_standing
pocket_pocket_sitting_sitting
pocket_pocket_sitting_standing
pocket_pocket_standing_sitting
pocket_pocket_standing_standing

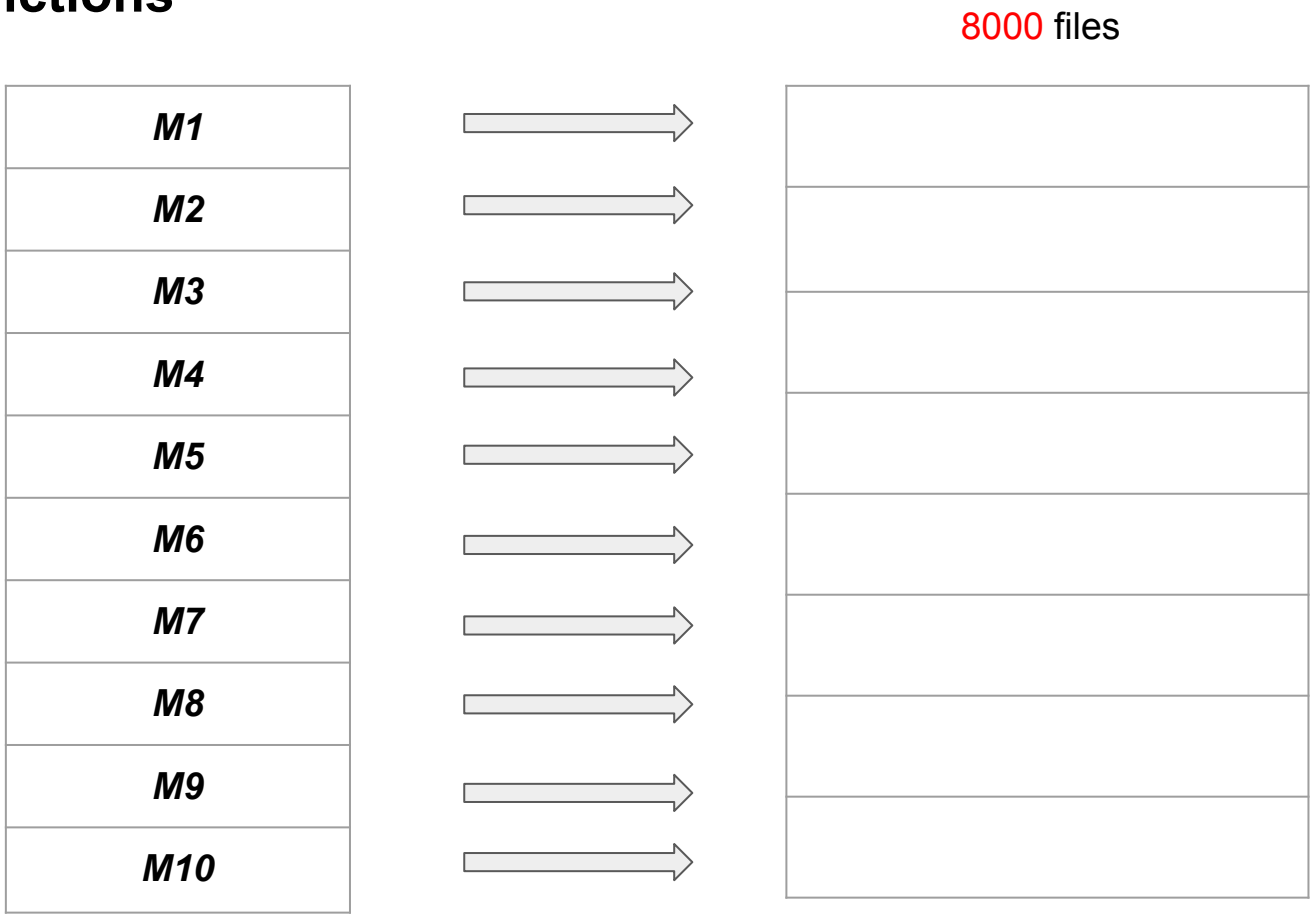
LinearRegression, RandomForestRegressor

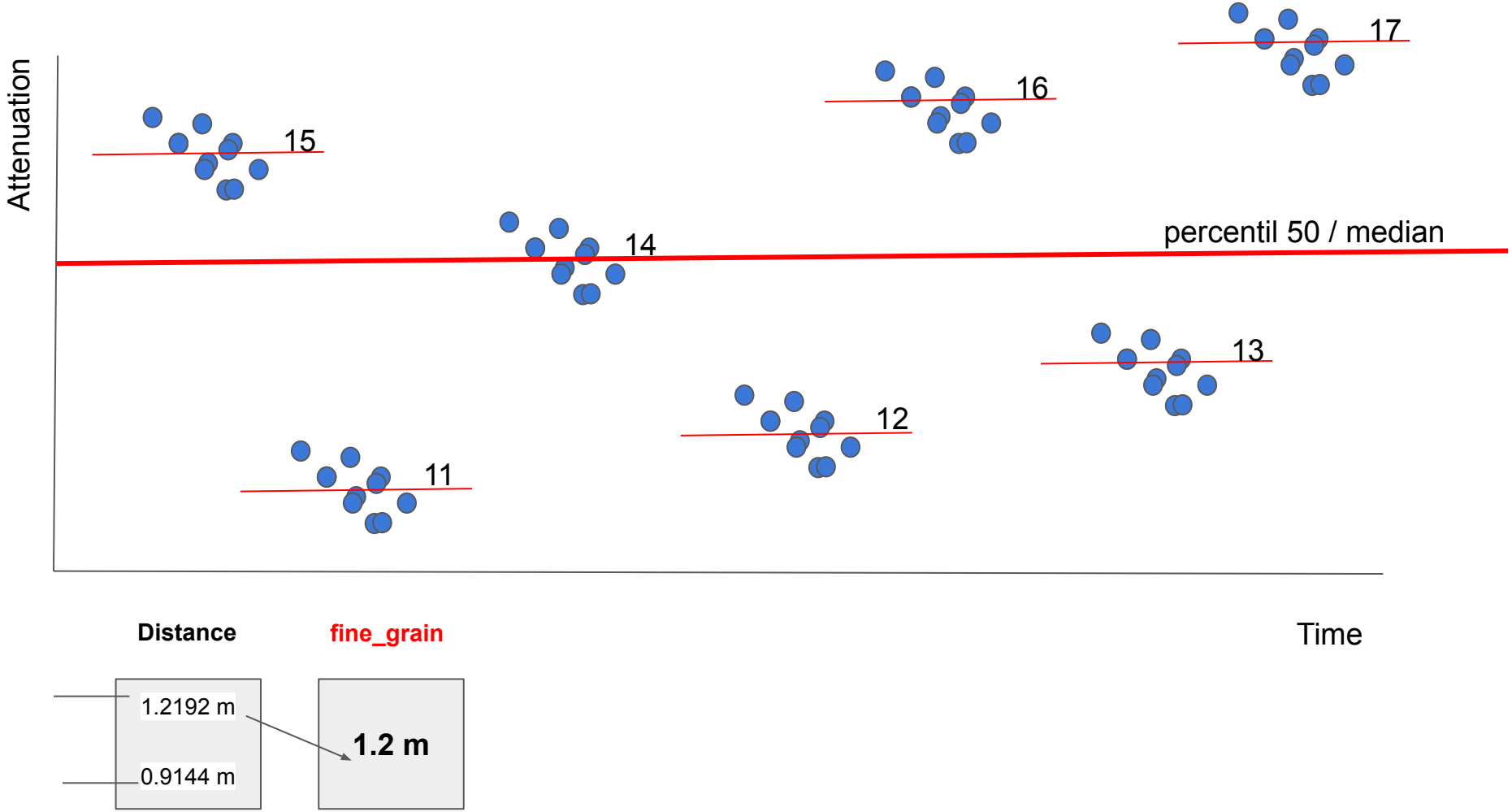
10 files

TXCarry_RXCarry_TXPose_RXPose

M1	hand_hand_sitting_sitting
M2	hand_hand_sitting_standing
M3	hand_hand_standing_sitting
M4	hand_hand_standing_standing
M5	pocket_hand_sitting_standing
M6	pocket_hand_standing_standing
M7	pocket_pocket_sitting_sitting
M8	pocket_pocket_sitting_standing
M9	pocket_pocket_standing_sitting
M10	pocket_pocket_standing_standing

Predictions




Attenuation
15
14
16
17
percentil 50 / median
13
12
11
Time
Distance
fine_grain
1.2192 m
0.9144 m
1.2 m