A Deep Neural Network Approach for Customized Prediction of Mobile Devices Discharging Time

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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Problem Definition

- *Problem:* smartphone's charge hardly reaches the end of the day
- *Fact:* power optimization is based on simple discharging time prediction
- *Observation:* battery consumption is user-dependent → prediction models are general but inaccurate

Make your smartphone **learn your usage** pattern day by day and adapt its prediction lifetime accordingly!

Machine Learning

Data easily accessible from smartphones

- Location
- Movements
- Calendar
- Time of the day
- Battery level
- Apps installed*

Privacy matters: the machine learning algorithm can work locally on the user device → no leakage of private info!

*Not used in this experiment

Dataset

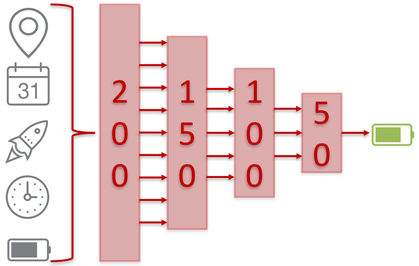
- LifeMap project
  J. Chon and H. Cha, "LifeMap: A Smartphone-Based Context Provider for Location-Based Services," IEEE Pervasive Computing, vol. 10, no. 2, pp. 58–67, Apr. 2011
- 6 months of data for 6 users
- Granularity of 10 minutes

Deep Neural Network

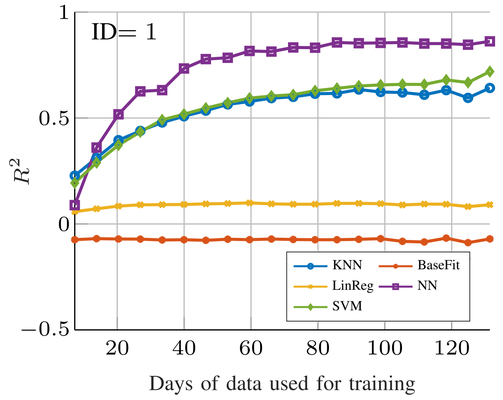
Structure after model selection:

- 4 fully connected layers of size 200, 150, 100, 50
- Hyperbolic tangent activation function
- Parameter learning via Limited-memory BFGS algorithm

Output: estimated discharging time

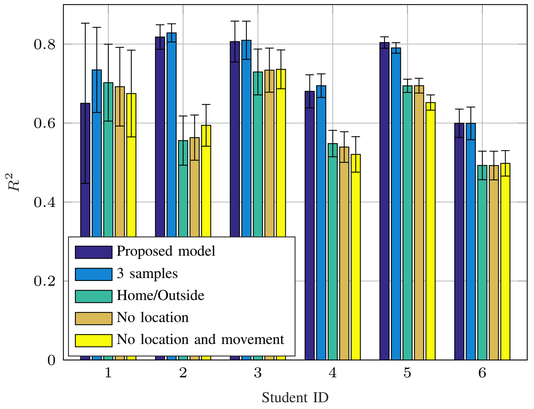


Main results



Prediction performance

- **NN:** deep neural network (our proposal)
- **BaseFit**: current approach (linear interpol.)
- **LinReg**: linear regression
- **KNN**: k-nearest neighbors regressor
- **SVM**: support vector machine



Sensitivity to data accuracy

- Three additional past battery samples
- Binary location (home/outside)
- No location
- No location and no info on movement

Test user

Train user ID	1	2	3	4	5	6
1	0.643	-0.0733	-0.293	-2.130	-3.508	0.642
2	-0.268	0.645	-0.581	-4.083	-6.479	-0.048
3	-0.195	-0.074	0.687	-2.490	-3.865	0.514
4	-0.121	-0.068	-0.220	0.664	-3.173	0.714
5	-0.110	-0.067	-0.223	-1.715	0.703	0.729
6	-0.070	-0.101	-0.423	-0.335	0.670	0.761
All	0.308	0.371	-0.167	-4.693	-3.725	-0.711

Specificity

Confusion matrix of the R^2 coefficient among different users → trained models are strictly personal and depend on the habits of each specific user

Low complexity:

- Training on one day data → 2 s
- Prediction → 100 μs (CPU time in **desktop PC**)

Future work: design pre-training algorithms implement and test on real devices