Pool Detection from Smart Metering Data with Convolutional Neural Networks

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FH Salzburg
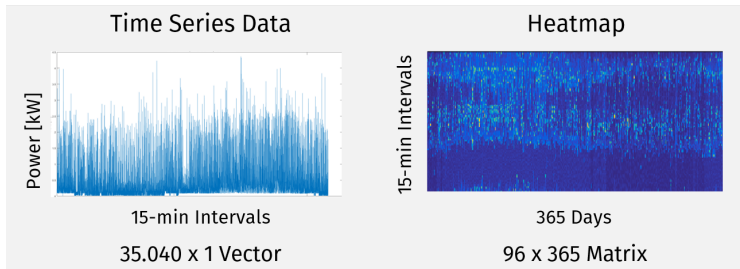Center for Secure
Energy Informatics

Dataset

- 15-minute load readings from 869 Upper Austrian households for a full year [1]
- information about presence of appliances:
  - swimming pool, home cinema, sauna, solarium, waterbed, aquarium
- swimming pools in 64 households (7.36%)

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Time Series Data	Heatmap
Power [kW] / 15-min Intervals	15-min Intervals / 365 Days
35.040 x 1 Vector	96 x 365 Matrix

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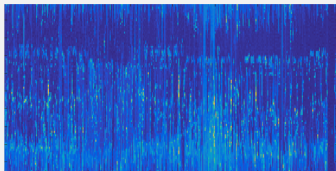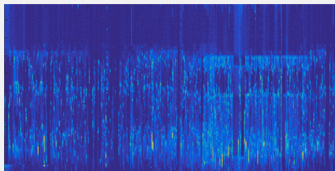
Examples of Different Households

Household with Pool
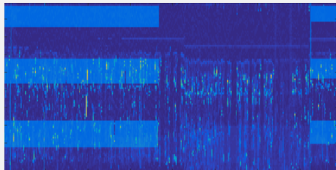
Household with Pool
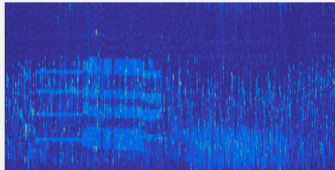
Household with Pool

Household without Pool

Pool Pump Heatmap Pattern

Preprocessed Heatmap

Image Preprocessing:

1. removing winter months
2. morphological operations
3. binarization
4. rectangle detection

Pool Pump Heatmap Pattern

Preprocessed Heatmap

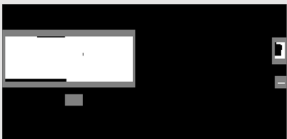

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Feature Engineering:

- number of rectangles
- total area
- average rectangle coverage
- median load of rectangle areas
- median load of non-rectangle areas

Pool Pump Heatmap Pattern

Preprocessed Heatmap

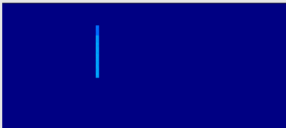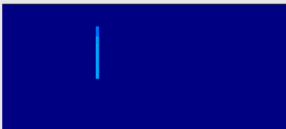Image Preprocessing:

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Classification Method	Accuracy	Precision
5-NN	94.0%	68.5%

Can we achieve the same result with deep learning?

Convolutional Neural Network Architecture
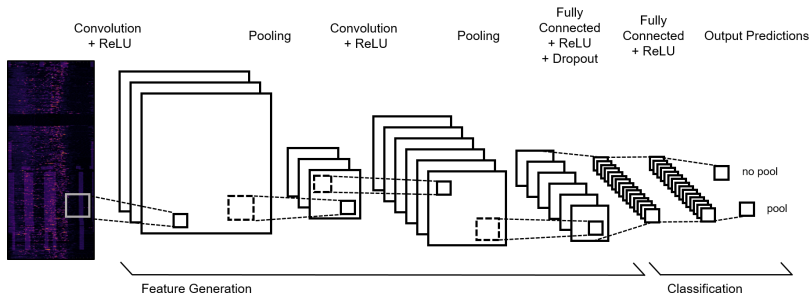
4x Convolution + Batch Normalization + ReLU + Max Pooling
1x Fully Connected + Batch Normalization + ReLU + Dropout
1x Fully Connected

Results

Classification Method	Accuracy	Precision
All-positive	7.4%	7.4%
All-negative	92.6%	-
5-NN	94.0%	68.5%
CNN	**95.5%**	**71.9%**

Predicted class

		no pool	pool	total
True class	no pool	789 *97.2%*	16 *28.1%*	805
	pool	23 *2.8%*	41 *71.9%*	64
	total	812	57	869
		100%	100%	

Conclusion and Future Work

Even with little data, we successfully trained a CNN to predict if a household does or does not have a pool.

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Even with little data, we successfully trained a CNN to predict if a household does or does not have a pool.

Open questions:

- Can we predict even more privacy-relevant features other than pools?
- Can we transform the trained model to other regions?

Thank you for your attention!

Questions?

References

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