Metadata for Energy Disaggregation

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INTRODUCTION

More than ten energy disaggregation datasets have been released over the last few years. These are a great step forward. But they each use a different file format and different metadata schemas. At best, the lack of a standard metadata schema makes it unnecessarily time-consuming to write software to process multiple datasets and, at worse, means that crucial information is simply absent from some datasets.

We propose a metadata schema called 'NILM Metadata' for representing appliances, meters, buildings, datasets, prior knowledge about appliances and appliance models. The schema is relational and provides a simple but powerful inheritance mechanism.

NILM Metadata is described in a recent paper [1] and is available online as an open-source project [2]. It has been used to describe the UK-DALE dataset [3].

THE NILM METADATA SCHEMA
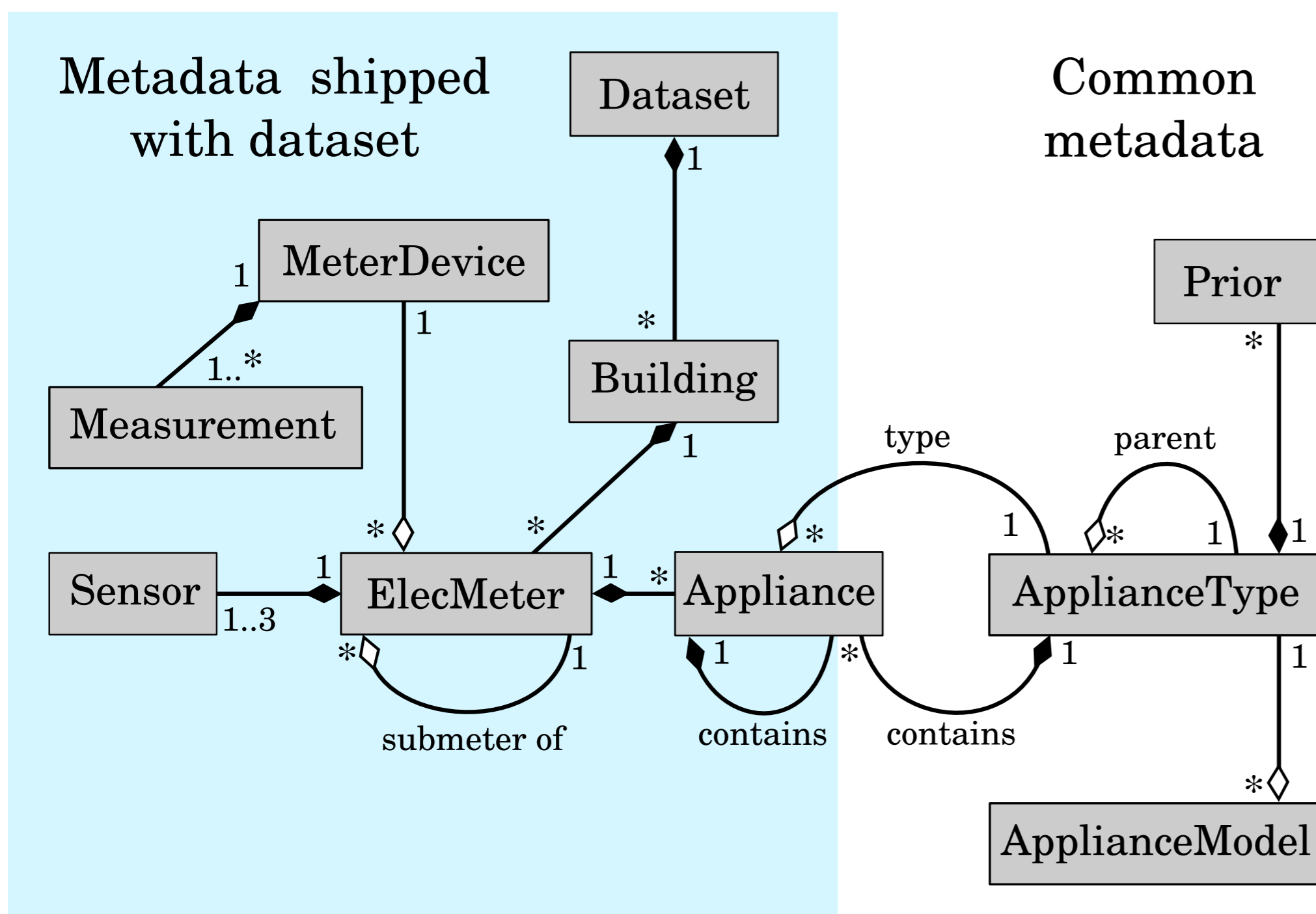
UML Class Diagram of the relationships between classes.

There are two sides to the NILM Metadata project:

1) Schema defining metadata describing a dataset
(Represented by the left side of the UML diagram)
The schema describes, amongst other things:
- electricity meters (e.g. wiring hierarchy of meters and a controlled vocabulary for measurement names)
- appliances (e.g. a controlled vocabulary for appliance names and each appliance can contain any number of components)
- buildings and datasets

2) A database and inheritance mechanism for common information about appliances.
(represented by the right side of the UML diagram)
- Categories for each appliance type
- Prior knowledge about the distribution of variables such as 'on power', 'usage (hours per day)', 'appliance correlations'
- valid additional properties for each appliance
- The common info about appliances uses a simple but powerful inheritance mechanism to allow appliances to inherit from a other appliances

EXAMPLE HOUSE
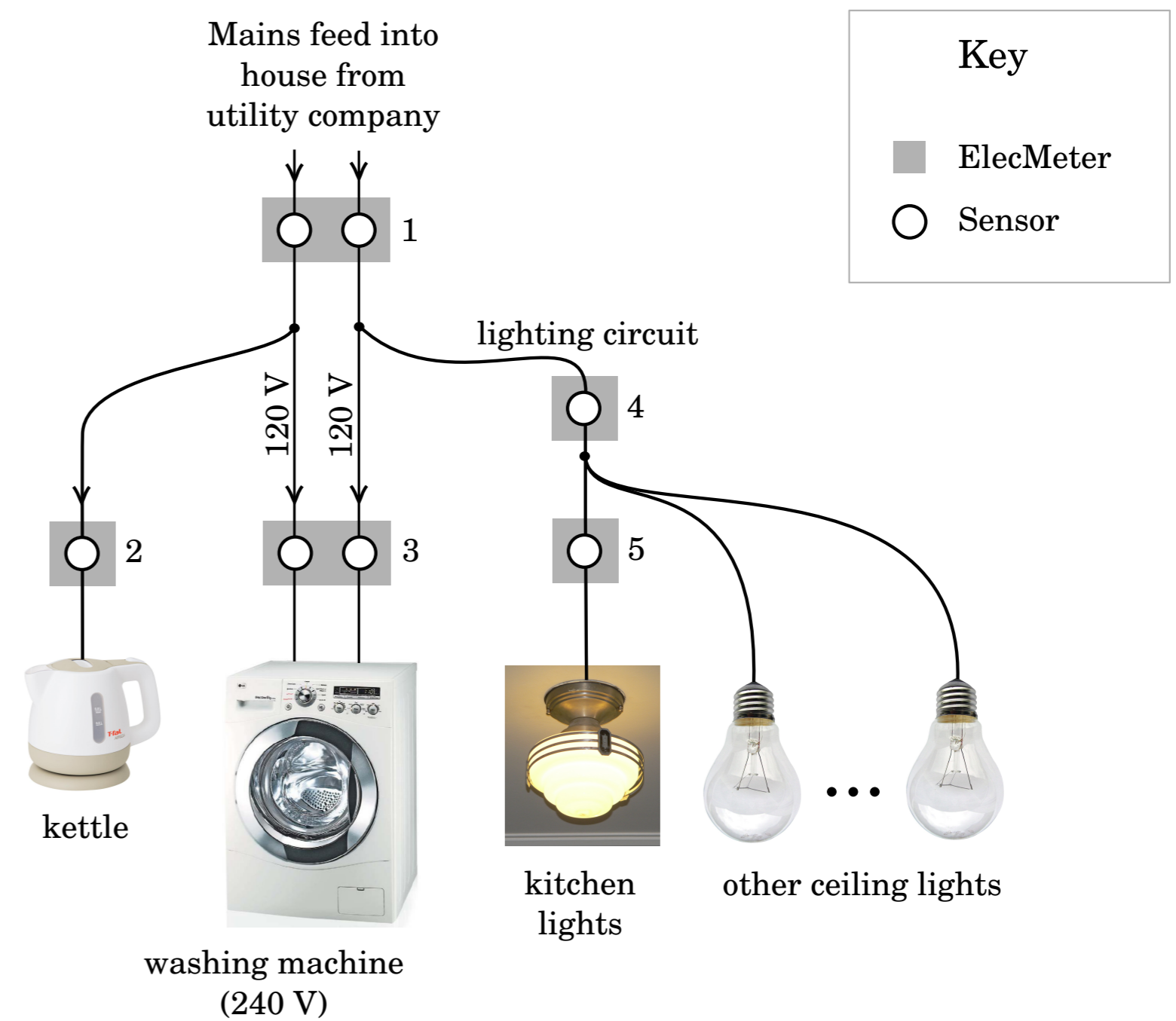
This home has a split-phase mains supply (common in North America, for example). Black lines indicate mains wires. The washing machine draws power across both splits. All other appliances draw power from a single split. We model it below:

```
dataset.yaml
name: UK-DALE
long_name: UK Domestic Appliance-Level Electricity demand
mains_voltage: {nominal: 230, upper_limit: 253, lower_limit: 215}
timezone: Europe/London

meter_devices.yaml
EnviR: # 'EnviR' is the model name of an electricity meter
  manufacturer: Current Cost
  measurements: # list all the measurements this meter records
  - physical_quantity: power # options: {power, energy, voltage}
    ac_type: apparent # options: {active, reactive, apparent}

building1.yaml
instance: 1 # building instance (integer starting at 1)
geo_location: {locality: London, country: GB}
elec_meters: # list all the ElecMeters for this building
  1: # meter instance (integer starting at 1)
    site_meter: true # meter records whole-house aggregate demand
    sensors: [{data_location: 1a.csv}, {data_location: 1b.csv}]
    device_model: EnviR # refers to 'EnviR' in meter_devices.yaml

  2:
    sensors: [{data_location: 2.csv}] # list sensors for this meter
    submeter_of: 1 # meter instance 1 is upstream of meter 2
    device_model: EnviR
    appliances: [{type: kettle}] # list downstream appliances

  3:
    submeter_of: 1
    appliances:
    - {type: washing machine, model: WD420, room: utility}
    sensors: [{data_location: 3a.csv}, {data_location: 3b.csv}]
    device_model: EnviR

  4: {sensors: [{data_location: 4.csv}], submeter_of: 1,
appliances: [{type: light, multiple: true}], device_model: EnviR}

  5:
    sensors: [{data_location: 5.csv}]
    submeter_of: 4
    device_model: EnviR
    appliances:
    - {type: light, on_power_threshold: 15, control: [manual],
        components: [{type: LED lamp, count: 10}, {type: dimmer}],
        main_room_light: true, dates_active: [{start: 2013}]}
```

REFERENCES

[1] Jack Kelly and William Knottenbelt (2014). Metadata for Energy Disaggregation. In The 2nd IEEE International Workshop on Consumer Devices and Systems (CDS) in Västerås, Sweden. arXiv:1403.5946
[2] github.com/nilmtk/nilm_metadata
[3] Jack Kelly and William Knottenbelt 2014. UK-DALE: A dataset recording UK Domestic Appliance-Level Electricity demand and whole-house demand. ArXiv e-prints, arXiv:1404.0284