INTRODUCTION TO MODELICA

Data management

Modelon

OVERVIEW

- Organizing Data
- Data records
- Modifiers in Models
- Deeper Hierarchies
- Data based components

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DATA MANAGEMENT

ORGANIZING DATA

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ORGANIZING DATA

- Data can be:
  - Organized in data packages using records
    - Constant data, never to be changed
    - Parameter data, allows for changes
  - Added to models in variants
    - Have a base model (preferably partial)
    - Create variants that extends the base model
    - Configure and set parameters in variants
  - Taken from databases outside Modelica models (or even Modelon Impact)
    - Requires customization
    - Modelon.DataAccess

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DATA MANAGEMENT

DATA RECORDS

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DATA RECORDS

```
record MyDataRecord
    extends Modelica.Icons.Record;
        parameter .Modelica.SIunits.Length L = 1 "Length";
        parameter .Modelica.SIunits.Diameter d = 0.1 "Diameter";
        parameter .Modelica.SIunits.Density rho = 1200 "Density";
end MyDataRecord;
```

- Create new datasets by modifying the first set:

```
record DataSet1
    extends DataPackage.MyDataRecord(L=10);
end DataSet1;
```

- In this case we modify the values of `L, d` and `rho` is kept.

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DATA RECORDS

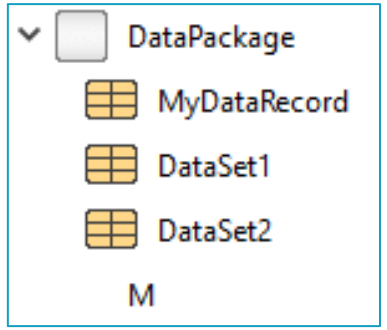
- Create new data record libraries that can be used by models.

```
package DataPackage
    extends Modelica.Icons.Package;
    record MyDataRecord
        extends Modelica.Icons.Record;
            parameter .Modelica.SIunits.Length L = 1 "Length";
            parameter .Modelica.SIunits.Diameter d = 0.1 "Diameter";
            parameter .Modelica.SIunits.Density rho = 1200 "Density";
    end MyDataRecord;

    record DataSet1
        extends DataPackage.MyDataRecord(L=10);
    end DataSet1;

    record DataSet2
        extends DataPackage.MyDataRecord(L=20);
    end DataSet2;

    model M
        parameter DataPackage.DataSet1 data;
        parameter Modelica.SIunits.Mass m=data.L*data.d*data.rho "Mass";
        annotation(...);
    end M;
end DataPackage;
```



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REPLACEABLE PARAMETER SETS

- Engine model

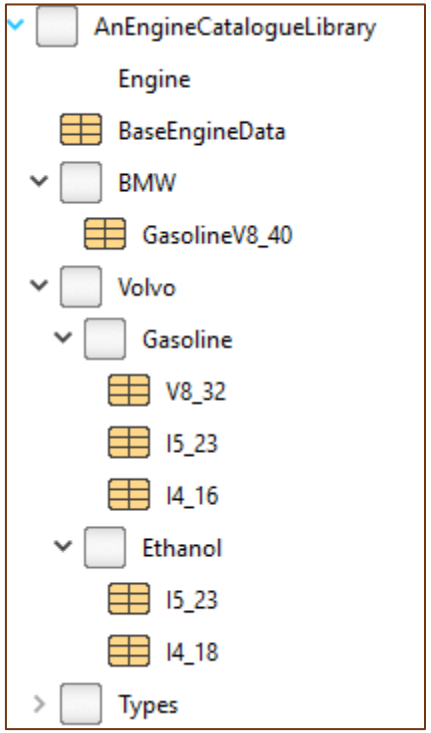
```
model Engine
 parameter BaseEngineData data;
 ...
end Engine;
```

- Base record

```
record BaseEngineData
 Types.CylinderArrangement cylinder_arrangement;
 Integer number_of_cylinders;
 Modelica.SIunits.Volume displacement;
end BaseEngineData;
```

- Specific configuration extending from engine record

```
record V8_32
 extends BaseEngineData(
 cylinder_arrangement = Types.CylinderArrangement.V,
 number_of_cylinders = 8, displacement = 3.2);
end V8_32;
```



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DATA RECORDS

- Pros:
  - Keep data separate from models
  - Easy model parameterization with drop-down list
  - Easy to see what data is used in a particular model

- Cons:
  - Must manually make sure that data records and models match if you modify components in a hierarchical model
    - SimpleShaft and ElasticShaft might not need same parameters
  - Have to maintain two different library structures so they match
    - Models
    - Data records

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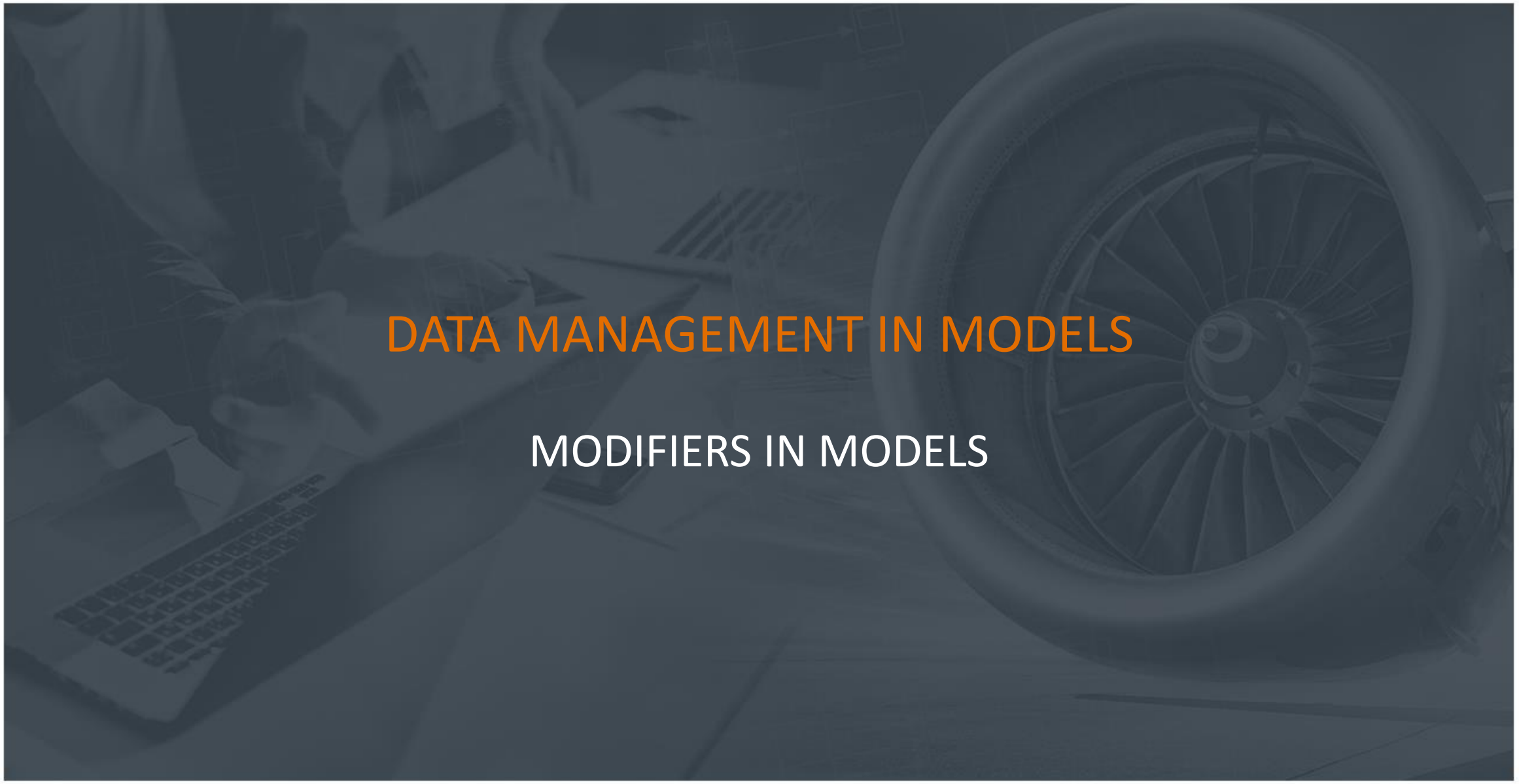

DATA MANAGEMENT IN MODELS

MODIFIERS IN MODELS

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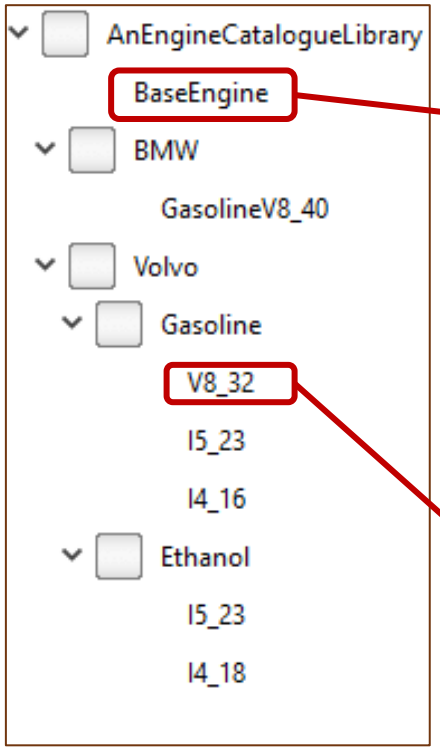
VARIANT LIBRARIES



Example of a catalogue library with variants:

- Base engine model

```
partial model BaseEngine
 parameter Types.CylinderArrangement
  cylinder_arrangement;
 parameter Integer number_of_cylinders;
 parameter Modelica.SIunits.Volume displacement;
 ...
end BaseEngine;
```

- Specific configuration extending from base engine model

```
model V8_32
 extends BaseEngine(
 cylinder_arrangement = Types.CylinderArrangement.V,
 number_of_cylinders = 8,
 displacement = 3.2);
end V8_32;
```

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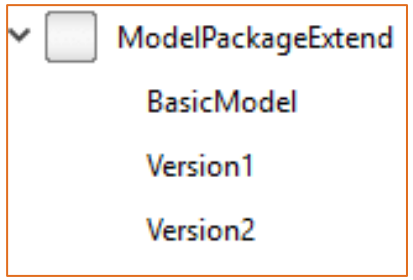
MODIFIERS IN MODELS

- Create a base class of your model
- Extend this base class and modify it




```
package ModelicaPackageExtends
    extends Modelica.Icons.Package;
    partial model BaseModel
        parameter .Modelica.SIunits.Length L = 1 "Length";
        parameter .Modelica.SIunits.Diameter d = 0.1 "Diameter";
        parameter .Modelica.SIunits.Density rho = 1200 "Density";
        annotation(•••);
    end BaseModel;
    model Variant1
        extends .ModelicaClasses.ModelicaPackageExtends.BaseModel(L=10);
    end Variant1;
    model Variant2
        extends .ModelicaClasses.ModelicaPackageExtends.BaseModel(L = 20);
    end Variant2;
```

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MODIFIERS IN MODELS

When using modifiers in this way, you store the model data inside the models.

Create parts catalog libraries

Pros:

- Quick and easy to create modifications from a nominal model.
- Data and model is always consistent.

Cons:

- Can be hard to get an overview of the data used in the model if it’s a large data set.
- Modifiers in a deep hierarchy can be confusing

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DATA MANAGEMENT

WORKING WITH DEEPER HIERARCHIES

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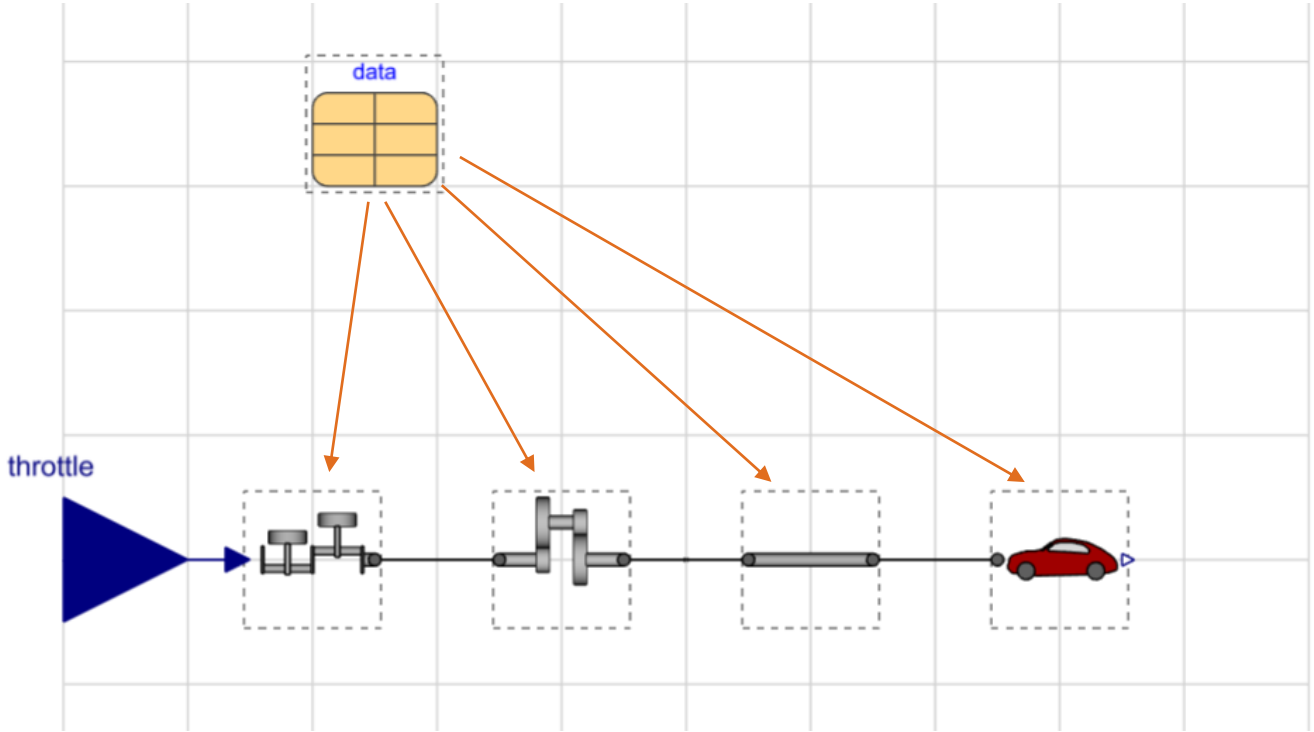
HIERARCHICAL DATA MANAGEMENT

Using Data Records:

- Create a top-level Data record



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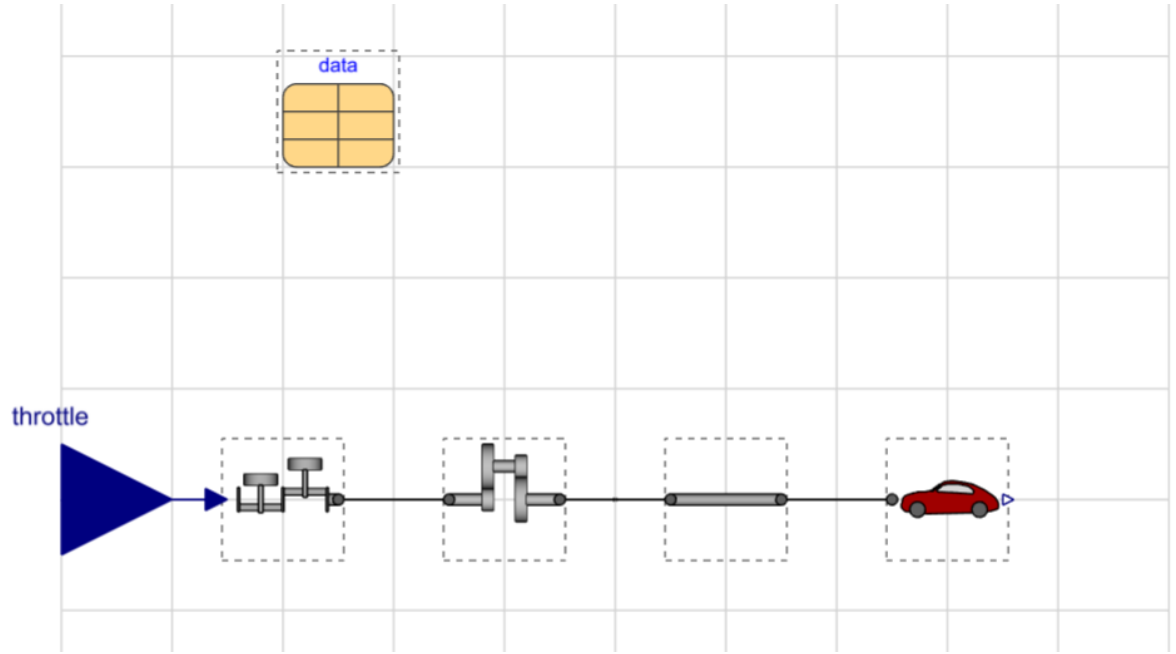
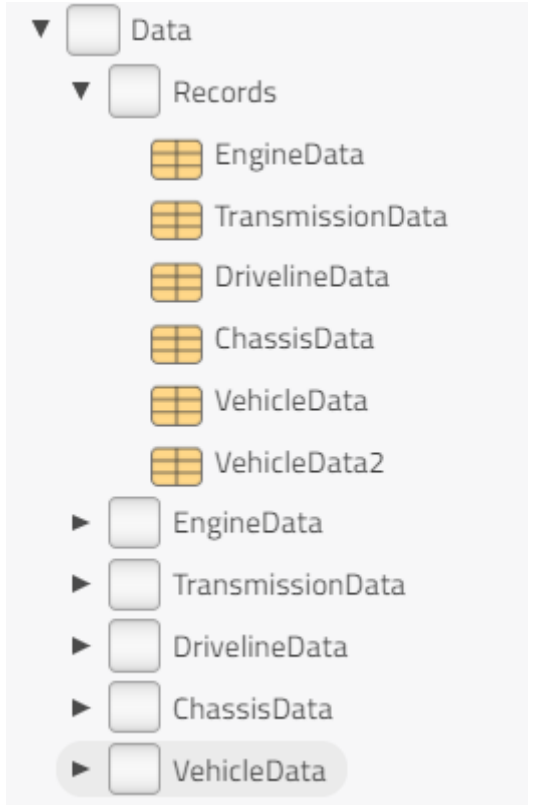
HIERARCHICAL DATA MANAGEMENT

- The record can contain one replaceable record for each submodel





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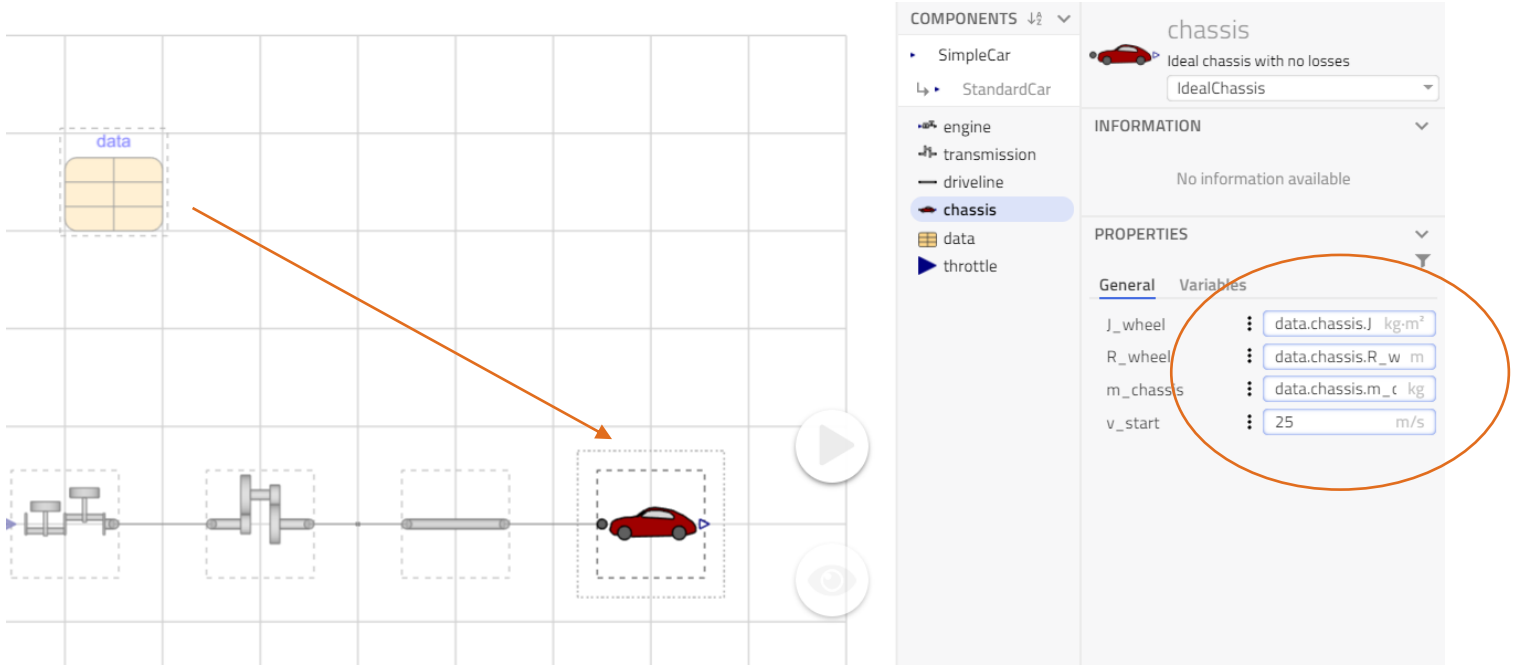
HIERARCHICAL DATA MANAGEMENT

- Data referencing can be done either element wise:



- Or the chassis component could have a record of its own and the whole sub-record `data.chassis` is referenced.

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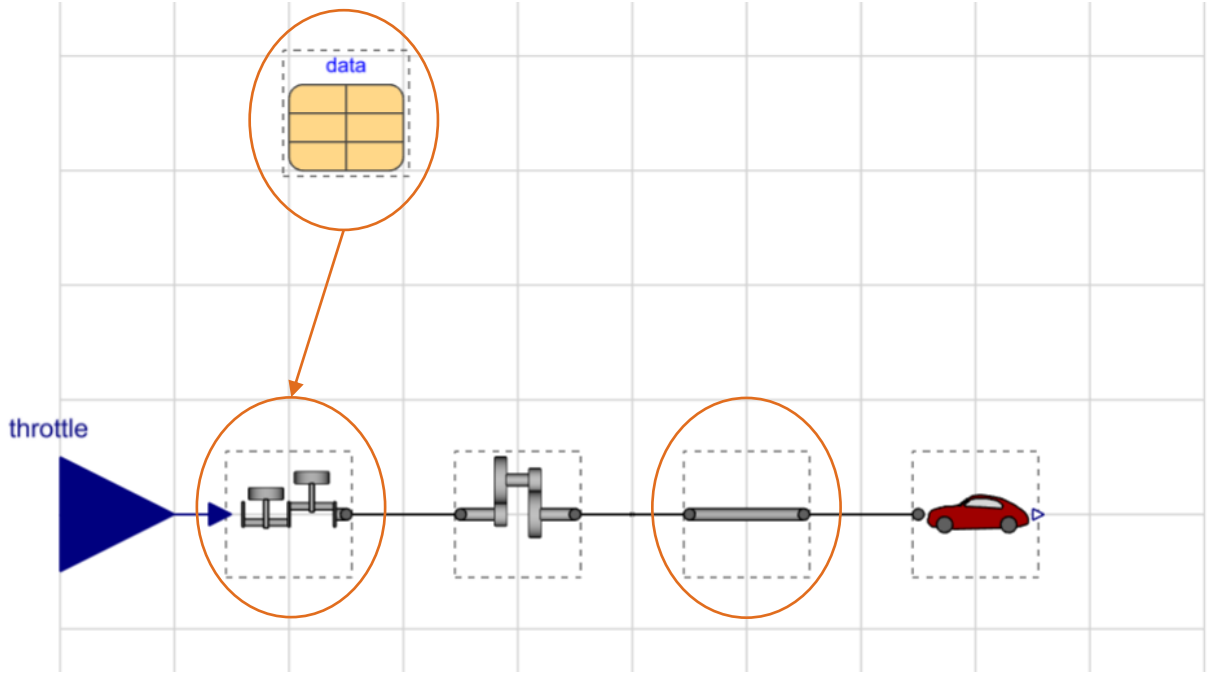
SUMMARY – HIERARCHICAL DATA MANAGEMENT

- Change component model
- Change data sheet



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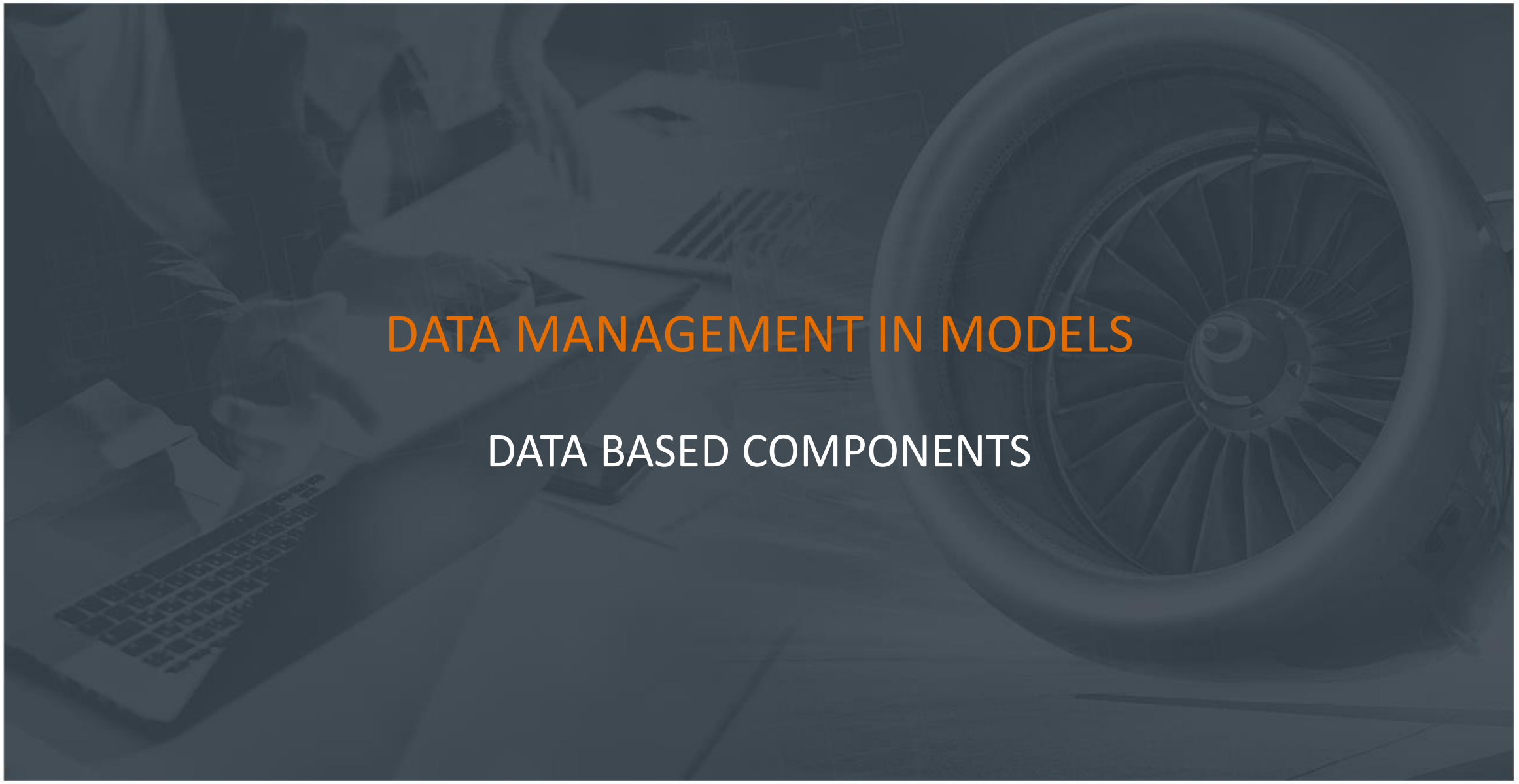

DATA MANAGEMENT IN MODELS

DATA BASED COMPONENTS

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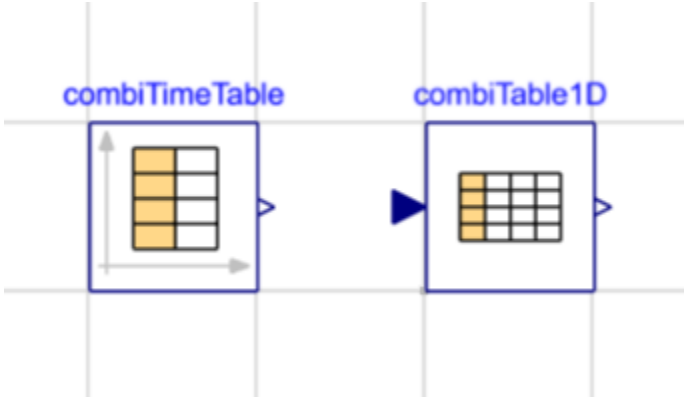
DATA INPUT BLOCKS

- MSL contains table-based input blocks.



- These can either depend on time directly or an arbitrary input signal

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DATA INPUT BLOCKS

- Tables can be defined as:
  - Matrix directly in Modelica
  - A matrix stored in a file

- Files can be .mat or .txt format

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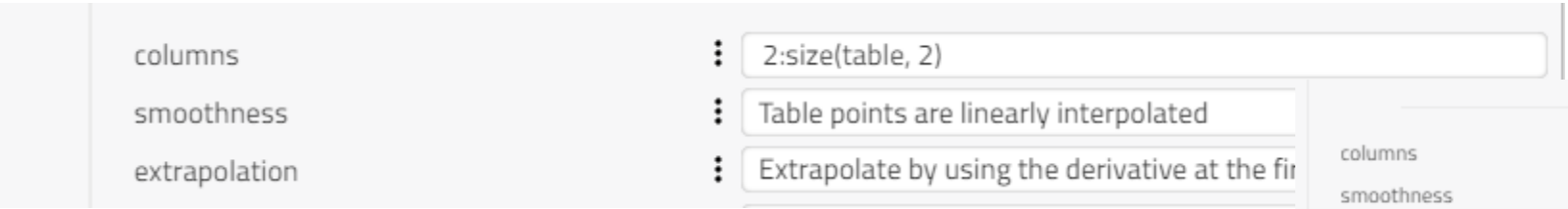
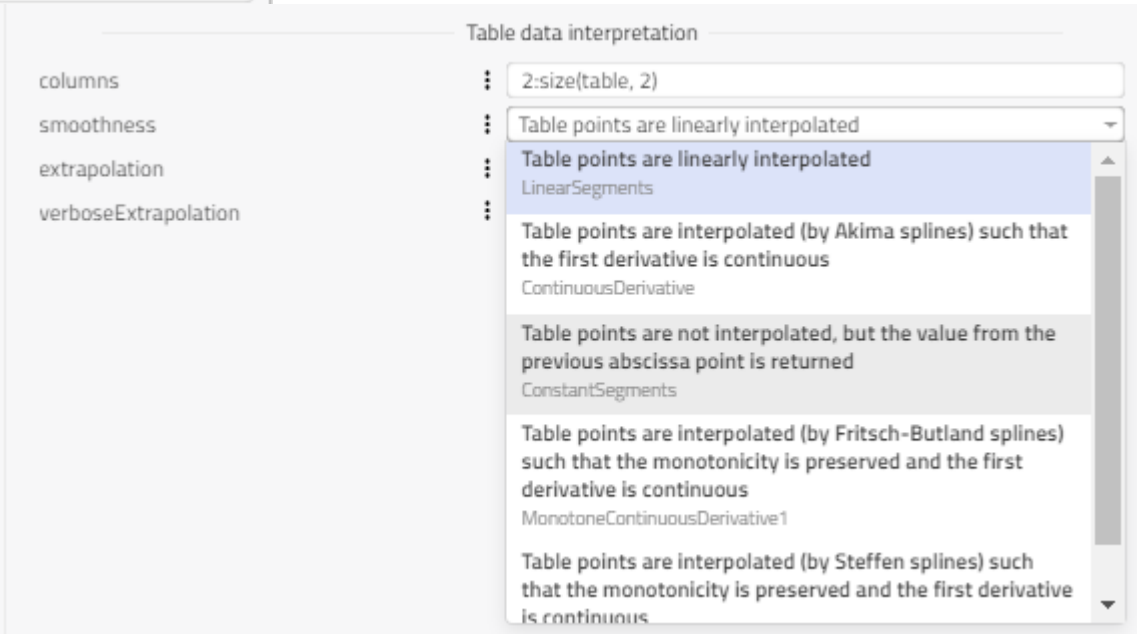
DATA INPUT BLOCKS

- The data is interpolated using piecewise polynomials
  - Constant
  - Linear
  - Continuous first derivative (splines)





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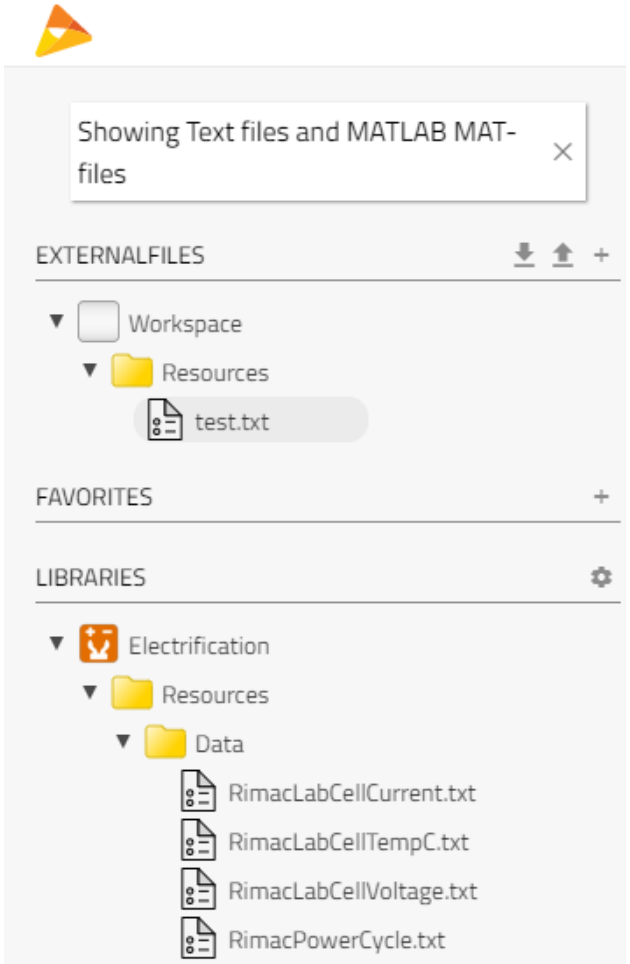
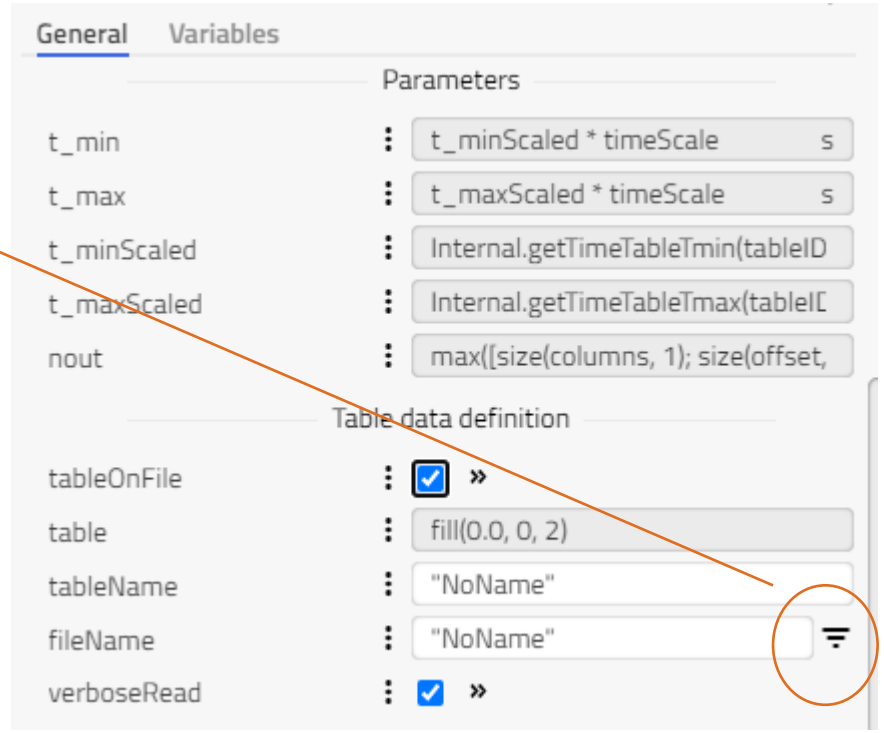
DATA INPUT BLOCKS

- Input files:





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WORKSHOP 4.2

In this workshop you will:

- Create Data record structure using templates and interfaces
- Add structure to existing model
- Propagate the record data into the model

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