AALBORG UNIVERSITY

Data modeling for Precision Dairy Farming within the competitive field of operational and analytical tasks

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Agenda

1. Background and motivation
2. Hybrid Modeling of Farm Data
3. Results
4. Relation to our project
5. Paper Evaluation

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Precision Farming

- **Incorporation of state-of-the-art technologies in day to day farming**
  - **GPS (Automatic Pilot, Location-based Cultivation,..)**
  - **GIS/Remote Sensing (Yield maps, soil sampling)**
  - **Sensor Networks (Climate, moisture, alarm)**
  - **Mobile devices (Mobile mapping, Farm owner notification)**
  - **…**

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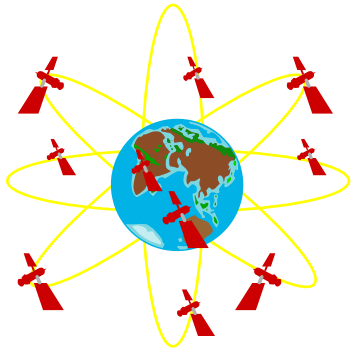
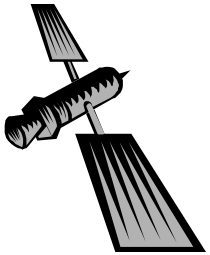
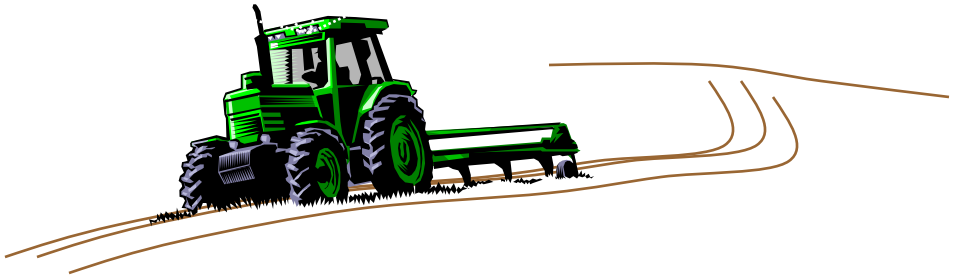
Precision Farming Benefits

- **Information to Act On**
- **Better view over the Farming processes**
- **Environmental Perspective**
- **Economical Perspective**







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PDF Data-Centric Gap

- **Multi-disciplinary domain**
- **Communication gap between involved parties**
- **Not much systematic use of RDBMS**
  - **Application Integration**
  - **Analytical Hindrance**

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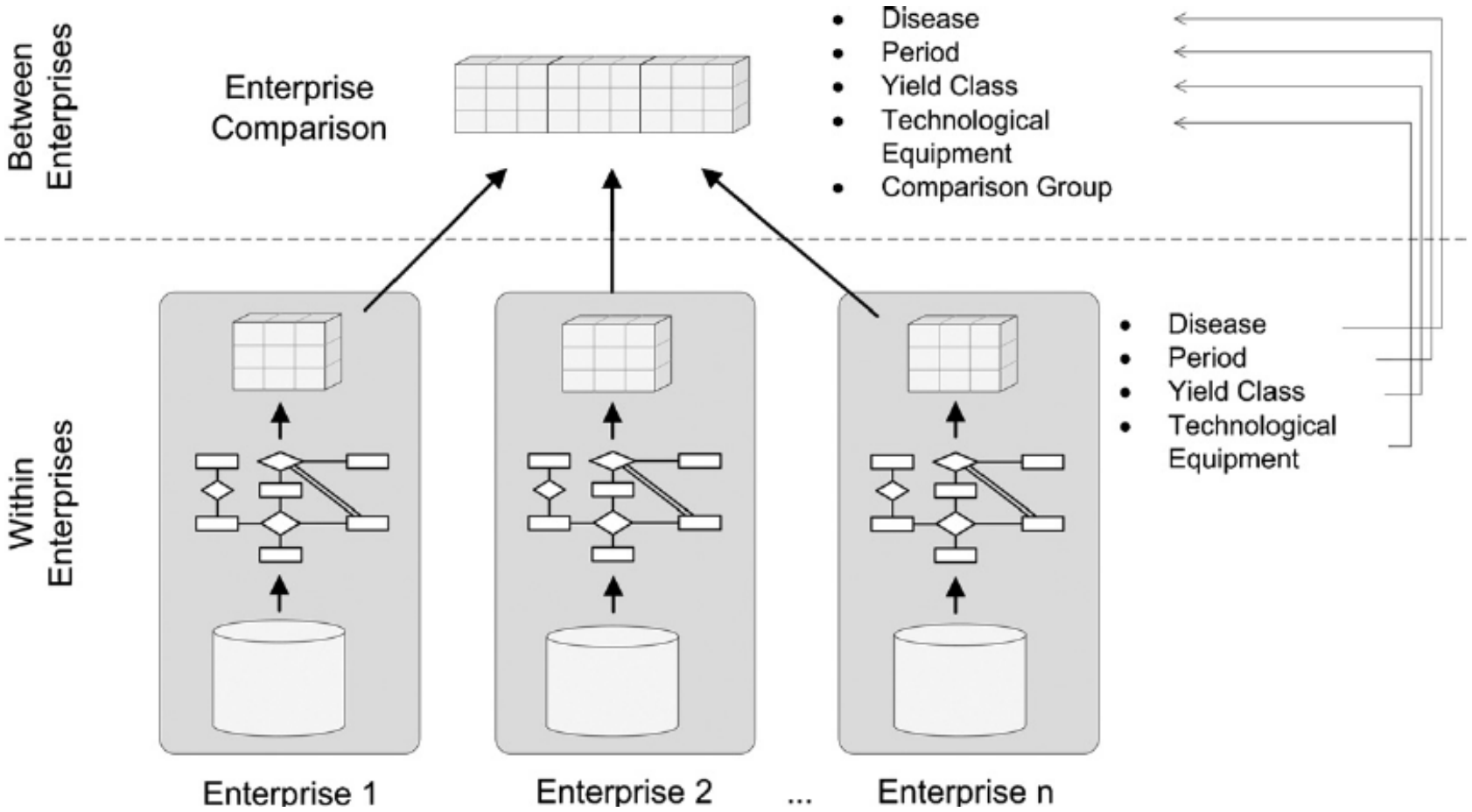
Enterprise Comparison



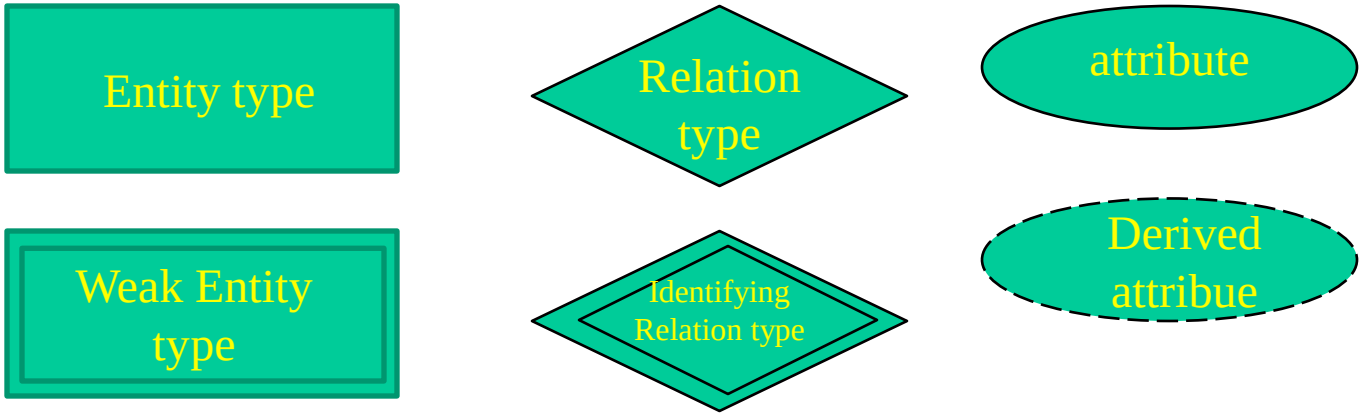
Two Views of Data

Operational View -

- **Support of business process**
- **Frequent update**
- **Normalized**
- **Short term decisions**

Eg. Disease database

- **E/RM notation for modeling**



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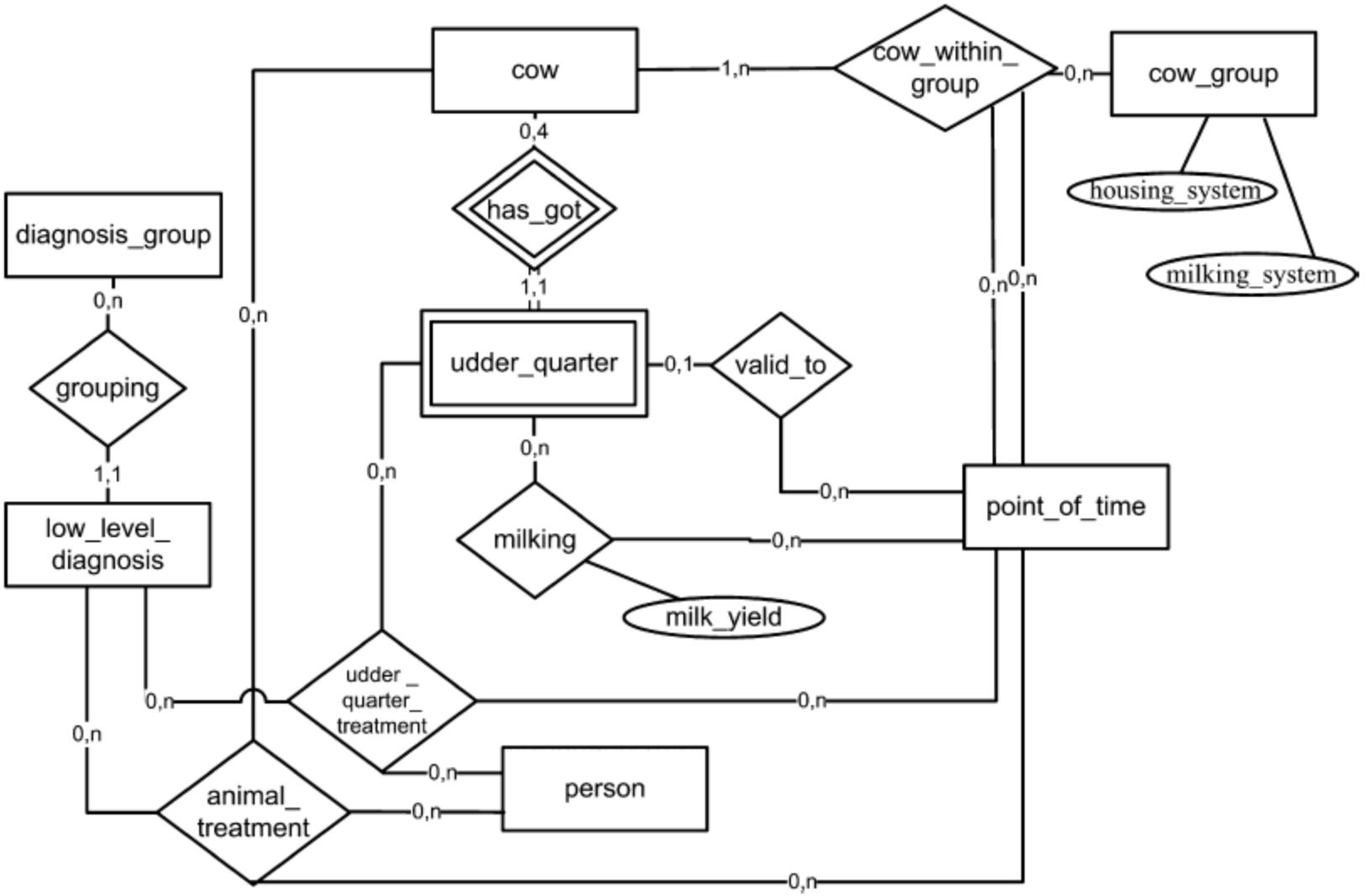
E/RM of application scenario



Two views of Data

Analytical View-

- **Historical view**
- **Strategic decisions**
- **Aggregated**
- **Integrated**
- **Use of mE/R notation**

- **Eg. Occurrence of a disease symptom in a timeline**

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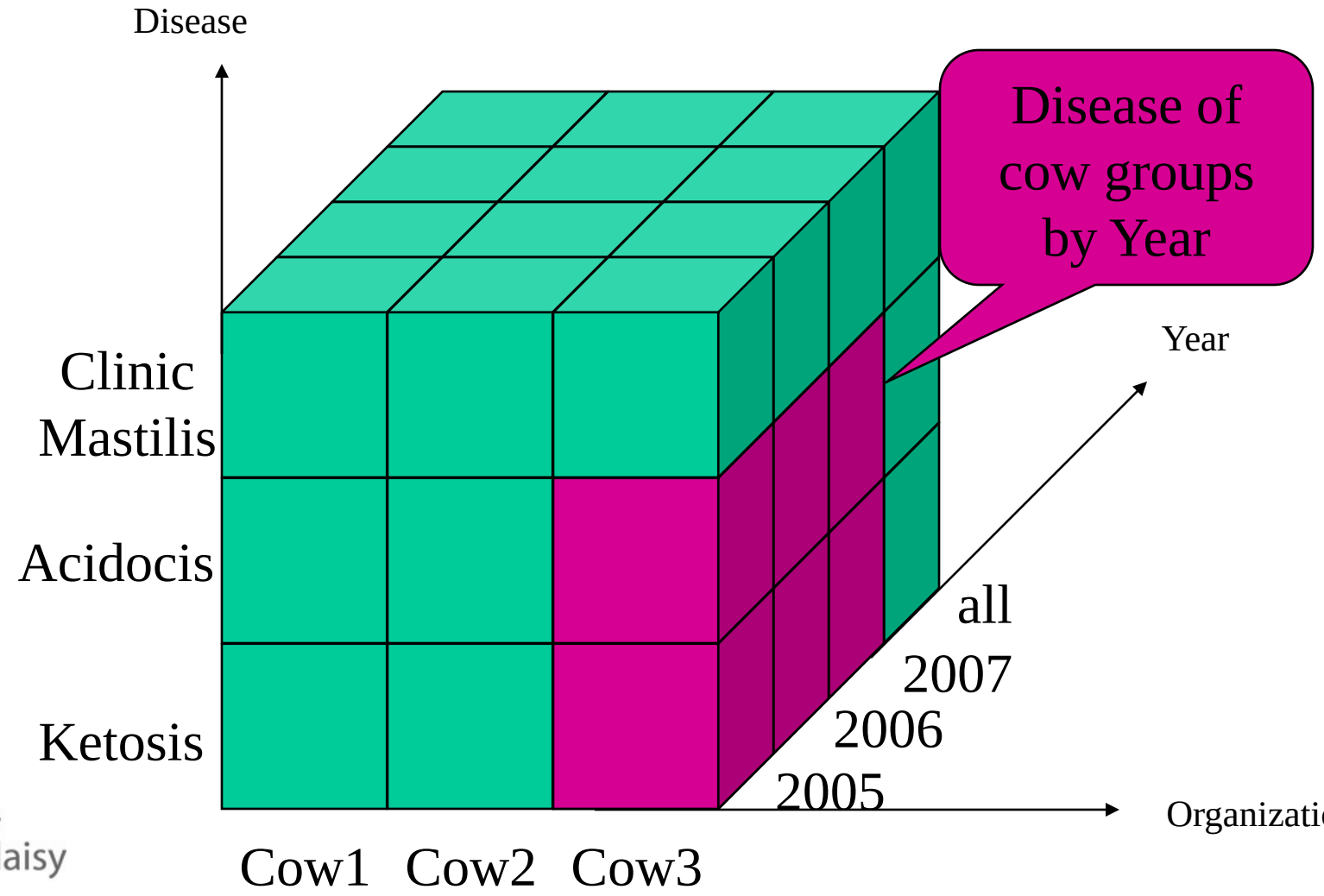
Data Cube



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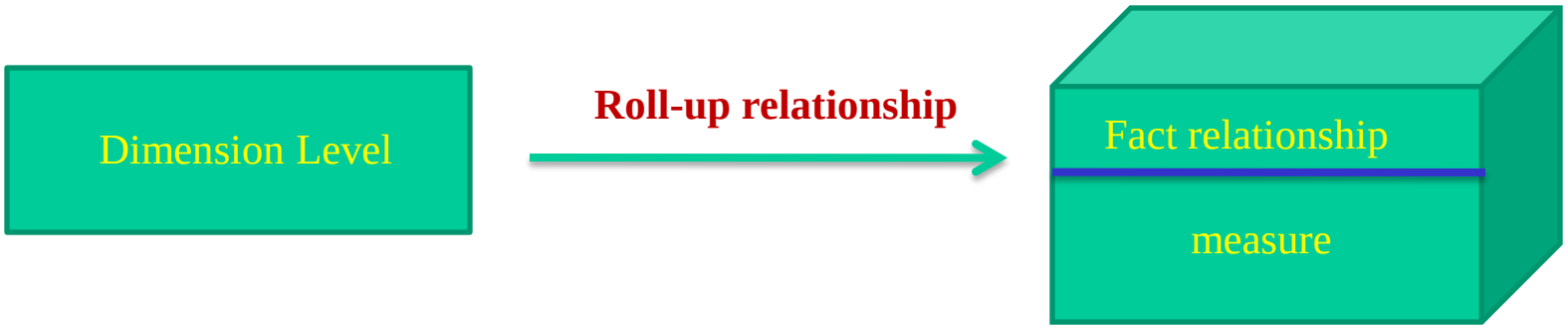
mE/RM

- **E/RM is not suitable for multi-dimensional data model**
- **mE/RM introduces:**



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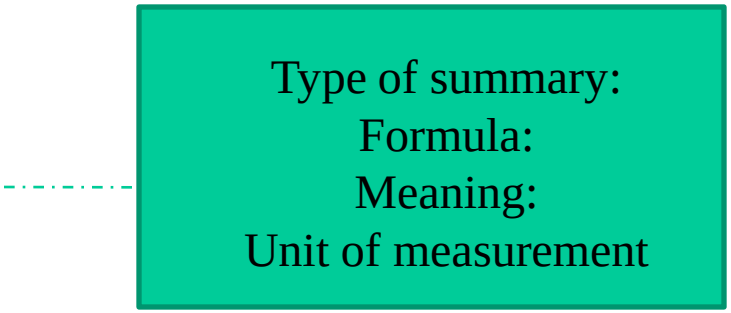
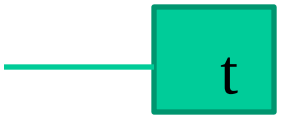
Extension of mE/RM

- **mE/RM lacks measuring properties**
- **Introduction of**



Property window to measures



Temporal restriction

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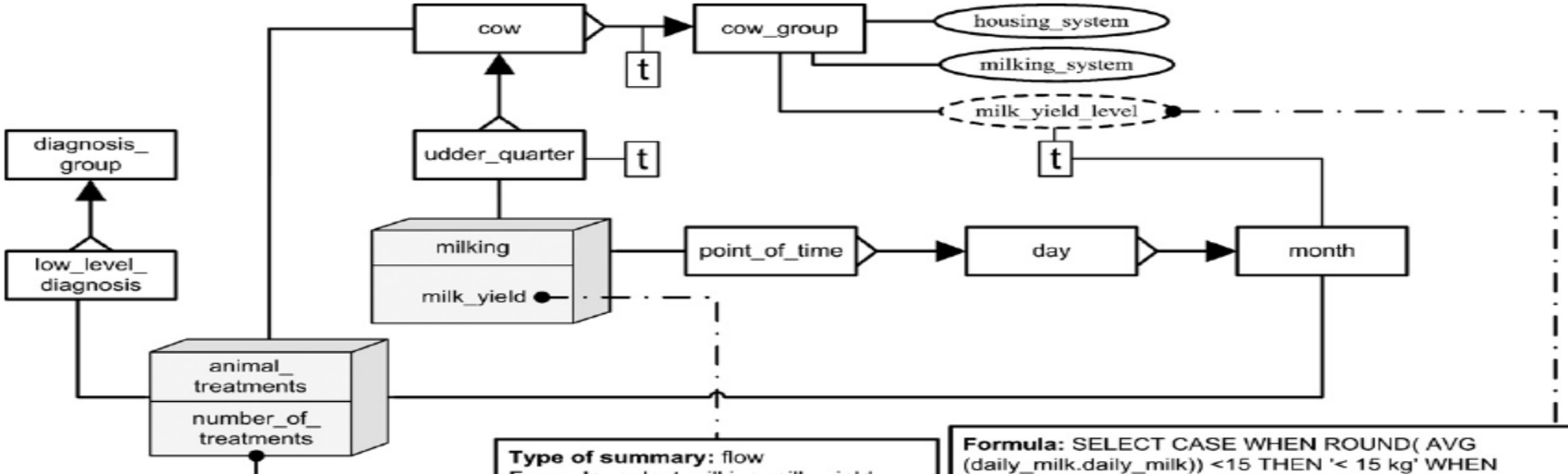
mE/RM of application scenario



Type of summary: flow
Formula: select milking.milk_yield from milking;
Meaning: Milk yield per udder quarter and milking
Unit of measurement: kg

Type of summary: flow
Formula: SELECT cow_no, diagnosis, month, sum(number_of_treatments) AS number_of_treatments FROM (SELECT animal_treatment.cow_no AS cow_no, animal_treatment.diagnosis AS diagnosis, (date_part('year', animal_treatment.point_of_time)|| '-' || date_part('month', animal_treatment.point_of_time)) AS month, count(animal_treatment.*) AS number_of_treatments FROM animal_treatment GROUP BY animal_treatment.cow_no, animal_treatment.diagnosis, month UNION SELECT udder_quarter_treatment.cow_no AS cow_no, udder_quarter_treatment.diagnosis AS diagnosis, (date_part('year', udder_quarter_treatment.point_of_time)|| '-' || date_part('month', udder_quarter_treatment.point_of_time)) AS month, count(udder_quarter_treatment.*) AS number_of_treatments FROM udder_quarter_treatment GROUP BY udder_quarter_treatment.cow_no, udder_quarter_treatment.diagnosis, month) AS treatment_union GROUP BY cow_no, diagnosis, month;
Meaning: number of treatments per cow, month and diagnosis
Unit of measurement: -

Formula: SELECT CASE WHEN ROUND(AVG (daily_milk.daily_milk)) <15 THEN '< 15 kg' WHEN ROUND(AVG (daily_milk.daily_milk)) >= 16 AND ROUND(AVG (daily_milk.daily_milk))< 25 THEN '16 - 25 kg' WHEN ROUND(AVG (daily_milk.daily_milk)) >= 26 AND ROUND(AVG (daily_milk.daily_milk))< 35 THEN '26 - 35 kg' WHEN ROUND(AVG (daily_milk.daily_milk)) >= 36 AND ROUND(AVG (daily_milk.daily_milk))< 45 THEN '36 - 45 kg' WHEN ROUND(AVG (daily_milk.daily_milk)) >= 46 THEN '> 46 kg' END AS milk_yield_level FROM (SELECT cow_no, sum(milk_yield) AS daily_milk, (date_part('year', milking.point_of_time)|| '-' || date_part('month', milking.point_of_time) || '-' || date_part('day', milking.point_of_time)) AS day, (date_part('year', milking.point_of_time)|| '-' || date_part('month', milking.point_of_time)) AS month FROM milking GROUP BY cow_no, day, month) AS daily_milk, cow_within_group WHERE daily_milk.cow_no = cow_within_group.cow_no AND daily_milk.day >= cow_within_group.valid_from AND daily_milk.day <= cow_within_group.valid_to AND daily_milk.month = (date_part('year', current_date - interval '1 month') ||'-'|| date_part('month', current_date - interval '1 month')) AND cow_within_group.group_name = cow_group.group_name
Meaning: level of milk yield per group and month as averaged milk yield per cow and day
Unit of measurement: -

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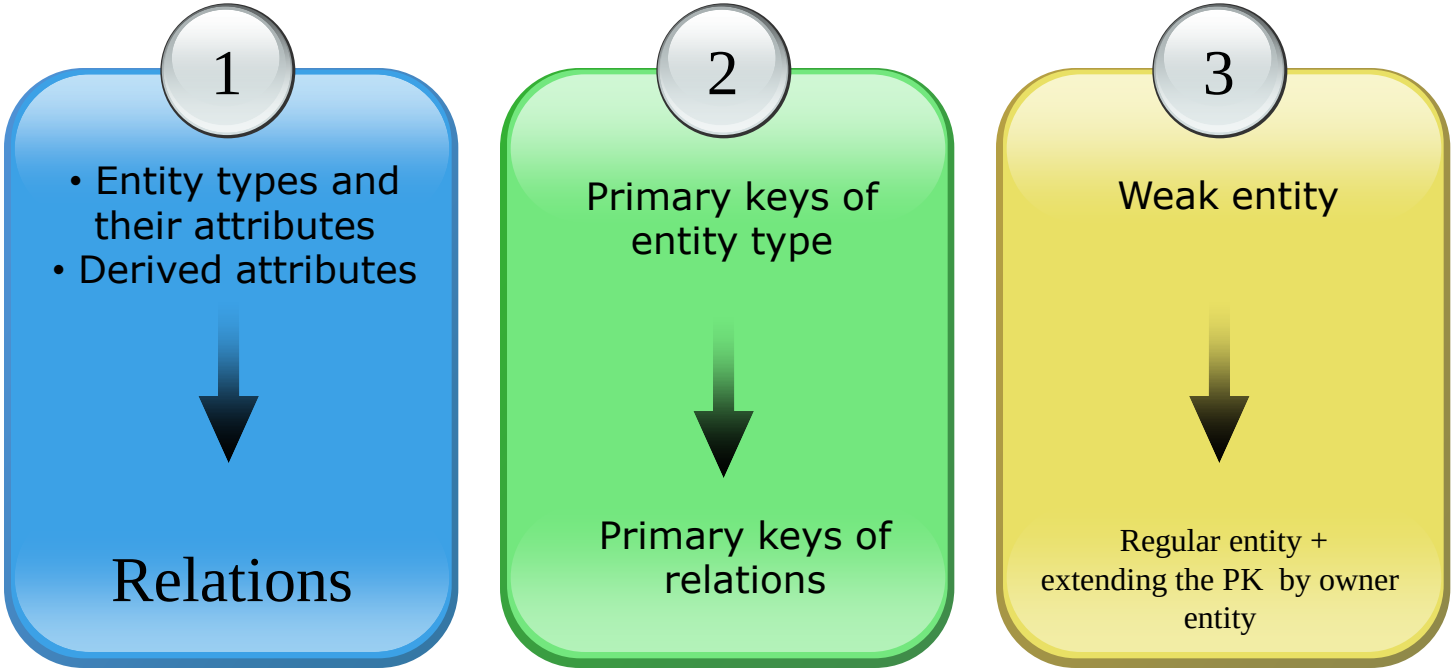
E/RM to the relational model transformation



mE/RM to the relational model transformation

1

Dimension

- One relation for every dimension level
- FK for the parent dimension in every relation,
- dimensional attributes as attributes of relation

2

Fact relationship

- Relations according to measures
- FK as lowest granularity PK

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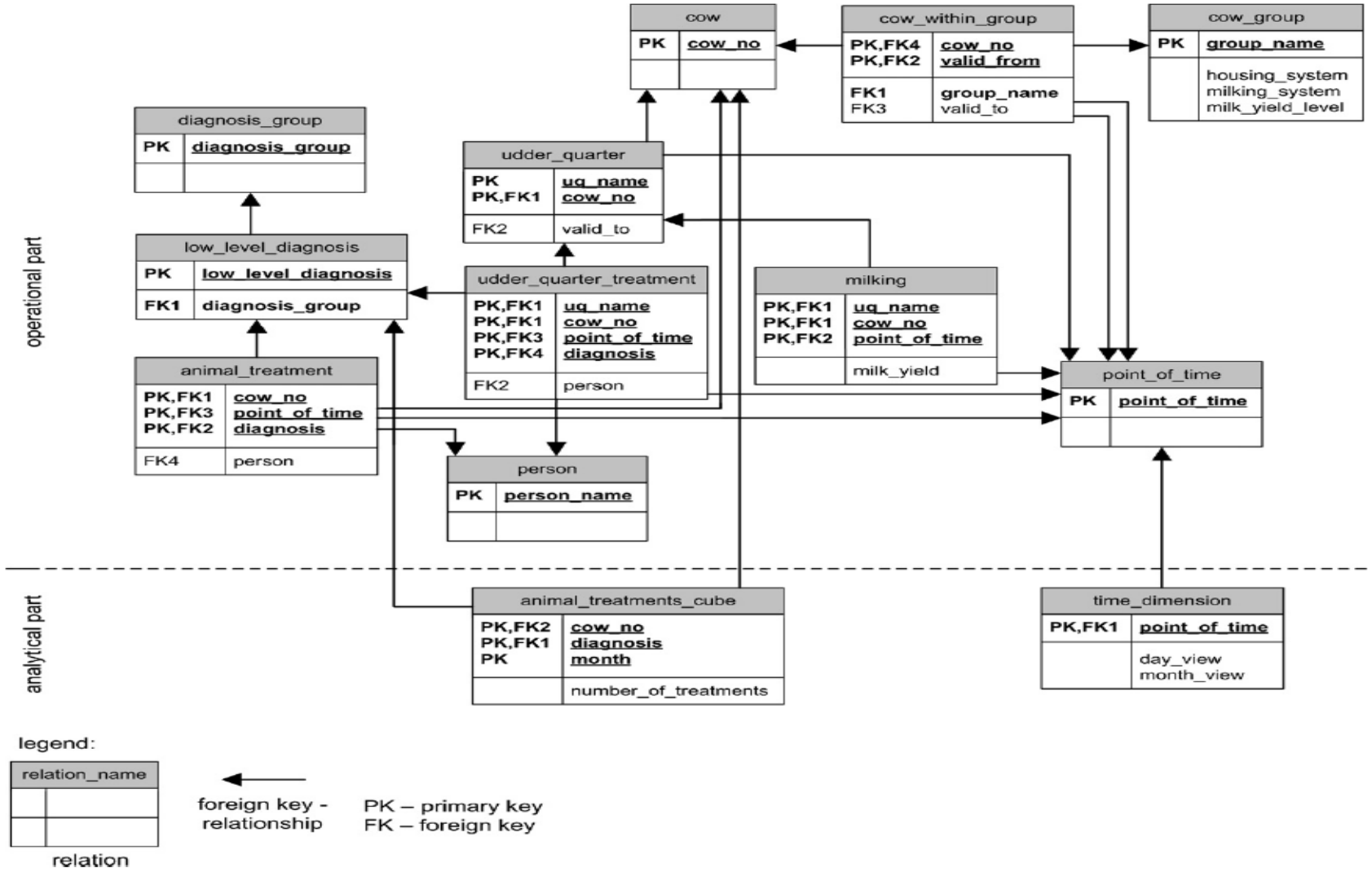
Relational Implementation



Functional Implementation

```
CREATE VIEW animal_treatment_cube AS
   SELECT    cow_no,
             diagnosis,
             treatment_union.month,
             sum(number_of_treatments) AS number_of_treatments
   FROM (SELECT animal_treatment.cow_no AS cow_no,
                animal_treatment.diagnosis AS diagnosis,
                (date_part('year', animal_treatment.point_of_time)|| '-' || date_part('month',
                 animal_treatment.point_of_time)) AS month,
                count(animal_treatment.*) AS number_of_treatments
           FROM animal_treatment
           GROUP BY animal_treatment.cow_no, animal_treatment.diagnosis, month
        UNION
        SELECT    udder_quarter_treatment.cow_no AS cow_no,
                  udder_quarter_treatment.diagnosis AS diagnosis,
                  (date_part('year', udder_quarter_treatment.point_of_time)|| '-' ||
                  date_part('month', udder_quarter_treatment.point_of_time)) AS month,
                  count(udder_quarter_treatment.*) AS number_of_treatments
           FROM udder_quarter_treatment
           GROUP BY    udder_quarter_treatment.cow_no,
                       udder_quarter_treatment.diagnosis, month
   ) AS treatment_union
   GROUP BY cow_no, diagnosis, month;
```

Results

- Hybrid/shared logical model
- Co-design of opertaional and analytical views
- Non-redundancy at schema level
- PostgreSQL implementation
  - Views
  - Materialised views
- Enterprise comparison

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Relation to our project- LandIT

- Modelling livestock (PDF) data for pig stables and poultry farms
- In our case an already existing opertaional data model
- Interesting to explore the shared model idea

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Evaluation

Pros –

- Easily understandable
- Illustrative
- A noble idea
- Generalizable to other domains

Cons –

- A bit loose and lengthy
- Extra implementation details (SQL script)
- Not evaluating the way of shared physical implentation
- Web examples not in English

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Thank You !