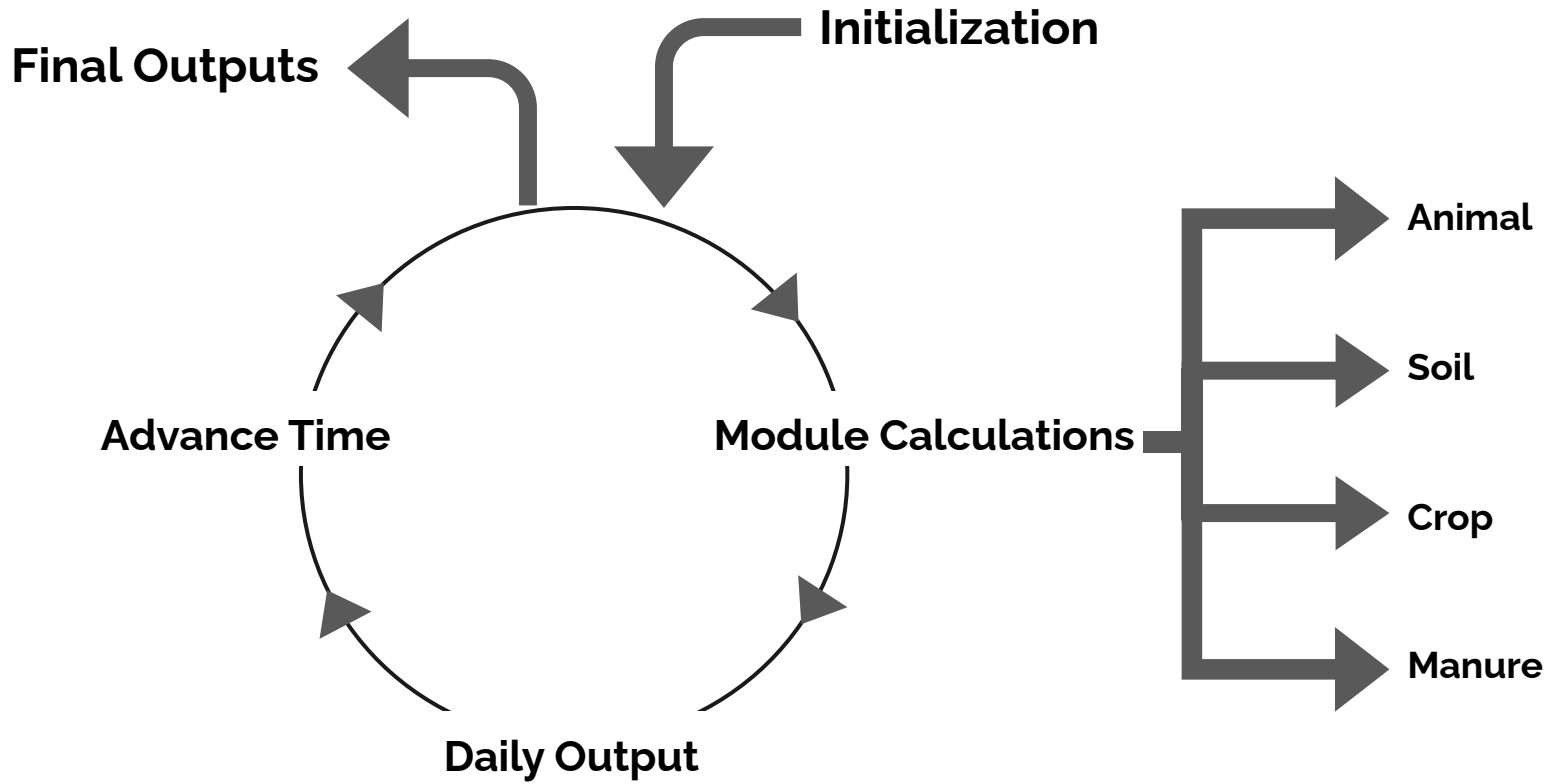# RuFaS: Restructuring the Animal Module

Militsa Sotirova
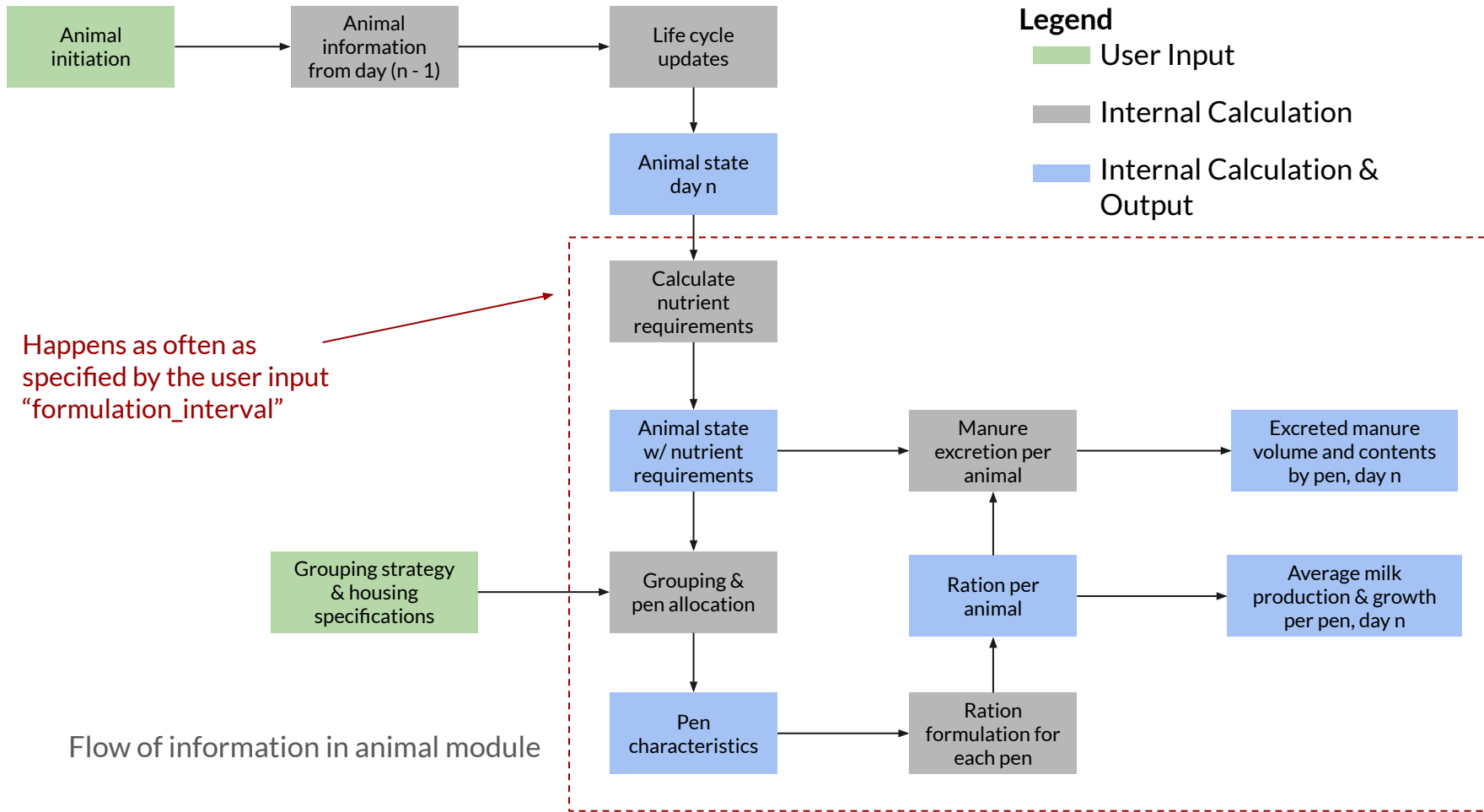
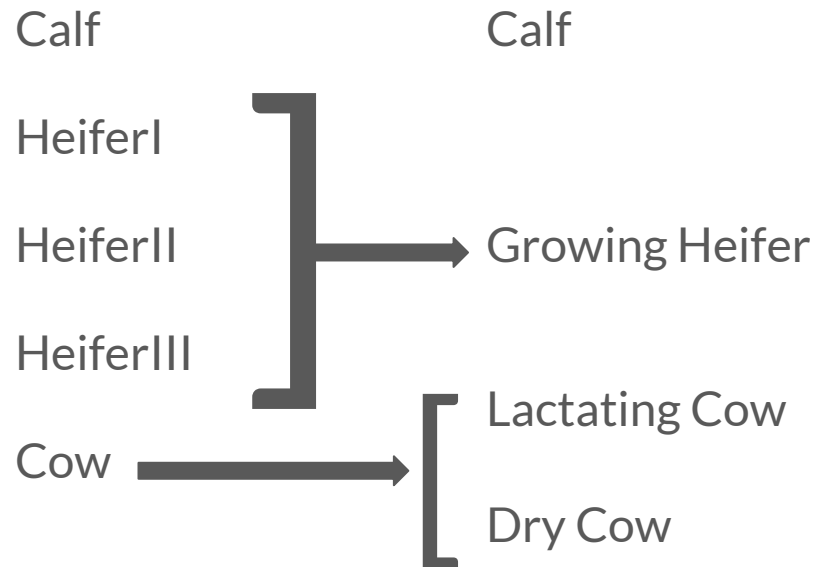Visual showing RuFaS's overall structure

Animal Module

- **Animal Management** - controls animal routines and keeps track of all animals and pens
- **Life Cycle** - manages the life cycles of animals
- **Manure** - defines manure excretion calculations
- **Ration** - defines ration formulation calculations

Flow of information in animal module

Legend
- User Input
- Internal Calculation
- Internal Calculation & Output

Animal initiation → Animal information from day (n - 1) → Life cycle updates → Animal state day n

Happens as often as specified by the user input "formulation_interval" → Calculate nutrient requirements

Animal state w/ nutrient requirements

Grouping strategy & housing specifications → Grouping & pen allocation

Pen characteristics → Ration formulation for each pen → Ration per animal → Manure excretion per animal → Excreted manure volume and contents by pen, day n

Ration per animal → Average milk production & growth per pen, day n

Classes of Animals

Calf

HeiferI

HeiferII → Growing Heifer

HeiferIII

Cow → Lactating Cow

Dry Cow

Calf

New Input Specifications

"herd_information":
{

        "calf_num": 160,
        "heiferI_num": 800,
        "heiferII_num": 820,
        "heiferIII_num": 50,
        "cow_num": 1000,
        "replace_num": 5000,
        "herd_num": 1000
}

"animal_config":
{

        "cow_times_milked_per_day": 1,
        "still_birth_rate": 0.065,
        "birth_weight_avg_je": 35.2,
        "wean_day": 60,
        ...
}

"pen_information":
{

        "pen0":
        {

                "id": 0,
                "vertical_dist_to_milking_parlor": 5,
                "horizontal_dist_to_milking_parlor": 5,
                "number_of_stalls": 100,
                "housing_type": "open air barn",
                "bedding_type": "sand",
                "pen_type": "freestall"
        },
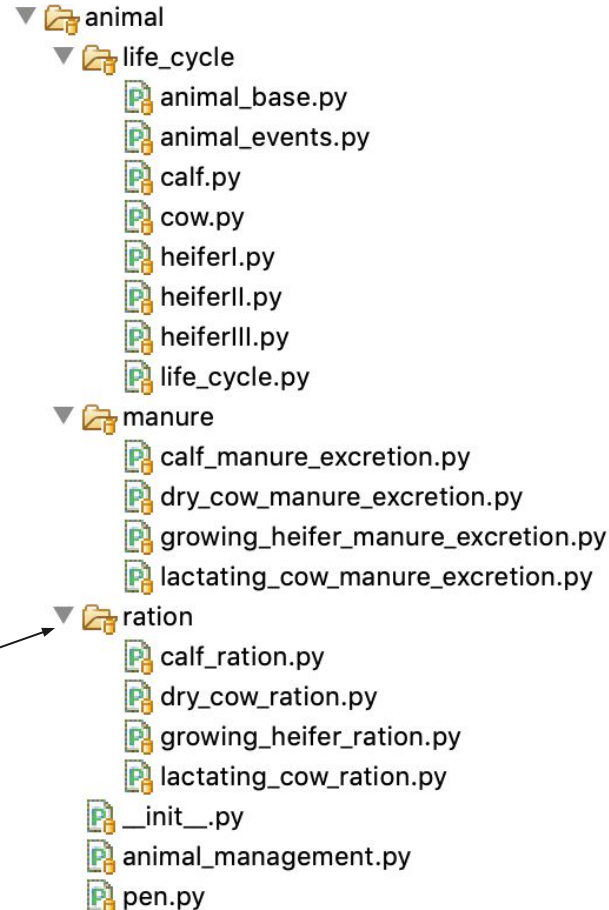   "pen1":
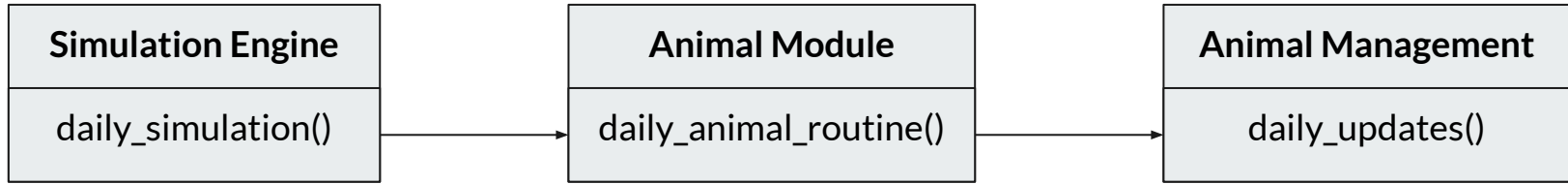   {
        ...
        },
        ...
}

Structure of information in animal module

File Structure

Each file contains both nutrient requirement calculations and linear optimizations for the respective animal group.

```
▼ 📂 animal
    ▼ 📂 life_cycle
         📄 animal_base.py
         📄 animal_events.py
         📄 calf.py
         📄 cow.py
         📄 heiferI.py
         📄 heiferII.py
         📄 heiferIII.py
         📄 life_cycle.py
    ▼ 📂 manure
         📄 calf_manure_excretion.py
         📄 dry_cow_manure_excretion.py
         📄 growing_heifer_manure_excretion.py
         📄 lactating_cow_manure_excretion.py
    ▼ 📂 ration
         📄 calf_ration.py
         📄 dry_cow_ration.py
         📄 growing_heifer_ration.py
         📄 lactating_cow_ration.py
    📄 __init__.py
    📄 animal_management.py
    📄 pen.py
```

```
┌─────────────────────────┐        ┌─────────────────────────┐        ┌─────────────────────────┐
│   Simulation Engine     │        │     Animal Module       │        │   Animal Management     │
├─────────────────────────┤        ├─────────────────────────┤        ├─────────────────────────┤
│   daily_simulation()    │──────→ │  daily_animal_routine() │──────→ │     daily_updates()     │
└─────────────────────────┘        └─────────────────────────┘        └─────────────────────────┘
```

self.life_cycle_manager.daily_update()

if *self*.end_ration_interval():
        self.calc_nutrient_rqmts()
        self.clear_pens()
        self.pen_allocation()
        self.calc_avg_nutrient_rqmts()
        self.calc_ration()
        self.calc_manure_excretion()
        self.calc_avg_growth()

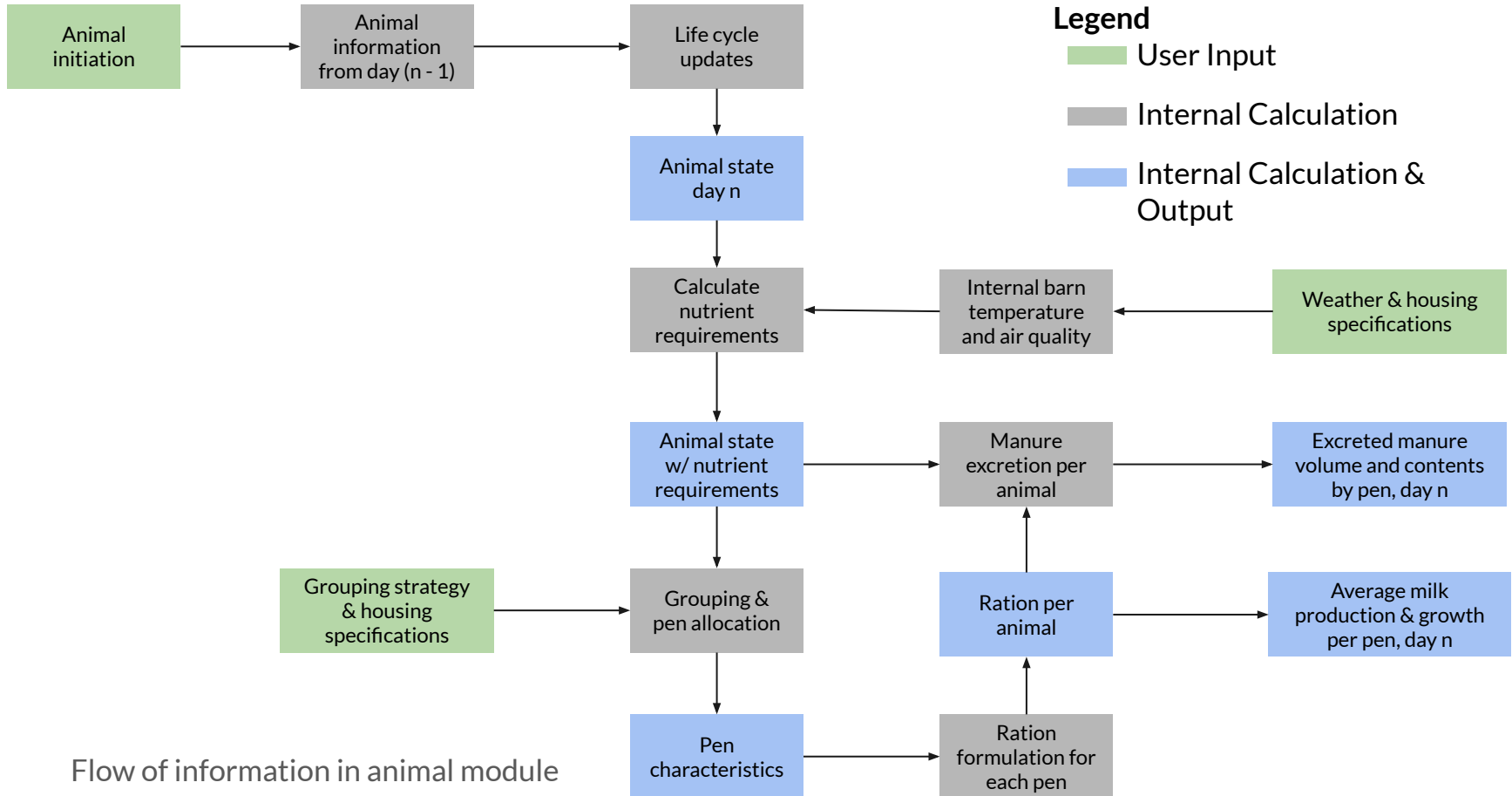Tracing the daily animal method calls in simulation

Demonstration

Future goals

- Implement ration and manure for the other animal groups
- Develop pen allocation algorithm
- Add environmental factors into nutrient requirement calculations
- Testing with data from a farm & analyze results

Flow of information in animal module

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Thank you!