A framework to model the diversity of reproduction strategies in ruminant livestock farms: application to dairy herds

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Context

Reproduction management

a key aspect of the operation of livestock farming systems

- A large ***diversity of reproduction strategies*** :
  - Technical project, number of reproductive sessions, targeted parturition rate / year, culling flexibility (Tichit and al, 2004),
  - Various managements of infertility (culled, sorted to another batch reproduction session, in dairy cows or goats : possibilities of long lactation...)
  - recruitment and culling policy and importance of calendar constraints in reproduction management (Cournut and al., 2001 and 2005)
- Few ***livestock farming system models*** are able to represent a wide range of reproduction strategies

Objective

- A generic representation framework of the reproduction strategy, able to connect
  - the productive behaviour of animals in the short and medium term
  - to the management of the reproduction and the replacement of the herd
  - the combination over time of diverse female productive trajectories

- In order to describe the construction of the herd production and replacement dynamic (yearly calendar and pluriannual scales)

From conceptual representation to computer simulation : Aligot project

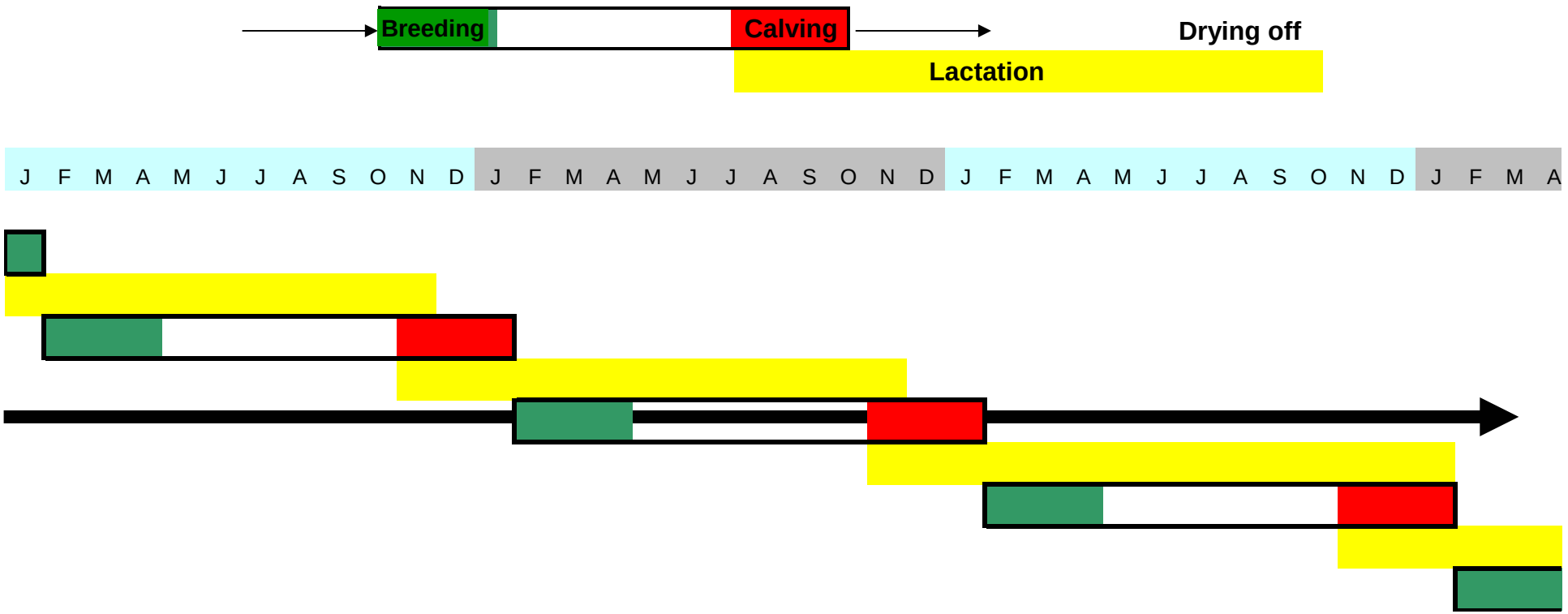
- Development of a formalism based on the use of temporal intervals to describe the dynamic of a livestock farming system
- Use of the « Allen algebra » as temporal logic (Allen 1983)
- Computer implementation of a rule-based model in Prolog (Pacaud and al, 2007))
- The isue : application to French dairy farm systems

  Control of work distribution, herd milk production curve, grass utilization and PDO products, direct selling initiatives

Preliminary illustrations in this paper

- The concepts
- Application of the framework to two opposing dairy herd reproduction systems
  - ***Grouped calvings*** in order to close the milking parlour for summer holidays : herd-based management of the reproduction with high calendar constraints
  - ***Spread calvings*** with individual and quite « tolerant » management of cow reproduction
- With :
  - description of the conceptualisation processus for the spread calvings system
  - Some elements of results obtained using the simulator in order to compare the two systems

To organise the linkage of production sessions
The batch production cycle (BPC)
breeding to calving



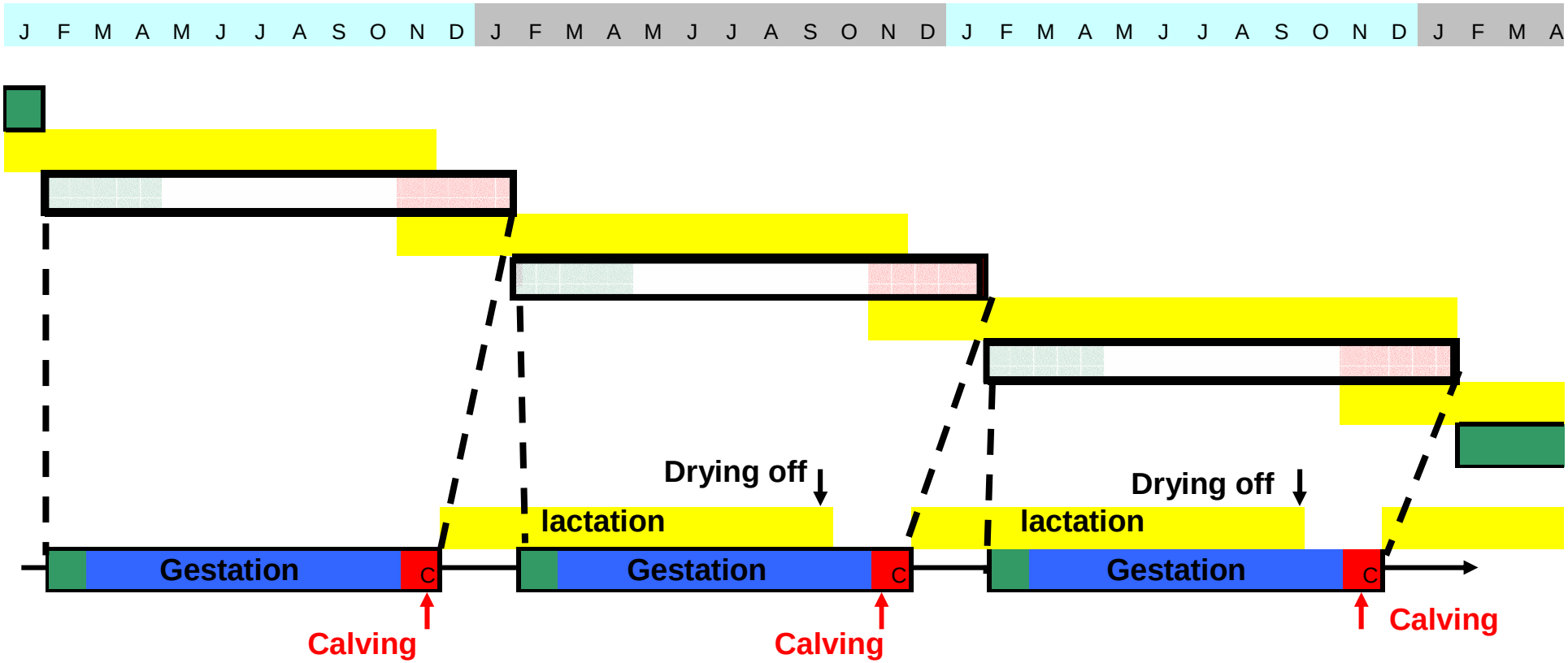
Functional batch : the cows that calve during summer

(from Cournut 2001 sheep)

To account for the connection between BPC linkage and each female production :

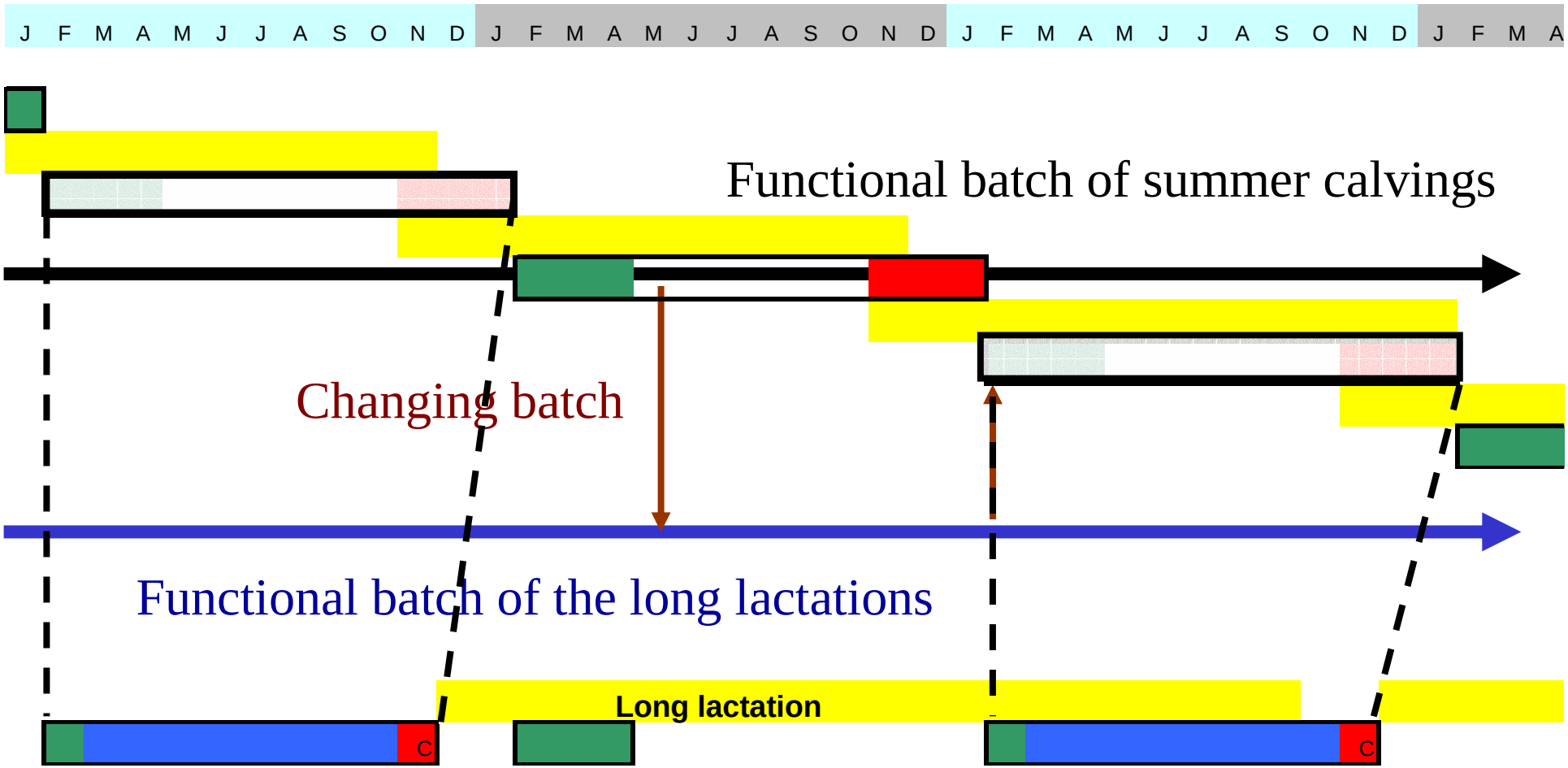
The productive trajectory

- Sequence of productive events of the female
- The path followed by this female through the successive BPC of the herd

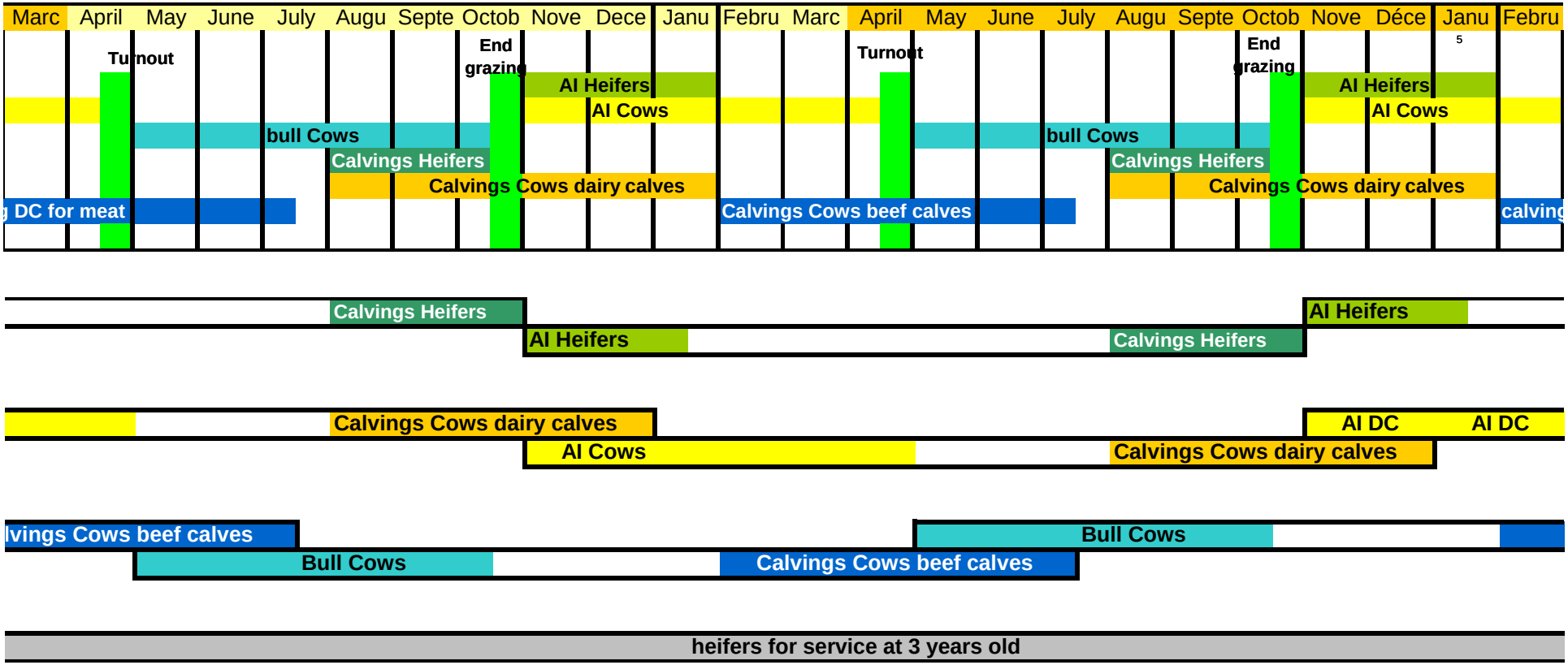


(from Cournut 2001 sheep)

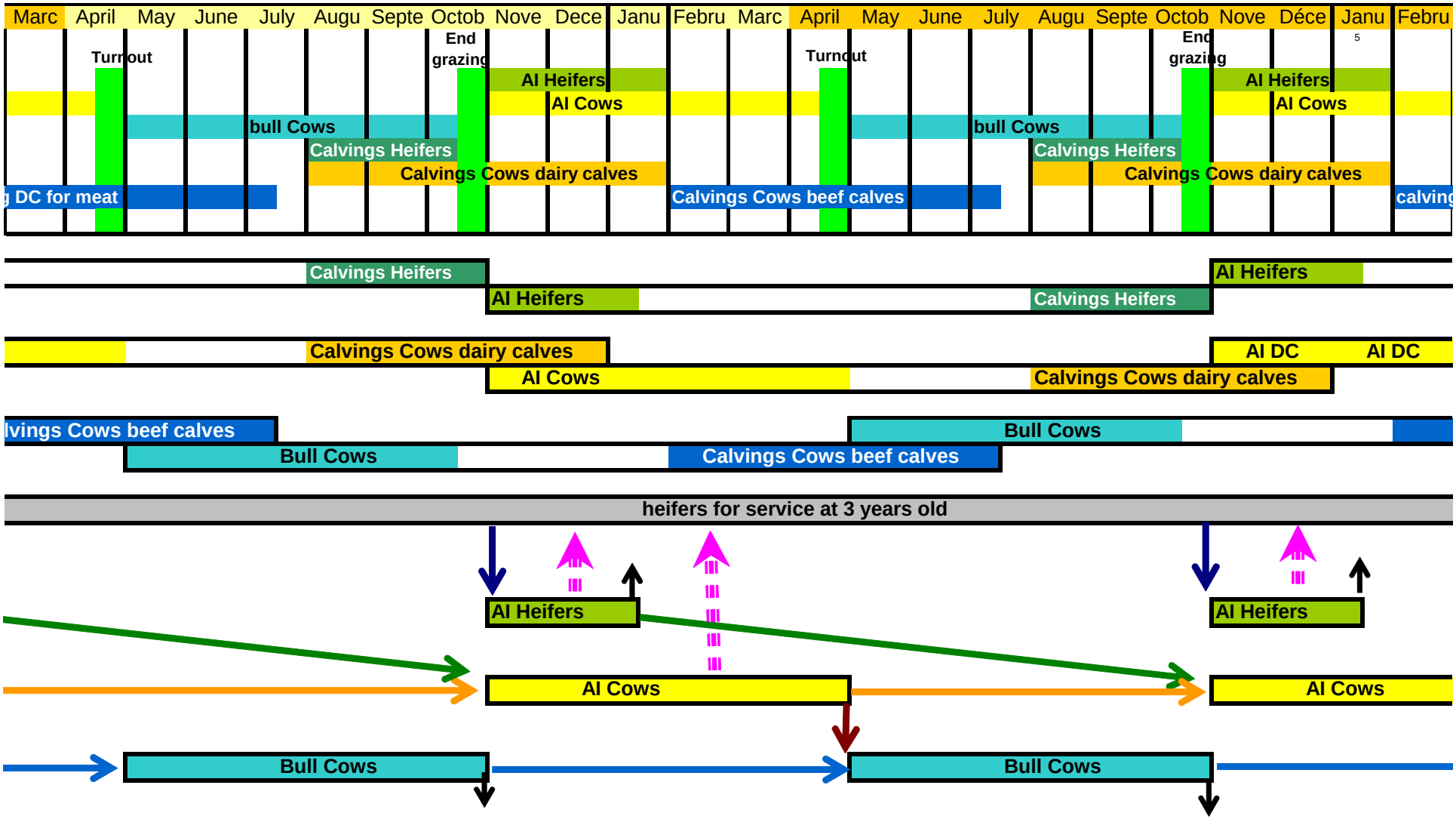
Long lactation management representation



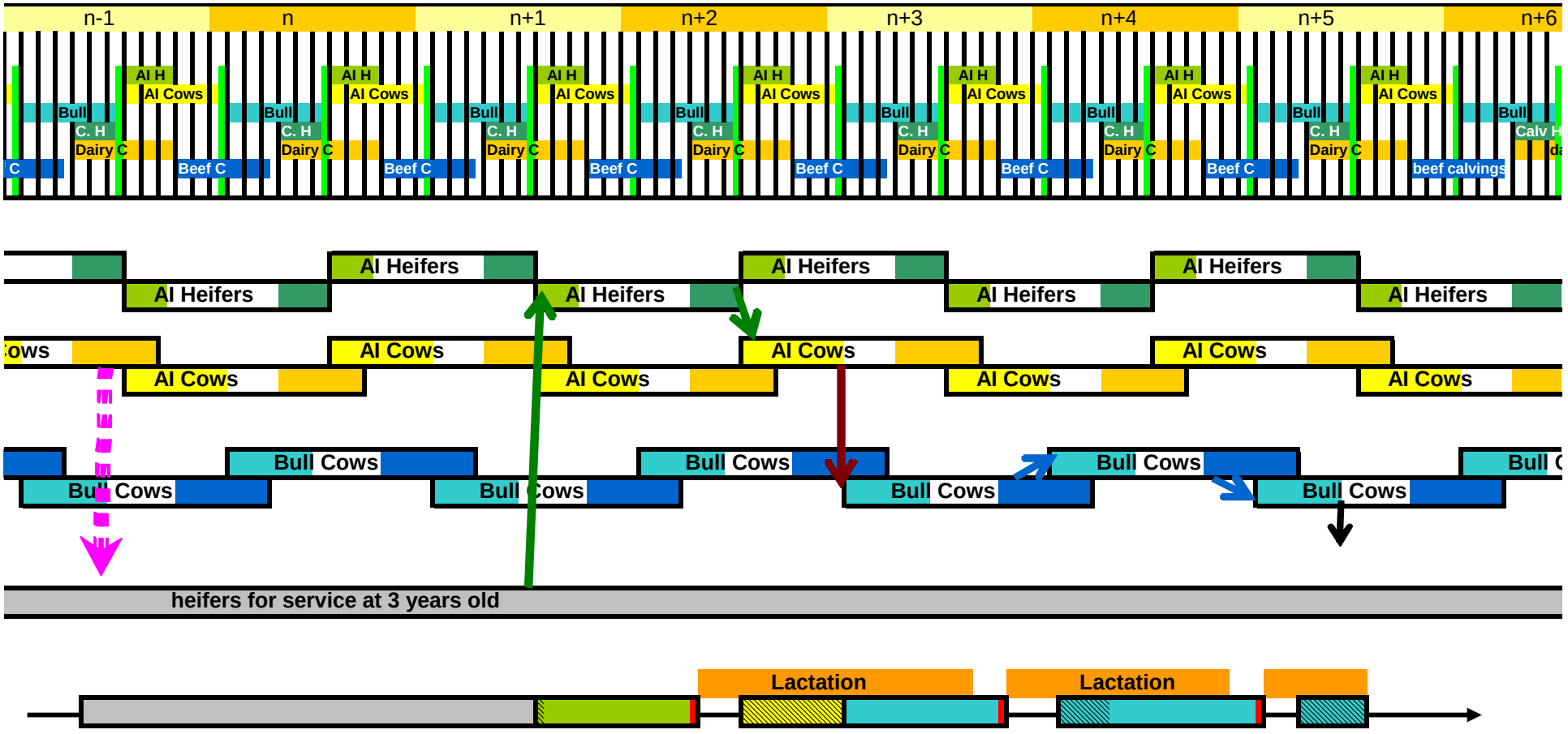
Framework application : which BPC and functional batches?



Which coordination between BPC ? How are reproduction and replacement combined?



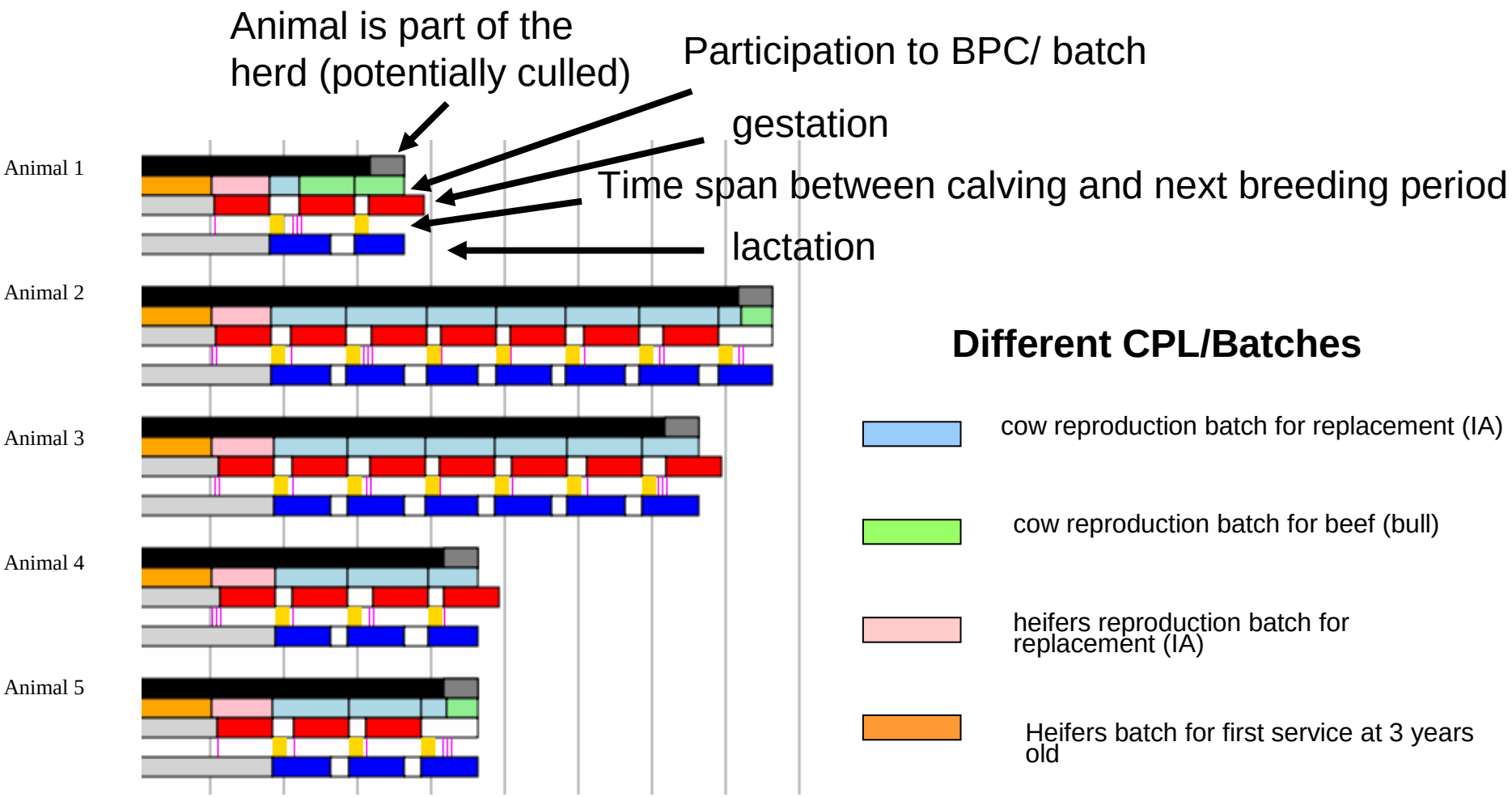
Can be represented as different paths through herd BPC



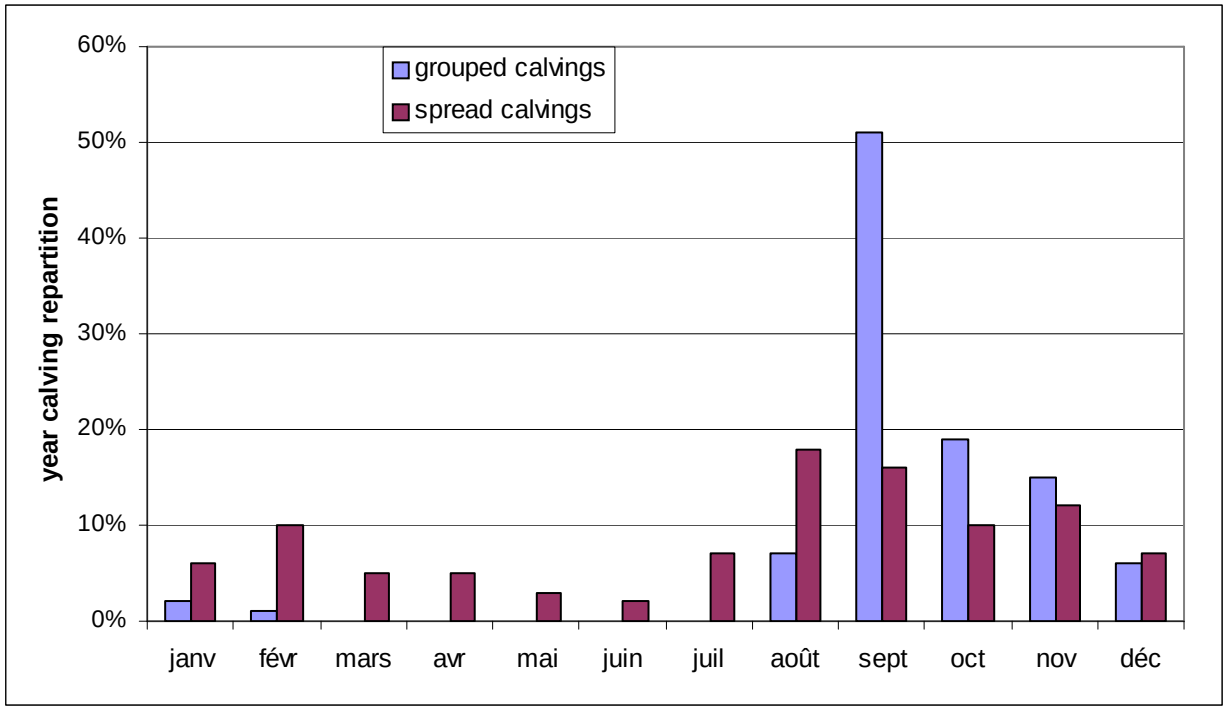
Use of the framework to read animal performances over some years

- To validate the conceptual representation of the reproduction management
- To analyse the exceptions and specify the conditional rules used by the farmer
- To identify the dynamic interactions between long term behaviour of the animals and management decisions

With Aligot platform : construction of diverse animal productive trajectories as succession of intervals

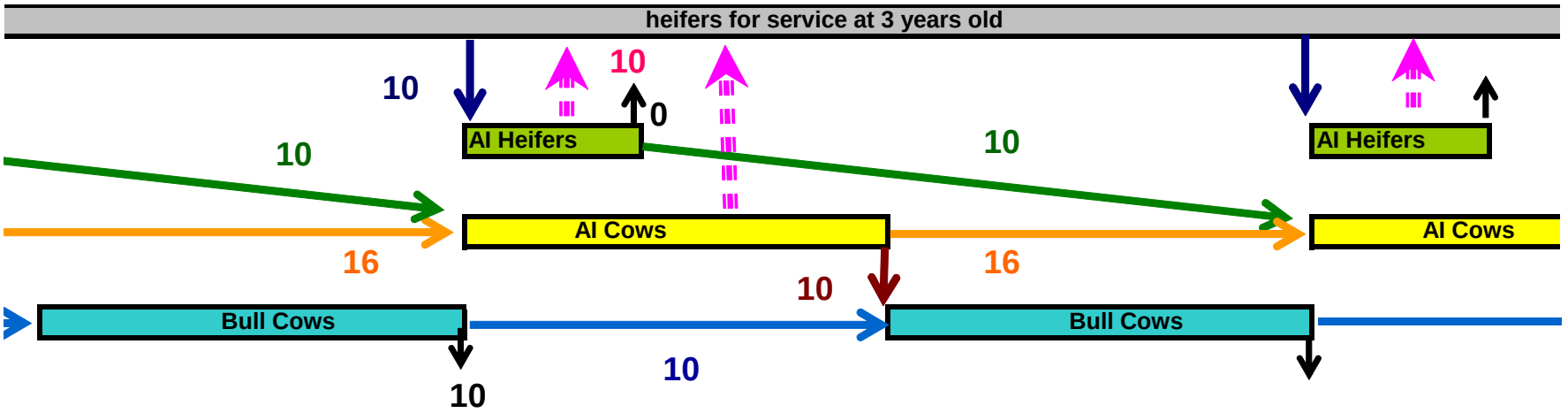


With Aligot platform : The building of herd calving distribution

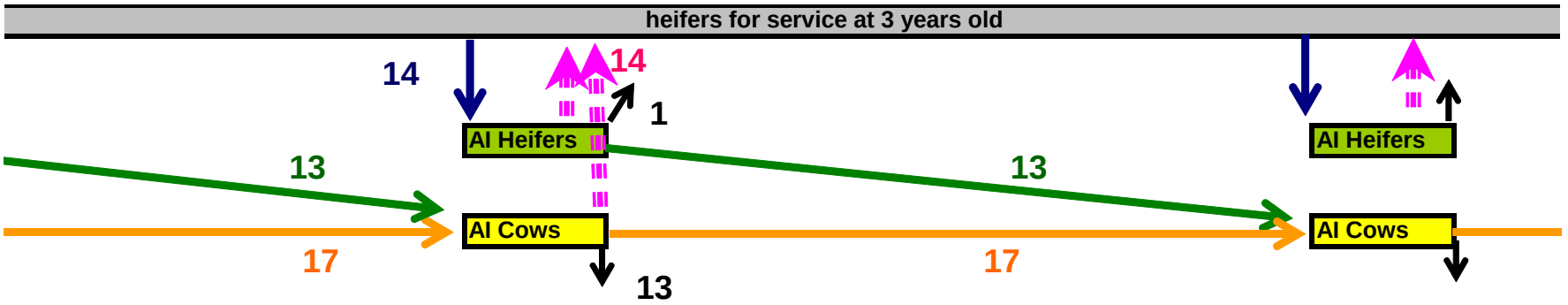


With Aligot platform : the inter BPC flow

•The spread calvings system



•The grouped calvings system



Conclusions

- This framework makes it possible to represent the diversity of reproduction management systems
- It gives priority to temporal dimensions (with intervals)
- Through the design of productive trajectories, it also combines decision rules with biotechnical dimensions on a long term time span,
- Further work is needed to improve the combination of this representation with lactation and reproduction biological models, while taking into account both animals' paths and associated feeding sequences for each functional batch of animals