Dairy Brain – Informing Decisions on Dairy Farms using Data Analytics

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(based on collaboration with A. Christensen and S. Wangen)

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Decision Support Tools

- Aim to exploit data streams from farm and other economic, health and agricultural sources
- Descriptive: Use collected information for reporting (financial and medical apps)
- Predictive: Apply models to forecast future events (weather and air quality apps)
- Prescriptive: Increase sophistication of analysis to evaluate which decisions lead to desired outcomes (resilient electricity dispatch, traffic routing)
- At single cow or farm level

Successful data analytics: some features

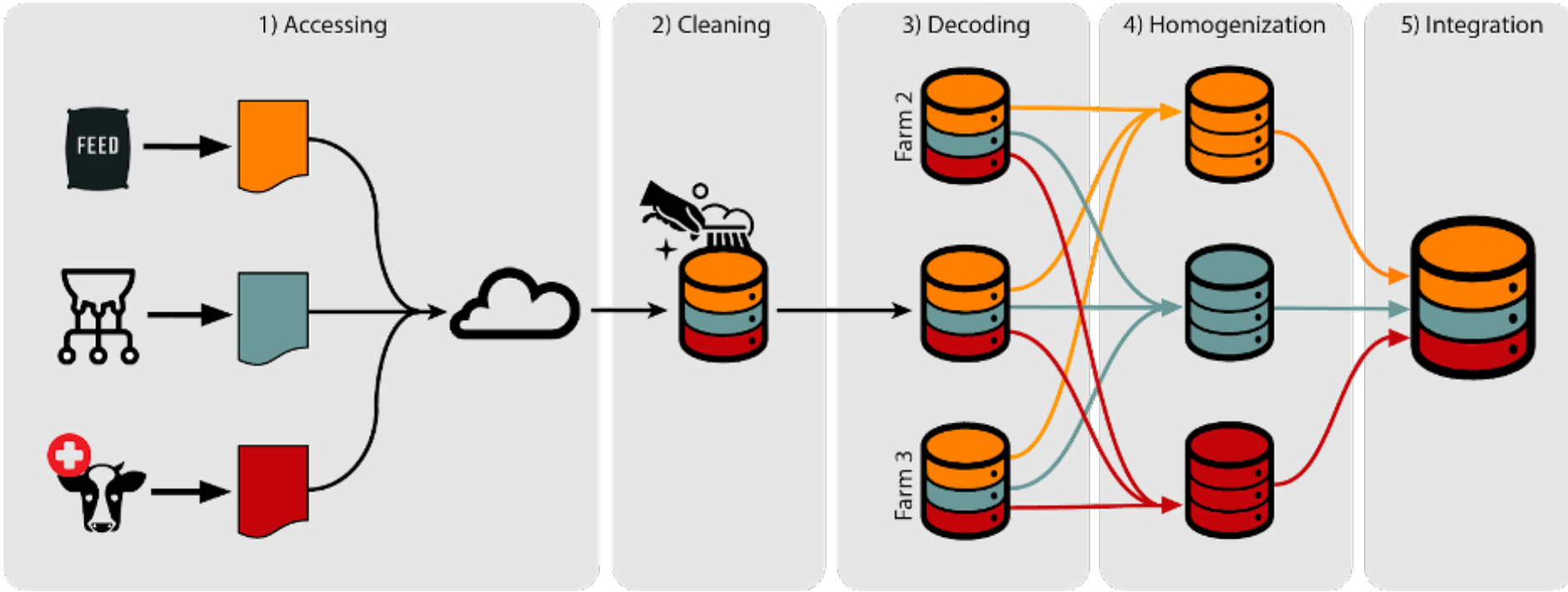
- Weather:
  - large scale, real time
  - open source/access
  - no private information (but apps that present information differently)
  - data provider is not the same as user
- Medical
  - shared/private information
  - multiple data types
  - recommender apps (diagnosis, treatments)
- Travel:
  - links different types of agents (drivers, riders, administrators)
  - real time, large scale
  - congestion pricing (public/summary information)
  - trips (private information)
  - required (user) inputs to generate specific user outputs
- Financial:
  - standards for interconnectivity (transfers)

All have reliable acquisition. Need to name things consistently.

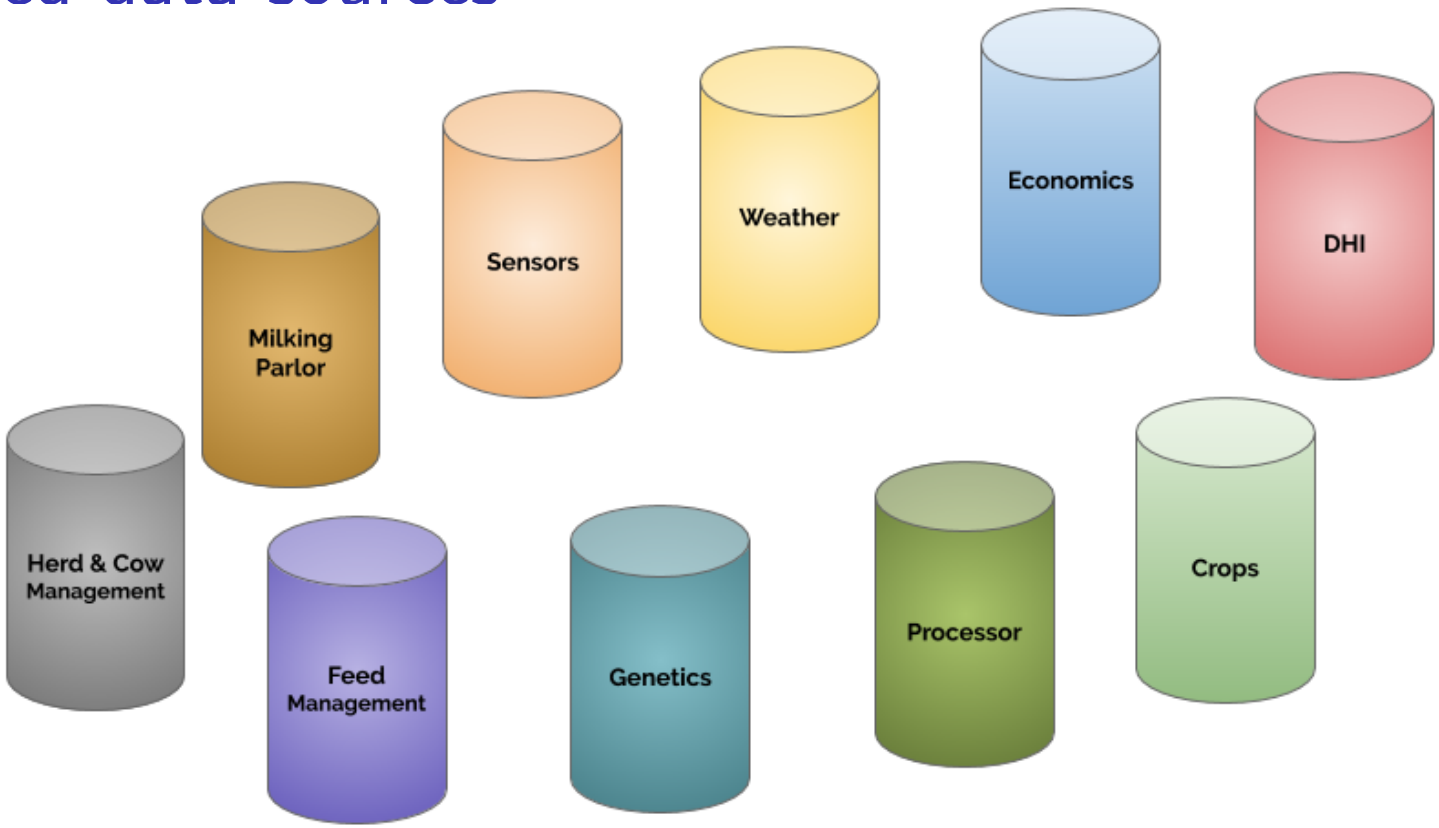
Issues regarding what to do for who?

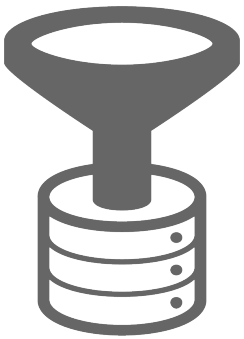
- Policy or individual farm?
- Operational (logistic, pen mgmt,) or strategic (capital expansion, pricing, culling)?
- When are decisions made: yearly, seasonal, daily, hourly?
- Inform human-in-the-loop decision making
- Ownership: whose data is it, after change/cleaning
- Privacy: who can see what and when
- Scale: the big data issue
- Missing data

The Data Setup



Monitored data sources

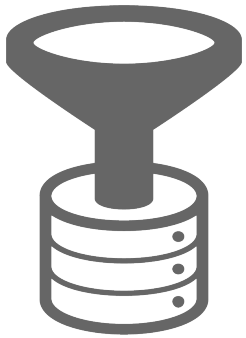




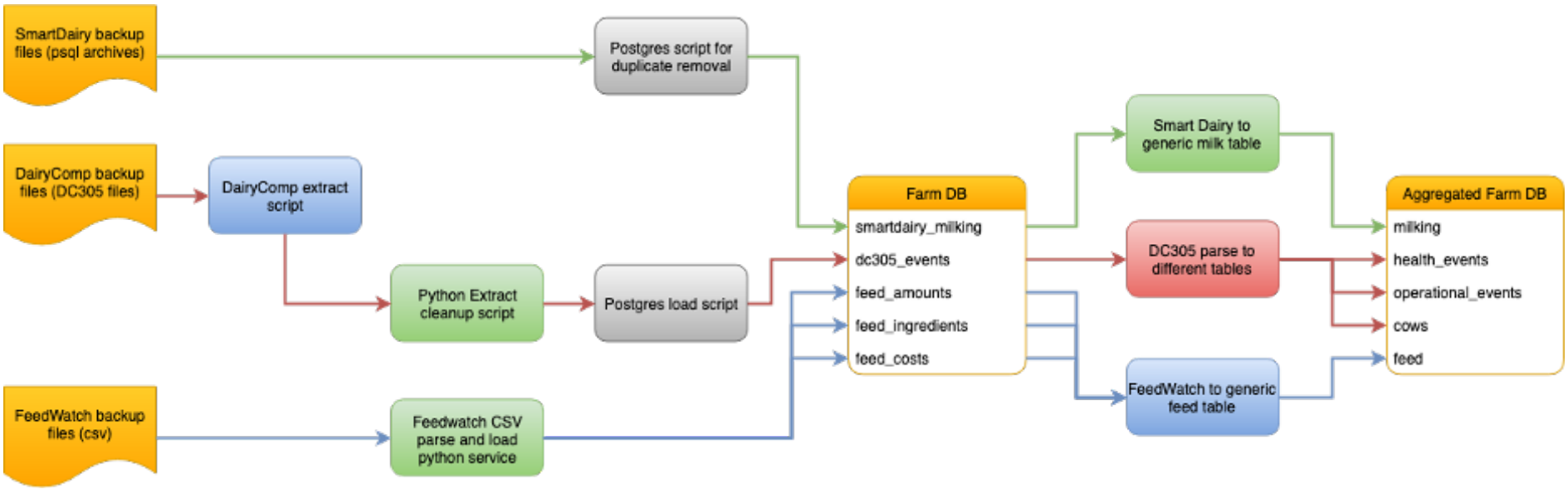
- Milk production
- Milk component analysis
- Milk spectral analysis
- Diet

- Activity
- Rumination
- Disease occurrence
- Management actions

Agricultural Data Hub (AgDH)



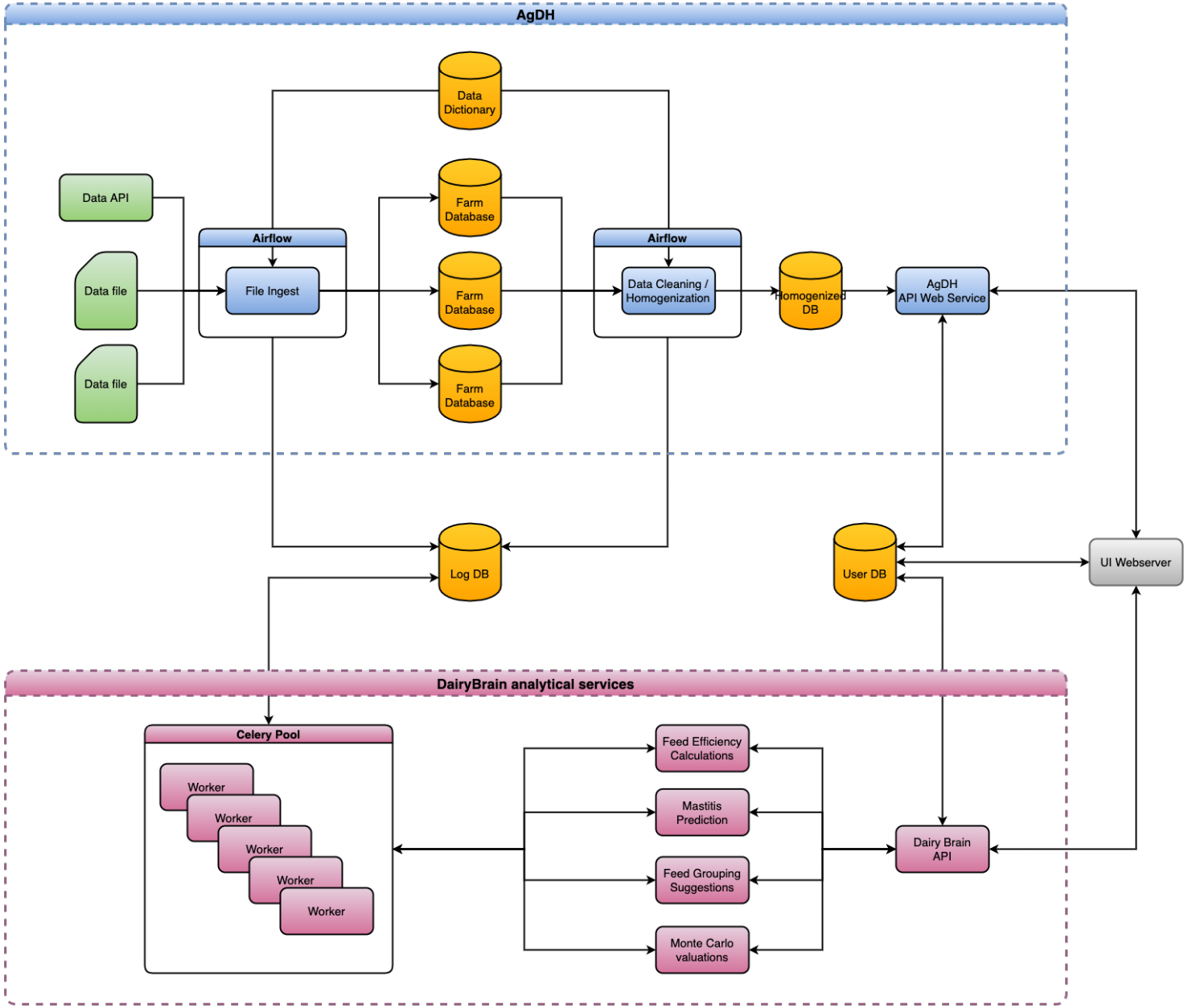
- Aggregate data from different sources
- Homogenize vendor-specific reporting
- Make data available for retrieval and analysis
- Entity matching (even for Cow ID)



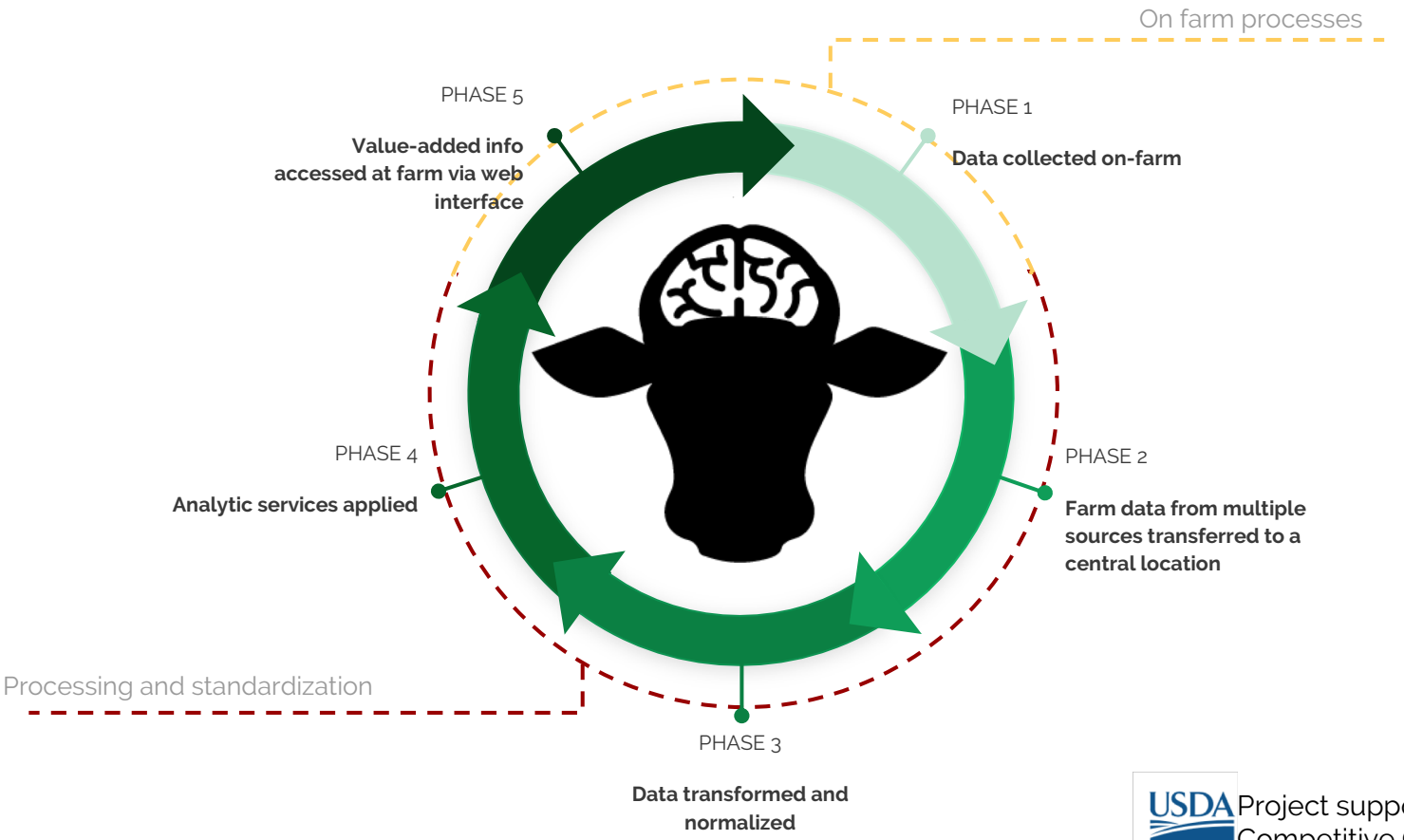
The model is only as good as the data

- Missing data: the norm rather than the exception (in farm data and many other settings)
- Unit-level (fail to take survey, handled via appropriate weighting) vs item non-response
- Listwise deletion (exclude whole item) or pairwise deletion (exclude only if missing in needed entry), mean imputation is ad-hoc, likely to be biassed and/or inefficient
- Newer and principled methods: multiple-imputation, full information maximum likelihood, expectation maximization, matrix completion (consider conditions under which missing data occurred, combine information with statistical assumptions)
- Database approach (dirty data): data cleaning via probabilistic inference, automatic repairs

Application Programming Interface (API) design



Dairy Brain - a continuous decision aiding engine



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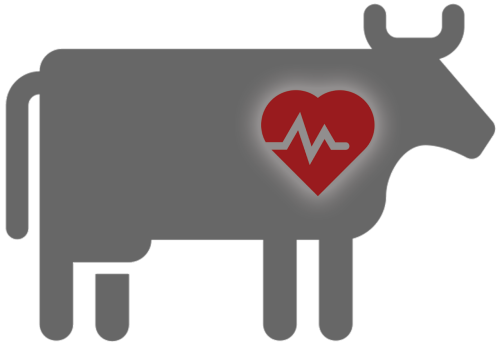
- Translate research outcomes to practical applications
- Provide access to analytical services to enhance operations

Cow health

- Early ketosis identification
- Monitoring the Risk of CM for 1st Lactation Heifers
- Early Prediction of Clinical Mastitis

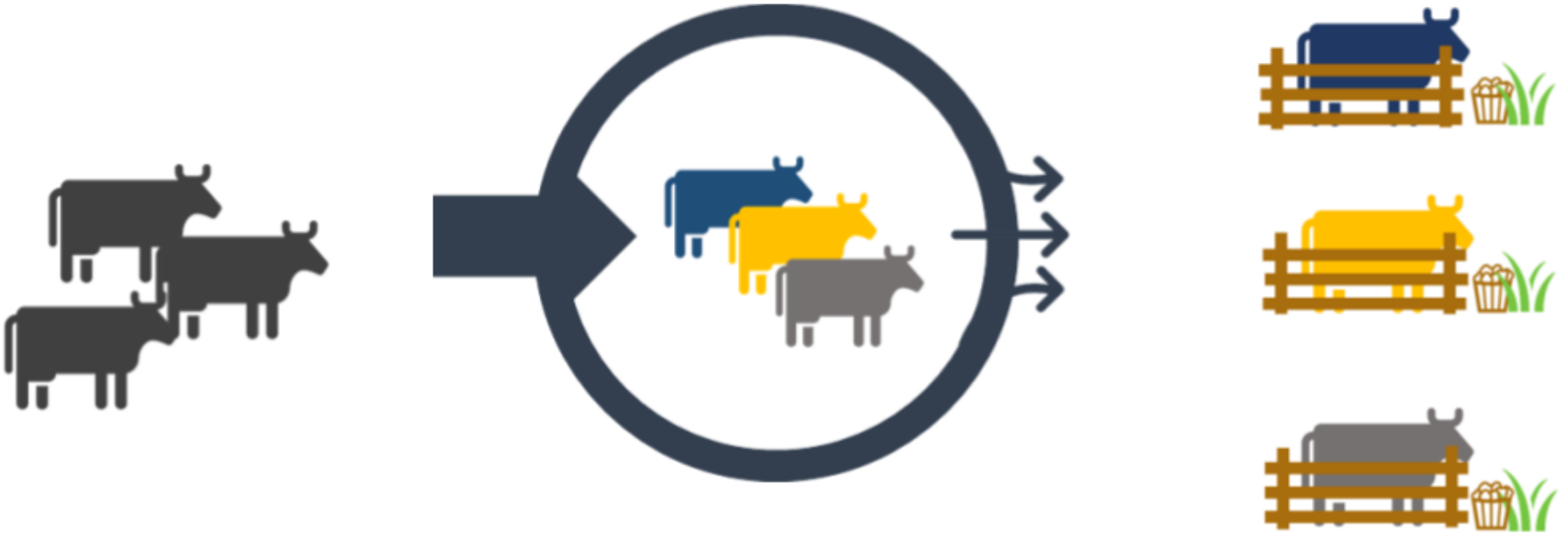


Nutritional grouping

Group of cows

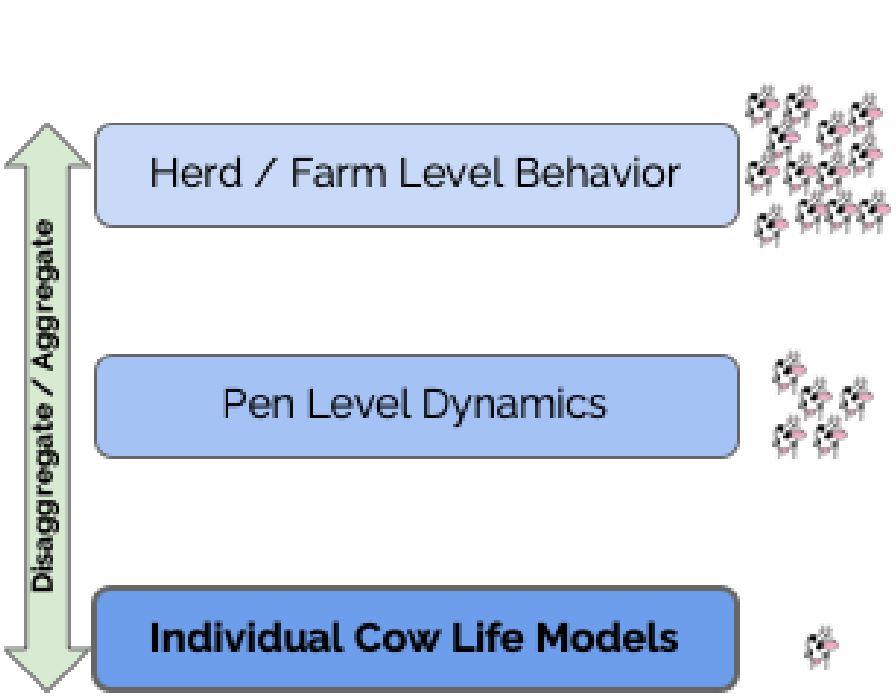
Cluster cows

Differentiated diet



Multiple applications at different scales

- Separately developed research products (as above)
- Connect via data and visualization APIs
- Utilize standard DS tools: feature selection, clustering, tensorflow, python, R, SQL, hadoop, deep learning, etc
- Conduit to translate research into (commercial) products



Scalable Decision Products

- Inter-farm performance comparisons
- Farm business performance evaluation
- Identify operational inefficiencies
- Cow group comparisons / optimization
- Sub-pen level cow movements / groups
- Individual cow valuation / herd expansion

Take home messages: Hoard's Dairyman (Feb-May 2020)

- Dairy Brain: Multiple data sources, multiple models (specialize to the question at hand)
- British proverb: Horses for courses (racehorse analogy)
- Establish a Coordinated Innovation Network (CIN)
- Ownership and security: Must determine data sharing policy/procedures
- Collection and communication: Must plan for missing data
- Farmer adoption: Must focus products/questions: be specific
- Business API's Must have API (standards) - think of this as bank transfers