Eagle Genomics

Microbiome Insights: Pioneering the Future of Precision Livestock Farming

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14th September 2023

Animal Microbiome Webinar

[Networking Microbiome Science]

eagle genomics

My journey

Cancer

University of East Anglia

CANCER RESEARCH UK

UNIVERSITY OF CAMBRIDGE

MANCHESTER 1824 The University of Manchester

UMDNJ University of Medicine & Dentistry of New Jersey

UNIVERSITÉ DE RENNES 1

EMBL

Scientist

Food & Nutrition

IFR Institute of Food Research

Exploring the relationship between food and health

Head of Business Development

Quadram Institute Science Health Food Innovation

Delivering healthier lives through innovation in gut health, microbiology and food

Head of Business Development

Microbiome

EnteroBiotix

Mastering the microbiome, transforming lives®

Chief Business Officer

COSMOSID Unlocking The Microbiome

Unlocking the microbiome

Director, Strategic Alliances

eagle genomics

Microbiome network science

Director, Microbiome Solutions

About Eagle Genomics

Deep Tech scale-up business in the TechBio space

- Driving the Bioeconomy through the digitization of science

Applying Microbiome Network Science

- Changing the face of One Health across various players in the ecosystem

Driving sustainable systems change

- Promoting and protecting the health of humans, animals and the environment

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- Award-winning AI-augmented knowledge discovery platform
- Leverages AI and network science, surfacing scientific connections and exploring multi-causal relationships

Challenges for future food production

Growing demand

- World population growth: 10 billions in 2050
- Increasing demd from developing countries

Limited resources

- >25% of food wasted in production, processing and consumption
- Water and arable land are becoming scarce resources

Lack of consumer trust

- Missing transparency in food production and processing
- Insufficient food safety in some region

Lack of integration along the value chain

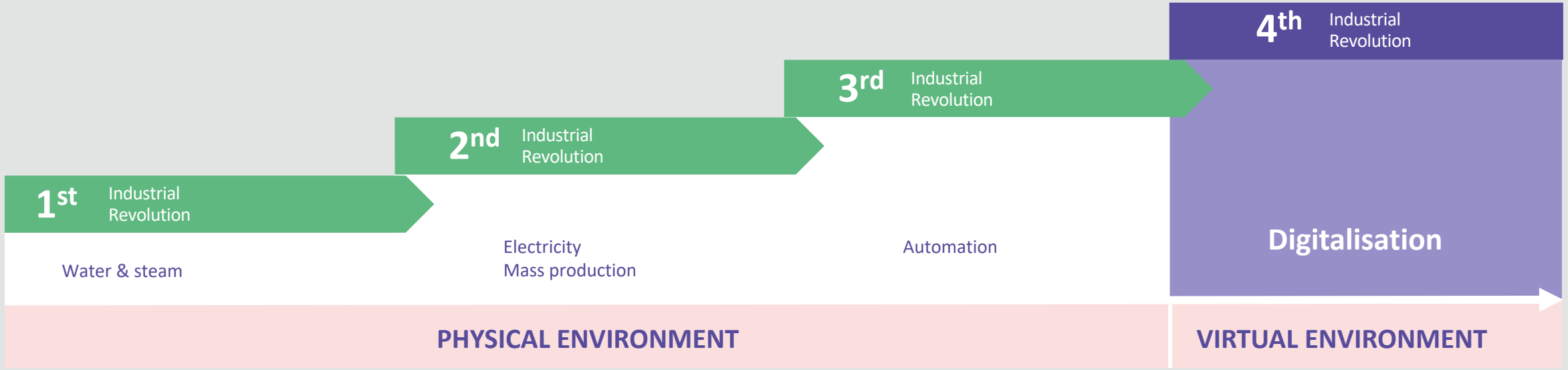
- Fragmented market

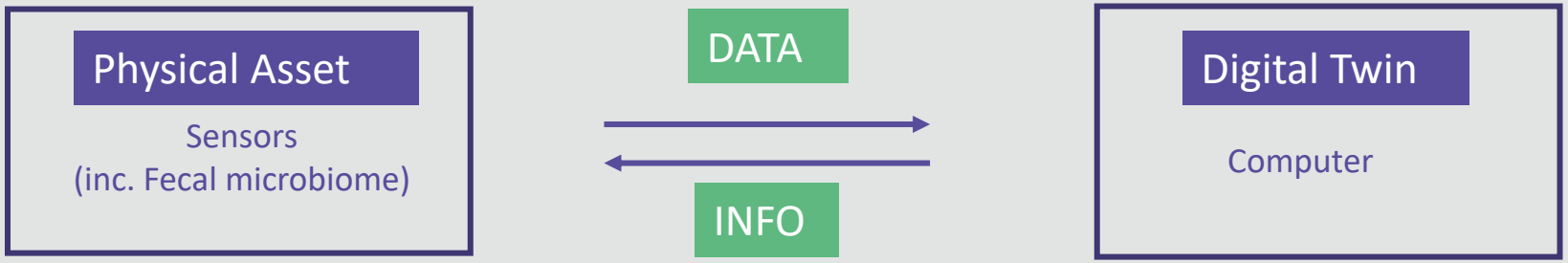
Food production and processing must become more ...

- **Efficient**
- **Sustainable**
- **Transparent**
- **Personalised**
- **Integrated**

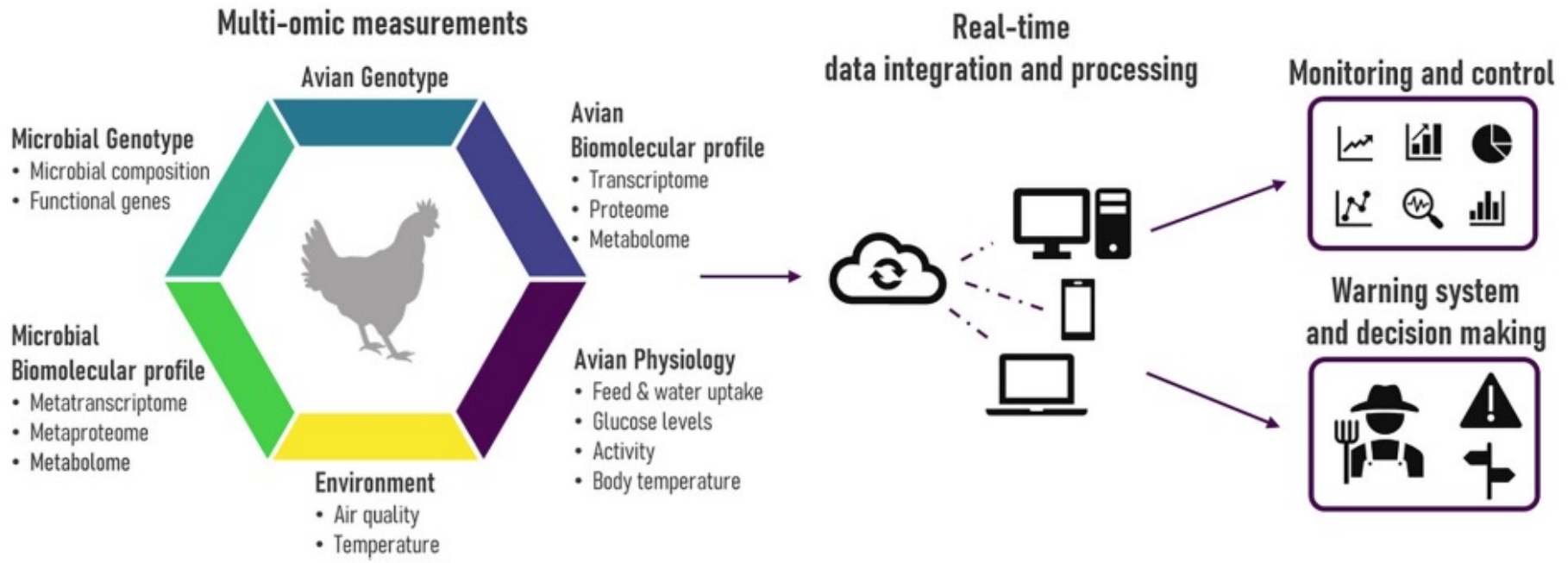
Animal Health & Welfare

From analog to digital





Future integration of multi-omics measurements



Goossens E, Dehau T, Ducatelle R, Van Immerseel F. Omics technologies in poultry health and productivity - part 2: future applications in the poultry industry. *Avian Pathol*. 2022;51(5):418-423.

Microbiota, Gut Health and Chicken Productivity

HOST FACTORS

Genetic background
- Bird species
- Type
- Breed
- Sex

Gut development and maturation
- Immune system
- Gut morphology
- Microbiota acquisition
- Gut region

ENVIRONMENTAL FACTORS

- Seasonal climate changes
- Geographical climate changes

FARM MANAGEMENT

Stress/Welfare
- Stocking density
- Temperature
- Photoperiod
- Ventilation
- Access to range

Health interventions
- Antibiotic growth promoters
- Therapeutic antibiotics
- Vaccination
- Probiotics / Prebiotics
- Plant bioactives

Litter management
- Litter components
- Humidity
- Reuse / Removal cycles

Feed management
- Feed access
- Water access
- Feed changes
- Feed quality

NUTRITION

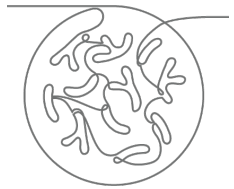
- Feed components
- Particle size
- Fiber source
- Protein source
- Micronutrients
- Enzymes

GUT HEALTH

- Nutrient assimilation
- Intestinal barrier integrity
- Immune response efficiency
- Inflammatory balance
- Susceptibility to enteric pathogens (E. coli, Salmonella, Campylobacter, C. perfringens)

LITTER MICROBIOTA

GUT MICROBIOTA

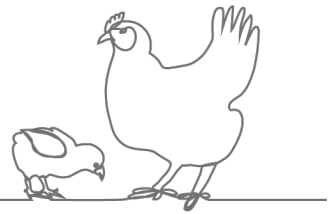


Functional output
- Production of SCFA
- Added metabolic potential
- Competitive exclusion of pathogens

Composition
- Richness of species
- Population structure and complexity
- Balance between commensal and detrimental microorganisms
- Competitive exclusion of pathogens

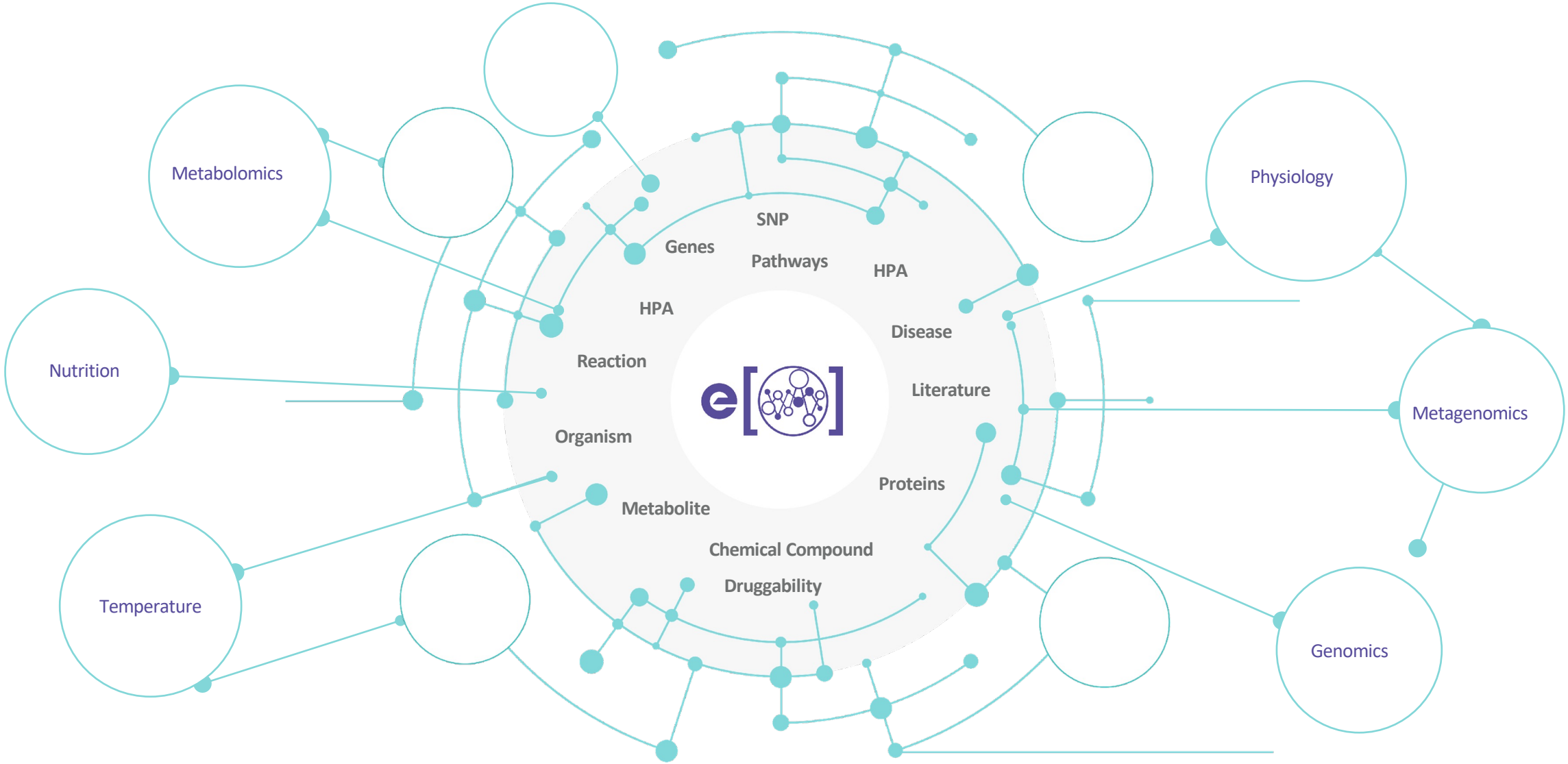
CHICKEN HEALTH & WELFARE

- Energy balance
- Feed efficiency
- Growth rate

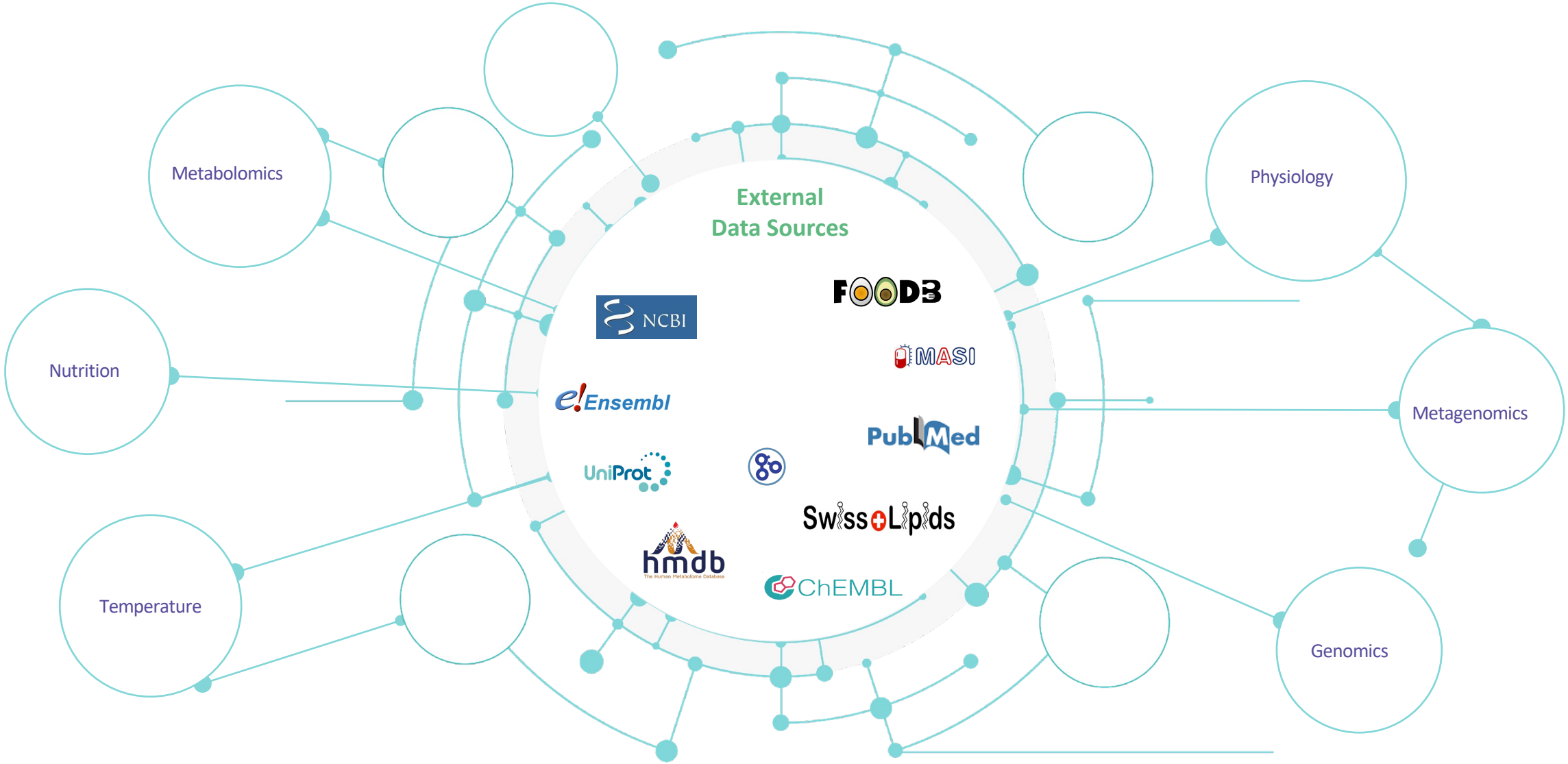


Adapted from: https://www.mdpi.com/2076-2607/7/10/374

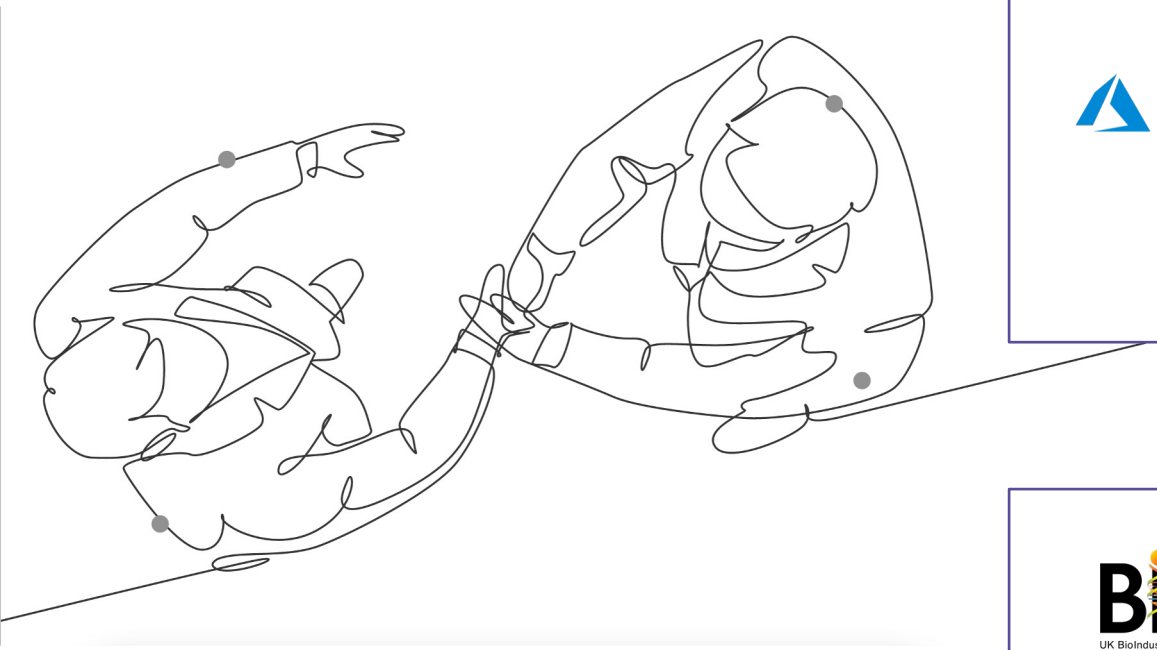
Our approach: create a data fabric from siloed data…



… and enrich it with additional data assets…



… including from our existing knowledge & technology partners



Technology Partners

Azure

aws

Knowledge Partners

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Quadram Institute

Earlham Institute

Ecosystem Entry Partners

BIA
UK BioIndustry Association

Pharmabiotic Research Institute

eit Food

Co-funded by the European Union

one nucleus

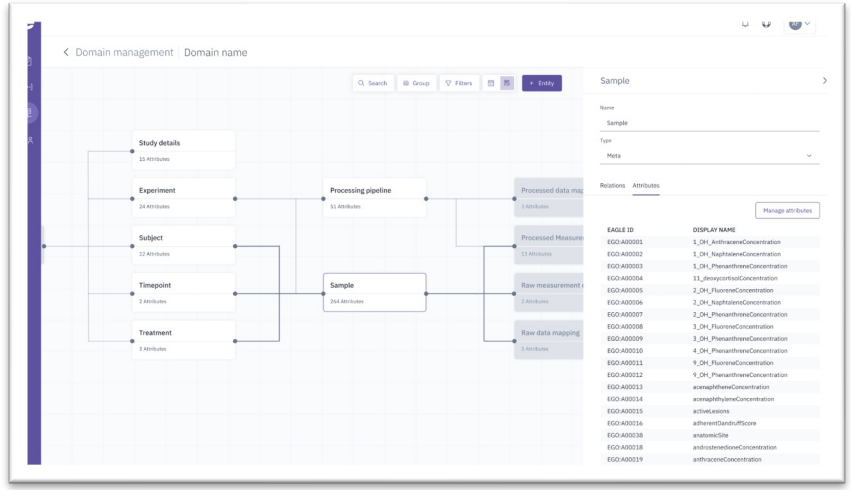
Pistoia Alliance

ktn

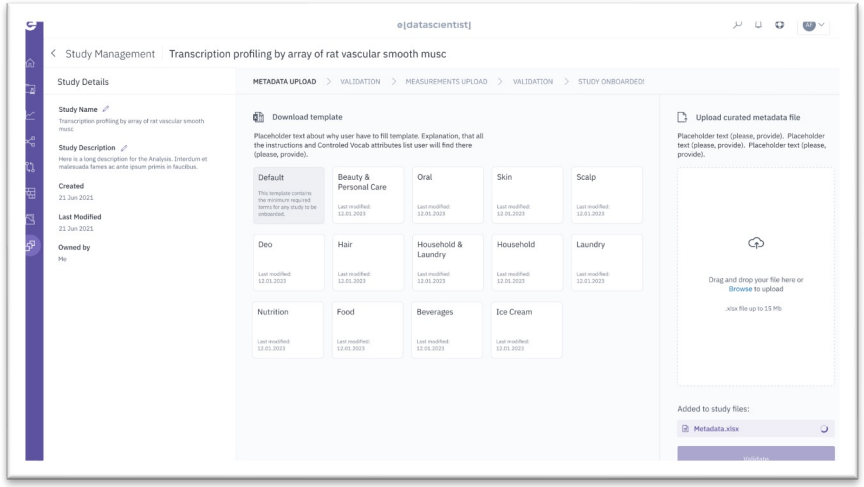
member of Medicon Valley Alliance

Step1: Onboarding measurement data and knowledge

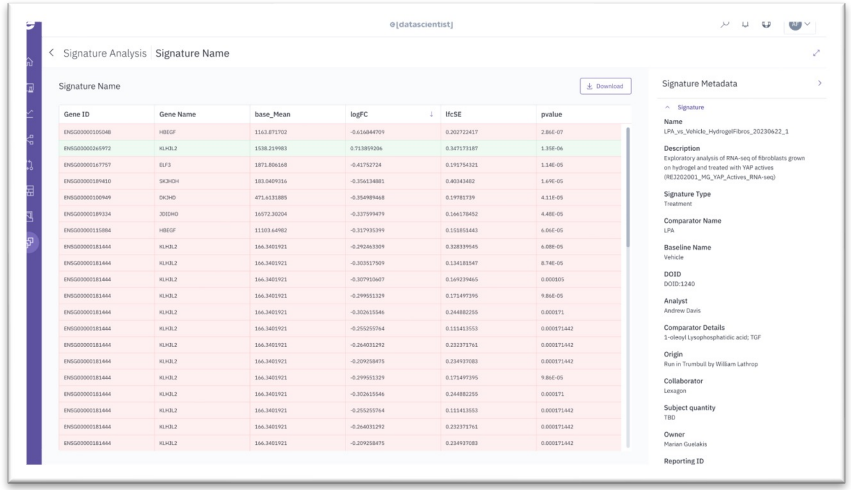
Data curation



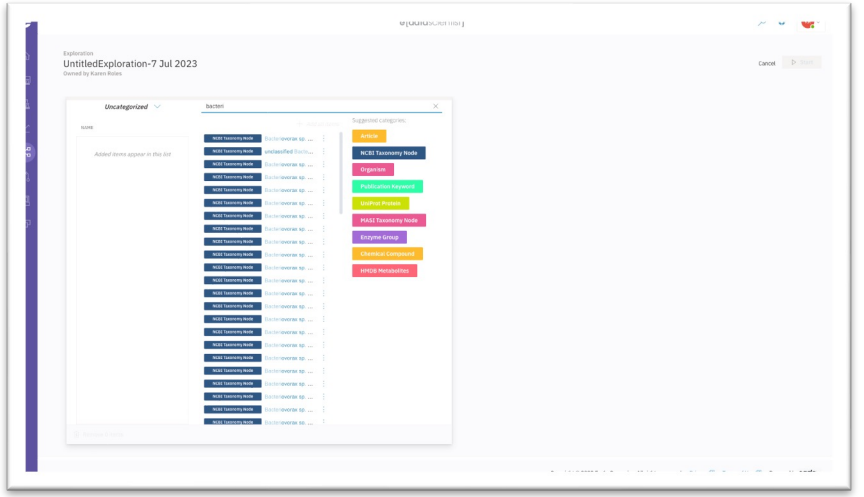
Study onboarding & management



Analyzed measurements e.g., signatures

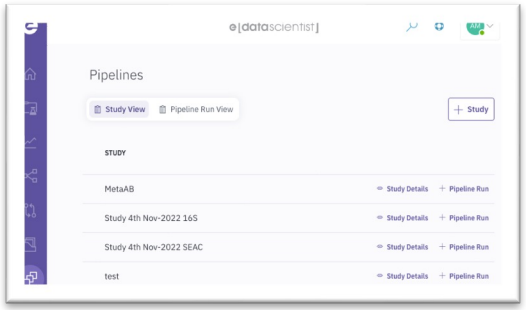


Onboarding public & premium datasets



Step 2: Analyzing and classifying raw measurement data

Selecting bioinformatics pipelines

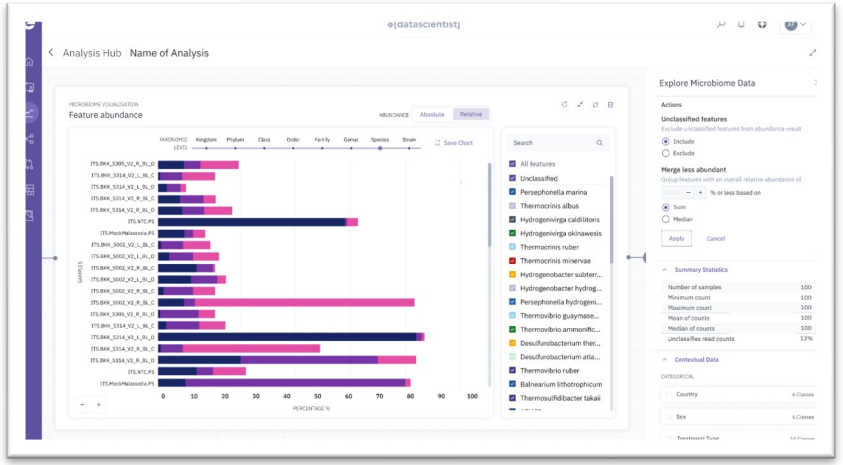


Configuring pipelines

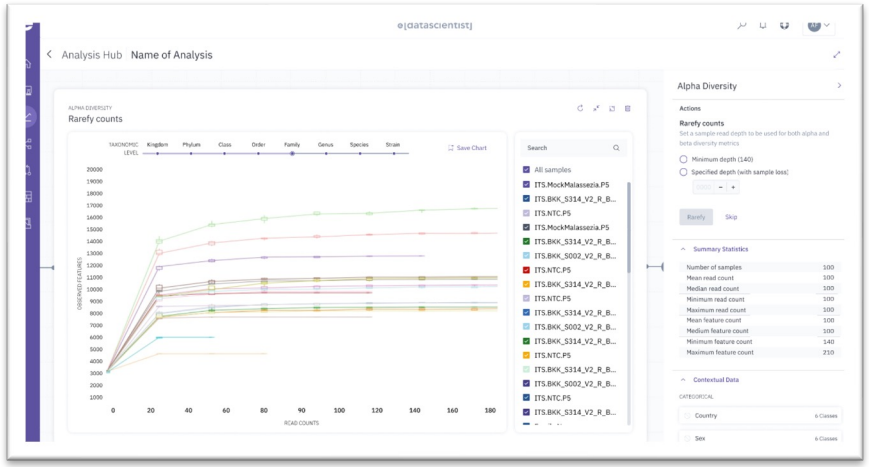
Name	Description
Metagenomics (WGS) assembly based	Processes metagenomic paired-end whole genome sequencing data to generate contig assemblies, gene predictions, taxonomic classification and functional annotation.
Metagenomics (WGS) read based	Processes metagenomic paired-end whole genome sequencing data and matches reads against references to generate taxonomic classification and functional annotation.
Illumina 16S	Processes 16S targeted sequencing data to generate prokaryotic taxonomic classifications and phylogeny.
Illumina 18S	Processes 18S targeted sequencing data to generate eukaryotic taxonomic classifications & phylogeny.
ITS marker gene	Processes ITS targeted sequencing data to generate fungal taxonomic classifications & phylogeny.
Illumina QC visualisation	Marker gene QC visualisation. Processes targeted sequencing data and performs quality assessment of the inputs.
Single isolate / Clonal Assembly	Processes single isolate genome sequences and generates complete whole genomes for individual bacterial strains. Provides characterisation including functional annotation, prediction of secondary metabolite gene clusters & antimicrobial resistance genes

Step 3: Carry out foundational microbiome analyses in Analysis Hub

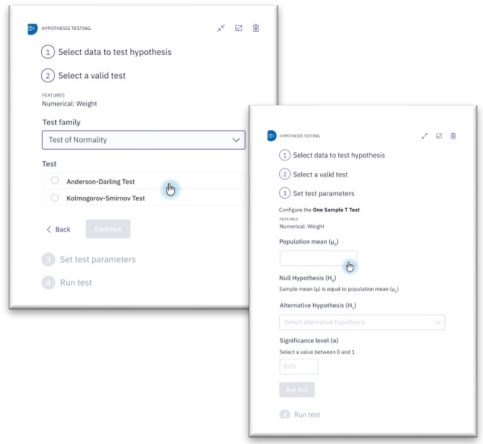
Feature Abundance



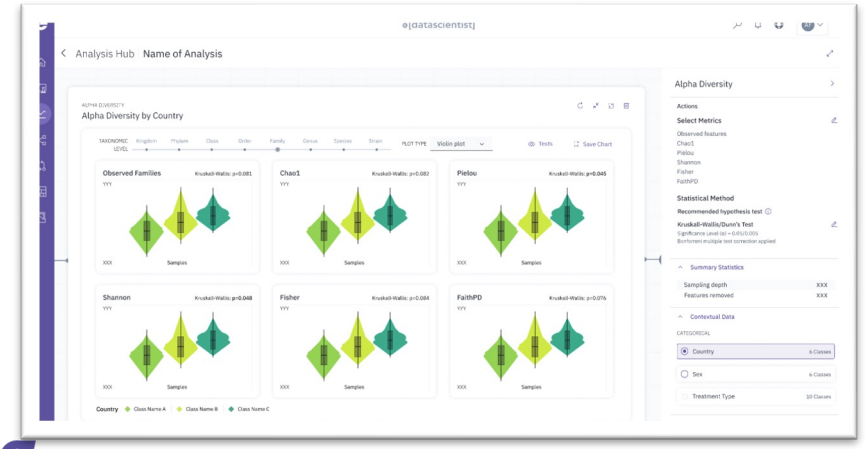
Rarefaction



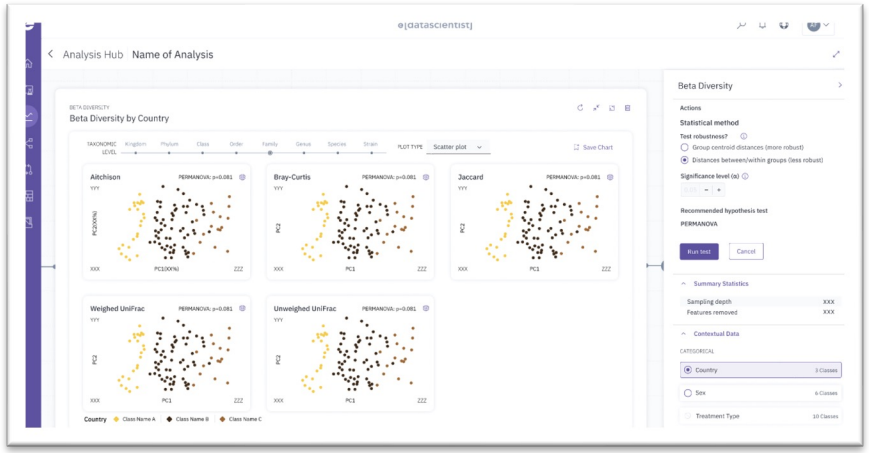
Hypothesis Testing



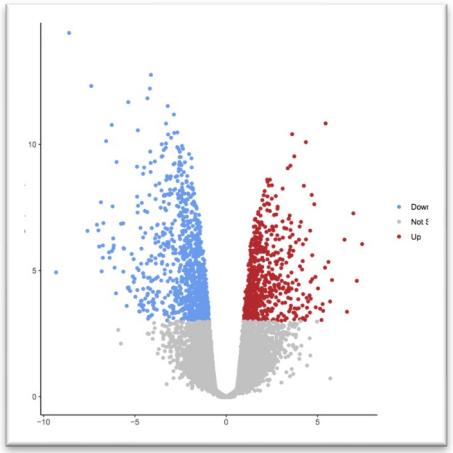
Alpha Diversity



Beta Diversity

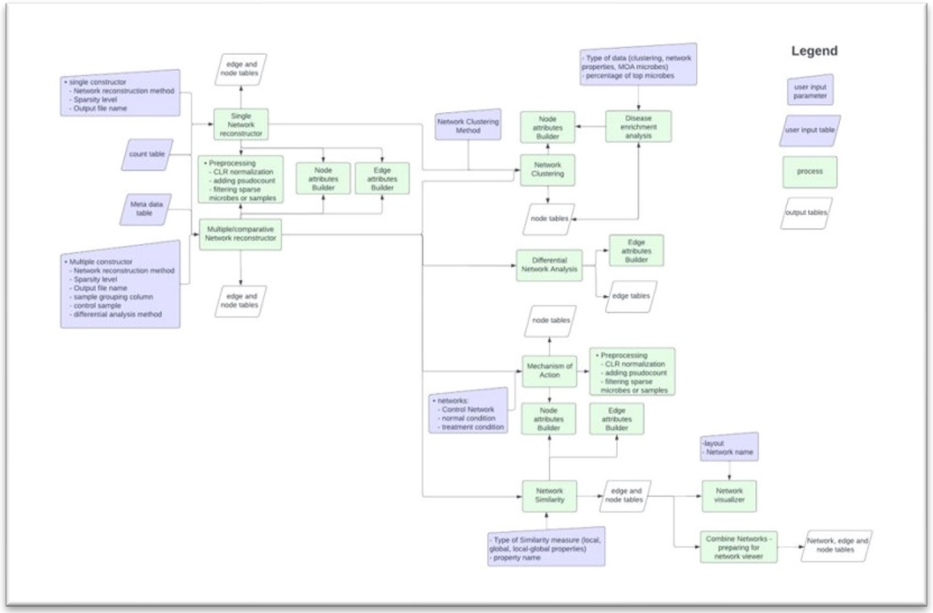


Differential Abundance

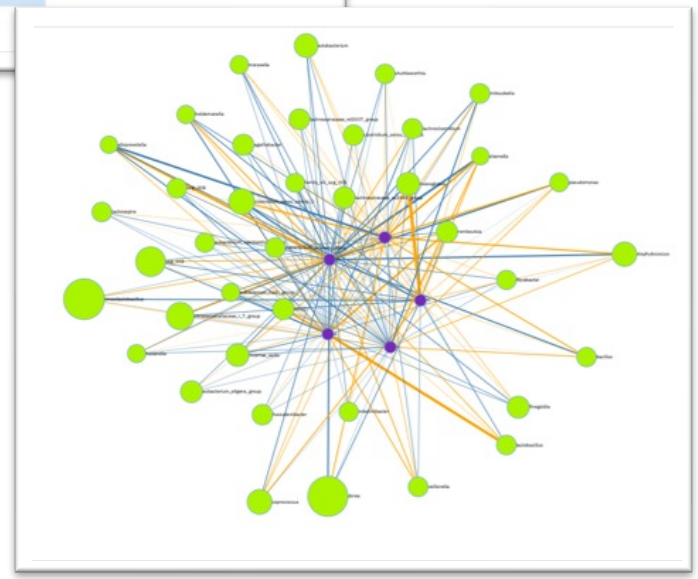


Step 4: Network based analysis of measurement data

Network-based analysis pipelines



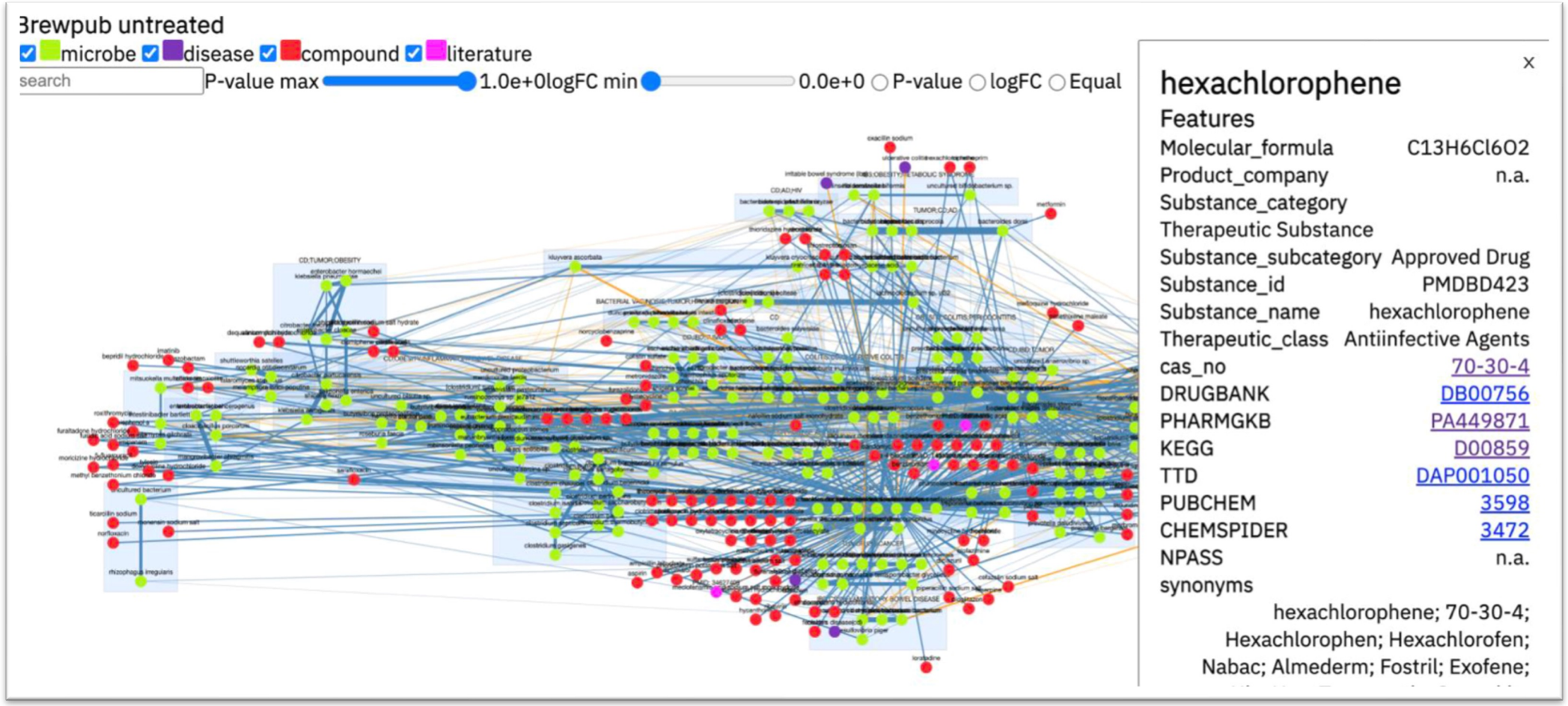
Networked omics data exploration



Identify hubs, biomarkers and controllers by exploring networked properties and functional clusters

Step 5: Enriching networks with information from the Knowledge Graph

Connecting known links to diseases, KEGG compounds and literature references



e[datascientist]™: Workflows enabling insight generation and impact...

Questions (Q)

DATA & PIPELINES

Data Upload → Data Mgmt. → Data Processing

Research Study Data Upload

Data Management

Data Pipelines

NETWORKS & ANALYSIS

Data Analysis → Data Exploration

Descriptive statistics, Hypothesis testing, Microbiome community profiling with Diversity analysis, Differential abundance, Network analysis, Multi-Omics analysis

INSIGHT

Knowledge Extraction → Scientific Outcome

Text-mining using literature data to compare against study results

Human Health, Animal Health, Soil/Plant Health, Environment Health

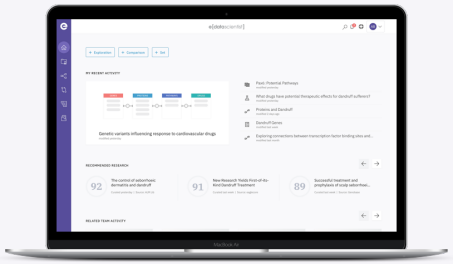
Impact (I)

Semi-Automated Curation
Common Data Model
Bio-Data Processing Pipelines

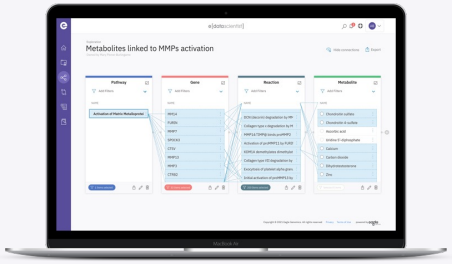
Multi-Layer Hypergraph, Network-, and Multi-Omics Analysis

Knowledge Extraction, Decision Support, Recommendations / Reporting

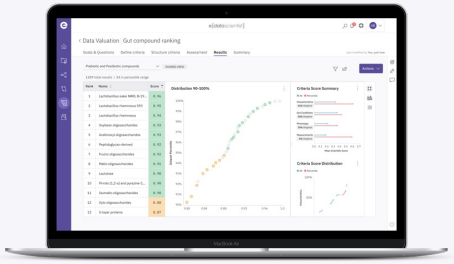
e[datascientist]™ Applications



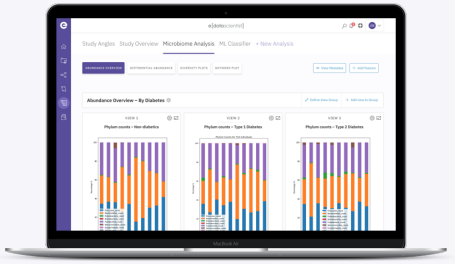
Conversational Interface



Data Exploration



Valuation & Decision Framework

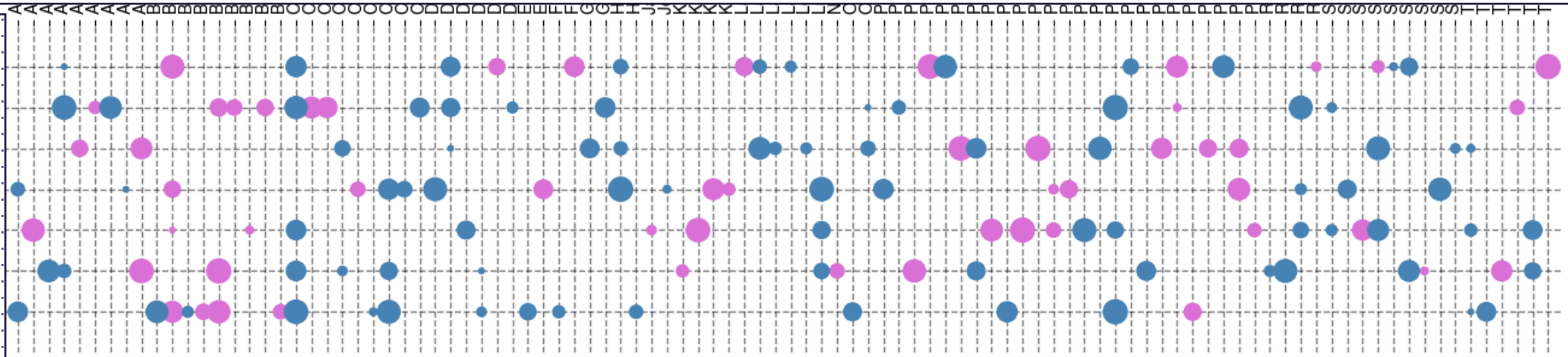


Data Analysis

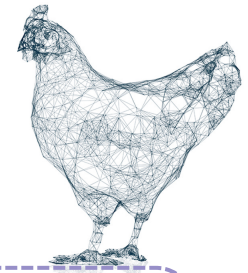
Feature importance for 21-days old chickens

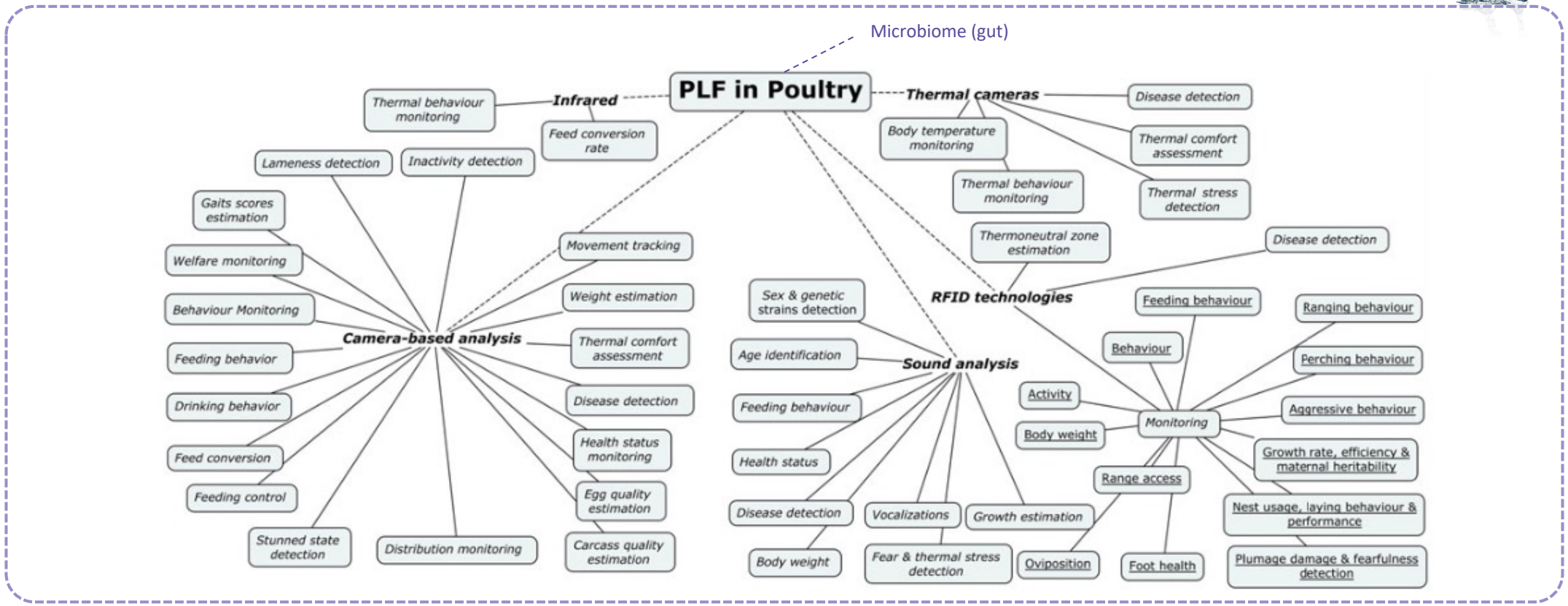
Redacted

Redacted



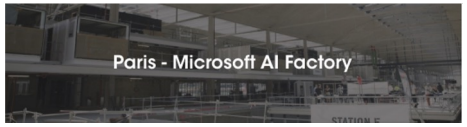
The microbiome is the next frontier in PLF

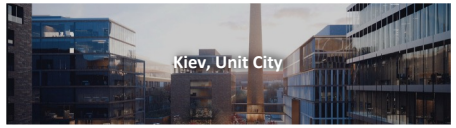




Tzanidakis, C., Simitzis, P., Panagakis, P. (2023). Precision Livestock Farming (PLF) Systems: Improving Sustainability and Efficiency of Animal Production. In: García Márquez, F.P., Lev, B. (eds) Sustainability. International Series in Operations Research & Management Science, vol 333. Springer, Cham.

Thank you





Microsoft AI Factory

JLABS Johnson & Johnson INNOVATION

STATION F

NEW YORK GENOME CENTER

KNOWLEDGE QUARTER

WELLCOME GENOME CAMPUS

THE FRANCIS CRICK INSTITUTE KQ LABS

POTSDAM SCIENCE PARK

Microsoft ScaleUp

TECH NATION UPSCALE

TOP 500 DEEPTECH STARTUP

UNIT.City

THE FOODTECH 500 powered by FORWARD FOODING

www.EagleGenomics.com

Christian.Roghi@EagleGenomics.com

Collaboration with **livestock**

- The health and wellness of livestock is critical to the economic success of the livestock industry
- There is no vehicle to address livestock health problems quickly.

Balanced Gut improves Livestock Health

A balanced and diverse gut microbiome promotes efficient digestion, better growth, and overall health.

Optimize Livestock Performance

A well-balanced livestock microbiome can improve production efficiency, allowing for body weight gain and increased production of eggs, milk, etc.

Efficiently Manage Disease

Identifying the specific microorganisms that are associated with disease could help prevent or treat disease outbreaks in livestock.

Enhance Feed Efficiency

Monitoring the effects of ingredients on gut health could help identify ways to enhance feed efficiency, leading to cost savings and improved sustainability.