

Value of big data & artificial intelligence for the pig industry

大数据和人工智能对养猪业的价值

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Data – the 'new black gold' 数据——“新的黑色黄金”



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Why now for big data and AI in pigs? 为什么现在要研究猪的大数据和人工智能?

- **Pressure:** Disease risk, AMR, cost volatility, sustainability targets
- 压力: 疾病风险、抗生素耐药性、成本波动性、可持续发展目标
- **Opportunity:** Sensors, farm software, slaughter data, and registries at scale
- 机遇: 传感器、农场软件、屠宰数据和大规模登记
- **Edge:** AI converts fragmented data into timely, farm-level decisions
- 边缘: 人工智能将碎片化数据转化为及时的、农场级的决策
- **Benchmark:** Other livestock sectors show measurable gains from data-driven ops
- 基准: 其他畜牧业部门从数据驱动的业务中获得了可观的收益
- **Thesis:** Data network effects favor those who start standardizing now
- 论文: 数据网络效应有利于那些现在开始标准化的人

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What counts as “big data” and “AI” in pigs 猪的“大数据”和“人工智能”是什么



Big data: High-volume, multi-source, longitudinal farm-to-slaughter records

大数据：高容量、多源、纵向的农场到屠宰数据



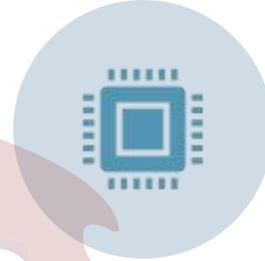
Granularity: From animal-level to batch, site, company, and region

颗粒度：从动物水平到批次、地点、公司和区域



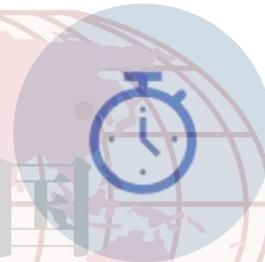
Outputs: Risk scores, forecasts, root-cause maps, and action recommendations

产出：风险评分、预测、根本原因图和行动建议



AI toolbox: Predictive modeling, anomaly detection, NLP, and causal inference

AI工具箱：预测建模、异常检测、NLP和因果推理



Time scale: Real-time alerts versus strategic quarterly insights

时间范围：实时警报与战略季度洞察

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Key data streams in the pig industry

生猪行业关键数据流

On-farm 在猪场

- Repro KPIs
- Mortality
- Treatments
- Feed
- Climate
- Behavior sensors

修订后的关键绩效指标
死亡率
治疗
饲料
气候
行为传感器



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Key data streams in the pig industry 生猪行业关键数据流

Animal & personal movements 动物和人员的移动

- Registries
- 登记处
- Transport events
- 运输事件
- Biosecurity checkpoints
- 生物安全检查点



Key data streams in the pig industry 生猪行业关键数据流

Diagnostics 诊断

- Lab results
- PCR panels
- Serology
- Sequencing of RNA/DNA
- Modelling of epitopes

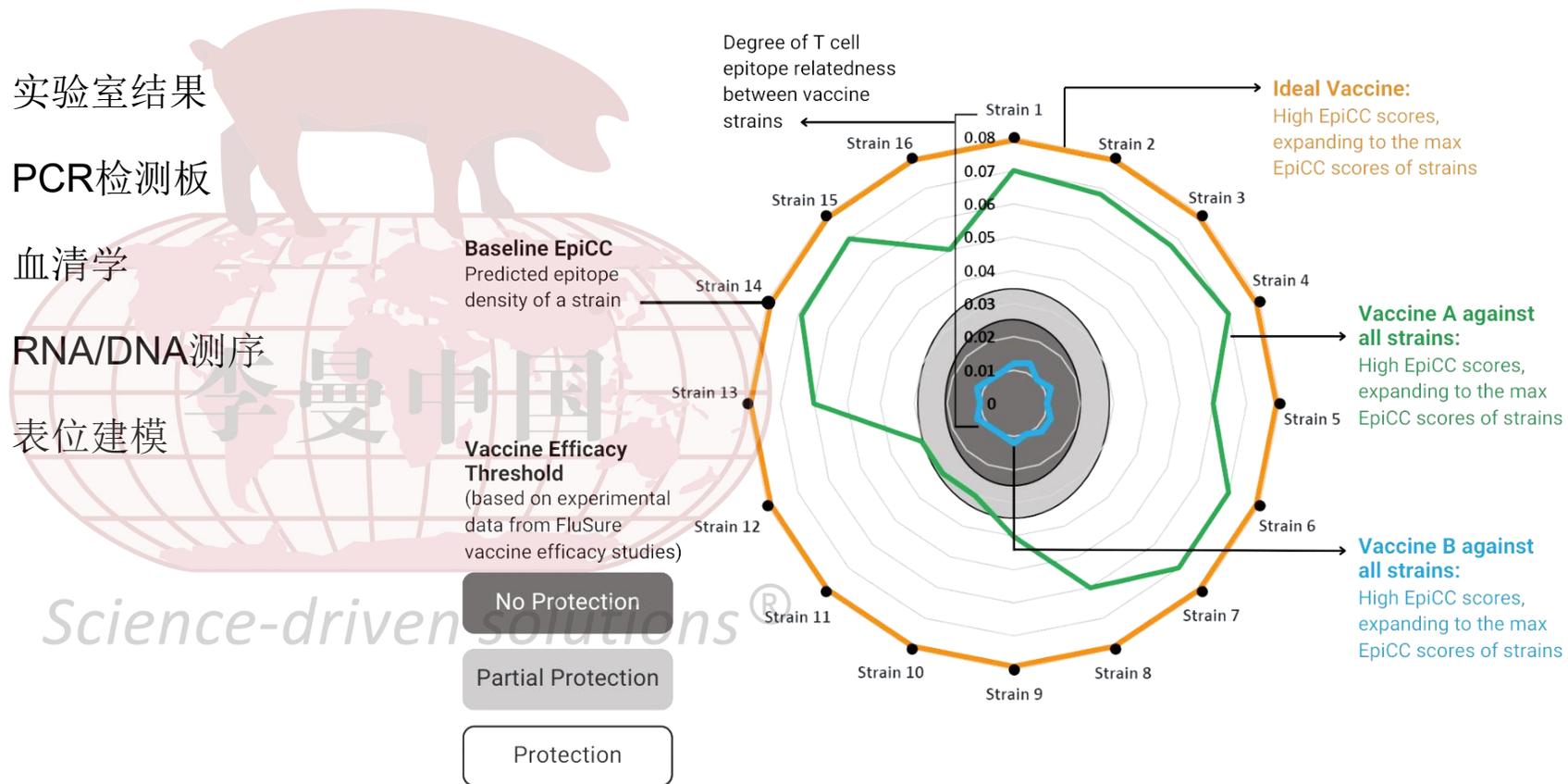
实验室结果

PCR检测板

血清学

RNA/DNA测序

表位建模



Key data streams in the pig industry 生猪行业关键数据流

Slaughter 屠宰

- Carcass weights
- 胴体重量
- Lesions
- 病变
- Trimming codes
- 修剪代码
- Condemnations
- 谴责

D'Angelo et al. *Porcine Health Management* (2025) 11:29
<https://doi.org/10.1186/s40813-025-00442-9> Porcine Health Management

RESEARCH

Open Access



Detecting ear lesions in slaughtered pigs through open-source convolutional neural networks

Matteo D'Angelo¹, Domenico Sciota², Anastasia Romano², Alfonso Rosamilia³, Chiara Guarnieri⁴, Chiara Cecchini², Alberto Olivastri⁵ and Giuseppe Marruchella^{2*}

Trachtman et al. *Vet Res* (2020) 51:51
<https://doi.org/10.1186/s13567-020-00775-z>

VR VETERINARY RESEARCH

RESEARCH ARTICLE

Open Access



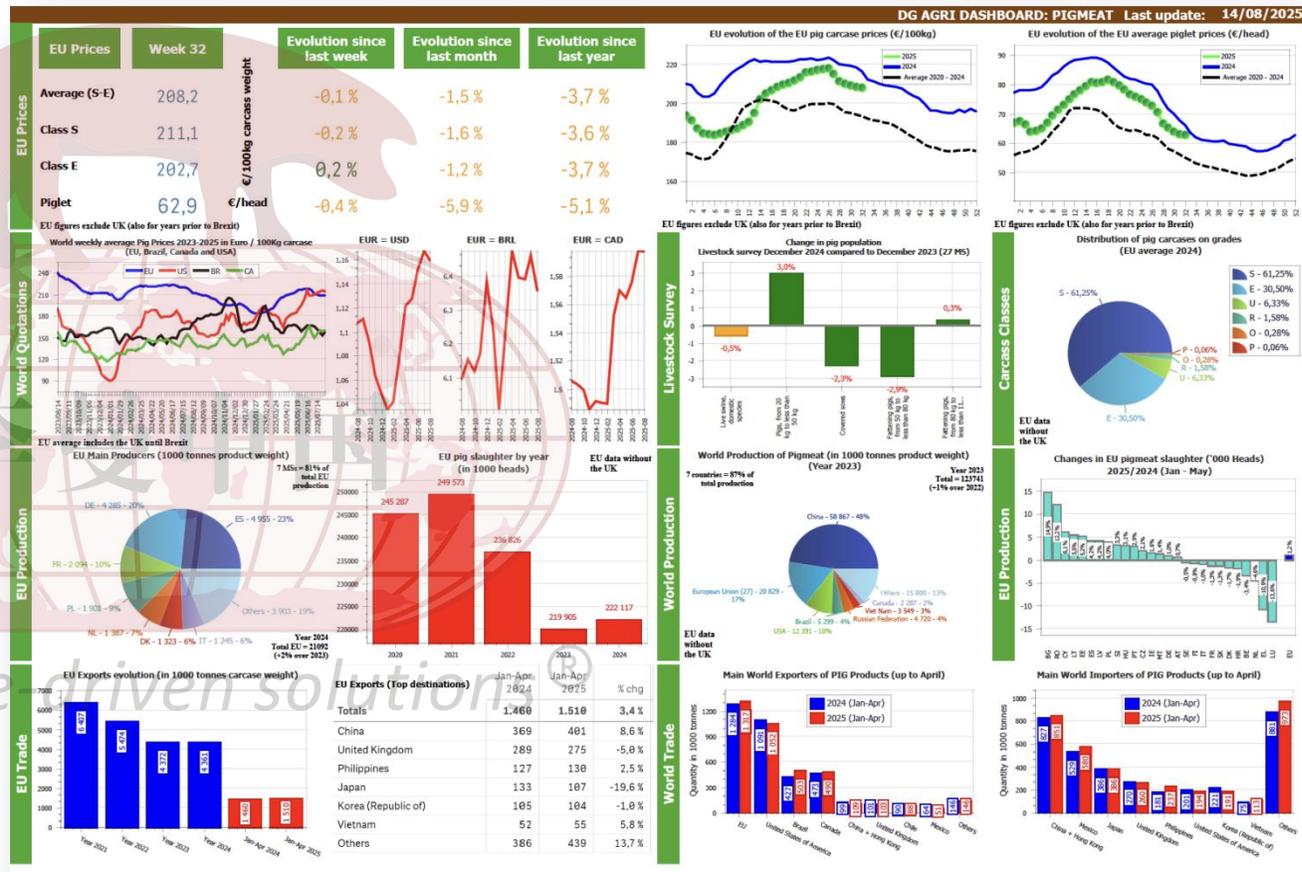
Scoring pleurisy in slaughtered pigs using convolutional neural networks

Abigail R. Trachtman¹, Luca Bergamini², Andrea Palazzi², Angelo Porrello², Andrea Capobianco Dondona³, Ercole Del Negro^{2,3}, Andrea Paolini¹, Giorgio Vignola¹, Simone Calderara² and Giuseppe Marruchella^{1*}

Key data streams in the pig industry 生猪行业关键数据流

Economics 经济

- Feed prices
- 饲料价格
- Medication costs
- 药物费用
- Labor/time stamps
- 工时/时间戳
- Energy use
- 能源使用





From data to information

从数据到信息 李曼中国

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The 'PIG DATA' project “PIG数据”项目

FNSNF

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SWISS NATIONAL SCIENCE FOUNDATION

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- 兽医公共卫生研究所, Vetsuisse Faculty, University of Bern, 瑞士
- Institute for Informatics, University of Zürich, Switzerland
- 瑞士苏黎世大学信息学研究所
- Swiss Federal Research Institute WSL, Research Unit Forest Dynamics, Switzerland
- 瑞士联邦研究所WSL, 森林动态研究部, 瑞士
- Clinic for Swine, Department of Veterinary Clinical Medicine, University of Bern, Switzerland
- 瑞士伯尔尼大学兽医临床医学系猪诊所

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PIG DATA project overview PIG数据项目概述

Goal 目标

- Turn routine Swiss swine data into actionable health and performance insights
- 将常规的瑞士猪数据转化为可操作的健康和性能见解

Scope 范围

- Integration of farm, movement, health, and abattoir datasets
- 整合农场、运动、健康和屠宰场数据集

Approach 方法

- Privacy-preserving, standardized, and interoperable pipelines
- 隐私保护、标准化和互操作的管道

Outcome 结果

- Validated use cases with measurable impact potential
- 经确认的用例，具有可衡量的影响潜力

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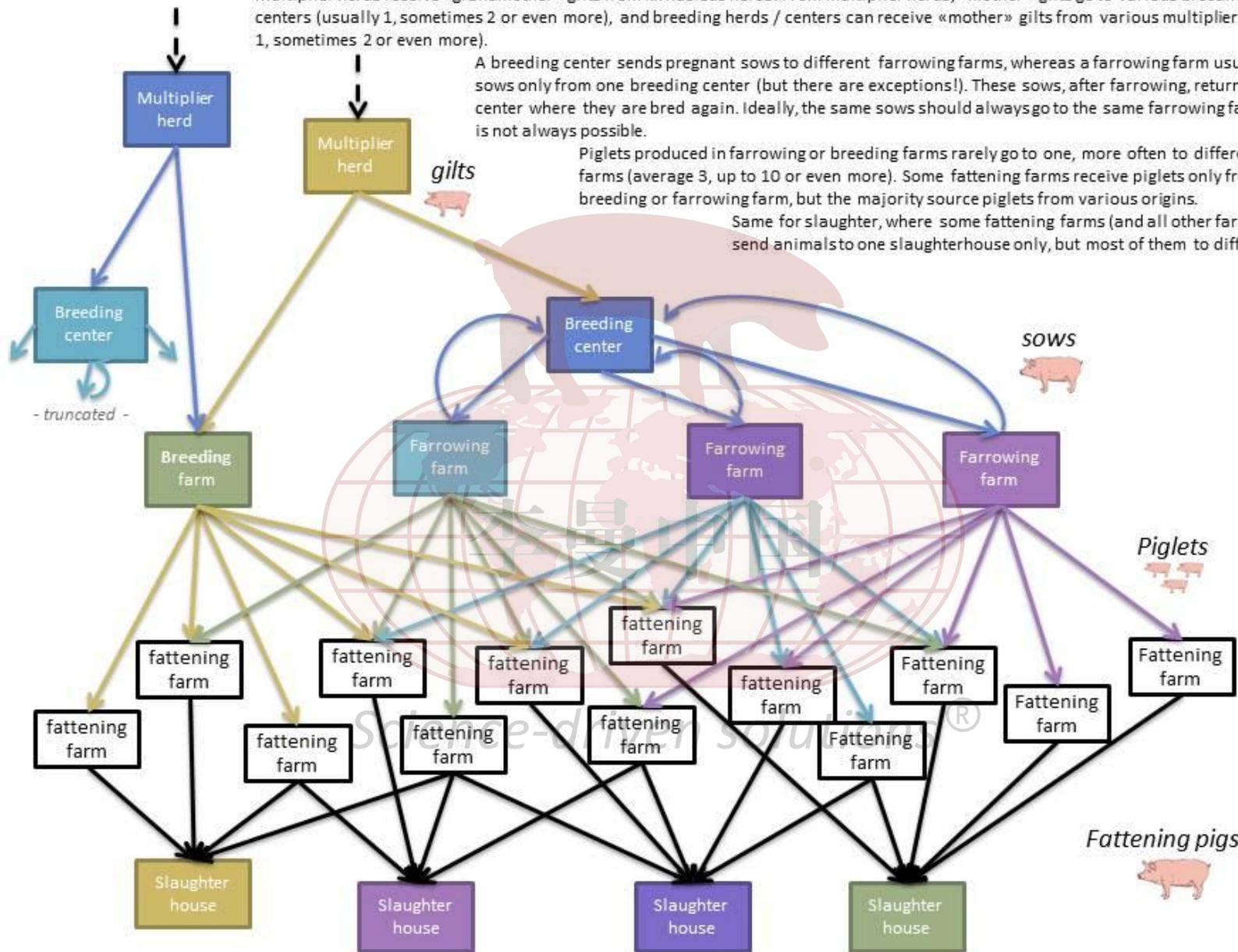
Schematic relationship between herds

Multiplier herds receive «grandmother» gilts from xx nucleus herds. From multiplier herds, «mother» gilts go to various breeding herds or centers (usually 1, sometimes 2 or even more), and breeding herds / centers can receive «mother» gilts from various multiplier herds (usually 1, sometimes 2 or even more).

A breeding center sends pregnant sows to different farrowing farms, whereas a farrowing farm usually receives sows only from one breeding center (but there are exceptions!). These sows, after farrowing, return to breeding center where they are bred again. Ideally, the same sows should always go to the same farrowing farm, but that is not always possible.

Piglets produced in farrowing or breeding farms rarely go to one, more often to different fattening farms (average 3, up to 10 or even more). Some fattening farms receive piglets only from one breeding or farrowing farm, but the majority source piglets from various origins.

Same for slaughter, where some fattening farms (and all other farm types!) send animals to one slaughterhouse only, but most of them to different ones.



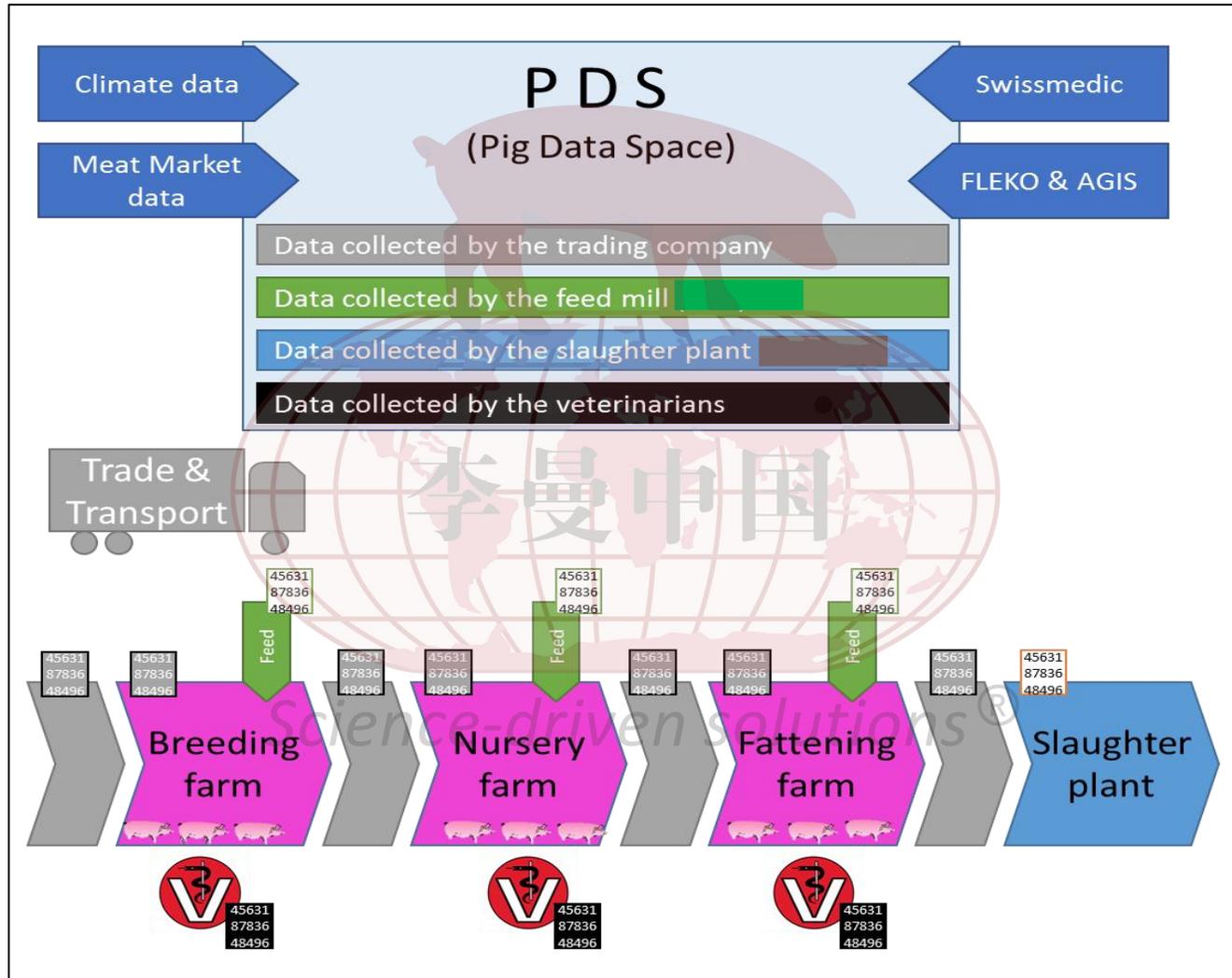
PIG DATA architecture and data governance

PIG数据架构和数据治理

- **Ingestion:** APIs, secure file drops, and scheduled ETL into a common model
• 摄入: **API**、安全文件下载和计划**ETL**到一个公共模型
- **Standardization:** Unified IDs, time alignment, and ontology for events/KPIs
• 标准化: 统一的**ID**、时间对齐和事件/**KPI**的**本体**
- **Quality:** Automated completeness checks, outlier flags, feedback loops
• 质量: 自动完整性检查、异常值标记、反馈循环
- **Privacy:** De-identification, access tiers, and purpose-bound data use
• 隐私: 去识别化、访问层和目的限定的数据使用
- **Traceability:** Data lineage and model versioning for audit and learning
• 可追溯性: 数据谱系和模型版本, 用于审核和学习

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PIG DATA SPACE PIG数据空间



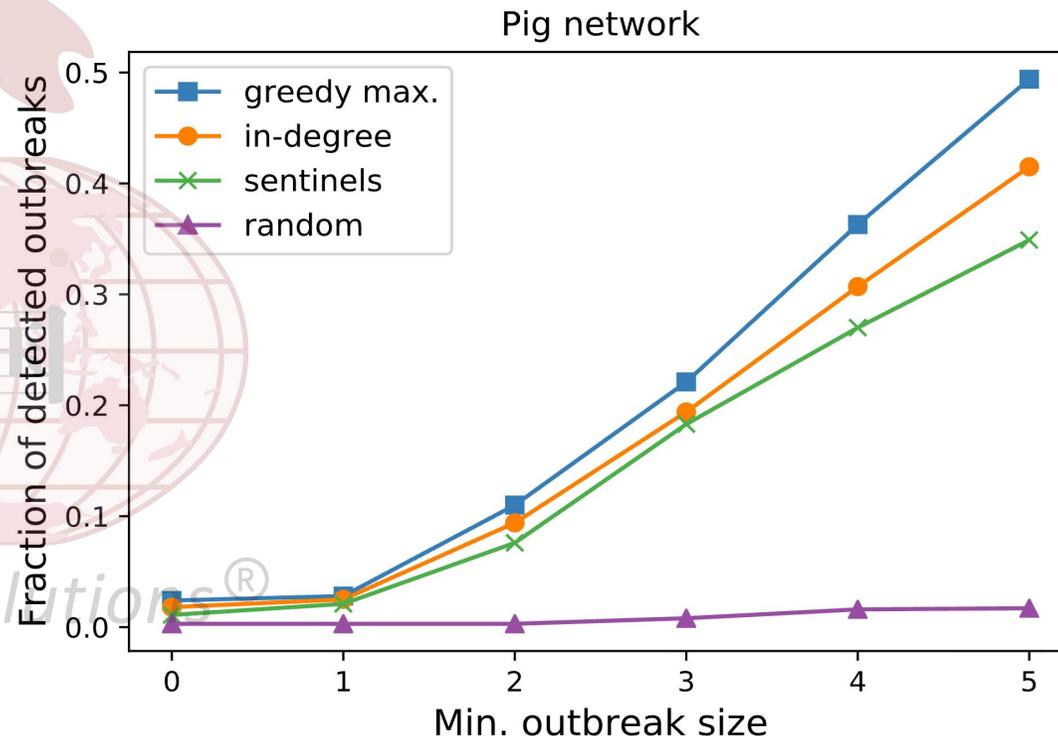
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Use case 1 使用案例1

Early health and mortality risk prediction

早期健康和死亡率风险预测

- Combine climate, intake, growth, and treatments to predict spikes
- 结合气候、摄入量、生长和治疗来预测峰值
- Aim for 3–7 days advance warning to intervene earlier
- 力争提前3-7天预警，以便更早介入
- Dynamic checklists—ventilation, water, feed transitions, isolation
- 动态检查表-通风、供水、饲料转换、隔离
- Reduced peak mortality and narrower variance in batch outcomes
- 降低峰值死亡率并缩小批次结果的差异
- Models improve when farms log interventions and outcomes consistently
- 当农场一致记录干预措施和结果时，模型会得到改善



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Use case 2 使用案例2

Repro and productivity optimization 重复和生产率优化

01

Farrowing forecasts: Predict farrowing room demand and staff allocation

分娩预测：预测产房需求和人员配置

02

Sow-level: Parity-specific risk for return to estrus and farrowing assistance

母猪水平：恢复发情和分娩协助的特定风险

03

Wean-to-finish: Forecast ADG/FCR by batch based on early-life signals

从断奶到育成：根据早期生命信号预测批次ADG/FCR

04

Bottlenecks: Identify calendar weeks with systematic throughput losses

瓶颈：识别具有系统通量损失的日历周

05

Result: Smoother flows, fewer stock-outs, and better labor utilization

结果：流程更顺畅，缺货更少，劳动力利用率更高

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Use case 3 使用案例3

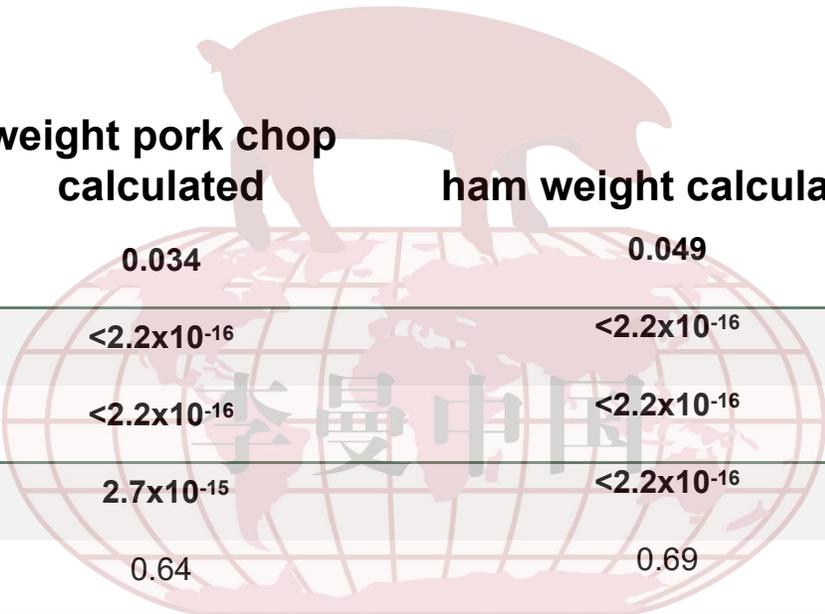
Welfare, AMU, and lesion analytics 福利、AMU和病变分析

- AMU patterns: Detect outlier usage and suggest narrow-spectrum alternatives
- AMU模式：检测异常使用情况并建议窄谱替代方案
- Lesions at slaughter: Link farm events to pleurisy / pneumonia /arthritis risk
- 屠宰时的病变：将农场事件与胸膜炎/肺炎/关节炎风险联系起来
- Welfare signals: Tail-biting risk from activity / feeding variability
- 福利信号：活动/摄食变化带来的咬尾风险
- KPIs: Welfare dashboards combining lesions, lameness, and intervention logs
- 关键绩效指标：将病变、跛行和干预日志结合在一起的福利仪表板
- Impact: Compliance support plus tangible cost and welfare improvements
- 影响：合规支持加上有形成本和福利改善

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Use case 3 使用案例3

Welfare, AMU, and lesion analytics 福利、AMU和病变分析



p-values LRT	weight pork chop calculated	ham weight calculated	ham weight calculated without bones, fat and tendons
<i>Transport Time</i>	0.034	0.049	0.027
<i>Lairage Time</i>	<2.2x10 ⁻¹⁶	<2.2x10 ⁻¹⁶	<2.2x10 ⁻¹⁶
<i>TempAvg</i>	<2.2x10 ⁻¹⁶	<2.2x10 ⁻¹⁶	<2.2x10 ⁻¹⁶
<i>TempD</i>	2.7x10 ⁻¹⁵	<2.2x10 ⁻¹⁶	2.6x10 ⁻¹⁶
<i>RelHumAvg</i>	0.64	0.69	0.93
<i>Loading time OTD</i>	0.0014	0.0001	7.4x10 ⁻⁵
<i>Drop time OTD</i>	1.8x10 ⁻¹⁴	3.0x10 ⁻¹⁶	4.7x10 ⁻¹⁶
<i>ProdType</i>	0.001	7.5x10 ⁻¹⁶	<2.2x10 ⁻¹⁶
<i>PigType</i>	0.0003	0.56	0.073

What we learned in PIG DATA 我们在PIG数据中了解到什么

Successes and stumbles 成功与挫折

Data reality 数据现实

- Missingness and inconsistent coding are the main bottlenecks
- 缺失和不一致的编码是主要的瓶颈

Small wins first 小胜为先

- Start with simple, high-ROI alerts to build trust 从简单、高ROI的警报开始，建立信任

Explainability 可解释性

- Feature attribution boosts adoption and better farm dialogue
- 功能属性有助于提高用户接受度并改善农场对话

Feedback loops 反馈回路

- Farmer input markedly improves model relevance 农民输入显著提高了模型的相关性

Scaling 缩放比例

- Standard schemas and governance matter more than fancy algorithms
- 标准架构和治理比花哨的算法更重要

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How to set up similar projects? 如何设置类似的项目?



u^b Practical adoption roadmap 实际应用路线图

Standardize data entry (events, treatments, deaths) and IDs

统一数据录入（事件、治疗、死亡）和ID

Connect core streams (farm software, climate, slaughter reports)

连接核心流（农场软件、气候、屠宰报告）

Pilot 1 - 2 use cases with clear KPIs and monthly reviews

试点1-2使用案例，具有明确的KPI和月度审查

Train people - turn model outputs into standard operating responses

培训人员---将模型输出转化为标准操作响应 solutions[®]

Iterate - retire weak models, scale proven ones across sites

迭代---淘汰薄弱模型，跨站点扩展经过验证的模型

Is it wise to invest now?

现在投资明智吗？

- **Estrus and farrowing prediction:** Computer vision and activity sensors detect standing heat and subtle behavior changes 24 - 48 hours in advance; models predict farrowing windows, staffing colostrum support and reducing stillbirths.
- **发情期和产仔预测:** 计算机视觉和活动传感器可提前**24 - 48**小时检测站立发情和细微的行为变化；模型预测产仔时间、人员初乳支持和减少死胎。
- **Precision sow feeding:** Body condition scoring by camera plus intake patterns adjusts gestation and lactation rations per sow, improving milk yield and wean weight while avoiding over- conditioning.
- **精准母猪饲养:** 通过摄像机评分和摄食模式调整母猪的妊娠期和哺乳期配给量，从而提高产奶量和断奶体重，同时避免过度调理。
- **Piglet survival and growth:** Vision and audio analytics flag chilling, crushing risk, scours, and cough signatures; targeted heat, creep feeding, and interventions cut pre- weaning losses.
- **仔猪存活率与生长:** 通过视觉和音频分析技术，可识别令人担忧的窒息、被压风险、腹泻及咳嗽特征；针对性的加热、教槽料饲喂及干预措施，有效降低断奶前死亡率。
- **Environment and health early- warning:** AI tunes ventilation, heating, and cooling by pen to keep THI on target; anomalies in water/feed, temp, and sound trigger biosecurity checks for PRRS/APP/streps and faster isolation.
- **环境和健康早期预警:** **AI**通过隧道通风、加热和冷却，以保持**THI**在目标水平；水/饲料、温度和声音的异常会触发生物安全检查，以检测**PRRS/APP/链球菌**并更快地隔离。
- **Finishing flow and marketing:** Weight cameras and smart scales forecast daily lot distributions; catch plans hit processor weight bands, reducing penalties and improving uniformity.
- **育成流程与市场营销:** 称重摄像机和智能秤预测每日批次分布；抓取计划符合加工重量范围，减少处罚并提高均匀性。
- **Maintenance and logistics:** Predictive maintenance for feed lines, drinkers, and ventilation fans reduces downtime; inventory algorithms right- size vaccines, meds, and feed deliveries.
- **维护和物流:** 对饲料线、饮水器和通风扇进行预测性维护，减少停机时间；库存算法正确确定疫苗、药物和饲料的交付规模。

Area	区域	KPI	关键业绩指标	Baseline	After AI	Improvement
Reproduction	繁殖	Litters/sow/year	每头母猪的产仔数	2.35	2.42	+0.07
Reproduction	繁殖	Farrowing rate	分娩率	82%	86%	+4 pp
Litter metrics	窝指标	Total born/litter	出生总数 / 窝数	13.0	13.3	+0.3
Litter metrics	窝指标	Born alive/litter	出生时存活/产仔数	11.2	11.6	+0.4
Litter metrics	窝指标	Weaned/litter	断奶仔猪	9.5	10.2	+0.7
Piglet survival	仔猪存活率	Pre- weaning mortality	断奶前死亡率	15%	11%	-4 pp
Grow- finish survival	生长-育成期存活率	Nursery/finisher mortality	保育/育成死亡率	5.0%	4.2%	-0.8 pp
Growth/feed	生长/饲料	Nursery/finisher FCR	保育/育成 FCR	—	—	-0.05 points
Sow feeding	母猪饲养	Sow feed use	母猪饲料使用	—	—	-1% net (gestation - 3%, lactation +2%)
Energy	能量	Climate/ventilation energy	气候/通风能耗	—	—	-7%
Quality	质量	Top- grade proportion	顶级比例	—	—	+1 pp
Operations	操作	Emergency call- outs	紧急呼叫	—	—	-10-15%



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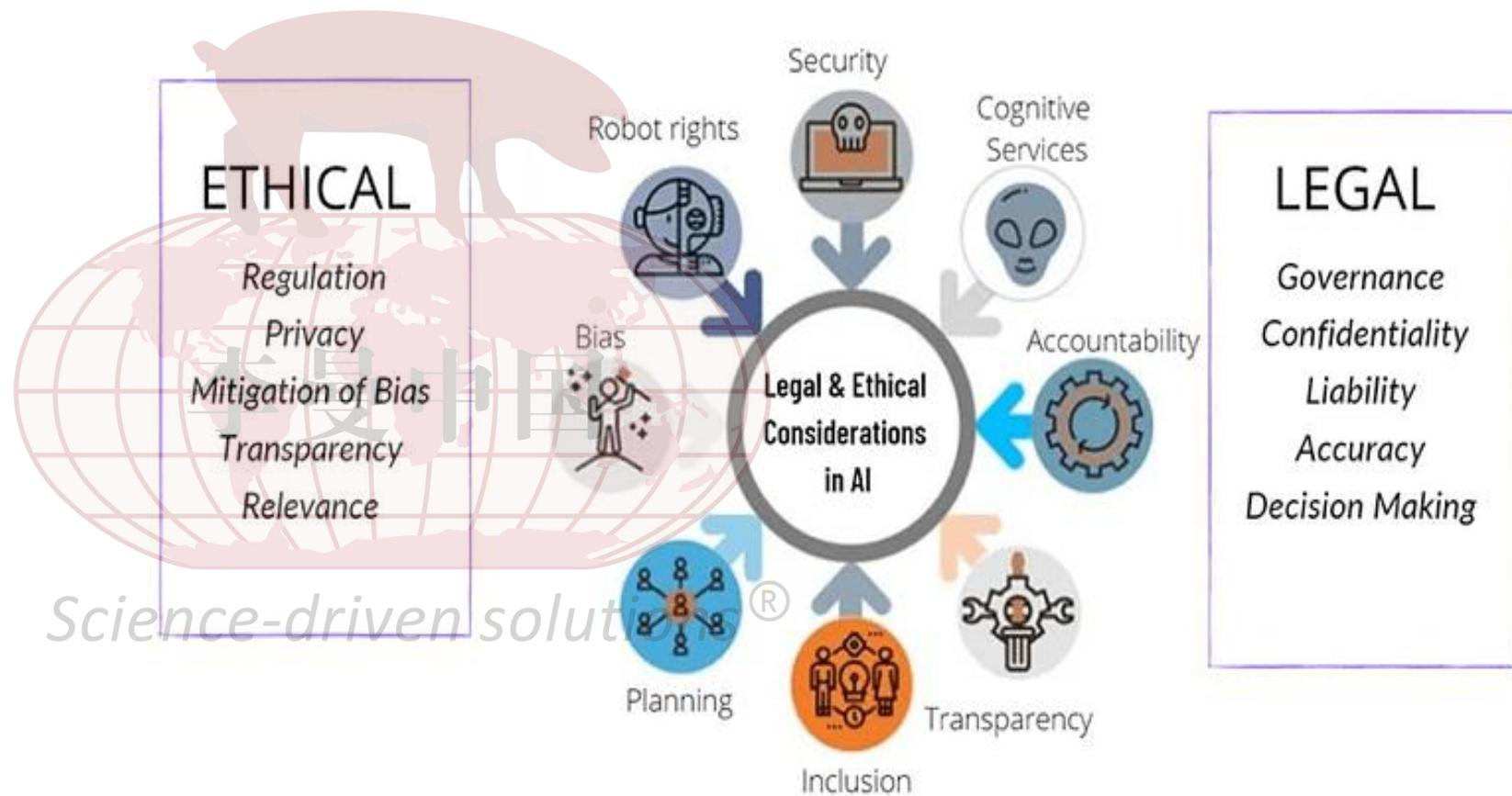
Is it wise to invest now? Maybe ... 现在投资明智吗？也许...

Impact level	影响等级	Assumptions/calculation	假设/计算	Benefit (RMB/year)
More pigs weaned and sold	更多猪断奶和出售	+0.7 weaned/sow/year → ~6,300 extra market hogs × RMB 150 margin	+0.7头母猪/年→~6300头额外市场生猪×150元利润	945,000
Lower finishing mortality	较低的致死率	~1,860 additional hogs × RMB 150 margin	~1,860头生猪×150元保证金	279,000
Feed savings from FCR	从FCR中获取饲料节省量	-0.05 points ≈ 4.75 kg/head × 227,000 head × RMB 6.0/kg	-0.05分≈4.75千克/头×227,000头×6.0元/千克	6,470,000
Sow feed optimization	猪饲料优化	-1% on ~12,000 t/year × RMB 3.0/kg	-1%对~12,000吨/年×3.0元/公斤	360,000
Energy savings	节省能源	-7% on RMB 12,000,000/year	-每年人民币1200万元的7%	840,000
Quality premium	品质尊享	+1 pp top- grade × 227,000 head × RMB 10/head	+1 pp顶级×227,000头×每头10元	2,270,000
Labor/maintenance	劳动力/维护	Fewer emergencies, targeted rounds (≈ 6 FTE/overtime avoided)	减少紧急情况，有针对性的轮班 (≈避免6个全职员工/加班)	900,000–1,200,000
Total annual benefit	年度总福利	Sum of above (midpoint for labor)	上述总和 (劳动力中位数)	≈ 12–13 million

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Economics, ethics, and regulation 经济学、伦理学和监管

- ROI framing
- 投资回报率框架
- Costs
- 费用
- Ethics
- 道德操守
- Regulatory fit
- 法规符合性
- Resilience
- 复原力



The next frontier 新的边界

- **Genomics + phenomics** 基因组学+表型组学
 - Breeding for robustness with real-world signals 通过真实世界信号进行稳健性培养
- **Causal AI** 因果人工智能
 - From correlations to confident intervention recommendations 从相关性到可靠的干预建议
- **Edge analytics** 边缘分析
 - Barn-level inference for low-latency alerts 低延迟警报的猪舍级推理
- **Federated learning** 联合学习
 - Learn across farms without centralizing raw data 了解各个农场的情况，而无需集中原始数据
- **Sustainability** 可持续性
 - Carbon, nitrogen, and welfare metrics embedded in ops 嵌入到操作中的碳、氮和福利指标

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u^b Thank you for your attention!
感谢您的关注!

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