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世界动物卫生组织猪链球菌病参考实验室
World Organisation for Animal Health (WOAH)
Reference Laboratory for Swine Streptococcosis

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教育部“动物健康与食品安全”国际合作联合实验室

农业农村部细菌学诊断实验室

张炜_细菌研究
2025.10

AI 在畜牧兽医人才培养方面的探索和应用

Exploration and application of AI in animal husbandry and veterinary personnel training

南京农业大学　　张 炜

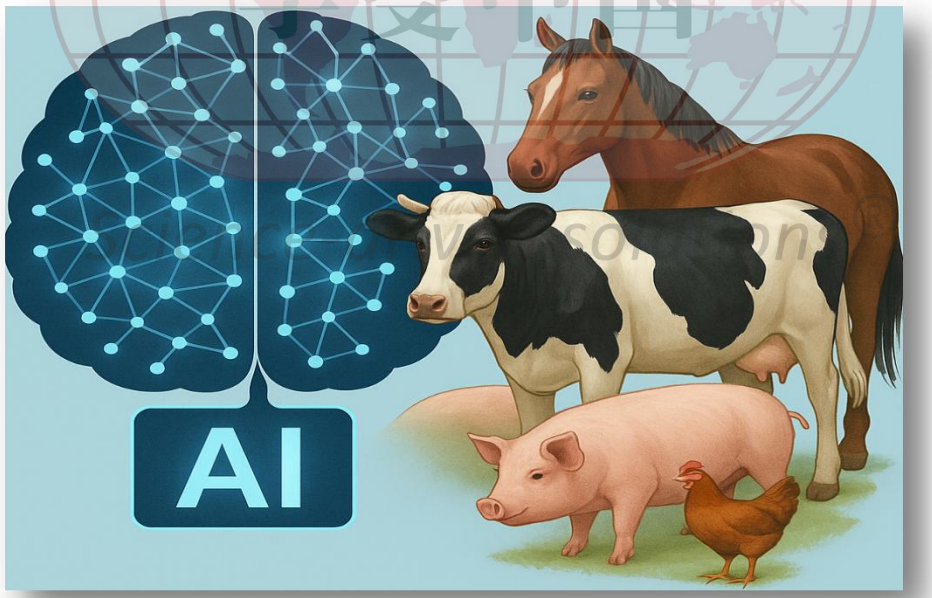
内容简介brief Introduction of the content

- **基本概念：Conceptual framework：**
  - 人工智能简介及可能在畜牧兽医领域的应用
  - **Introduction to artificial intelligence and its possible applications in animal husbandry and veterinary medicine**
- 入局和尝试：Join and try:
  - 动物疫病人工智能诊断及生态防控的整体构想
  - **The overall concept of artificial intelligence diagnosis and ecological prevention and control of animal diseases**
  - 人工智能平台的搭建：**Building an AI platform:**
  - 基于视觉识别的动物疫病的人工智能诊断平台应用
  - **Application of artificial intelligence diagnosis platform for animal diseases based on visual recognition**
  - 动物疫病生态防控手段简介
  - **Introduction to ecological prevention and control of animal diseases**
- **愿景和思考 Vision and Thinking**
  - 养殖智能化疫病诊断和防控多模态愿景
  - **Multimodal vision for intelligent disease diagnosis and prevention in farming**
  - AI时代的畜牧兽医人才所需要职业技能的思考
  - **Thinking about the vocational skills needed by animal husbandry and veterinary talents in the AI era**

人工智能简介及主要分类
Introduction to Artificial Intelligence and its main categories

一、什么是人工智能？What is artificial intelligence?

- 人工智能（Artificial Intelligence，简称 AI）是研究、开发用于模拟、延伸和扩展人类智能的理论、方法、技术及应用系统的一门交叉学科。
- Artificial Intelligence (AI) is an interdisciplinary field dedicated to researching, developing, and applying theories, methods, technologies, and systems that simulate, extend, and enhance human intelligence.
- 其核心目标是使机器具备类似人类的感知、推理、学习、决策等能力，从而实现自主处理复杂任务的功能。
- Its core goal is to make machines capable of human-like perception, reasoning, learning, decision-making, and so on, so as to achieve the ability to autonomously process complex tasks.



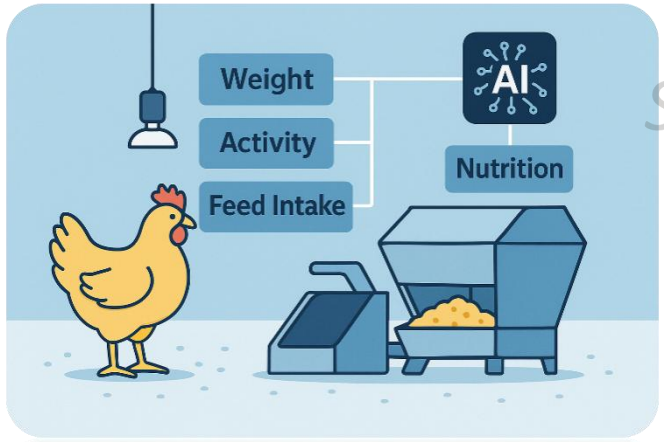
人工智能的主要研究方向
The main research direction of artificial intelligence

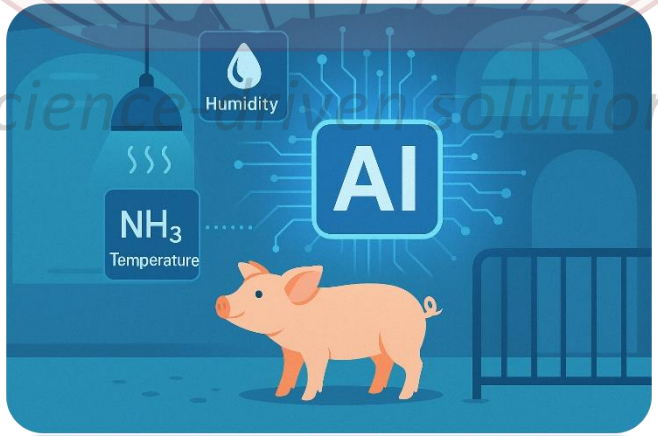
- 1. 机器学习（Machine Learning）1.Machine Learning
- 2. 计算机视觉（Computer Vision）2.Computer Vision
- 3. 自然语言处理（Natural Language Processing，NLP）3.Natural Language Processing (NLP)
- 4. 机器人学（Robotics）4.Robotics
- 5. 知识图谱（Knowledge Graph）5.Knowledge Graph

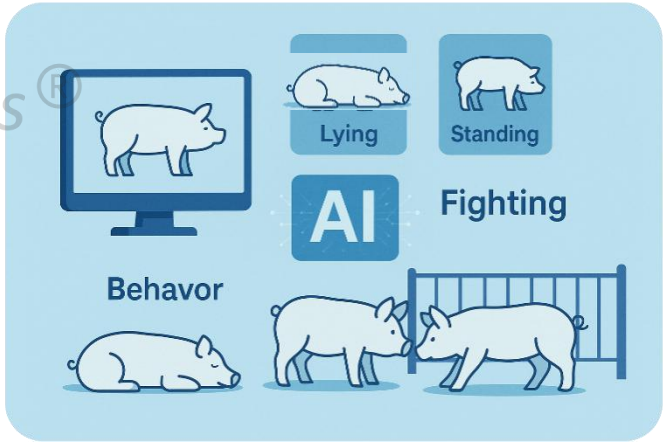
人工智能在畜牧兽医领域的可能应用方向Possible applications of artificial intelligence in animal husbandry and veterinary medicine

智能化养殖管理

精准饲喂：传感器采集体重、活动量和采食数据，AI 分析营养需求，自动调整饲喂量和配方（如肉鸡分阶段定制饲料）。
Precision feeding: Sensors collect data on weight, activity, and feed intake, while AI analyzes nutritional needs to automatically adjust feed amounts and formulas (e.g., customized feed for broilers at different growth stages).
环境调控：基于温湿度和氨气浓度等数据，AI 实时控制通风供暖，维持适宜环境（如仔猪舍温度保持 28–32℃）。
Environmental control: AI controls ventilation and heating in real time based on data such as temperature, humidity, and ammonia concentration to maintain optimal conditions (e.g., maintaining a temperature of 28–32℃ in piglets pens).
行为监测：计算机视觉识别猪的躺卧、站立、打斗等行为，AI 判断异常（如活动量骤降提示疾病，打斗频繁提示密度过高）。
Behavior monitoring: Computer vision identifies pig behaviors such as lying down, standing, and fighting, with AI detecting abnormalities (e.g., sudden drop in activity indicating illness, frequent fighting suggesting overcrowding).





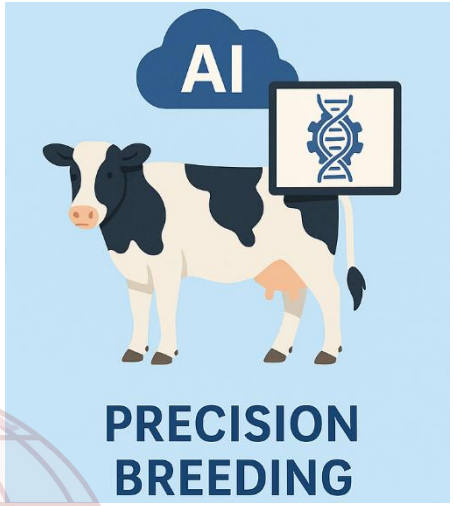


人工智能在畜牧兽医领域的可能应用方向Possible applications of artificial intelligence in animal husbandry and veterinary medicine

育种与繁殖优化

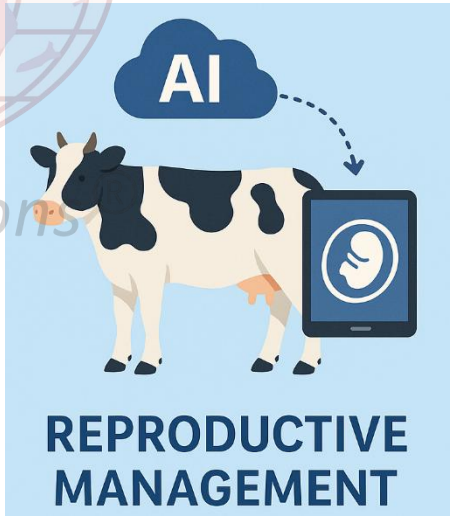
精准选种： AI 综合基因组、生长性能和抗病性数据，筛选优良个体（如奶牛选育产奶高、抗病强的母牛）。

Precision breeding: AI integrates genomic, growth performance, and disease resistance data to identify superior individuals (e.g., selecting dairy cows with high milk yield and strong disease resistance).



繁殖管理： 传感器监测发情行为，AI 预测最佳配种时间并结合胚胎数据优化授精，提高受胎率。

Breeding management: Sensors monitor estrus behavior, AI predicts optimal breeding time and optimizes insemination based on embryo data to improve conception rate.

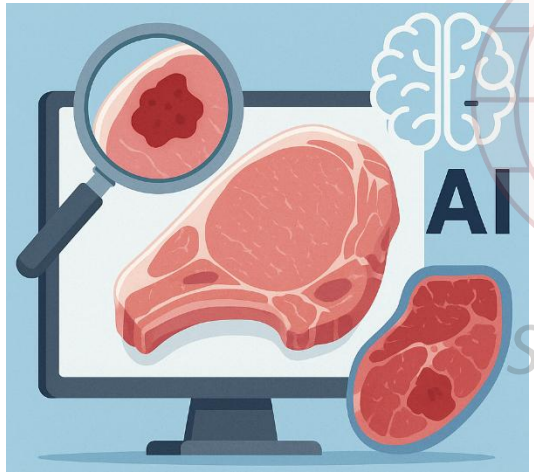


人工智能在畜牧兽医领域的可能应用方向Possible applications of artificial intelligence in animal husbandry and veterinary medicine

屠宰与食品安全

肉质检测：计算机视觉识别颜色与纹理，AI 判断淤血或病变（如识别病死猪肉斑块）。

Meat quality inspection: Computer vision identifies color and texture, and AI detects stasis or lesions (such as identifying plaques in diseased pork).



溯源管理：区块链结合 AI 整合养殖、屠宰、运输信息，扫码即可追溯肉品全生命周期，保障安全。

Traceability management: Blockchain combined with AI integrates information of breeding, slaughtering and transportation. Scan the code to trace the whole life cycle of meat products and ensure safety.

人工智能在畜牧兽医领域的可能应用方向Possible applications of artificial intelligence in animal husbandry and veterinary medicine

疾病防控与诊断

早期预警：AI 基于体温、呼吸、粪便等数据建立健康模型，异常自动报警（如牛体温连续超 39.5℃提示肺炎风险）。

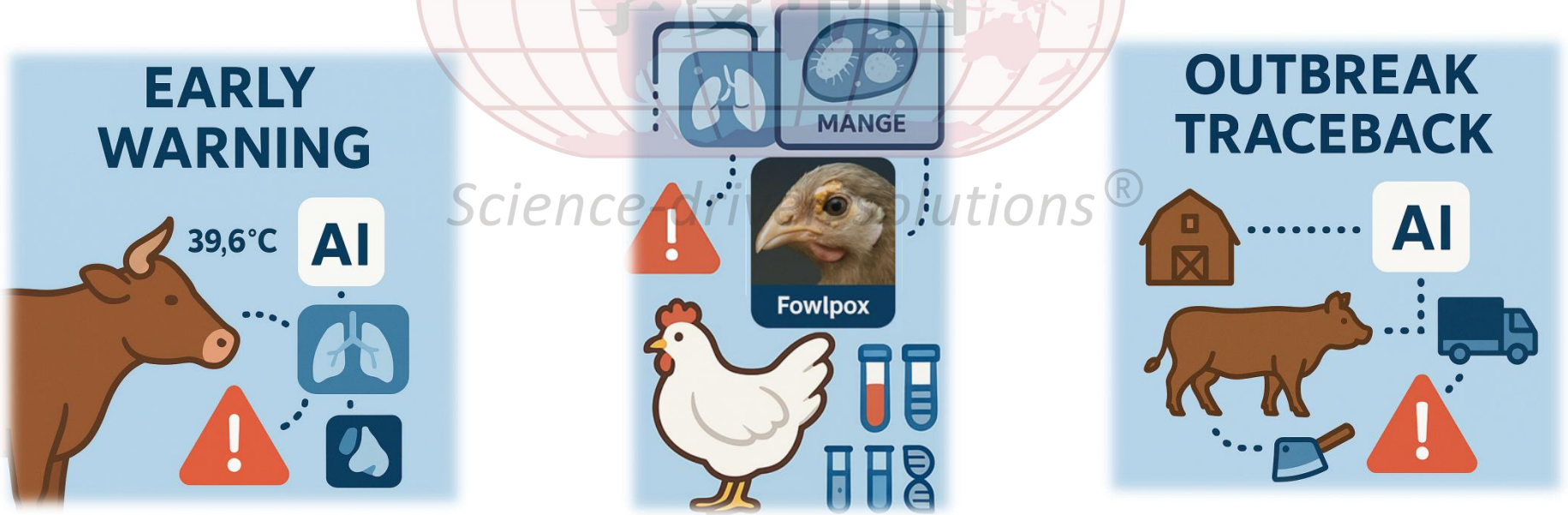
Early warning: AI builds health models based on data such as body temperature, breathing, and feces, and automatically alerts for abnormalities (such as a cows body temperature continuously exceeding 39.5℃ indicating the risk of pneumonia).

快速诊断：结合图像识别（如识别疥螨病、禽痘）与实验室数据（血液、生化、PCR），AI 辅助区分疾病（如非洲猪瘟 vs 古典猪瘟）。

Rapid diagnosis: Combining image recognition (e.g., scabies mite detection, avian pox) with lab data (blood, biochemical, PCR) to assist AI in distinguishing diseases (e.g., African swine fever vs classical swine fever).

疫情追溯：知识图谱整合养殖、运输、屠宰信息，AI 快速定位传播链（如追溯发病仔猪来源及接触群体）。

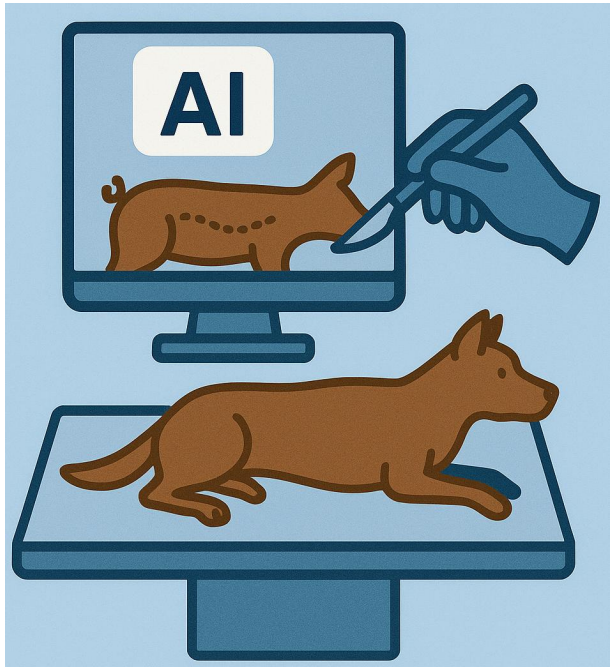
Epidemic tracing: The knowledge graph integrates information on breeding, transportation, and slaughtering, while AI rapidly identifies transmission chains (e.g., tracing the origin of infected piglets and contact groups).



人工智能在畜牧兽医领域的可能应用方向
Possible application direction of artificial intelligence in animal husbandry and veterinary medicine

教学与技能培训

虚拟仿真实践：AI 构建解剖与手术场景（如犬剖腹产模拟），学生可反复练习并获得实时纠错，弥补实践资源不足。
Virtual simulation practice: AI construction of anatomy and surgery scenarios (such as dog cesarean section simulation), students can practice repeatedly and get real-time error correction, making up for the lack of practical resources.



智能教学辅助：基于 NLP 的问答系统解答病例与用药问题，AI 根据学习薄弱点推送个性化资料（如驱虫剂量计算案例）。
Intelligent teaching assistance: the NLP-based question answering system can answer cases and medication questions, and the AI can push personalized materials (such as the calculation case of anthelmintic dosage) according to weak learning points.

人工智能教学科研平台的搭建

Building artificial intelligence teaching and research platform

基于python人工智能平台的搭建
Building a Python artificial intelligence platform

人生苦短®
我用python

python基本知识

- 数据类型和变量
- 流程控制
- 函数
- 类和实例

python基本库

- numpy
- pandas
- matplotlib

数学知识

- 线性代数
- 微积分
- 概率统计

python专门库

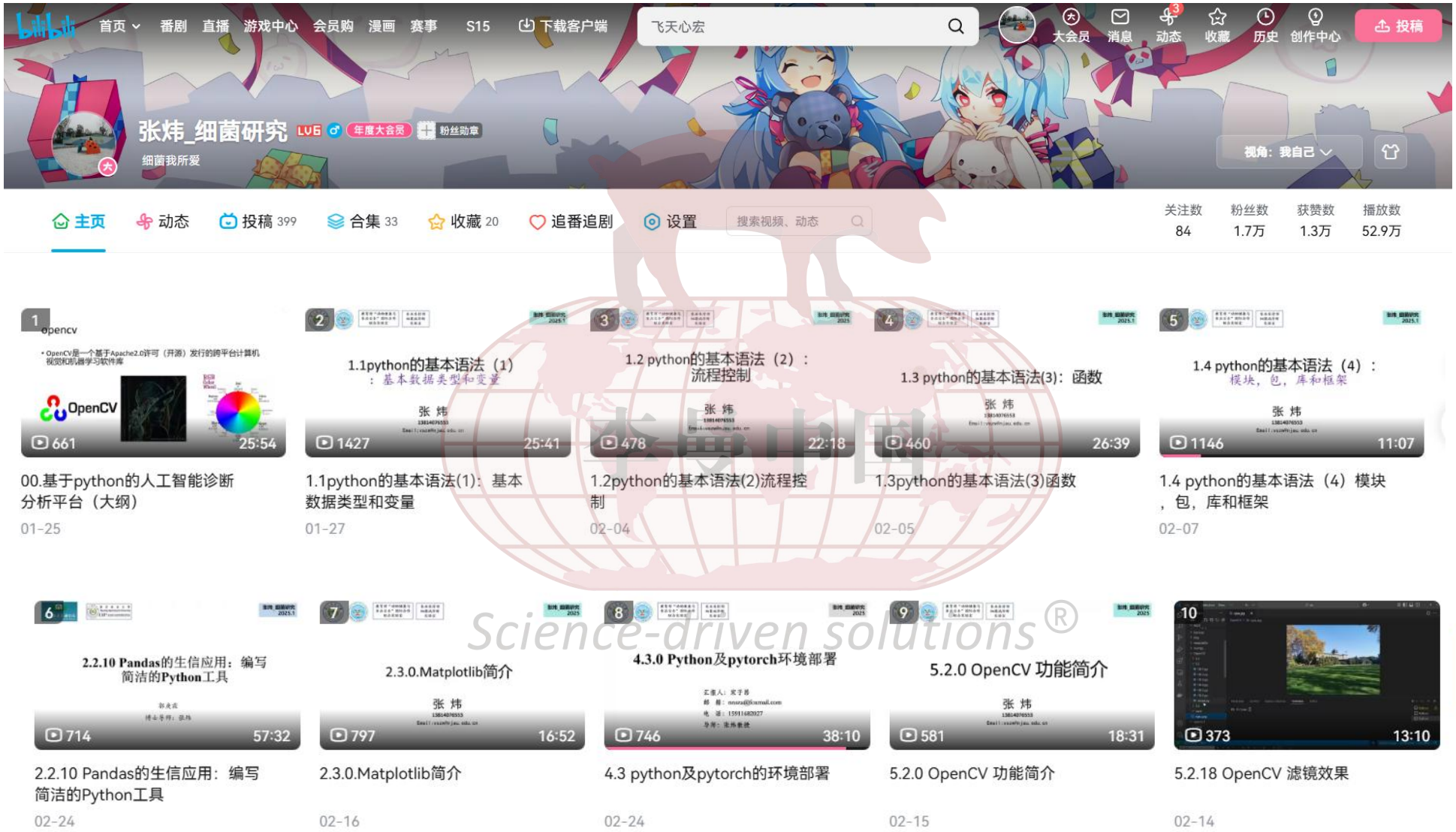
- Pytorch
- Opencv
- yolo

应用端

- 数据分析和作图
- 计算机视觉实时诊断
- 疫苗设计
- 分子互作

自建免费课程：python和人工智能应用

Self-built free course: Python and Artificial Intelligence Applications



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自建免费课程：细菌生信分析平台

Self-built free course: bacterial bioinformatics analysis platform

2025 张炜细菌研究培训02A 生信平台（专题一）

07-31

2025 张炜细菌研究培训02B 生信平台（专题二）

08-01

2025 张炜细菌研究培训02C 生信平台（专题三）

08-07

2025 张炜细菌研究培训02D 生信平台（专题四）

08-28

2025 张炜细菌研究培训02D 生信平台（专题4-2）Python生物信息学入门

09-04

2025 张炜细菌研究培训02E 生信平台（专题五【上】）： 命令行软件的使用简介

09-10

2025 张炜细菌研究培训02E 生信平台（专题五【下】）： 命令行软件的使用简介

09-13

https://space.bilibili.com/315989791/lists/5932390?type=season

自建免费课程：猪的免疫学与病原学

Self-funded free course: Immunology and Pathogenetics of pigs

https://space.bilibili.com/315989791/lists/4893577?type=series

三个层次硬件平台Three levels of hardware platform

个人电脑

- 系统：
  - 虚拟机
  - WSL
  - 双系统/全新安装
  - ssh登录
- 分析能力：
  - 小数据量
  - 视觉模型应用

高性能台式机

- 系统：
  - 生信：linux
  - AI：window
- 分析能力：
  - 中数据量
  - 几百株的泛基因组
  - 人工智能分析

服务器

- 系统：
  - 生信：linux
  - 人工智能服务器
- 分析能力：
  - 大模型建立
  - 根据您的钞能力

动物疫病人工智能诊断及生态防控的整体构想

"Ecosystem" for Artificial Intelligence Diagnosis, Prevention and Control of bacterial diseases

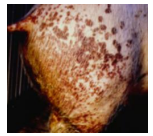
实时的人工智能诊断
Ai diagnostics in real time

三种症候群

呼吸道

消化道

皮肤异常



pytorch
OpenCV
YOLO

计算机视觉
分析建模

三层次的模型

区分正常和异常状态

特定症状匹配特定疫病

早期发病预警模型体系

病原分离和分型
Pathogen isolation and typing

现场诊断

宏基因组

病原的培养及鉴定

表型

耐药性
血清型
毒力评估

基因型分析

耐药基因
毒力基因
基因分型
泛基因组
血清分子分型

主要细菌病鉴定和分型

生态友好型防控技术
eco-friendly bacterial disease control measures

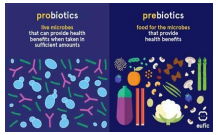
抗菌肽

基于反向疫苗学的高效亚单位疫苗

针对性噬菌体鸡尾酒制剂

猪

益生元/菌建立群动物肠道稳态

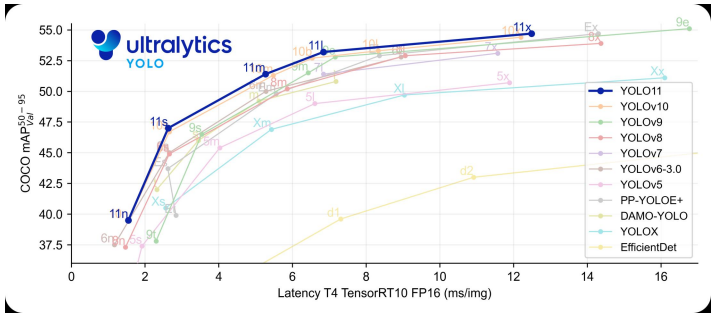


什么是计算机视觉？ What is computer vision?

•计算机视觉：利用摄像机和电脑对目标进行分割、分类、识别、跟踪、关键点等功能。简单来说，就是给计算机安装上“眼睛”（照相机）和“大脑”（算法），让计算机能够感知环境。

•Computer vision: The use of cameras and computers to segment, classify, recognize, track, and identify points of interest. Simply put, it is to give the computer an "eye" (camera) and a "brain" (algorithm) so that the computer can perceive the environment.

YOLO（You Only Look Once）是一种实时目标检测系统，通过单个神经网络预测目标边界框和类别
YOLO (You Only Look Once) is a real-time target detection system that uses a single neural network to predict target bounding boxes and categories



兽医开发计算机视觉诊断体系的机遇和优势
Opportunities and advantages for veterinarians to develop computer vision diagnostic systems

- 基于**yolo算法进行目标分类和检测**，普通电脑+小数据量；
- Object classification and detection based on yolo algorithm, ordinary computer + small data volume;
- 借助**deepseek等工具**可以辅助代码生成
- Tools such as DeepSeek can be used to assist code generation
- 模型事实上相当于一个**经验丰富的兽医24小时实时观察和初步诊断。**
- The model is in effect the equivalent of an experienced veterinarian observing and making a preliminary diagnosis 24 hours a day.
- **非介入式诊断**有效防止疾病传播
- Non-invasive diagnosis is effective in preventing the spread of disease

经典诊断方法
Classic diagnostic methods

“智能时代”兽医
Intelligent Age" Veterinary

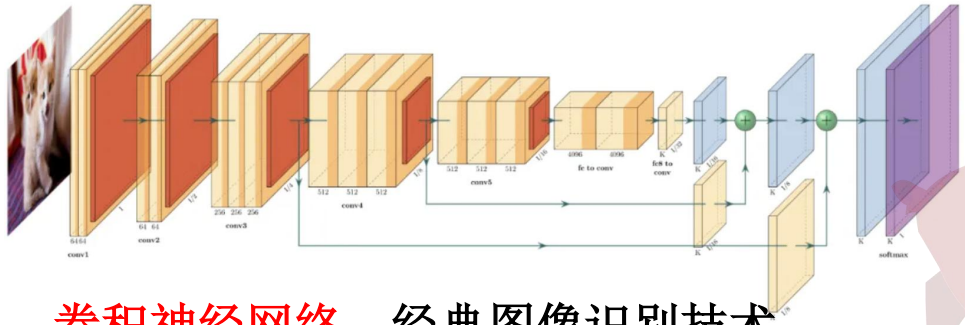
计算机知识
Computer knowledge

Deepseek等代码生成

yolo

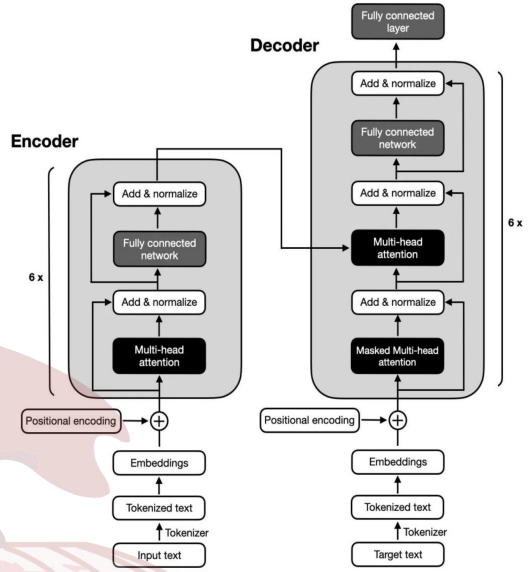
传感器

计算机视觉相关原理
Principles of computer vision



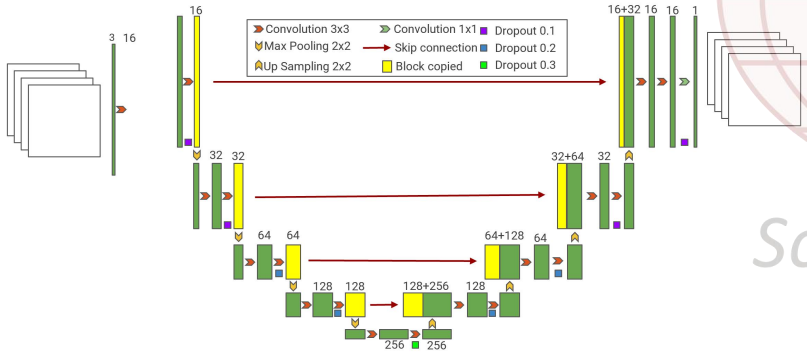
卷积神经网络，经典图像识别技术

Convolutional neural network, classical image recognition technology



Transformer技术，也是chatGPT核心技术，其注意力机制后被YOLO12算法引入

The Transformer technology, a core component of ChatGPT, was later enhanced by the YOLO12 algorithm through its attention mechanism.



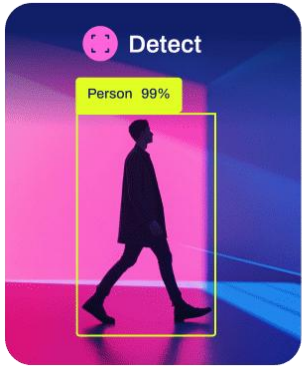
U-Net 图像分割技术

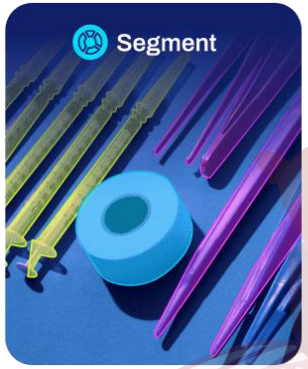
U-Net image segmentation

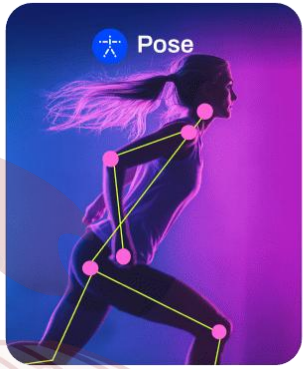
目标检测Object detection

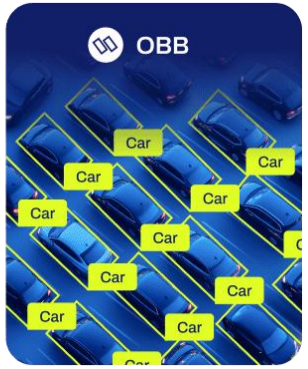
yolo的算法的功能及在动物疾病诊断建模

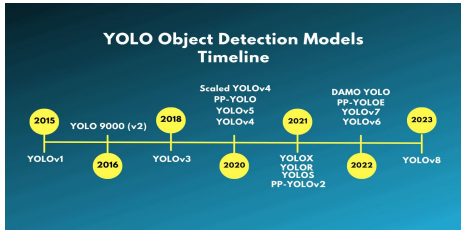
The functionality of Yolos algorithm and its application in animal disease diagnosis modeling











- 1. 基础目标检测（核心功能）1.Basic object detection (core feature)
- 2. 颜色识别2.color discrimination
- 3. 动作识别3.movement identification
- 4. 姿态估计4.attitude estimation

- 动物在哪里？ Where are the animals?
- 动物的颜色动作是不是正常？ Is the animals coloration and behavior normal?
- 可能是什么病？ What could it be?

基于计算视觉的动物疫病诊断模型训练流程

Training process of animal disease diagnosis model based on computational vision

Pytorch yolov8 | LSTM（时间序列分析） | Deepsort（图像跟踪） | opencv | pyside6

三种症候群

Three types of syndromes

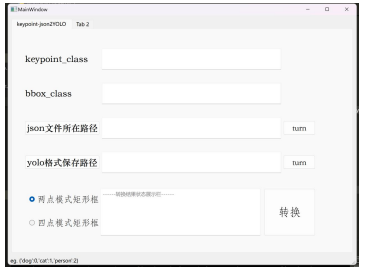
- 呼吸道：
- Respiratory tract:
- 消化道：
- Digestive tract:
- 皮肤：
- Skin:

1.采集视频

Capture video

2.提取关键帧

Extract key frame

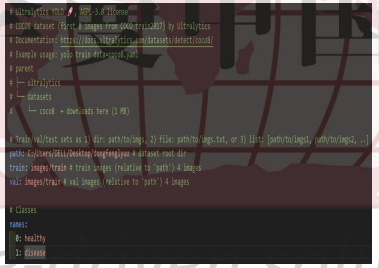


3.转码

transcoding

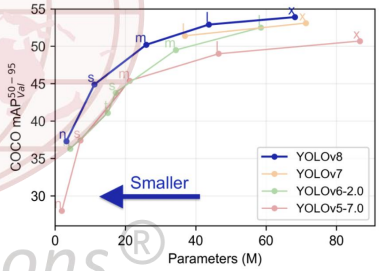
4.图像标注

Image annotation



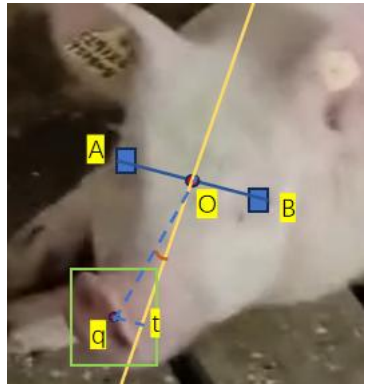
5.部署训练

Deployment training



6.验证集验证

Verification set verification



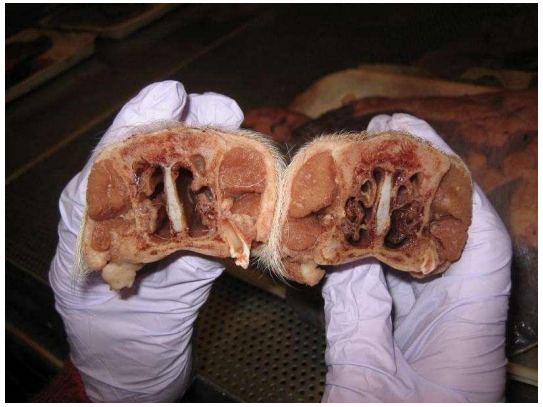
获得患病模型识别效果

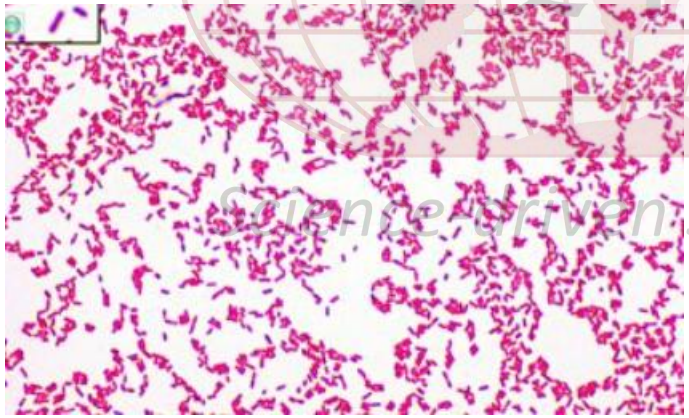
The effect of disease model identification was obtained

呼吸道症候群：猪萎缩性鼻炎
Respiratory syndrome: swine atrophic rhinitis

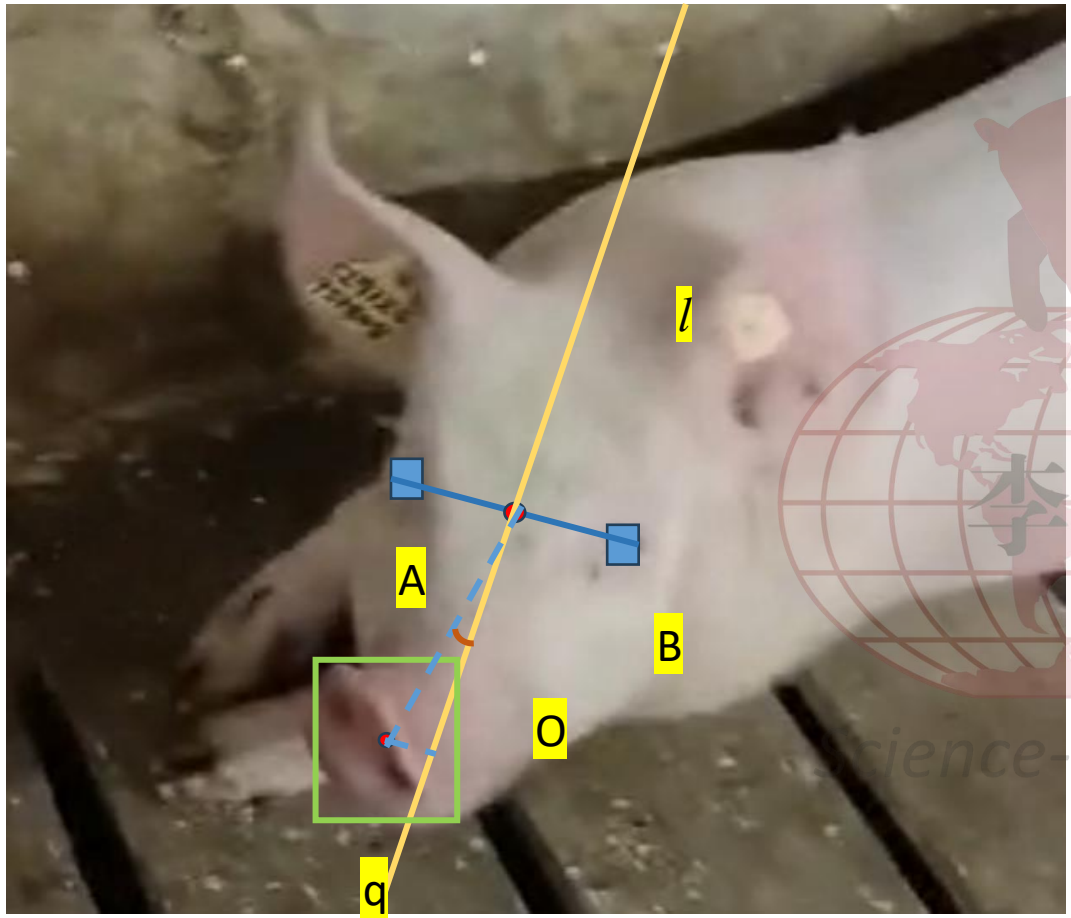
可能病原：Possible pathogen:

- 多杀性巴氏杆菌（*Pasteurella multocida*）
- 支气管败血波氏杆菌（*Bordetella bronchiseptica*）





针对萎缩性鼻炎的歪鼻子症：姿态异常
The crooked nose condition associated with atrophic rhinitis: abnormal nasal posture



1.此时**眼睛**即为及其准确的特征锁定点，连接双眼A与B，做**中垂线l**，这条中垂线即为猪头的中线，根据三角形相似原理，**只要暴露双眼，那么双眼连线的中垂线一定是猪头中线**，而不会随猪头角度的改变而改变这个原则

1.At this moment, the eyes serve as the most precise feature reference point. By connecting points A and B of the eyes and constructing the perpendicular bisector l, this line becomes the midline of the pigs head. According to the principle of similar triangles, once the eyes are exposed, the perpendicular bisector of their connecting line will always align with the pigs midline, remaining constant regardless of head angle variations.

2.给**猪鼻子**单独做图像识别，识别框的中心即为鼻镜的中心q，可以体现吻突部分的位置。

2.For pig nose image recognition, the center of the recognition box corresponds to the center q of the nasal mirror, which can reflect the position of the snout protrusion.

3.此时如果做qO连线，可直接用qO与l的角度表示猪鼻子弯曲度，通过反三角函数求解。把q坐标位置带入l线的一元一次表达式，又可以得到猪鼻子到底是往左眼还是右眼方向弯曲的。

3.In this scenario, by establishing a qO connection, the curvature of the pigs nose can be directly represented through the angle between qO and l, with solutions obtained via inverse trigonometric functions. Substituting the q-coordinate position into the linear equation of l further determines whether the nose curves toward the left or right eye.

（宋子昂，张炜）

算法设计：针对萎缩性鼻炎（代码实现）

Algorithm design: atrophic rhinitis (code implementation)

```
from PySide6.QtCore import *
from PySide6.QtGui import *
from PySide6.QtWidgets import *
from PySide6.QtMultimedia import *
from home import Ui_MainWindow
from pathlib import *
from ultralytics import YOLO
import cv2
import math
def calculate_perpendicular_bisector(point1, point2,x):
    # 计算中点坐标
    midpoint_x = (point1[0] + point2[0]) / 2
    midpoint_y = (point1[1] + point2[1]) / 2


    # 计算两点连线的斜率
    if point2[0] - point1[0] != 0:
        slope = (point2[1] - point1[1]) / (point2[0] - point1[0])
.....（省略数行）
```

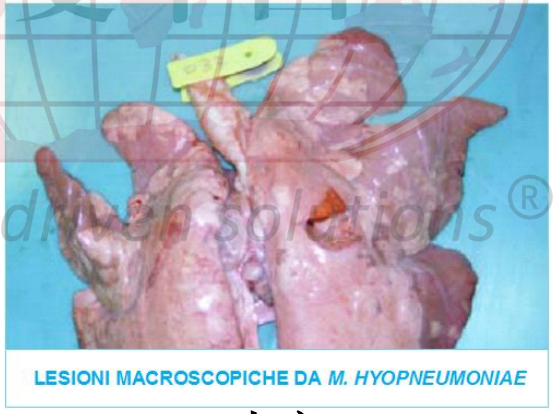
```
def 中垂线方程(point1, point2):
    # 计算中点坐标
    midpoint_x = (point1[0] + point2[0]) / 2
    midpoint_y = (point1[1] + point2[1]) / 2

    # 计算两点连线的斜率
    if point2[0] - point1[0] != 0:
        slope = (point2[1] - point1[1]) / (point2[0] - point1[0])
        # 计算中垂线的斜率
        if slope != 0:
            slope = -1 / slope
        else:
            slope = float('inf')  # 当连线斜率为 0 时，中垂线斜率为无穷大
    else:
        slope = 0  # 当连线斜率为无穷大时，中垂线斜率为 0

    # 计算中垂线的截距
    if slope != float('inf'):
        intercept = midpoint_y - slope * midpoint_x
        # 输出中垂线方程
        return slope,intercept
    else:
        # 当斜率为无穷大时，中垂线方程为 x = 常数
        intercept = midpoint_x
        slope=0
    return slope,intercept
```

萎缩性鼻炎实机演示
Atrophic rhinitis demonstration

呼吸道症候群：猪喘气病
Respiratory syndrome: Swine dyspnea

- 病原：猪肺炎支原体（*Mycoplasma hyopneumoniae*）
- Pathogen: Mycoplasma hyopneumoniae (porcine pneumonia)
- 典型症状：犬坐式，事实上是呼吸困难。
- Typical symptoms: Dog sitting, which is actually dyspnea.

犬坐式
Dog sitting



肉变
Meat like lesions

煎蛋样菌落
Pancake-like colonies

犬坐式算法模型设计：姿态/动作异常

Design of dog sitting algorithm model: posture/behavioral anomaly

猪支原体感染后，呈现犬坐式症状

After infection with Mycoplasma suis, the dog sits down

设计3个关键点，分别为颈，中，尾 部，通过比较这三个关键点位置特征，来辅助说明猪目前一个大致的体态

The three key points of design are neck, middle and tail. By comparing the positional characteristics of these three key points, the general body posture of pigs can be illustrated

图1、2都是一个犬坐式姿势，这个姿势的特征是∠ABC在一个钝角范围，并且按位置高度 **A ≈ B >> C**

Figure 1 and 2 are both dog sitting positions, which are characterized by an obtuse angle ∠ ABC and a positional height A ≈ B>> C

图3 是一个正常的觅食状姿态，它的位置特征是**B ≈ C > A**

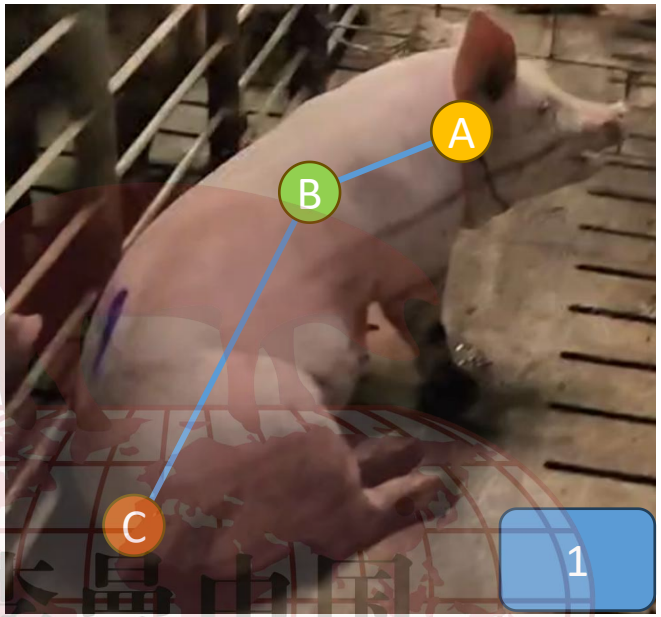
Figure 3 is a normal foraging posture, whose positional feature is B ≈ C> A

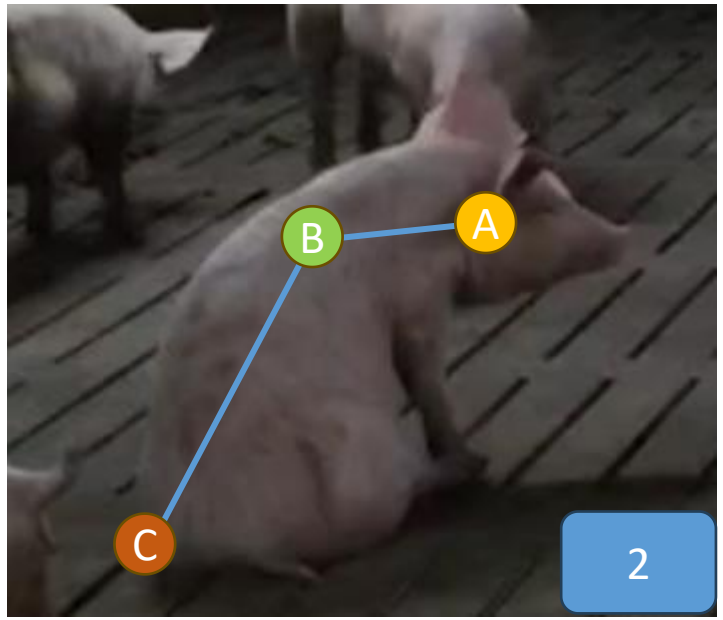
图4是一个仰头状姿态，可能与角弓反张等病态有关，其位置高度特征是

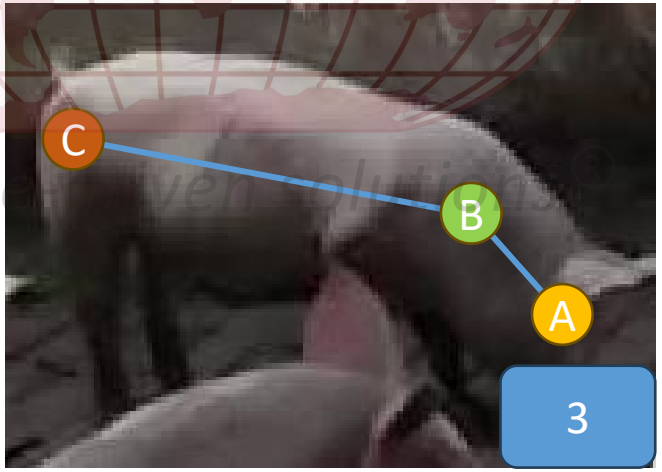
A > B ≈C

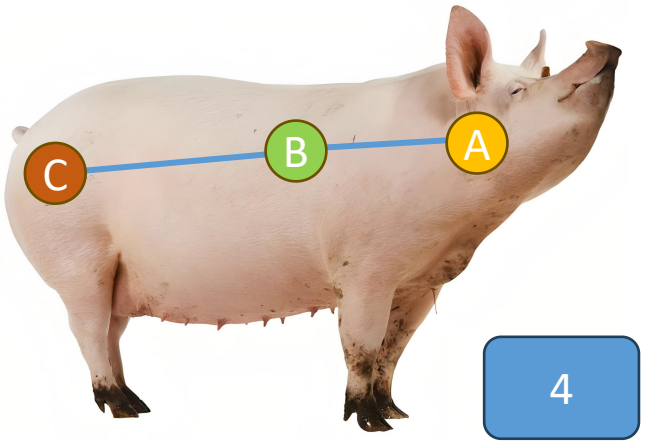
Figure 4 is a supine head posture, which may be related to pathological conditions such as opisthotonos. The height characteristics of its position are

A > B ≈ C



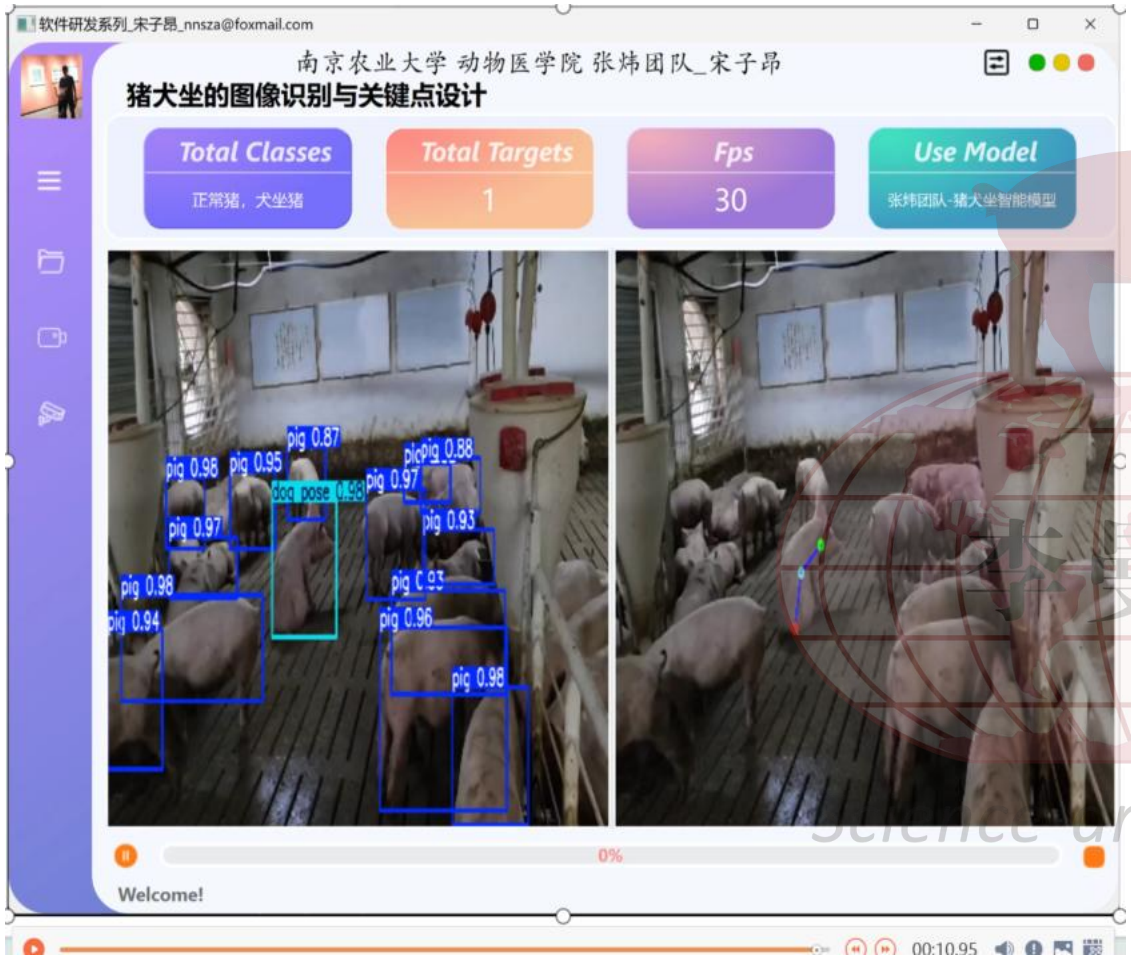






（宋子昂，张炜）

猪犬坐式算法实机展示：
Pig sitting algorithm demonstration:



消化道症候群：猪腹泻：颜色状态异常

Gastrointestinal syndrome: Pig diarrhea: abnormal color and condition

仔猪白痢
Piglet white diarrhea

大肠杆菌
Escherichia coli

仔猪黄痢
Piglet Yellow diarrhea

仔猪红痢
Piglet dysentery

https://nadis.org.uk/disease-a-z/pigs/swine-dysentery/

产气荚膜梭菌/
Clostridium perfringens /
短螺旋体
Short spirochetes
胞内劳森菌
Intracellular Lawsonella

- 通过粪便的颜色和质地，对典型的猪消化道细菌病原进行初步诊断
- The color and texture of feces are used to make a preliminary diagnosis of typical bacterial diseases in the digestive tract of pigs

仔猪黄白痢模型
Piglet Yellow and White Diarrhea Model

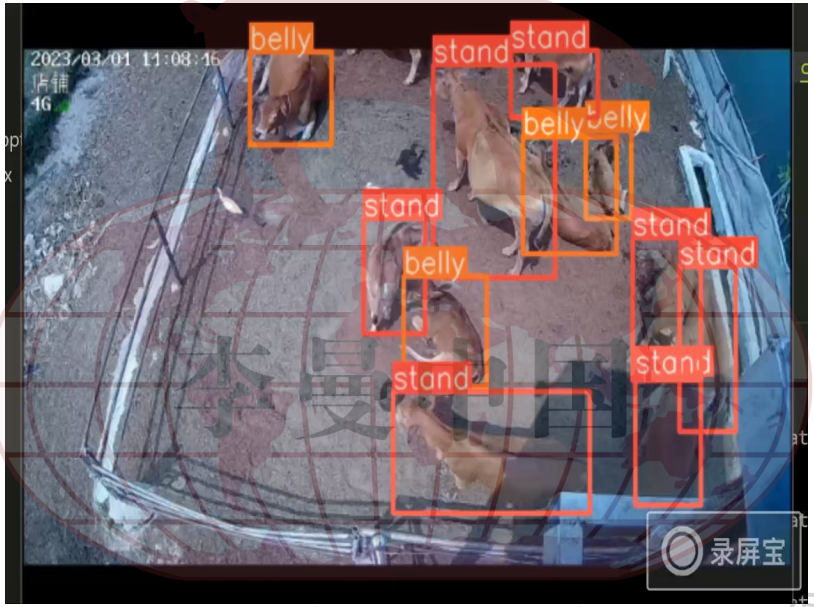
（宋子昂，张炜）

消化道症候群：产气荚膜梭菌引起的异常动作

Gastrointestinal syndrome: abnormal movements caused by gas-producing Clostridium perfringens

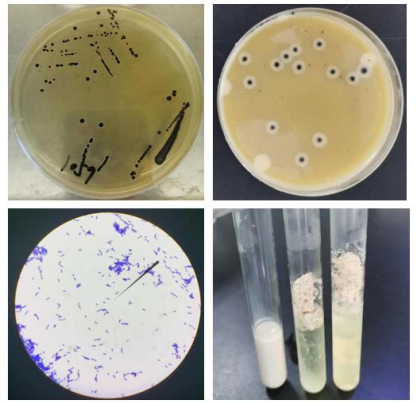
牛场原视频记录

The original video recording of the cattle farm



牛场梭菌病实时检测（四肢划水）

Real-time detection of bovine clostridium disease



产气荚膜梭菌分离株形态

Morphology of Clostridium perfringens isolates

（宋子昂、田睿，张炜）

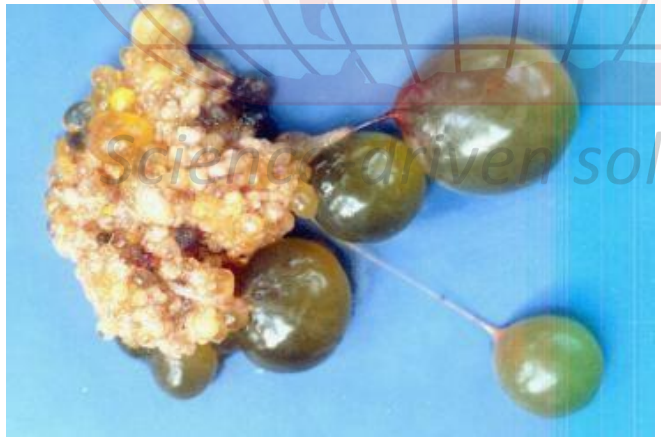
产气荚膜梭菌（***Clostridium perfringens***）：厌氧，产芽孢，产毒素

Clostridium perfringens: an anaerobic spore-forming bacterium that produces toxins

消化道症候群：鸡白痢：颜色和状态异常
Gastrointestinal syndrome: White diarrhea: abnormal color and condition

病雏由于严重拉痢，肛门下放绒毛被粪便粘集在一起形成‘糊屁股’
The sick puppy developed severe diarrhea, with anal hair being stuck to feces and forming a glutinous butt (a colloquial term for sticky stool).

肝脏上的灰白色坏死灶
Grayish-white necrotic foci in the liver



成年鸡卵巢变性、变形、坏死
Adult chicken ovarian degeneration, deformation and necrosis

宋子昂 孟慧 孙卫东 张炜

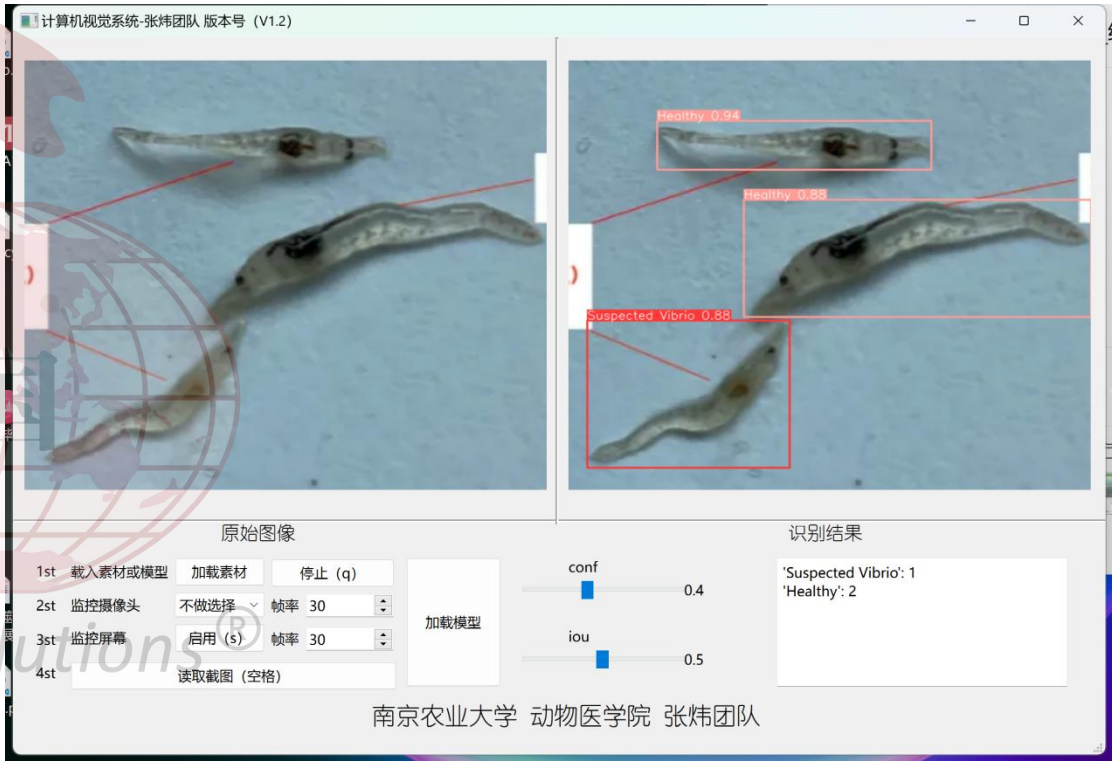
病虾：虾线及虾胃颜色变浅

Sick shrimp: the color of shrimp line and stomach becomes lighter

- 副溶血弧菌感染对虾后，引起早期死亡综合征（EMS）或急性肝胰腺坏死综合征（AHPNS）可导致肠道发白
- Vibrio parahaemolyticus infection in shrimp can trigger early death syndrome (EMS) or acute hepatopancreatic necrosis syndrome (AHPNS), which may cause intestinal whitening.

实际检测场景示例（图上片来自中网络上代表性发病和健康虾图片）

Actual test scenario example (top image shows representative images of diseased and healthy shrimp from the Zhong Network)



玻璃苗：病虾肠道明显发白，变透明

Glass seedling: the intestinal tract of sick shrimp is obviously white and transparent

（宋子昂，张炜）

皮肤症候群：猪皮肤局部颜色异常

Skin syndrome: abnormal local color of pig skin

油皮病
Lard skin disease

表皮葡萄球菌
Staphylococcus epidermidis

猪丹毒
Pig erysipelas

猪丹毒丝菌
Porcine erysipelas fungus

- 通过皮肤异常的颜色变化，对典型皮肤症候群进行初步诊断
- The preliminary diagnosis of typical dermatological syndromes is made by abnormal skin color changes

油皮病诊断模型
Diagnosis model of lard skin disease

（宋子昂，张炜）

计算机视觉—皮肤及体表

Computer vision-skin and body surface

乌鳢眼睛与鱼鳍部位检测与病症特写

Detection of the eyes and fins of Channa argus and close-ups of the symptoms

关节和动作：猪链球菌四肢划水

Joints and movements: Streptococcus suis paddling on all four limbs

- 猪链球菌是重要的人畜共患病病原。
  Streptococcus suis is an important zoonotic pathogen.

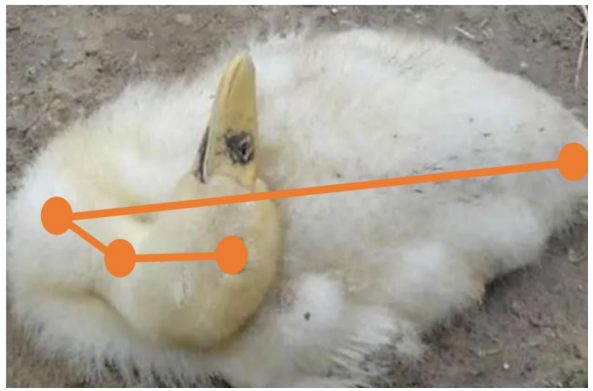
关节炎
Arthritis

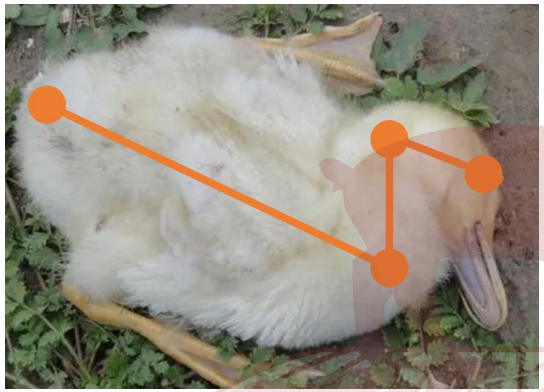
脑膜炎
Cephalomeningitis

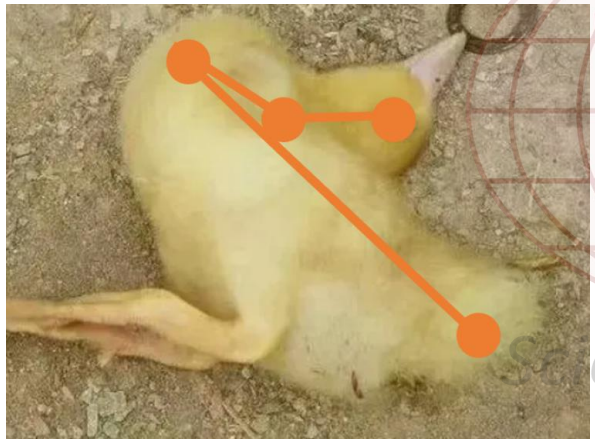
败血症
Sepsis

关节和动作：鸭头颈歪斜和马步态

Joints and movements: duck head and neck tilt and horse stance

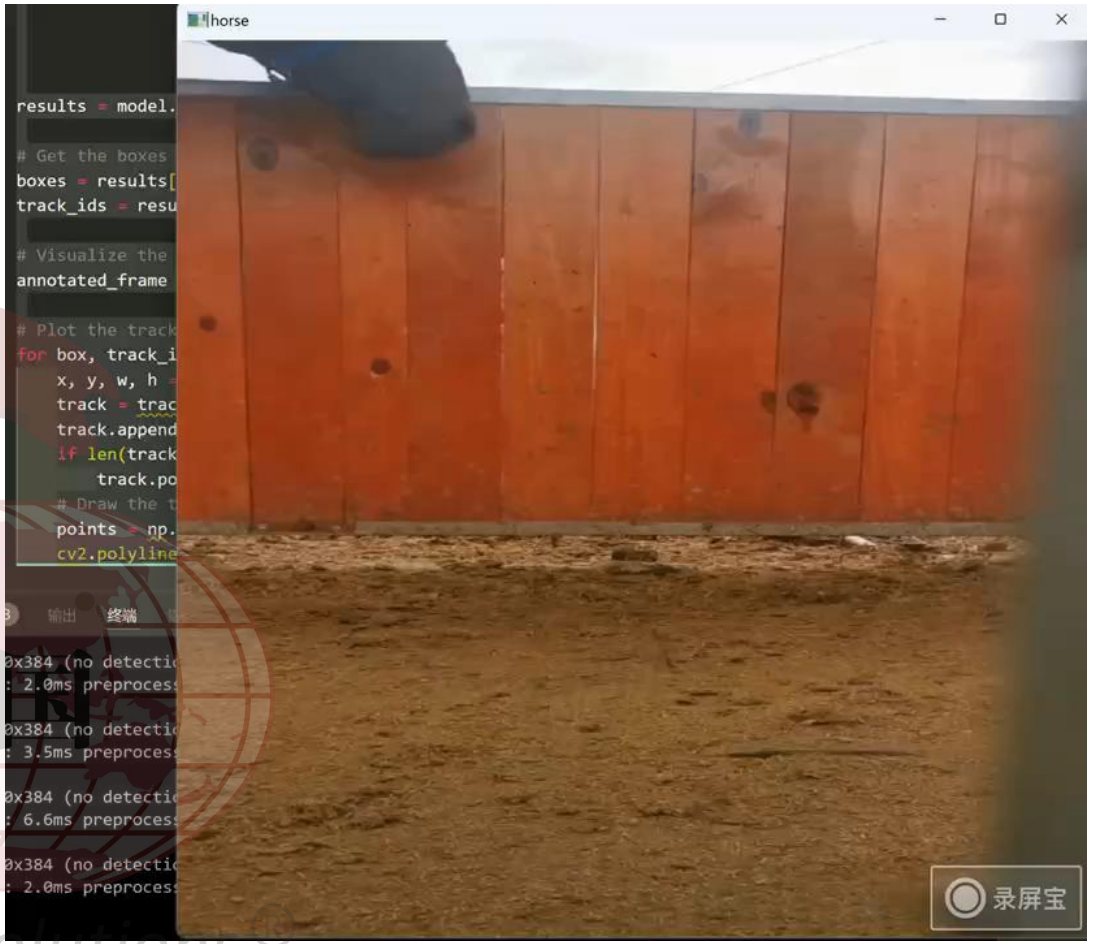






鸭疫里氏杆菌：采取头、颈、胸与泄殖腔部四点关键点标注，根据脖颈扭曲程度，判断是否歪头

Brucella avium: Mark four key points on the head, neck, chest, and cloaca. Determine if the head is tilted based on the degree of neck twisting.



正常马步态：马匹腿部关键点检测，根据关键点连线形成角度判断腿部健康

Normal gait: Detects key points on a horses legs and assesses leg health by analyzing the angles formed by connecting these points.

（宋子昂，张炜）

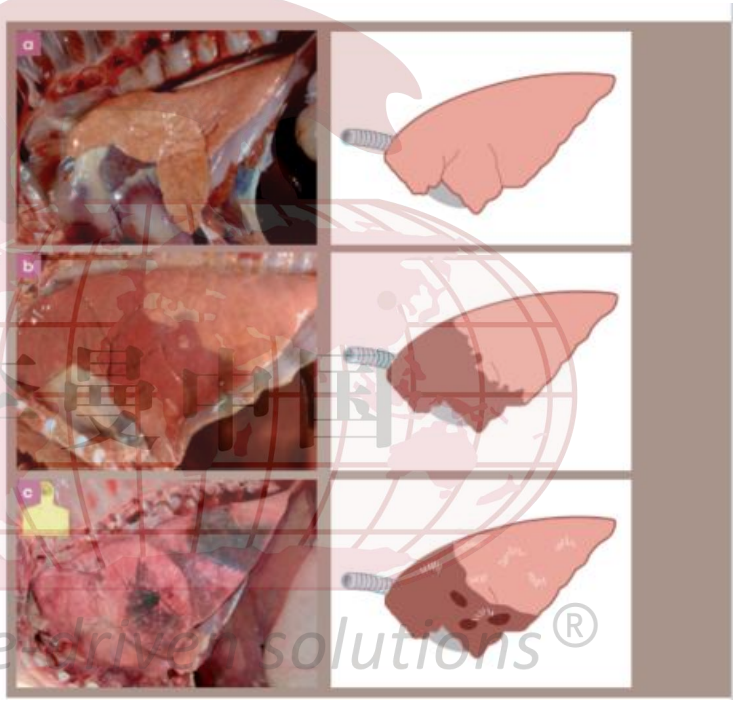
视觉诊断的扩展Extended Visual Diagnosis

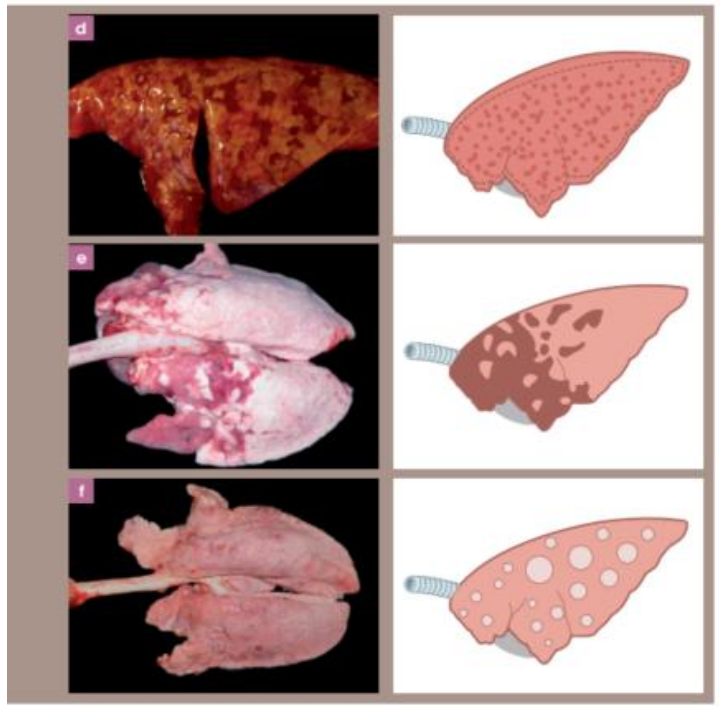
- 体温异常
- Body temperature abnormal

红外线检测

Infrared inspection

- 病变组织辅助检测
- Histopathological examination of lesions





肺部病变评分

Lung lesion score

视觉以外的其它人工智能诊断指标
Other AI diagnostic indicators beyond vision

声音sound

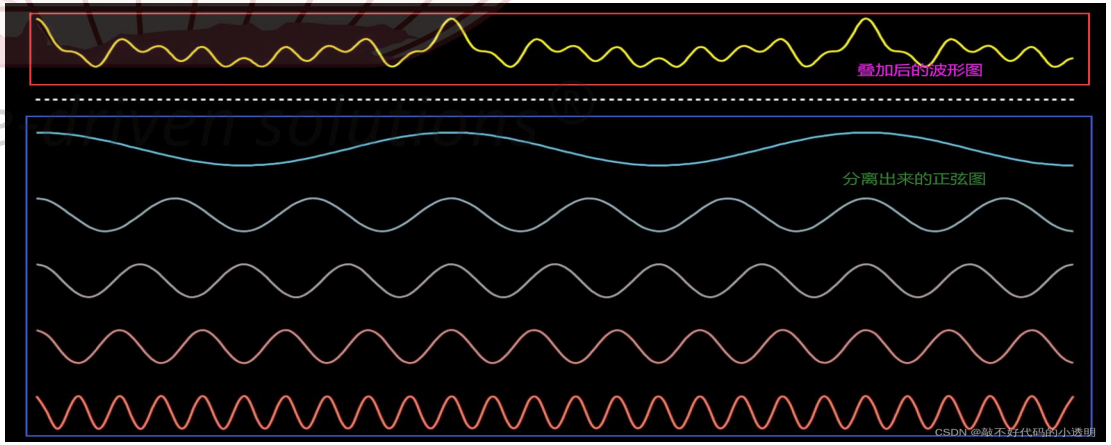
本团队自研发猪咳嗽声音分类器实现对短语句进行标注分类

Our team has developed a pig cough sound classifier to annotate and classify phrases.

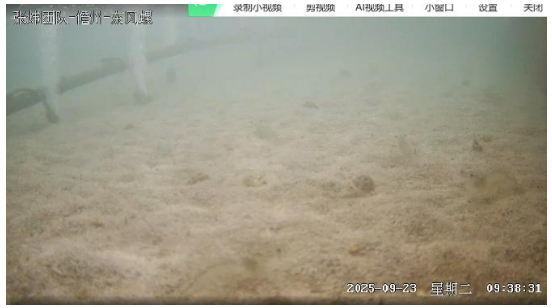
计算机听觉—猪咳嗽识别应用

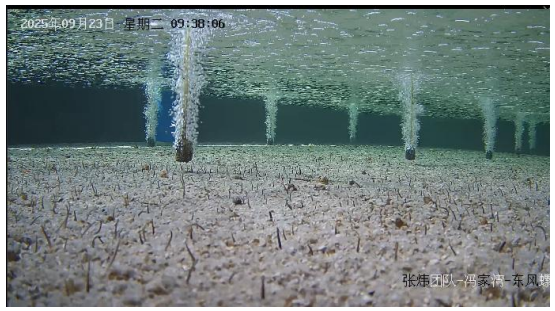
Computer hearing-Pig cough recognition application

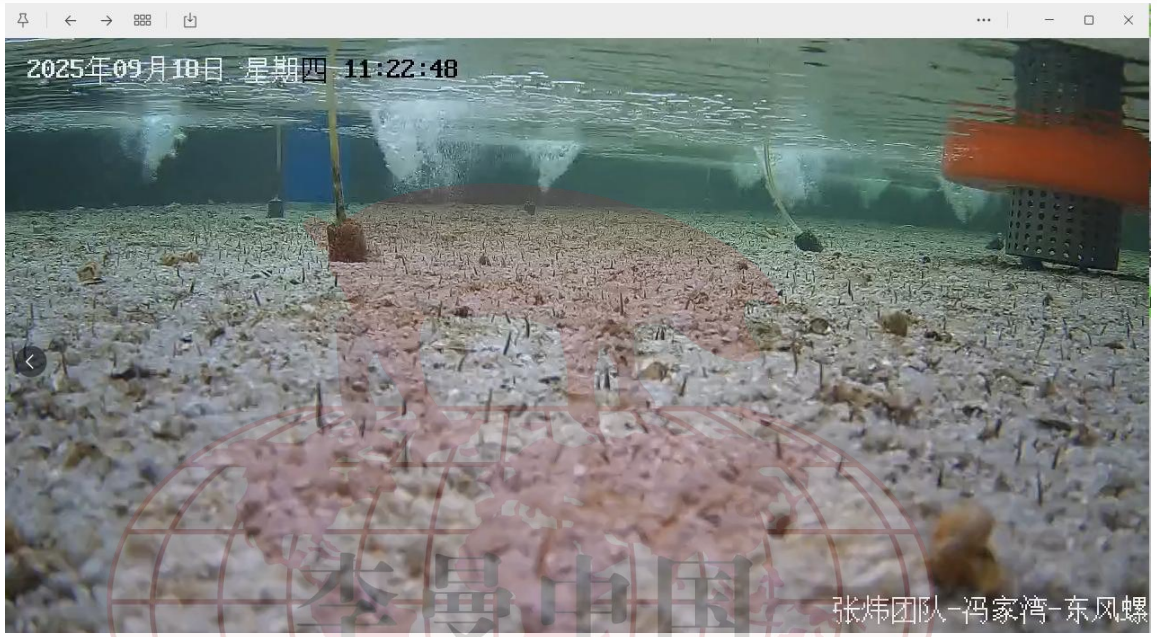
- 几个关键步骤：声音数据的收集与预处理、特征提取、模型训练和分类。
- Several key steps: sound data collection and preprocessing, feature extraction, model training and classification.
- 数据加载与预处理：代码段load_audio_files函数用于加载音频文件，将其处理为MFCC特征，并为每个文件分配标签。
- **Data loading and preprocessing: The load_audio_files function loads audio files, processes them into MFCC features, and assigns labels to each file.**
- 特征提取：使用Librosa库提取MFCC特征。
- **Feature extraction: Extract MFCC features using the Librosa library.**
- 模型构建：使用TensorFlow/Keras构建一个卷积神经网络（CNN）模型。
- **Model construction: Build a convolutional neural network (CNN) model using TensorFlow/Keras.**
- 模型训练：使用训练数据对模型进行训练，并使用测试数据进行验证。
- **Model training: Train the model with training data and validate it with test data.**
- 模型评估与保存：评估模型的准确性并保存训练好的模型以供后续使用。
- **Model evaluation and save: evaluate the accuracy of the model and save the trained model for later use.**



多种环境因子的实时检测（水产动物）
Real-time detection of multiple environmental factors (aquatic animals)







时间	ph值	溶解氧(毫克/	浊度(度)	瞬时水温(摄氏度	盐度
2025-09-	7.64	8.38	4.5	26.6	29.2
2025-09-	7.64	8.25	3.6	26.6	29
2025-09-	7.64	8.22	4.4	26.6	28.7
2025-09-	7.64	8.2	4	26.6	28.7
2025-09-	7.64	8.19	4.3	26.6	28.7
2025-09-	7.64	8.19	3.5	26.6	28.7
2025-09-	7.66	8.18	3.4	26.6	28.7
2025-09-	7.64	8.17	4.2	26.6	28.7
2025-09-	7.64	8.16	3.4	26.6	28.7
2025-09-	7.64	8.16	4.5	26.6	28.7
2025-09-	7.64	8.16	3.7	26.6	28.7
2025-09-	7.64	8.15	3.7	26.6	28.7
2025-09-	7.63	8.14	3.8	26.6	28.7
2025-09-	7.64	8.14	4.4	26.6	28.7
2025-09-	7.64	8.15	4.1	26.6	28.7
2025-09-	7.63	8.15	3.9	26.6	28.7
2025-09-	7.64	8.14	4.4	26.6	28.7
2025-09-	7.63	8.14	4.2	26.6	28.4
2025-09-	7.61	8.12	4.4	26.6	28.4
2025-09-	7.61	8.12	3.6	26.6	28.4
2025-09-	7.61	8.12	3.4	26.6	28.2
2025-09-	7.61	8.11	4.1	26.6	28.2
2025-09-	7.61	8.12	3.9	26.6	28.2
2025-09-	7.63	8.11	4.2	26.6	28.2
2025-09-	7.63	8.11	4.2	26.6	28.4
2025-09-	7.63	8.1	4.5	26.6	28.4
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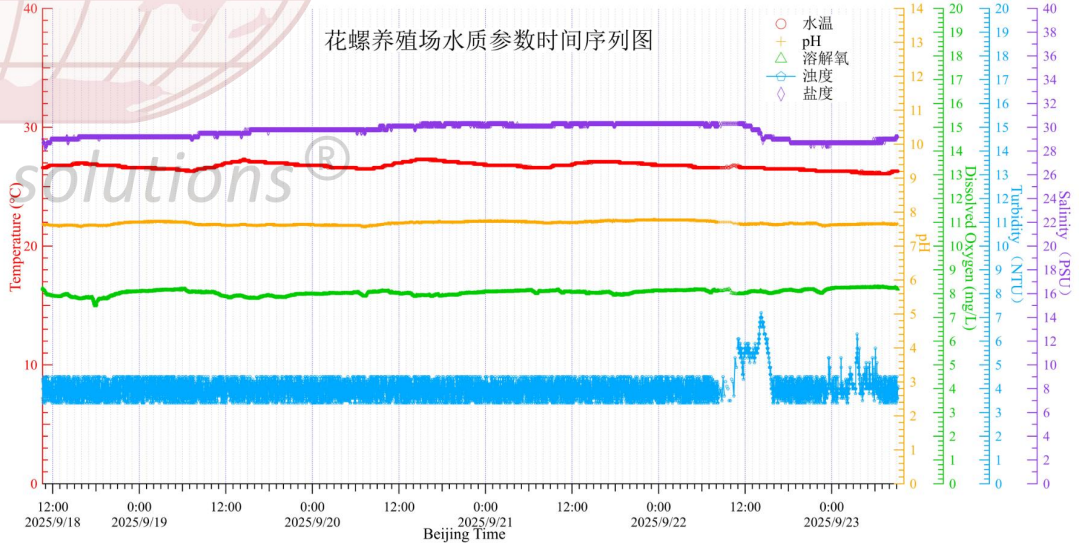
2025-09-	7.64	8.05	4.3	26.6	28.4



多种环境因子的实时检测（陆生动物）
Real-time detection of multiple environmental factors (terrestrial animals)

无线氨气传感器

测量范围:0~100 ppm
测量精度: ±10%
分辨率:0.1PPM
预期寿命:空气中6个月
15ppm氨气浓度下3个月
供电电源:12-24 VDC
工作环境:
- 温度:-30℃-50℃
- 湿度:0~99.9% RH无凝露

通讯方式:Sub-1G
防护等级:IP65
便捷扩展:支持5秒钟添加更换超便捷扩展

无线二氧化碳传感器

测量范围:0~10000 ppm
测量精度:±(50ppm+3% 读数)
分辨率:1PPM
供电电源:12-24 VDC
工作环境:
- 温度:-30℃-50℃
- 湿度:0~99.9% RH无凝露

通讯方式:Sub-1G
防护等级:IP65
便捷扩展:支持5秒钟添加更换超便捷扩展

温度 Temperature	湿度 Humidity
氨浓度Ammonia concentration	光线 Light

无线光照传感器

测量范围:0.01~83000 Lux
测量精度:±2%
分辨率:1Lux
供电电源:一次性锂锰电池
电池寿命:12个月
工作环境:
- 温度:-30℃-50℃
- 湿度:0~99.9% RH无凝露

通讯方式:Sub-1G
防护等级:IP65
便捷扩展:支持5秒钟添加更换超便捷扩展

无线硫化氢传感器

测量范围:0~50 ppm
测量精度:±10%
分辨率:0.1PPM
预期寿命:12个月
供电电源:12-24 VDC
工作环境:
- 温度:-30℃-50℃
- 湿度:0~99.9% RH无凝露

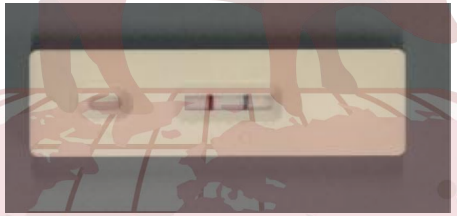
通讯方式:Sub-1G
防护等级:IP65
便捷扩展:支持5秒钟添加更换超便捷扩展

现场快检和整体诊断
On-site rapid test and overall diagnosis

快速检测Rapid testing

可以采用RPA和手持qPCR等快检方法，初步筛选和建立主要病原菌的快检方法，最快可在**30 min**内完成病原的检测，并具有良好的特异性和灵敏度。Rapid detection methods such as RPA and handheld qPCR can be used to preliminarily screen and establish rapid detection methods for major pathogenic bacteria. The detection of pathogens can be completed in 30 min at the earliest, with good specificity and sensitivity.

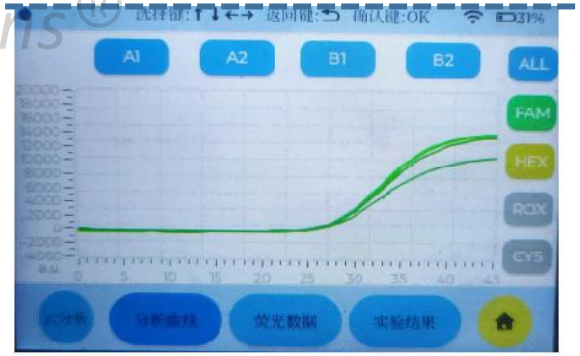
定性



基于等温重组酶聚合酶扩增（RPA）和侧向层析试纸（LFD）建立一种**快速、简单、高特异性**的细菌检测方法。
A rapid, simple and highly specific bacterial detection method was established based on isothermal recombinase polymerase amplification (RPA) and lateral chromatography test paper (LFD).

RPA-F：TTCGTGCTCTAGGTTCCAGACAAAGTGATCCG
RPA-R：/Biotin/CCACAACACTCAGCTCCAAGTCAATATCTTCG
RPA-探针:/FAM/TCGGAAGGATCGCCCTCCAAGTACATACCG/dSpacer/CATTGTCAGTACTAAT/C3spacer

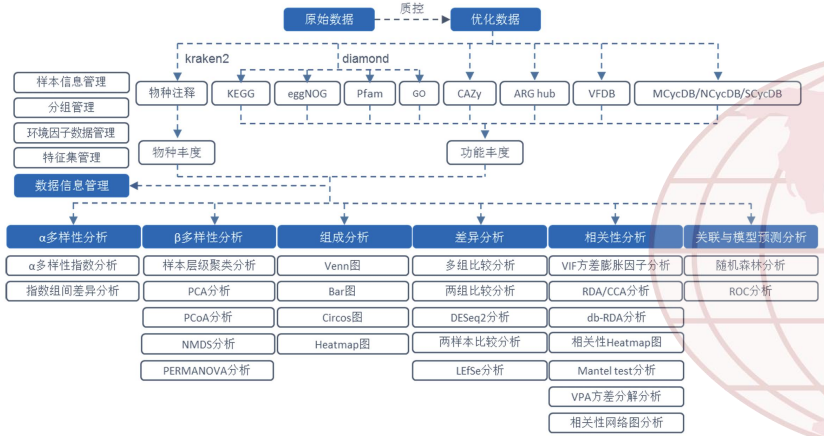
定量



使用噬菌体后宏基因组监测
Metagenomic monitoring after phage use

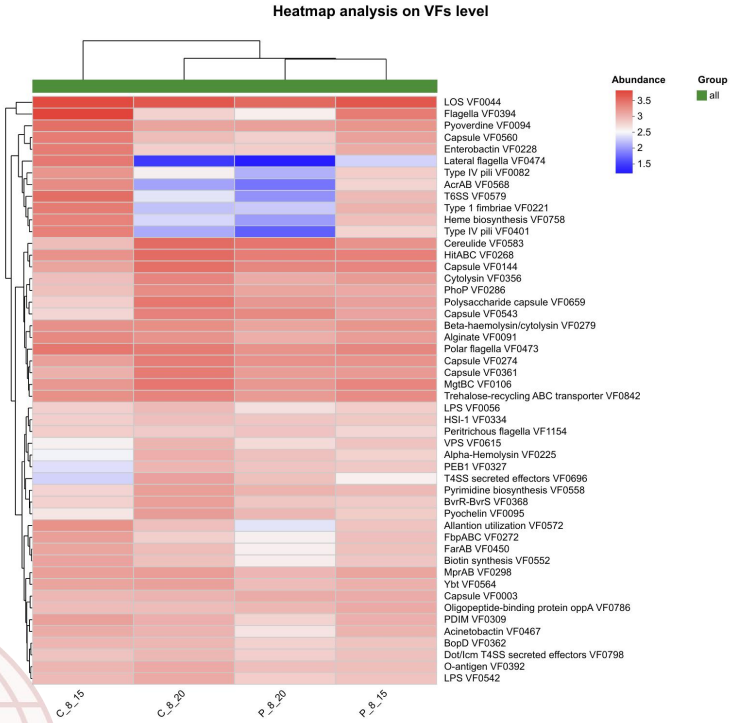
2. 基于reads的宏基因组云分析流程——基于reads的分析服务

使用质控的clean reads直接与已知物种和功能数据库进行比对，得到每个样本的物种、功能注释信息和相对丰度变化等，分析速度快。



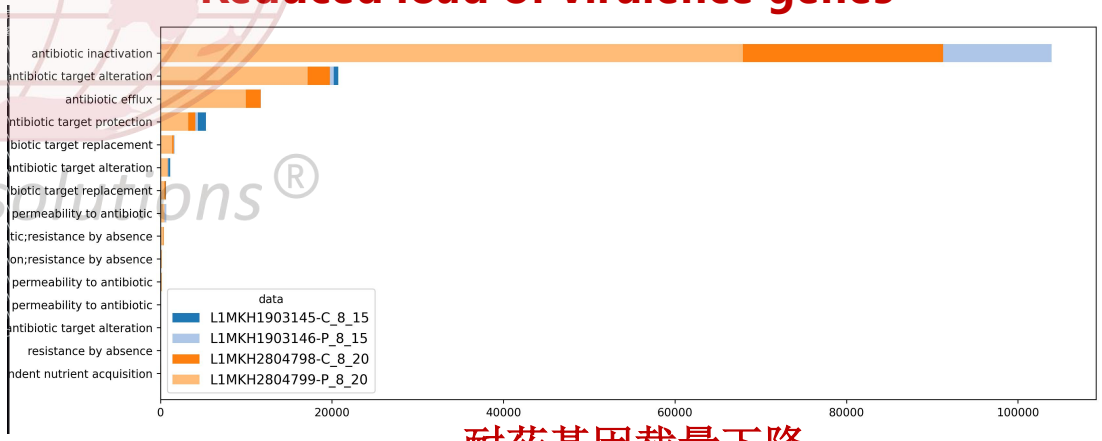
使用噬菌体作为重要细菌病（沙门和大肠）控制剂后，可以有效降低群体外排菌群中耐药基因和毒力基因的载量

The use of phages as important bacterial disease (salmonella and colitis) control agents can effectively reduce the load of drug resistance genes and virulence genes in the population of excreting bacteria



毒力基因载量下降

Reduced load of virulence genes



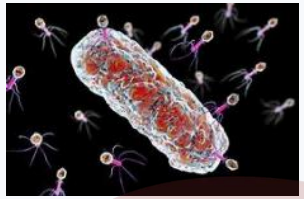
耐药基因载量下降

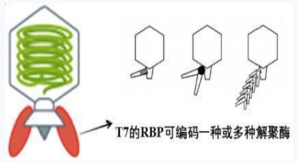
Decreased load of drug-resistant genes

（宋子昂，张炜）

细菌病原的生态防控
Ecological control of bacterial pathogens

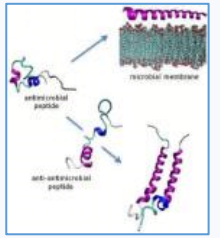
细菌病生态防控手段
Bacterial disease control measures

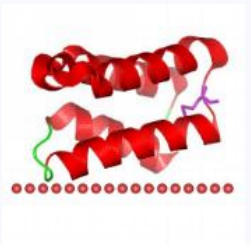




噬菌体及其抗菌酶
Bacteriophages and their antibacterial enzymes

中草药/精油
Chinese herbal medicine/essential oil

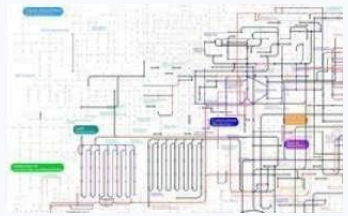


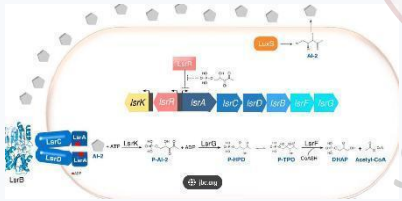


抗菌肽
Antibacterial peptide

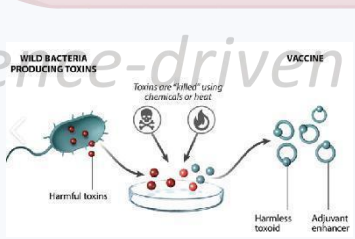
细菌素
Barteriocin

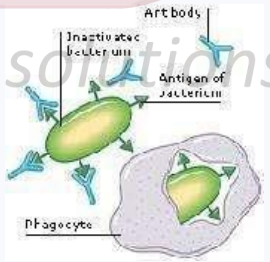
抗生素可能的替代品
Possible alternatives to antibiotics



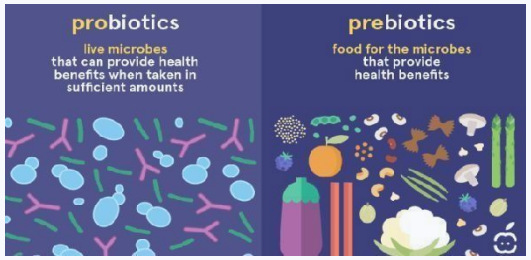


代谢通路/抑制小分子
Metabolic pathways/inhibitory small molecules





疫苗/抗体
Vaccine/antibody



益生菌/益生元
Probiotics/Prebiotics

菌株和噬菌体库是开展后续防控的基础

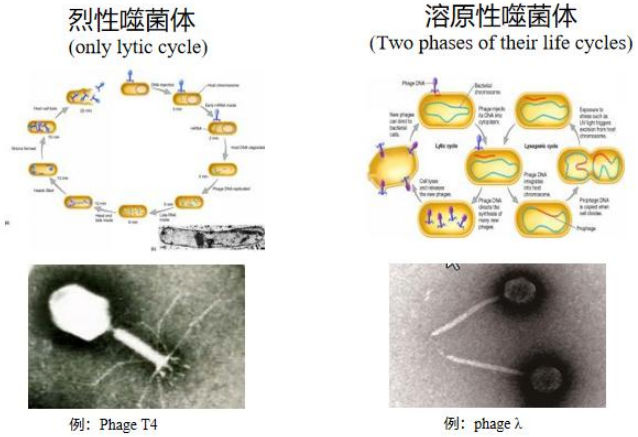
The bacterial and phage libraries are the basis for subsequent prevention and control

菌株	菌株数	测序	噬菌体	测序
大肠杆菌	1774	118	870	21
沙门氏菌	625	29	236	9
肺炎克雷伯菌	1375	348	206	35
弧菌	330	56	80	3
铜绿假单胞菌	65	4	13	4
产气荚膜梭菌	150	48	3	2
鲍曼不动杆菌	310	57	30	21
小肠结肠炎耶尔森菌	57	4	12	2
肠球菌	28	2	7	-
阴沟阴杆菌	60	5	5	-

全国性设立/合作的实验室

National laboratories established or operated in collaboration

噬菌体及产业化



- 直接治疗
- **Direct treatment**
- 用作消毒剂
- **Use as a disinfectant**

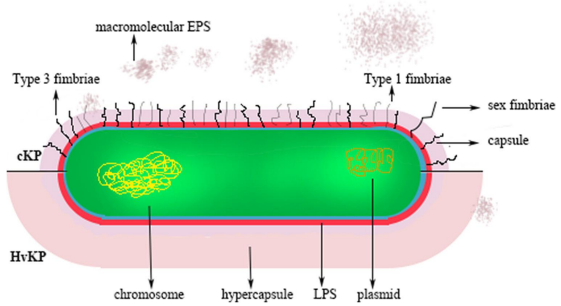
- ListShield™: Intralytics
- EcoShield™: Intralytics
- SalmoShield™: Intralytics
- Listex™: Micreos Food Safety, USDA approval, GRAS;
- AgriPhage: Omnilytics, EPA approval
- Phage against *Salmonella* (PLSV-1™) and *Clostridium perfringens* (INT-401™) in poultry licensed products: Intralytics;
- BioPhage-PA: Biocontrol (UK) , Clinical Phase 2 finished
- Custom designed phage therapies in Poland, Georgia, Russia

团队产出：Team output:

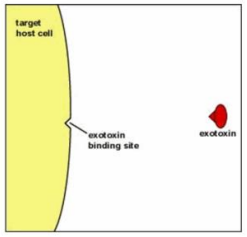
- 南农大烟台动物保健品产业研究院
- Yantai Institute of Animal Health Products, Nanjing Agricultural University
- 张炜担任院长，研究院围绕噬菌体技术研发和科技成果转化，建设现代农业技术创新试验研究院。
- Zhang Wei served as the dean of the institute, which focused on phage technology research and development and the transformation of scientific and technological achievements, and established the Modern Agricultural Technology Innovation and Experiment Institute.

细菌疫苗研究框架及产业化

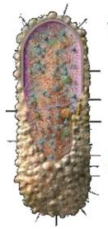
Vaccine research framework and industrialization



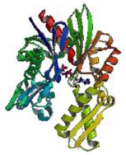
疫苗研发的关键点：鉴定出或者包含保护性抗原



WHOLE ORGANISM

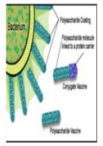


SUBUNIT VACCINE



EPITOPE VACCINE

polysaccharide vaccine



肺炎克雷伯疫苗的探索研究

Exploratory study of pneumonia K. pneumoniae vaccine

Genome data (NCBI and sequencing)

Core genome extraction (Prokka and Roary)

Pan-genome Analysis

VaxiJen
Psortb
TMHMM
size

potential cross-protective antigens

Reverse Vaccinology

recombinant Expression

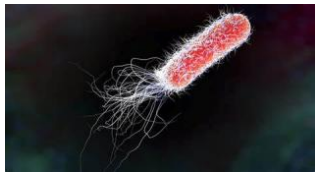
Western blotting

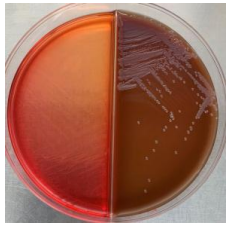
Broad-spectrum vaccine candidates

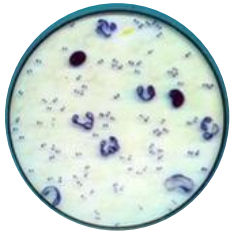
Cross-immunoreactivity Validation

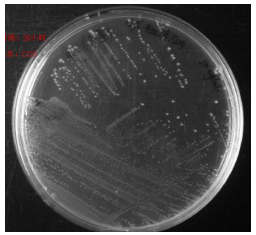
禽用细菌性疫苗技术开发项目

Avian bacterial vaccine technology development project



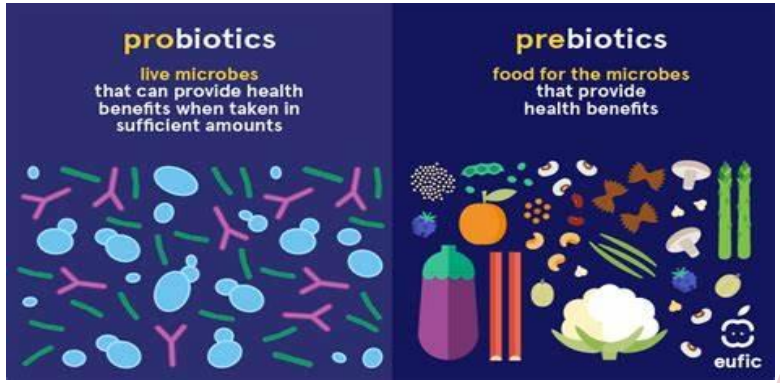


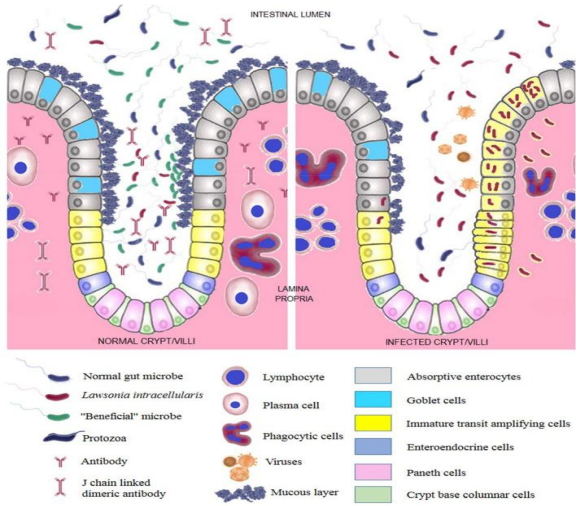




益生菌/元简介及应用Probiotics/Introduction and application

- 益生菌是对动物体有益的微生物Probiotics are microbes that are good for animals
- 益生元是有益微生物的食物，而动物本身不能利用Prebiotics are food for beneficial microbes that animals themselves cannot use

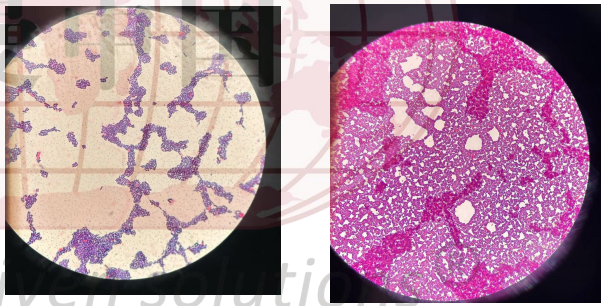




益生菌/益生元的使用，有利于对抗肠道病原菌

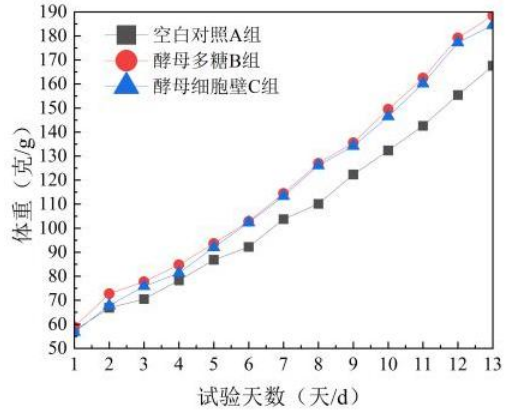
The use of probiotics/ prebiotics is beneficial to fight intestinal pathogens

doi: 10.3389/fvets.2018.00181.



采集饲喂益生元后粪便样本，分离出的唾液乳杆菌，罗伊氏乳杆菌和约氏乳杆菌等益生菌

Fecal samples were collected and fed with prebiotics, and probiotics such as Lactobacillus salivarius, Lactobacillus reuteri, and Lactobacillus casei were isolated.



机遇和挑战
Opportunities and challenges

机遇和挑战
Opportunities and challenges

掌握人工智能研究方法，并可以使用具体的应用场景的人，拥有更多的话语权。
People who understand the research methods of artificial intelligence and can use specific application scenarios have more say.

给了大家重新起跑的机会。无论对于老师，学生，还是养殖场的技术人员。
It gave everyone a fresh start, whether for teachers, students, or farm technicians.

具体的能力：从“工具使用者”到“技术整合者”
Specific skills: From "tool user" to "technology integrator"

在人工智能深度渗透畜牧兽医行业的时代，传统“经验驱动”的人才能力模型正加速向“技术 + 数据”的复合型体系转型。
As artificial intelligence deeply penetrates the animal husbandry and veterinary industry, the traditional "experience-driven" talent competency model is accelerating the transformation to a "technology + data" composite system.

养殖智能化疫病诊断和防控多模态愿景

Multimodal vision for intelligent disease diagnosis and prevention in farming

健康多模态养殖

多重关键环境因子正常

温度

湿度

NH_3等

人工智能诊断：动物颜色状态正常

摄像头实时监测

宏基因组检测菌群正常

体内菌群结构

环境菌群结构

稳态被破坏

外因：环境因子

内因：菌群组成

仔猪

生长期

成品

恢复稳态

确定病原：细菌、病毒等

生态防控：噬菌体、益生菌

环境因子：湿度、温度、NH_3

环境因子异常

温度过高过低

湿度异常

NH_3异常

行为症状异常

犬坐式

划水状

菌群异常

支原体/链球菌异常升高

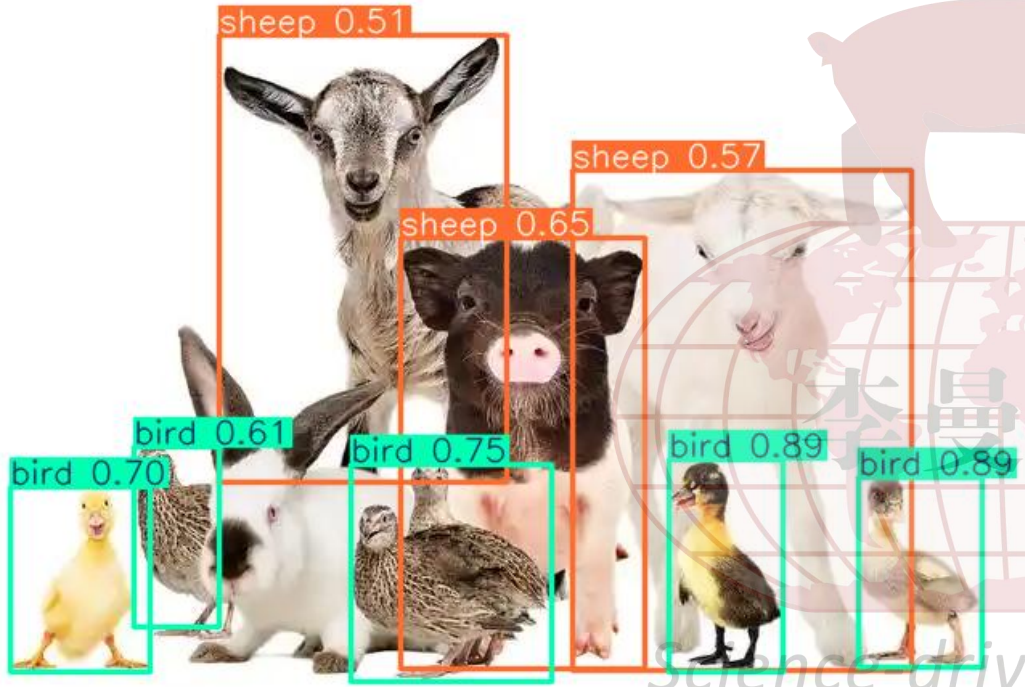
菌群结构异常

非健康多模态

Unhealthy multimodal

我们一起来用人工智能研究细菌病！

Lets use artificial intelligence to study bacterial diseases!



Thanks

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