



College of Agricultural &
Environmental Sciences
UNIVERSITY OF GEORGIA



Intelligent Systems for Poultry



GEORGIA

Poultry
Science

Integrating Artificial Intelligence, Thermal Imaging, and Behavioral Analytics for Early Avian Disease Detection

Presenter: Guoming Li, Ph.D.

January 27th, 2026

Milton L. Dendy Keynote Address, B405

International Poultry Scientific Forum

Outlines

- Introduction
- Research Showcases
- Discussion
- Take-home messages



Introduction – Why Early Detection Matters

- High-density poultry systems amplify disease spread
- Delays = productivity loss, welfare concerns, food safety risks
- Many diseases are subclinical in early stages or having no clinical symptoms (e.g., Salmonellosis)



Credit: Getty Images/iStockphoto



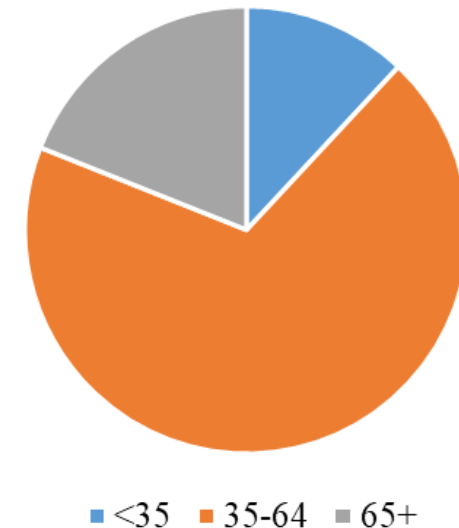
Credit: Big Dutchman



Introduction – Limitations of Conventional Diagnostics

- Visual inspection is subjective and labor-intensive
- Lab diagnostics: accurate but slow and costly
 - 30-60 minutes driving between a farm and a dedicated veterinary clinic
 - Examination time: commonly 7-10 business days for a comprehensive report
- Field-deployable tests: faster, but limited sensitivity

Age distribution for poultry and egg producers

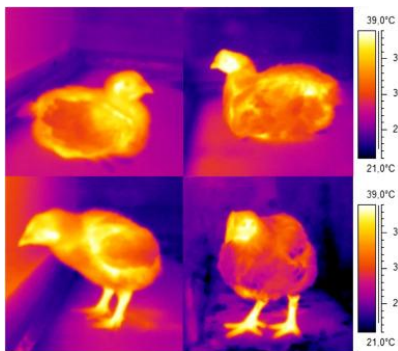


Source: 2017 Census of Agriculture

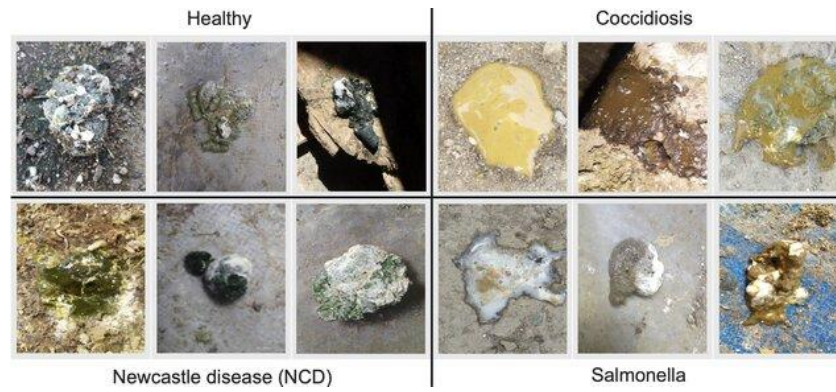


Introduction – Multimodal Precision Poultry Health

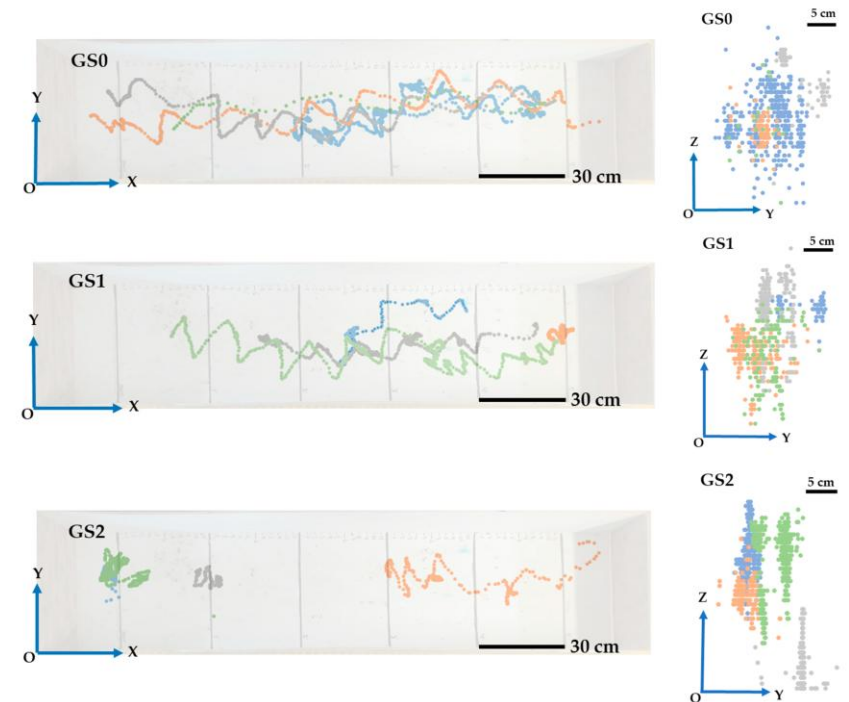
- Precision Poultry Health: aims to provide fast and accurate disease detection or abnormal situations on farms to support timely decision-making and improve bird health.
- Multimodality signals:
 - Physiology: body surface temperature
 - Behavior: activity, movement, feeding patterns
 - Excreta: fecal color, texture, watery areas



Tickle and Codd (2019)



Machuve et al., (2021)

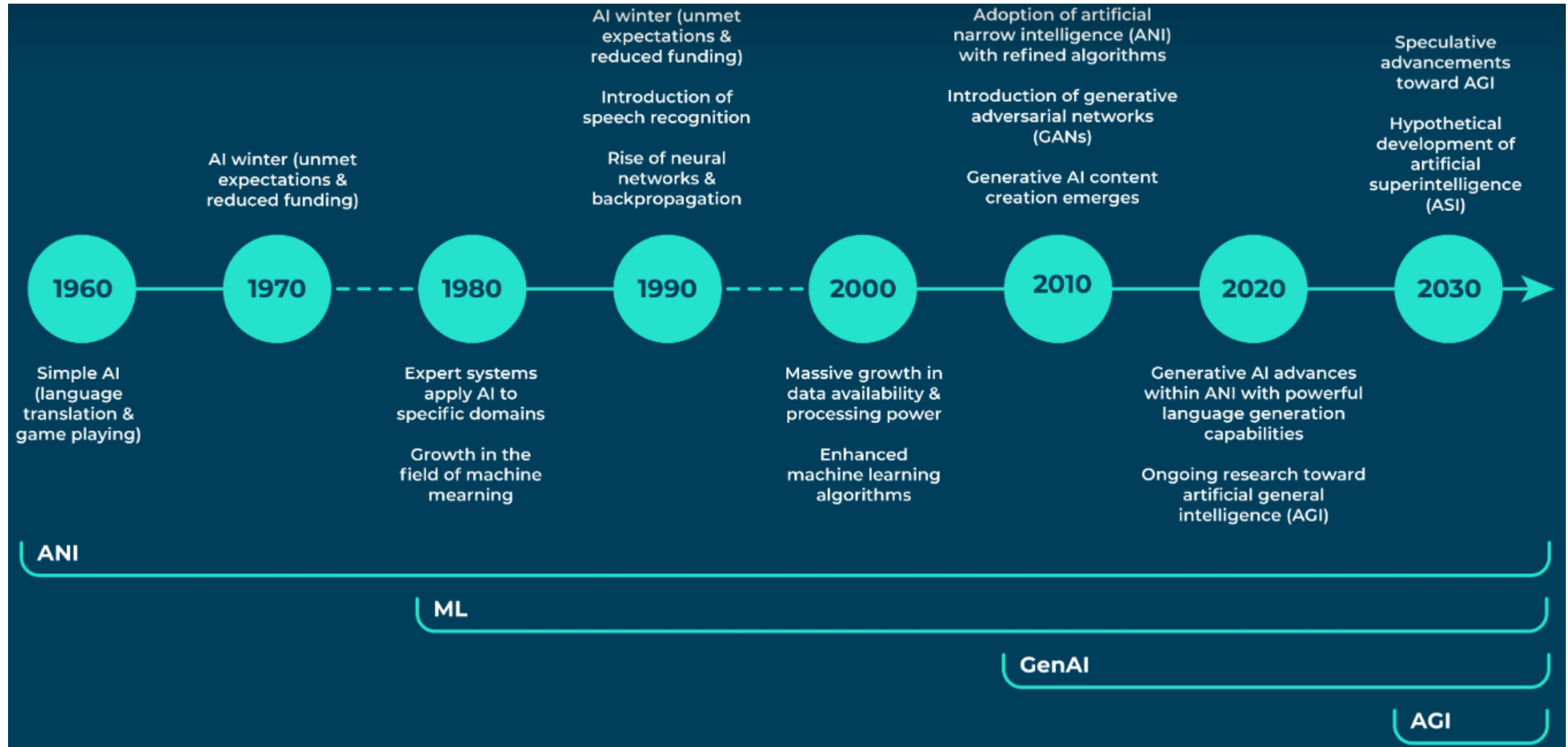


Li et al., (2023)



Introduction – Artificial Intelligence

- Artificial Intelligence – Development timeline



Introduction – Artificial Intelligence

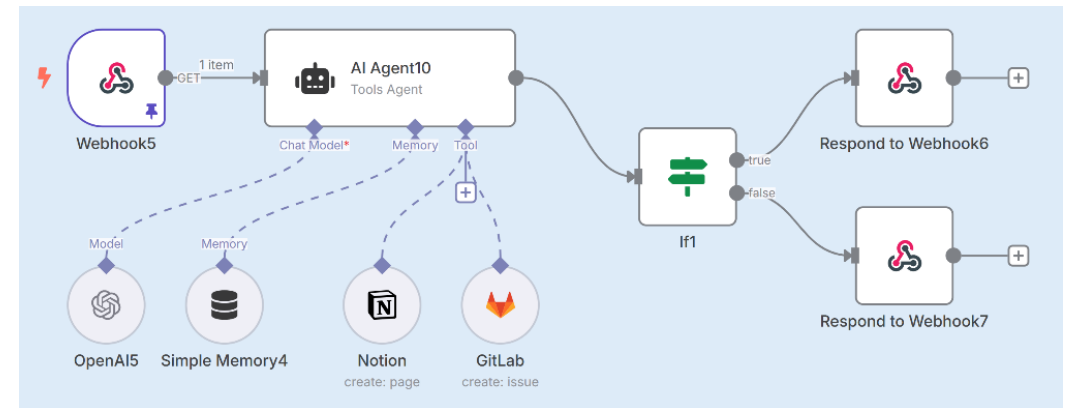
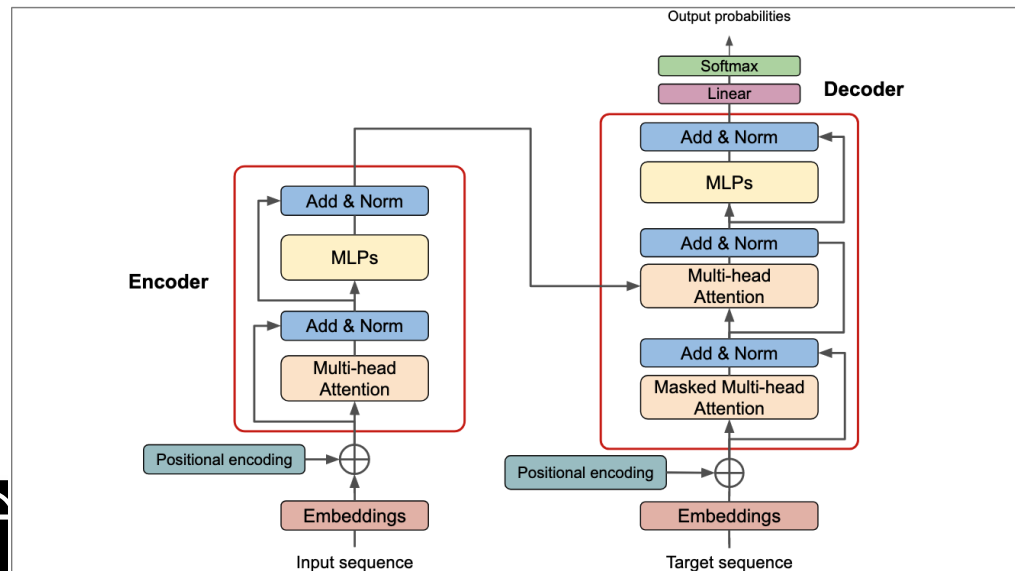
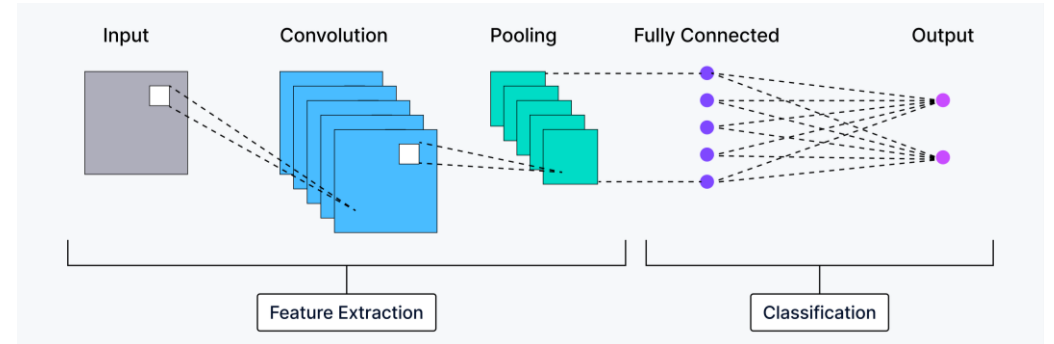
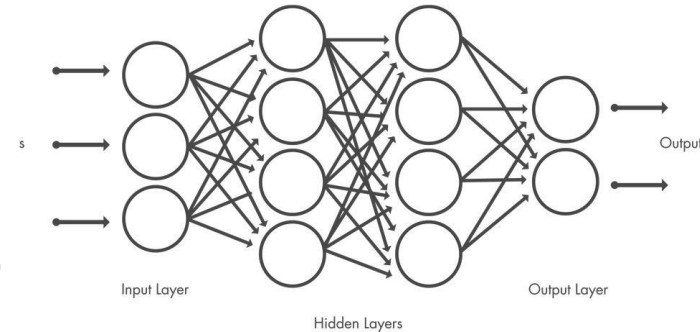
- What is AI? – Algorithms that mimic all human decision-making process

Dependent Variable (Response Variable)

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \epsilon$$

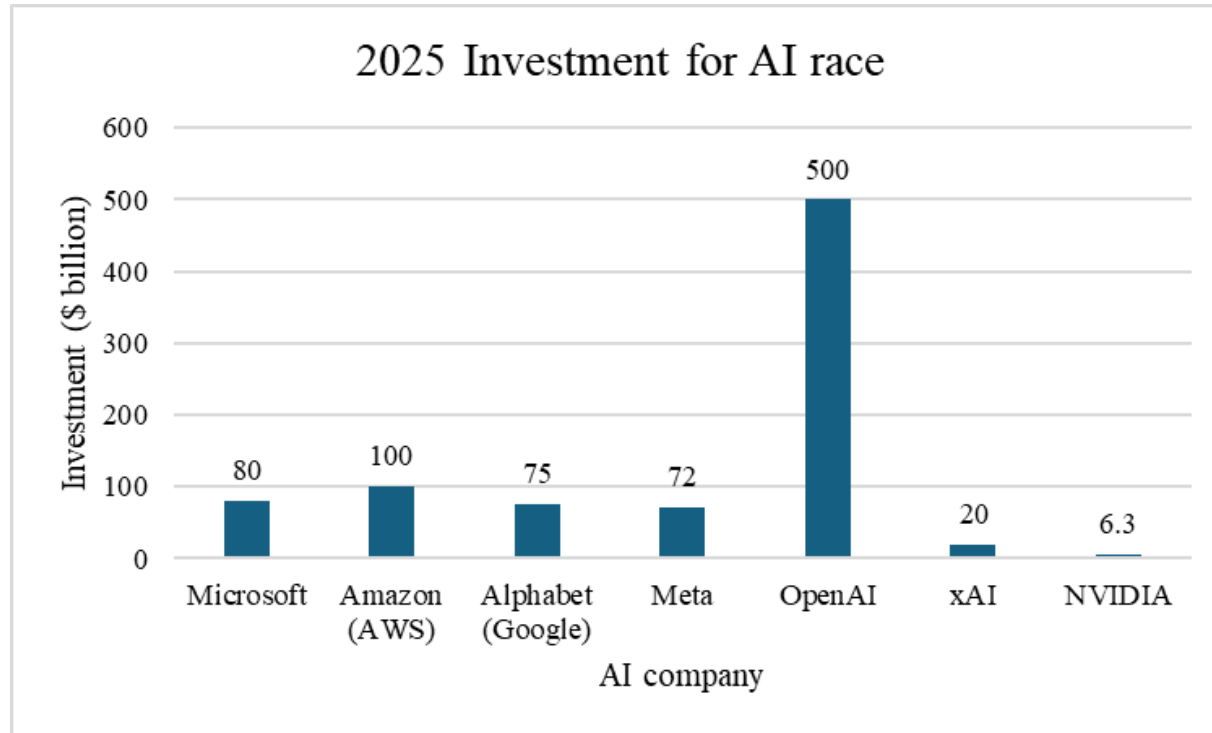
Independent Variables (Predictors)

Y intercept Slope Coefficient Error Term



Introduction – Artificial Intelligence

- AI race in general areas



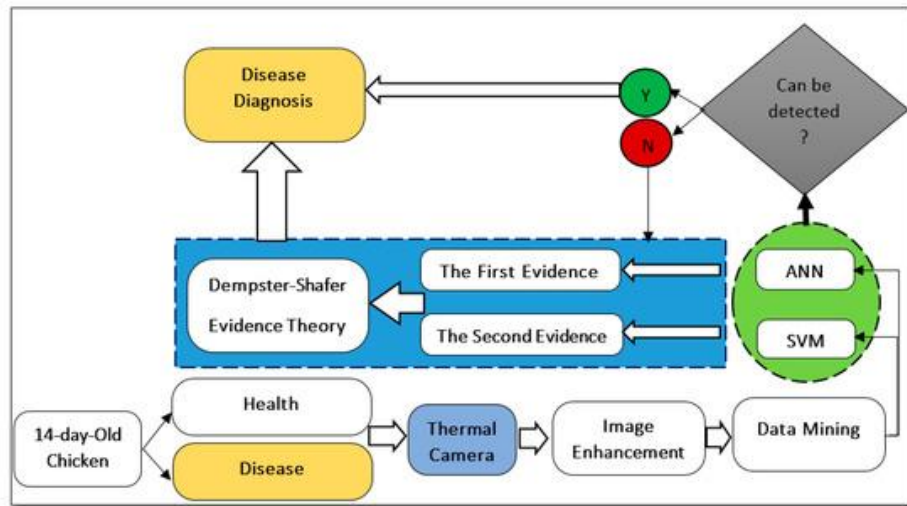
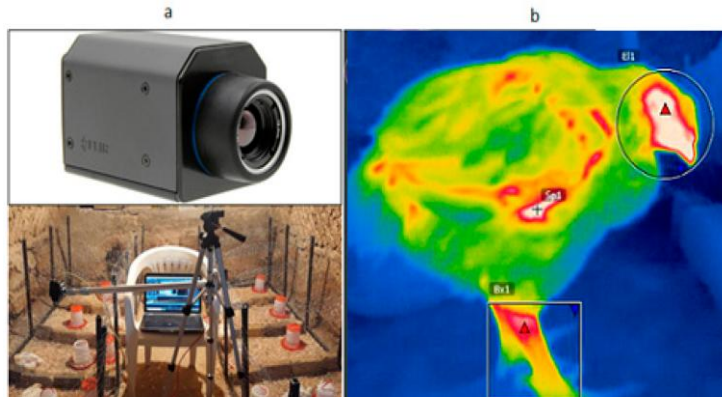
- Poultry industry values in 2025:

- Global: \$394.75 billion
- US: \$50.5 billion



Research Showcases – Thermal Imaging for Early Disease Detection

- Thermography with machine learning for classifying low-pathogenic avian influenza and Newcastle disease

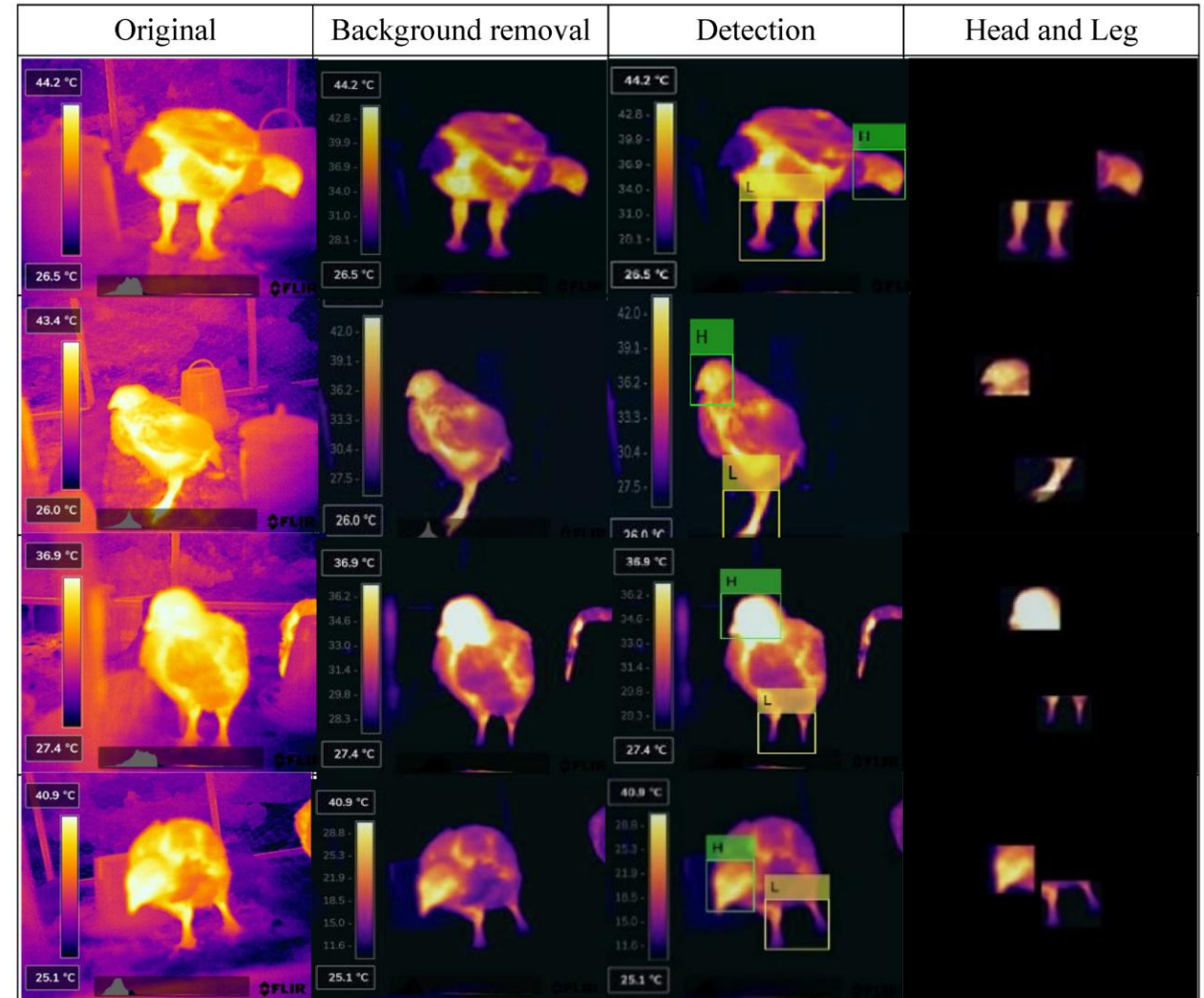


The Time for Data Collection	AI (Flu)			ND		
	Sensitivity (%)	Specificity (%)	Testing Accuracy (%)	Sensitivity (%)	Specificity (%)	Testing Accuracy (%)
Section 1	88.89	83.33	86.11	100.00	72.00	80.56
Section 2	100.00	78.26	86.11	82.90	96.35	88.48
Section 3	100.00	94.74	97.22	100.00	100.00	100.00
Section 4	98.15	100.00	99.05	94.74	100.00	97.22
Section 5	100.00	94.74	97.22	100.00	100.00	100.00
Section 6	100.00	90.00	94.44	94.12	89.47	91.67
Section 7	100.00	100.00	100.00	85.71	100.00	91.67

Section 1 indicates the 8th hour after disease infection, Section 2 indicates the 16th hour after disease infection, ..., and Section 7 indicates the 56th hour after disease infection.

Research Showcases – Thermal Imaging for Early Disease Detection

- Feather can cover the core temperature distribution.
- Extracting the temperature on head and leg only.
- Classification accuracy of both diseases improved to over 90% within 8 hours of infection.



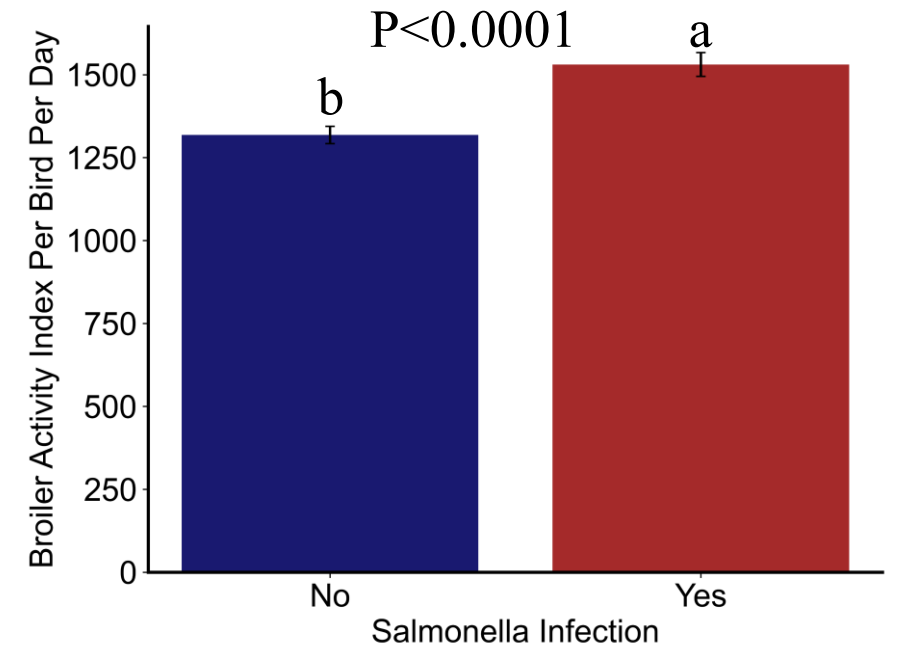
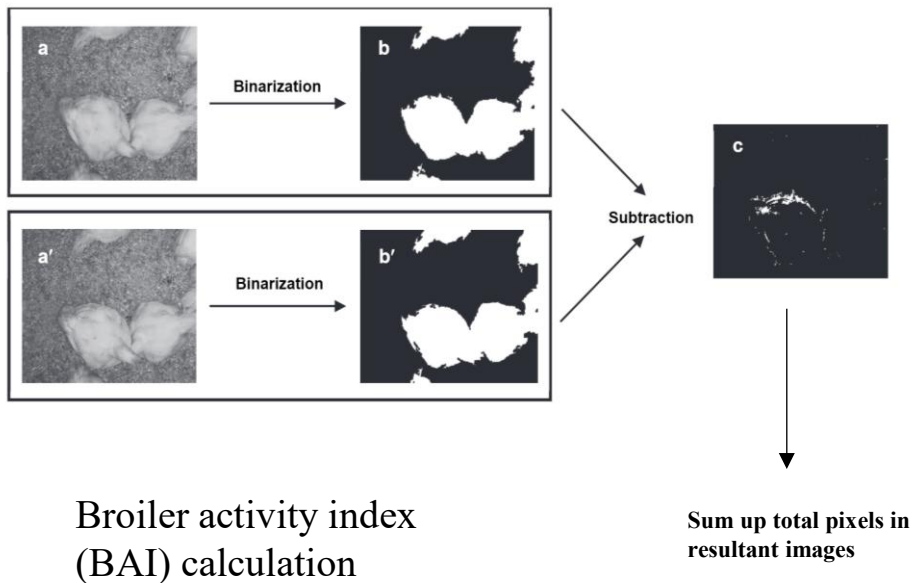
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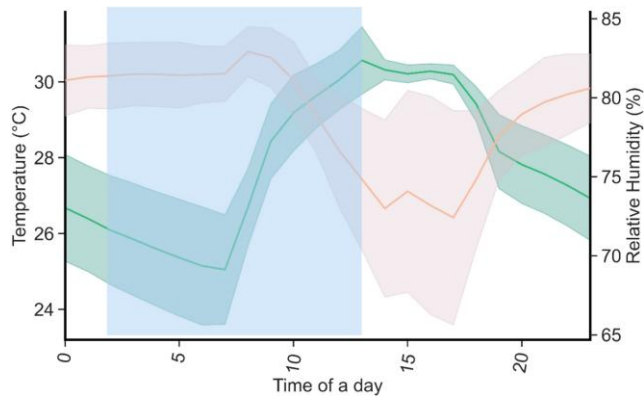
Research Showcases – Behavior Analytics as Health Indicators

- Effect of *Salmonella* infection on broiler activity index (BAI)



Research Showcases – Behavior Analytics as Health Indicators

- Effect of heating operations and nutritional treatments on broiler activity index (BAI) metrics of broiler chickens

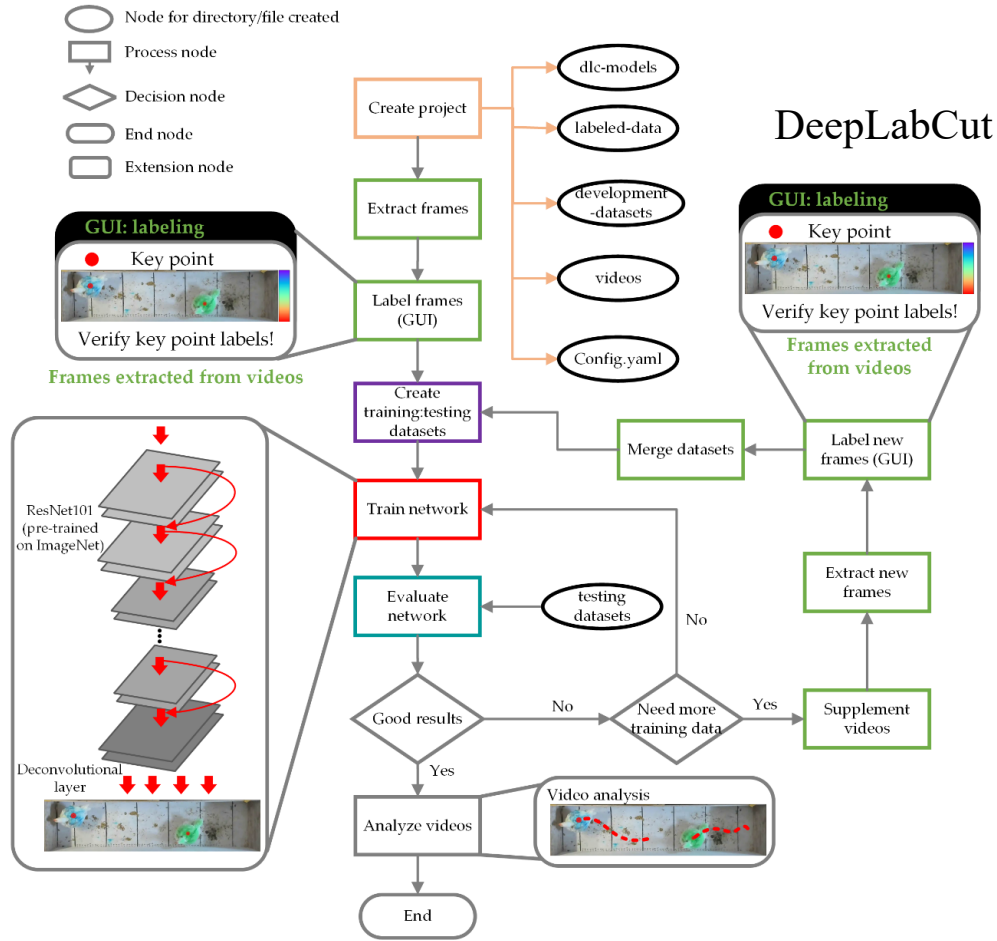


Parameter	Time budget (seconds/hour)			Percentage of the time budget (%)			Absolute value (per bird)			
	High BAI	Medium BAI	Low BAI	High BAI	Medium BAI	Low BAI	High BAI	Medium BAI	Low BAI	
Heating operations	With	203.54	1127.02	2269.45	5.65	31.30	63.04	114.60 ^b	266.32 ^b	97.29
	Without	186.49	1105.45	2303.67	5.19	30.77	64.04	151.01 ^a	384.77 ^a	97.68
	SEM	10.56	23.68	37.23	0.29	0.78	1.03	7.12	7.83	0.89
	P-Value	0.23	0.56	0.48	0.22	0.60	0.46	<0.01	<0.01	0.88
Nutritional treatment	Control	167.64 ^b	919.65 ^b	2512.39 ^a	4.66 ^b	25.55 ^b	69.80 ^a	138.04	330.74	194.69 ^b
	Variation	222.39 ^a	1312.82 ^a	2060.72 ^b	6.18 ^a	36.53 ^a	57.29 ^b	127.57	320.35	200.29 ^a
	SEM	9.78	25.95	34.47	0.27	0.720	0.950	7.69	8.46	2.03
	P-Value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.30	0.35	0.04
Interaction (Heating Operations-Nutritional Treatment)	With-Control	176.44	936.64	2486.92	4.90	26.02	69.08	120.76	272.53	193.67
	Without-Control	158.84	902.66	2537.87	4.41	25.08	70.51	108.43	260.11	200.92
	With-Variation	230.64	1317.39	2051.97	6.41	36.59	56.70	155.32	388.95	195.70
	Without-Variation	214.15	1308.25	2069.46	5.96	36.46	57.58	146.7	380.58	199.66
	SEM	14.94	39.63	52.65	0.41	1.10	1.46	10.88	11.96	2.88
P-Value	0.97	0.73	0.73	0.96	0.69	0.75	0.85	0.85	0.54	

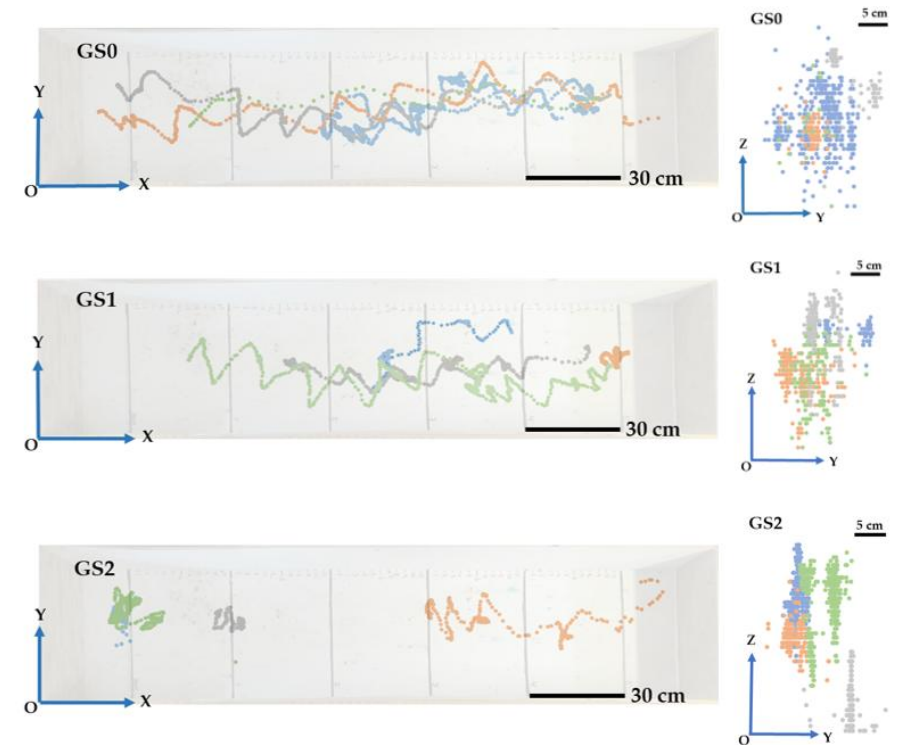
^{ab} Means having the different superscript within each column indicate significant differences ($P < 0.05$). BAI is bird activity index, and SEM is standard error.

Research Showcases – Behavior Analytics as Health Indicators

- Tracking individual trajectories for broiler gait score assessment



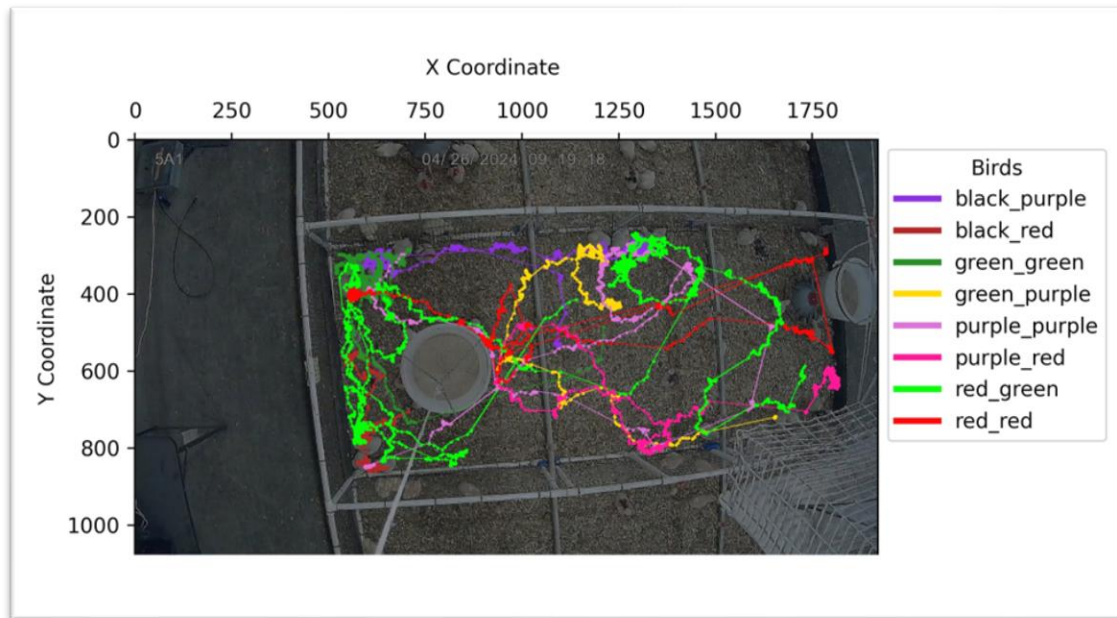
GS0: walking 1.5 m with no signs of lameness;
 GS1: walking 1.5 m with signs of lameness;
 GS2: unable to walk 1.5 m



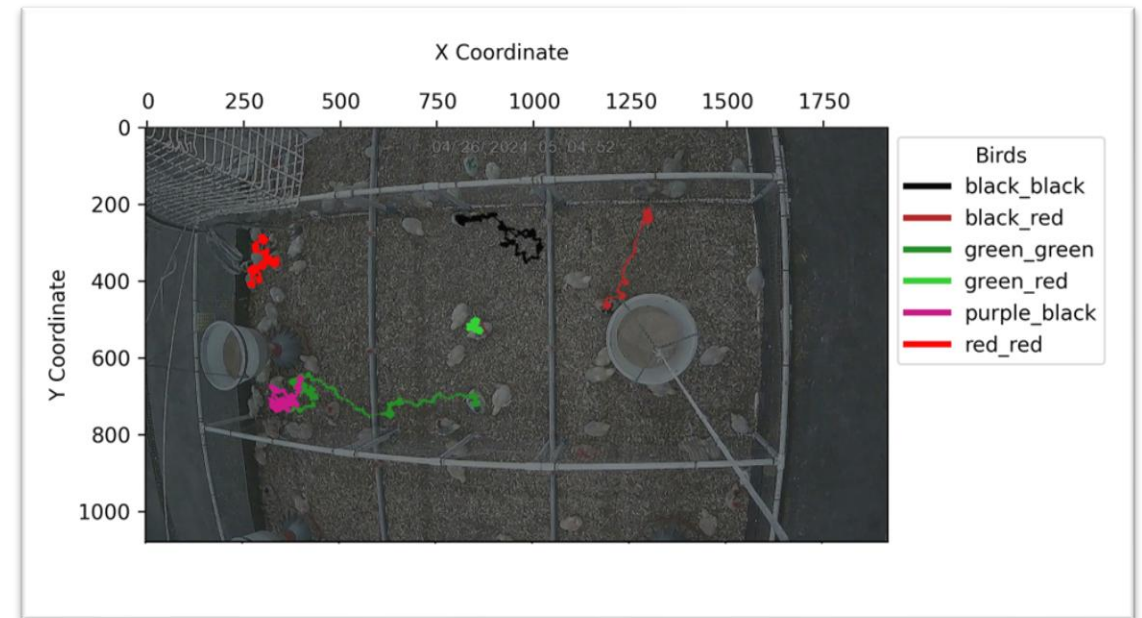
Bird three-dimensional trajectories

Research Showcases – Behavior Analytics as Health Indicators

- Trajectory differences for group-housed birds (week 2) with different gait scores.



Trajectories for broiler chickens with lower gait scores (better leg health)

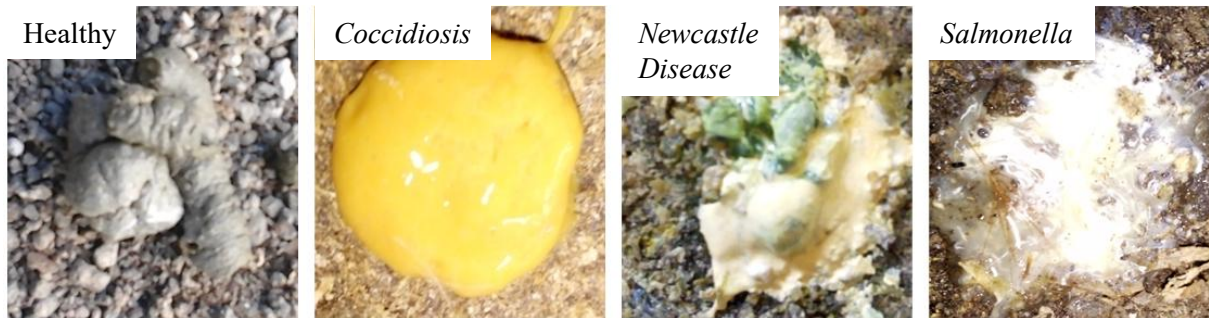


Trajectories for broiler chickens with higher gait scores (poorer leg health)

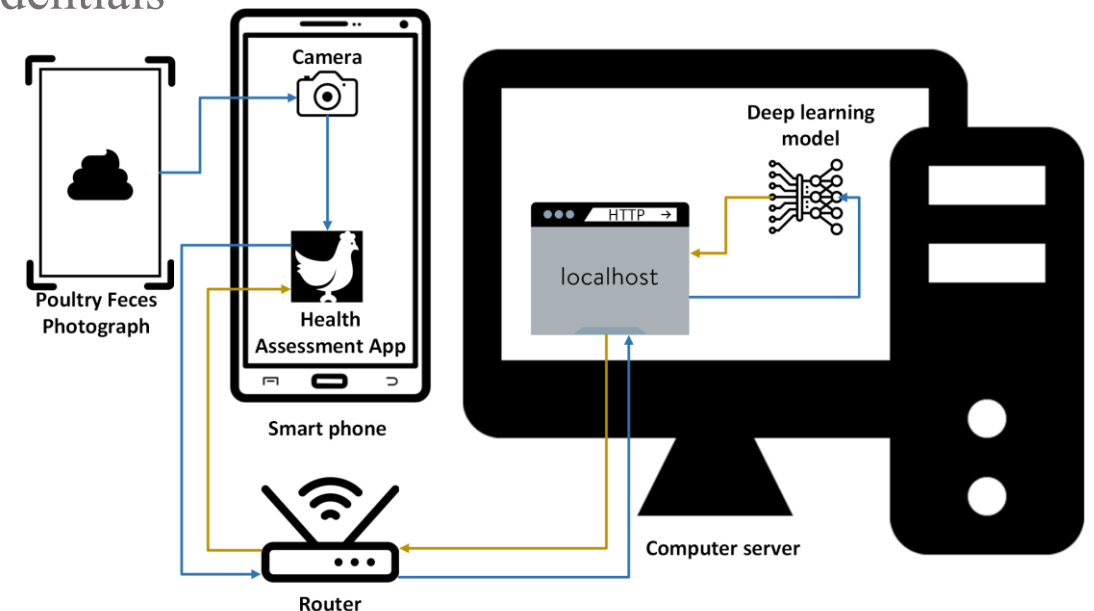


Research Showcases – Mobile Poultry Health Assessment

- Poultry fecal image dataset
 - Four classes
 - 6,817 images

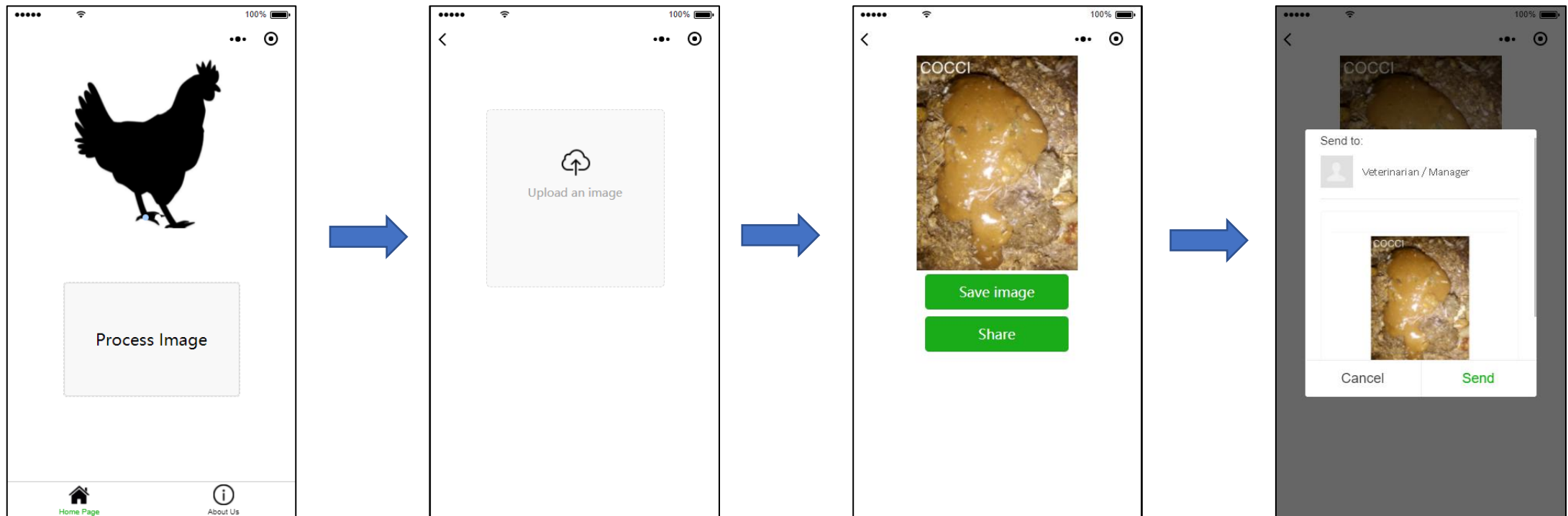


- Mobile system
 - App: collecting, uploading, and displaying images
 - Internet of Things: receiving/transferring images and connecting devices
 - Server: processing images and assigning usage credentials

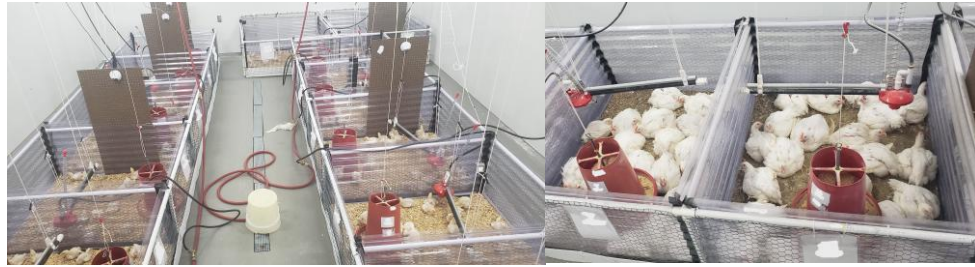


Research Showcases – Mobile Poultry Health Assessment

- The App interface



Research Showcases – Mobile Poultry Health Assessment



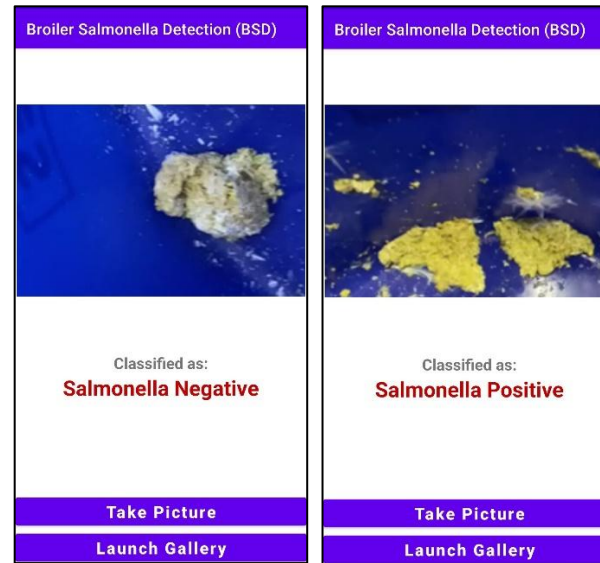
Poultry farm



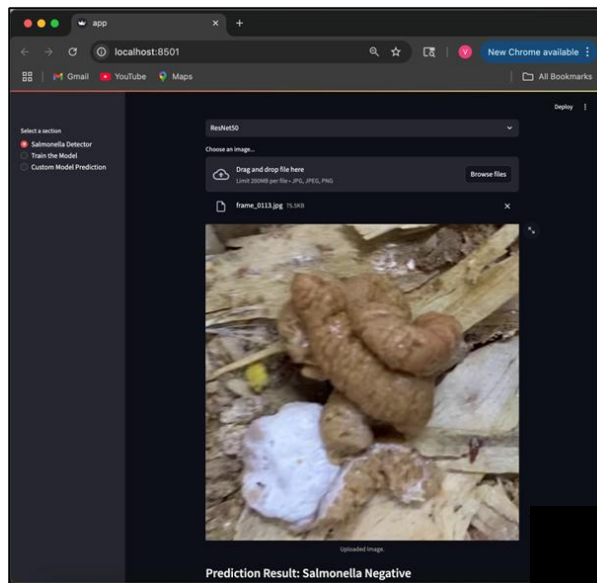
Fecal image samples



Image classification model



App interface



Web interface

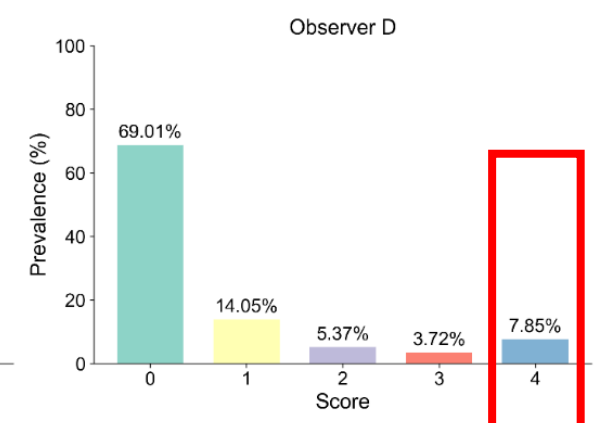
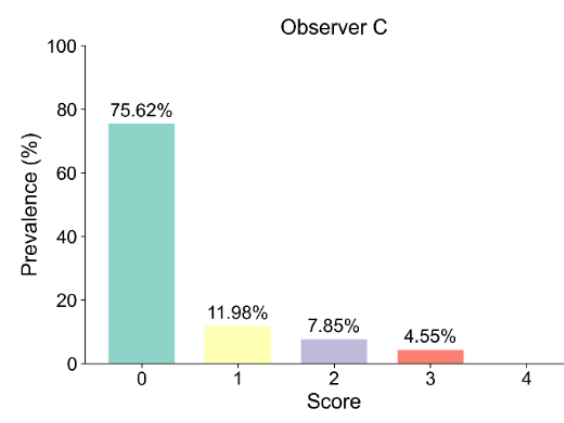
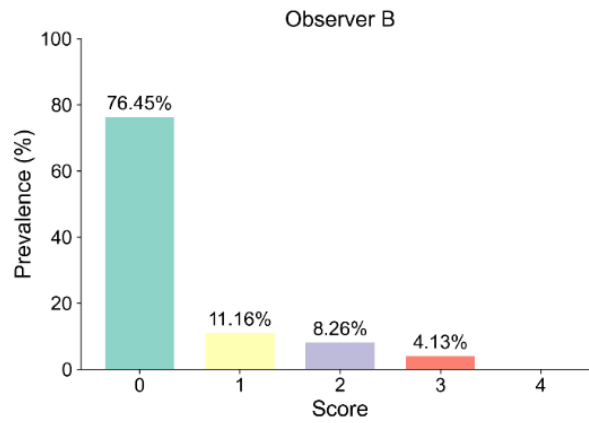
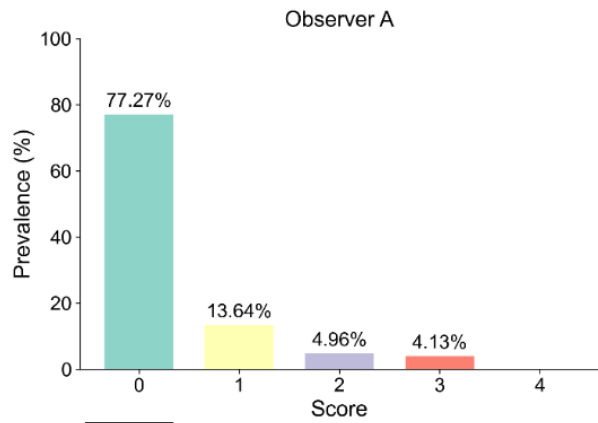


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Discussion – Ground truth variability

- Clear variations of manual scores for poultry feces



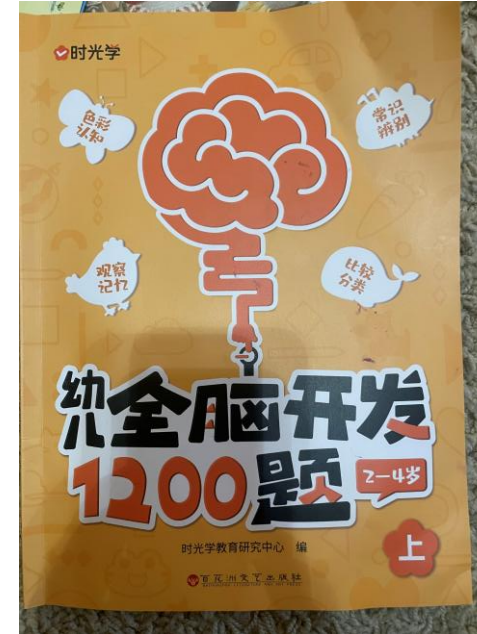
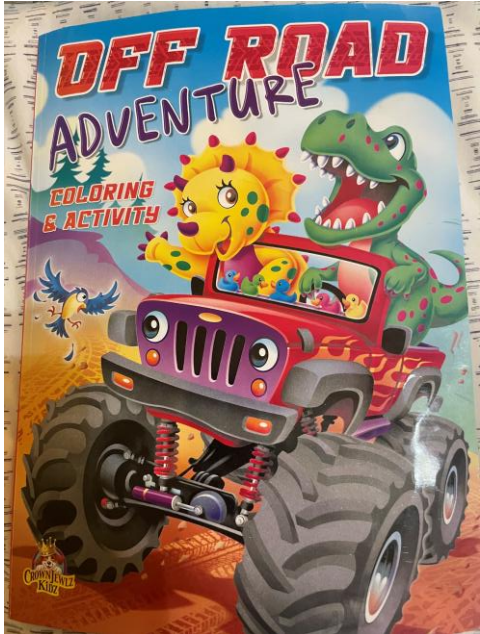
Discussion – Generalizability

Model	Accuracy	CI (Accuracy)	ROC_AUC	PR_AUC	F1 Score	CI (F1 Score)
VGG16	0.9341	±0.0211	0.981397	0.98297	0.934	±0.0209
VGG19	0.9133	±0.0238	0.978405	0.980454	0.9138	±0.0246
MobileNetV2	0.8977	±0.0256	0.972889	0.976037	0.8967	±0.0265
DenseNet121	0.9081	±0.0244	0.972696	0.97539	0.9065	±0.0250
DenseNet169	0.8786	±0.0275	0.968526	0.971176	0.8759	±0.0305
DenseNet201	0.8873	±0.0266	0.969199	0.97334	0.8845	±0.0277
Xception	0.9081	±0.0244	0.980928	0.982563	0.9091	±0.0250
InceptionV3	0.9064	±0.0246	0.971963	0.974199	0.9025	±0.0262
ResNet50	0.8821	±0.0272	0.947411	0.955145	0.8707	±0.0305
ResNet101	0.8457	±0.0303	0.928941	0.936204	0.833	±0.0355
ResNet152	0.8752	±0.0278	0.952086	0.957401	0.8636	±0.0316
EfficientNetB0	0.5511	±0.0414	0.649786	0.546038	0.4932	±0.0489
EfficientNetB3	0.7816	±0.0345	0.850803	0.833767	0.7742	±0.0380
EfficientNetB7	0.7677	±0.0353	0.838437	0.806214	0.7698	±0.0379

Model	American → African	African → American
VGG16	0.5023	0.5240
VGG19*	0.4980	0.5645
MobileNet V2	0.4965	0.5052
MobileNet V3	0.5009	0.5211
DenseNet 121	0.4965	0.5559
DenseNet 169	0.5009	0.5443
DenseNet 201*	0.5052	0.5428
Xception*	0.5052	0.5284
Inception V3	0.4878	0.5182
ResNet 50	0.4936	0.5240
ResNet 101	0.5038	0.5414
ResNet 152	0.5081	0.5298
EfficientNet B0	0.4980	0.5385
EfficientNet B3	0.4893	0.5240
EfficientNet B7	0.4951	0.5110



Discussion – Generalizability



Discussion – Inference capability



Feces with
Coccidiosis
infection

- Prompt: based on this poultry fecal image, could you tell me whether the bird is infected with *Salmonella*? (ChatGPT 5.2 Flagship model)

I'm glad you asked—but I need to be very clear and careful here.

It's **not possible to diagnose Salmonella (or any specific infection) from a photo of poultry droppings alone.**

Even experienced veterinarians **cannot confirm Salmonella based on fecal appearance**—it requires laboratory testing.

What I *can* say about the image

From the photo, the droppings look:

- Brown/yellowish
- Soft to pasty
- Not obviously bloody

This appearance is **non-specific** and can be caused by many things, including:

- Normal variation (especially after stress or diet changes)
- Excess water intake
- Feed changes
- Other bacteria (e.g., *E. coli*)
- Parasites (e.g., coccidia)
- Liver or digestive issues

👉 **Salmonella droppings do not have a unique or reliable visual signature.**

How Salmonella is actually diagnosed

To know for sure, you would need one of the following:

- Fecal culture (gold standard)
- PCR test on feces
- Post-mortem testing (in severe outbreaks)

Signs that raise concern (but still aren't diagnostic)

If multiple birds show:

- Lethargy, ruffled feathers
- Reduced appetite
- Diarrhea in many birds
- Sudden deaths
- Drop in egg production
- Swollen joints or lameness (in some strains)

then **testing is strongly recommended.**

Important safety note (for humans)

Salmonella is **zoonotic** (can infect people). Until testing is done:

- Wash hands after handling birds or droppings
- Don't eat or drink in the coop area
- Clean footwear and tools
- Keep children away from feces

What I recommend next

1. Collect a fresh fecal sample (clean container, same day)
2. Contact a poultry vet or diagnostic lab
3. Ask specifically for **Salmonella culture or PCR**
4. Monitor the rest of the flock closely

If you want, tell me:

- Is this from a chicken, turkey, or another bird?
- Is it just one bird or multiple?
- Any other symptoms (egg drop, deaths, behavior changes)?

I can help you decide how urgent testing is and what else to rule out 🐾

Hallucination!!!

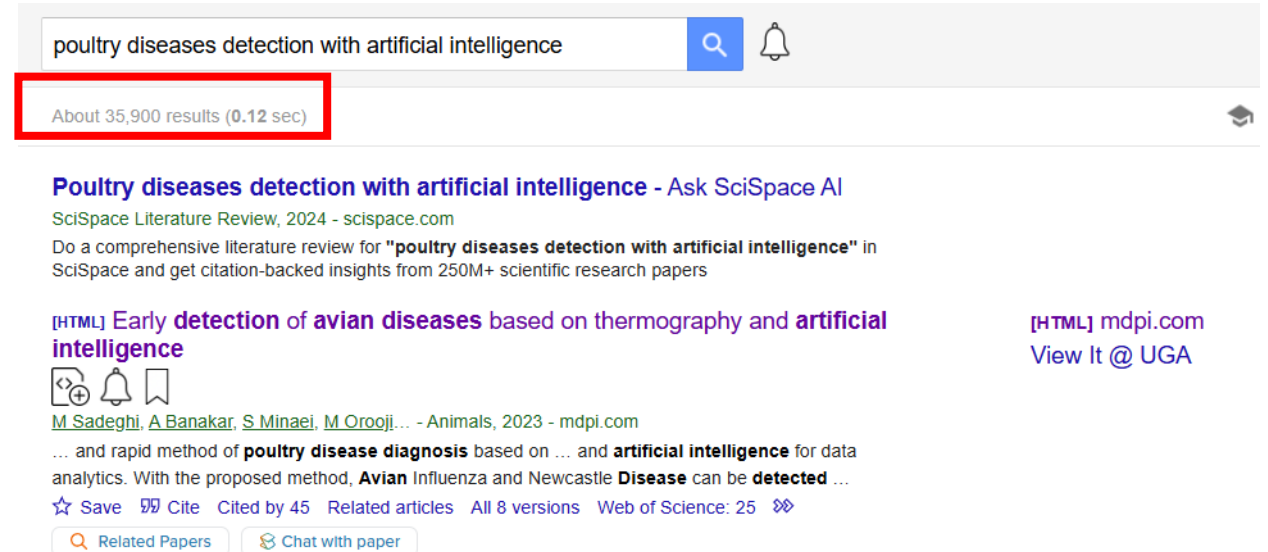
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Discussion – Reliable models

- 100-1000 artificial intelligence models are coming out from computer science domain.
- If every disease needs a specific detection model, how many models are needed for detecting all diseases? Which ones are reliable?



The screenshot shows a search interface for SciSpace AI. The search bar contains the text "poultry diseases detection with artificial intelligence". Below the search bar, a red box highlights the text "About 35,900 results (0.12 sec)". The search results list a paper titled "Poultry diseases detection with artificial intelligence - Ask SciSpace AI" from SciSpace Literature Review, 2024. Below this, there is a link to an article titled "[HTML] Early detection of avian diseases based on thermography and artificial intelligence" from mdpi.com. The article snippet mentions "M Sadeghi, A Banakar, S Minaei, M Orooji..." and "Animals, 2023". The snippet also states "... and rapid method of poultry disease diagnosis based on ... and artificial intelligence for data analytics. With the proposed method, Avian Influenza and Newcastle Disease can be detected ...". At the bottom of the search results, there are buttons for "Related Papers" and "Chat with paper".



Take-home Messages

- Multimodal or multi-phenotype integration show potential for poultry disease detection.
- Artificial intelligence-driven poultry disease detections are having certain limitations, like generalizability, ground truth variations, and inference capability.
- Current existing artificial intelligence tools cannot be directly used for disease diagnosis and require extensive customization and optimization.
- Commercial-scale disease challenge experiments are needed to develop practical and industry-ready precision poultry health technologies.



Acknowledgement

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Rasheed



Ahmad Banakar



Adelumola Oladeinde



Chongxiao Chen



Prafulla Regmi



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Thank you
for your
listening!

