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GENES, PUBLICLY AVAILABLE DATABASES, AND BAYESIAN NETWORKS:

A STRATEGIC APPROACH TO PROBABILISTIC NETWORKS IN POULTRY AND STRESS.

Emiliano A. Videla Rodríguez, J. B. O. Mitchell, and V. A. Smith.
University of St. Andrews

MARIE CURIE ACTIONS

ChickenStress

Universitat de Lleida

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IRB Lleida
Institut de Recerca Biomèdica

SRUC

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Increase stress resilience and/or stress resistance

Economic impact

Animal welfare

Universiteit Utrecht

ILVO
Flanders research institute for agriculture, fisheries and food

HENDRIX GENETICS

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

University of St Andrews

Vencomatic Group
Agro Supply – Prinzen – Vencomatic

TEL AVIV UNIVERSITY

The Lakes Free Range Egg Co

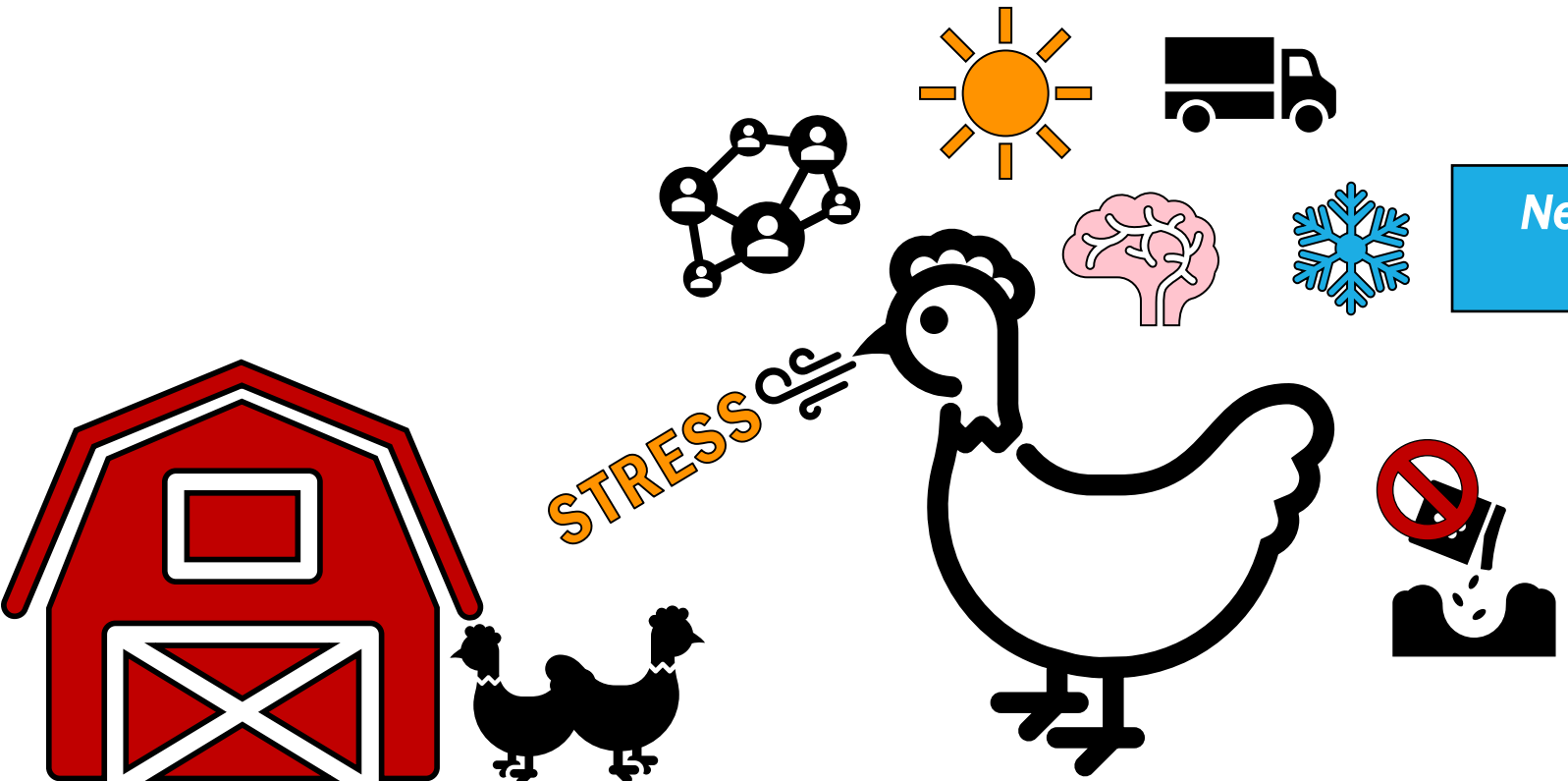
vetmeduni vienna

Max Plank Institute for Ornithology

Noldus
Information Technology

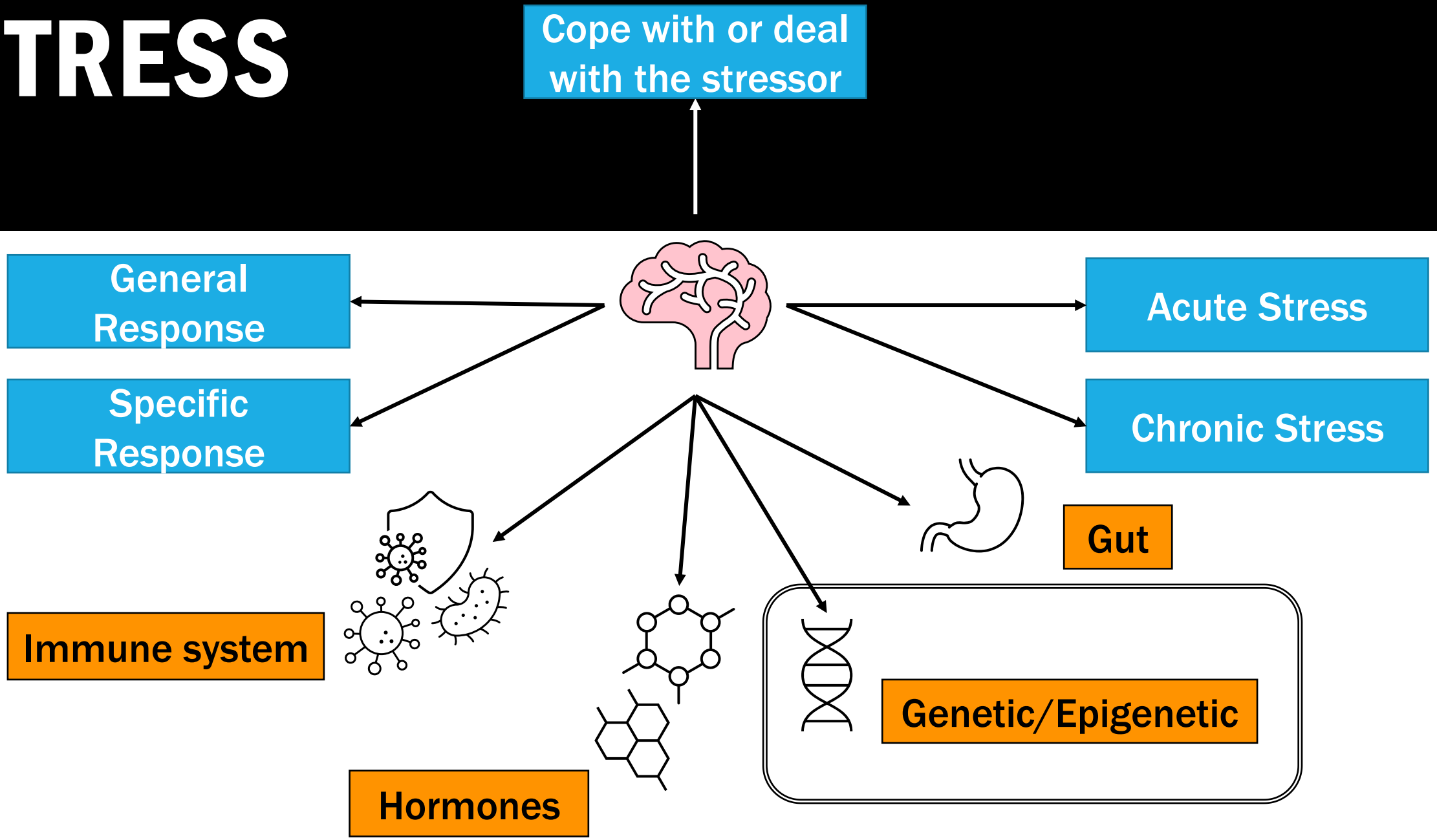
LINKÖPING UNIVERSITY

STRESS



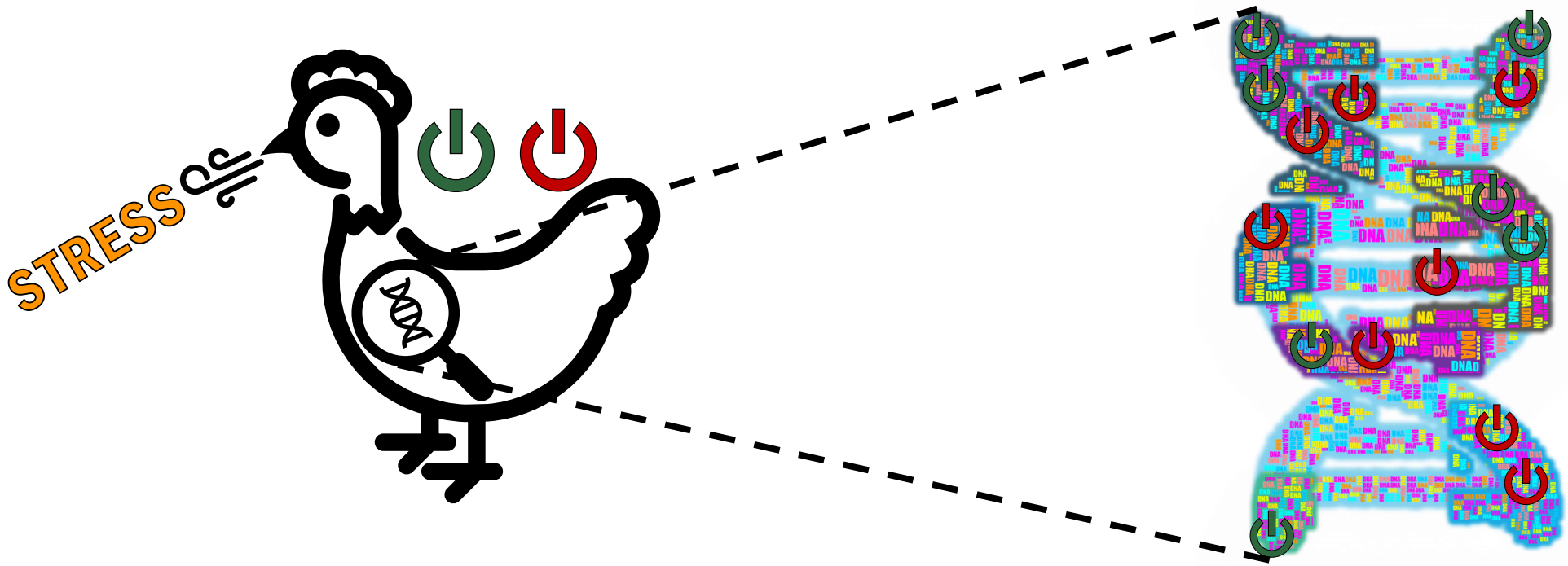
- ***Neuroendocrine system***
  - ***Sympathetic nervous system***
  - ***Hypothalamus-Pituitary-Adrenal axis***
  - Vagal-cholinergic pathway
  - Gut-Brain axis

STRESS


Cope with or deal with the stressor
General Response
Specific Response
Acute Stress
Chronic Stress
Gut
Immune system
Genetic/Epigenetic
Hormones

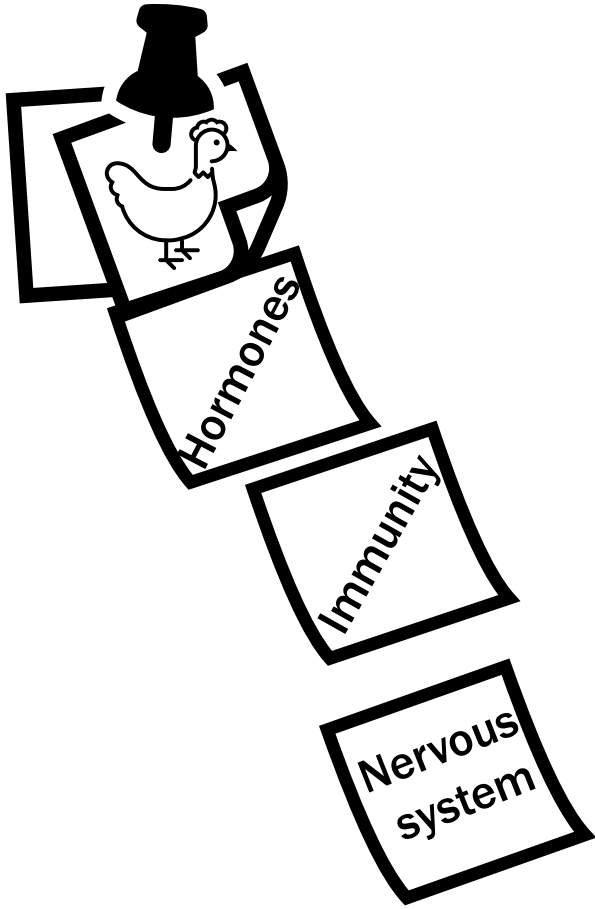
STRESS AND GENETICS

Stress can have a **major impact on** the expression pattern of genes, activating or deactivating certain genes.

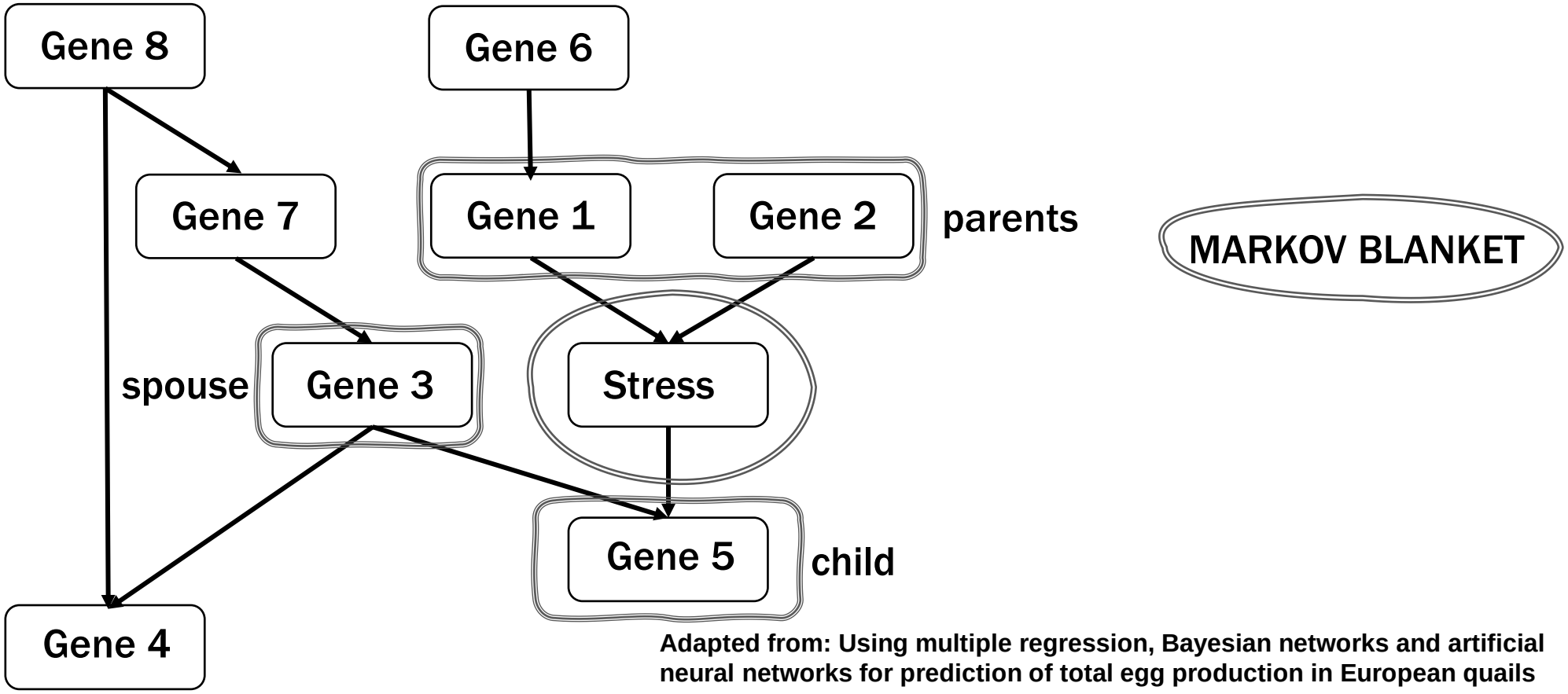


High-throughput technologies

BIOINFORMATICS



BAYESIAN NETWORKS



Adapted from: Using multiple regression, Bayesian networks and artificial neural networks for prediction of total egg production in European quails based on earlier expressed phenotypes.

Vivian P. S. Felipe,∗1 Martinho A. Silva,† Bruno D. Valente,∗ and Guilherme J. M. Rosa

OBJECTIVE

Identify genes associated with stress in chickens, invoking an approach to Bayesian networks that involved:

- the **identification of genes** of interest,
- the **selection of highly important features**,
- followed by the **learning the structure** of the consensus Bayesian network.

PUBLICLY AVAILABLE DATABASES

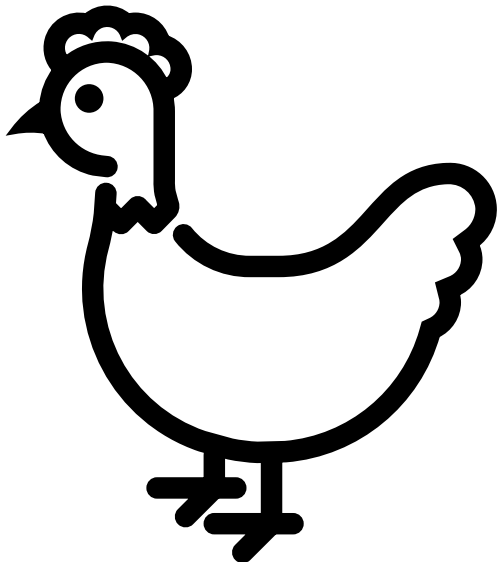
Gene Expression Omnibus

GEO is a **public functional genomics data repository** supporting MIAME-compliant data submissions. Array- and sequence-based data are accepted. Tools are provided to help users query and **download experiments** and **curated gene expression profiles**.

ArrayExpress – Functional Genomics Data

ArrayExpress Archive of Functional Genomics Data stores data from **high-throughput functional genomics experiments**, and provides these data for **reuse to the research community**.

DIFFERENCES BETWEEN ANIMAL MODELS



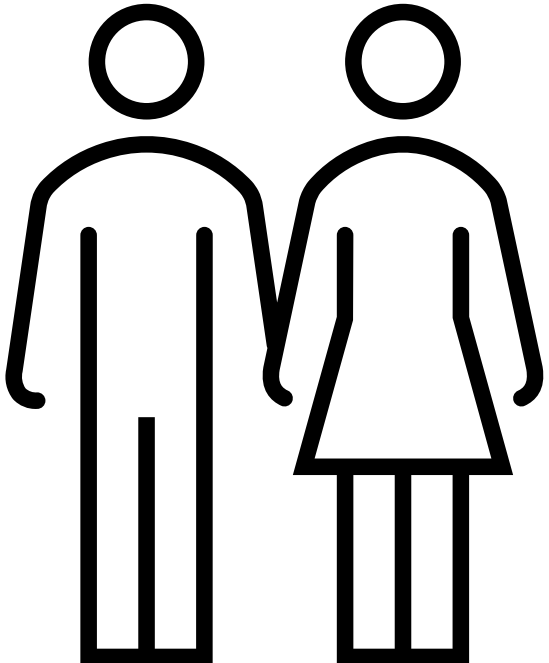
Experimental designs

Number of individuals

Different tissues

Bayesian networks

Strategic approach



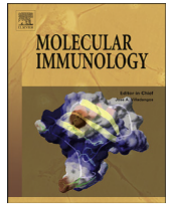
STRATEGIC APPROACH

First step: How did we identify genes of interest?

Contents lists available at ScienceDirect

Molecular Immunology

journal homepage: www.elsevier.com/locate/molimm



Identification of genes related to effects of stress on immune function in the spleen in a chicken stress model using transcriptome analysis

Yujie Guo[a], Ruirui Jiang[a,b,1], Aru Su[a], Huihui Tian[a], Yanhua Zhang[a], Wenting Li[a,b], Yadong Tian[a,b], Kui Li[a], Guirong Sun[a,b], Ruili Han[a,b], Fengbin Yan[a,b,*], Xiangtao Kang[a,b]

[a] College of Animal Science and Veterinary Medicine, Henan Agricultural University, Zhengzhou 450002, China
[b] Henan Innovative Engineering Research Center of Poultry Germplasm Resource, Henan Agricultural University, Zhengzhou 450002, China

Gene ID
ENSGALG00000000081
ENSGALG00000000140
ENSGALG00000000162
ENSGALG00000000395
ENSGALG00000000620

196 identifiable genes

STRATEGIC APPROACH

First step: How did we identify genes of interest?

NCBI

Chickens (*Gallu*

DATASET 1		

Dataset: 101 genes + 50 observations				Stress

(n = 196)
00000081
00000140
00000162
00000395
00000620

STRATEGIC APPROACH

Second step: How did we select highly important features?

Naïve Bayes

Supervised Algorithm

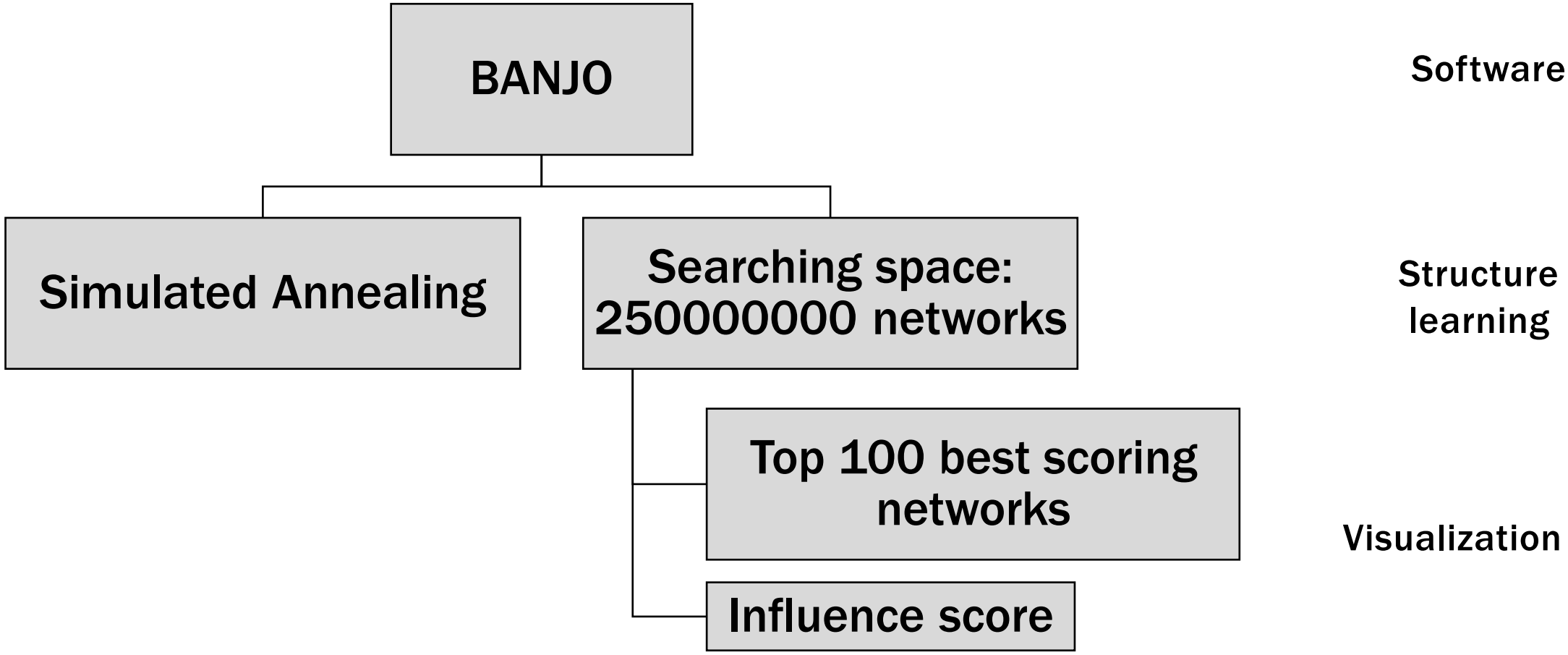
Class: Stress

R package: *caret*.

Top ten genes	
ENSGALG00000005123	WNT7A
ENSGALG00000016981	SPERT
ENSGALG00000002550	TSHB
ENSGALG00000005842	GDPD2
ENSGALG00000002086	RASL10B
ENSGALG00000023824	LIPML5
ENSGALG00000027853	CTNNA2
ENSGALG00000017077	HSPH1
ENSGALG00000026613	S100A4
ENSGALG00000005584	GALNT18

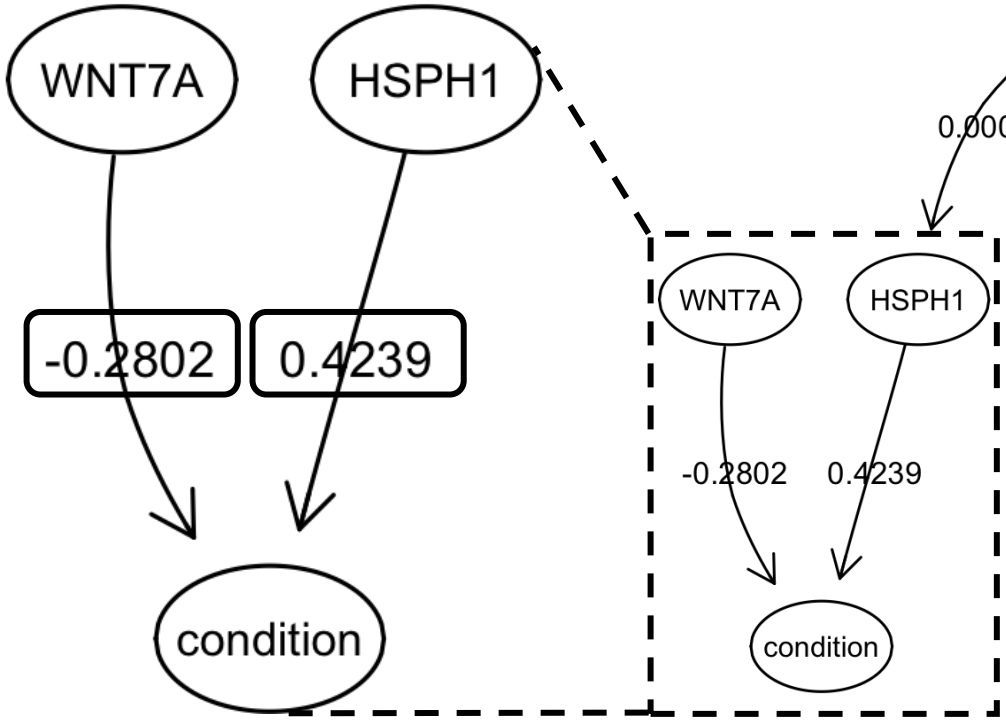
STRATEGIC APPROACH

Third step: How did we **learn of the structure** of the Bayesian network?

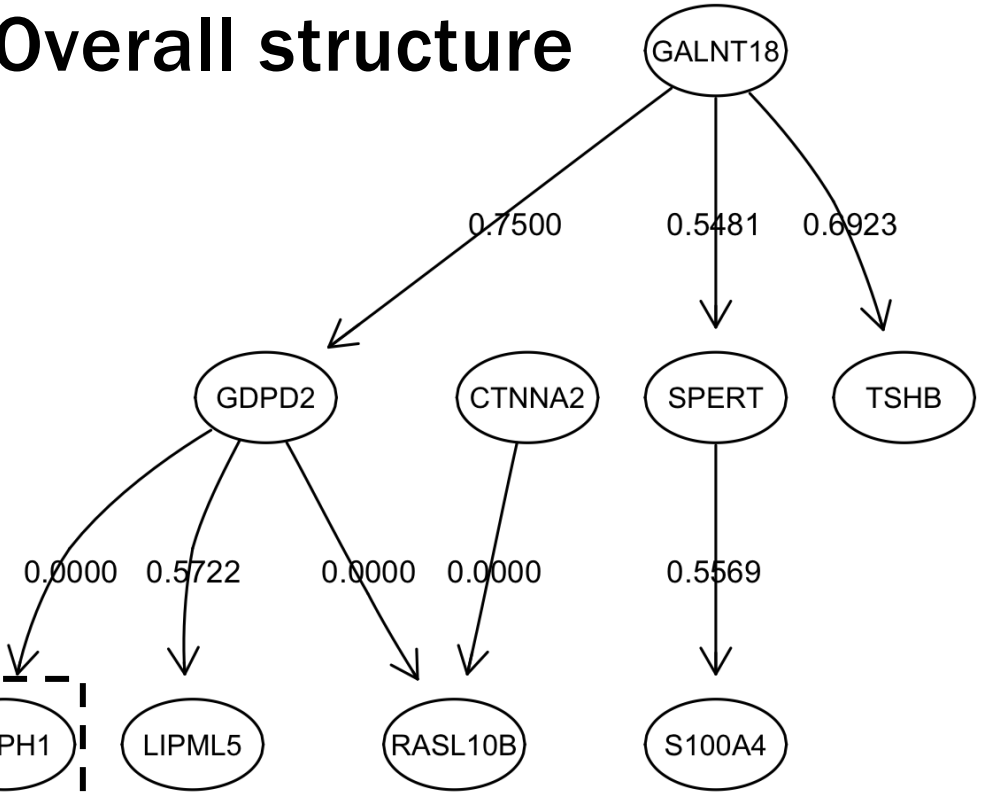


RESULTS

Markov Blanket



Overall structure



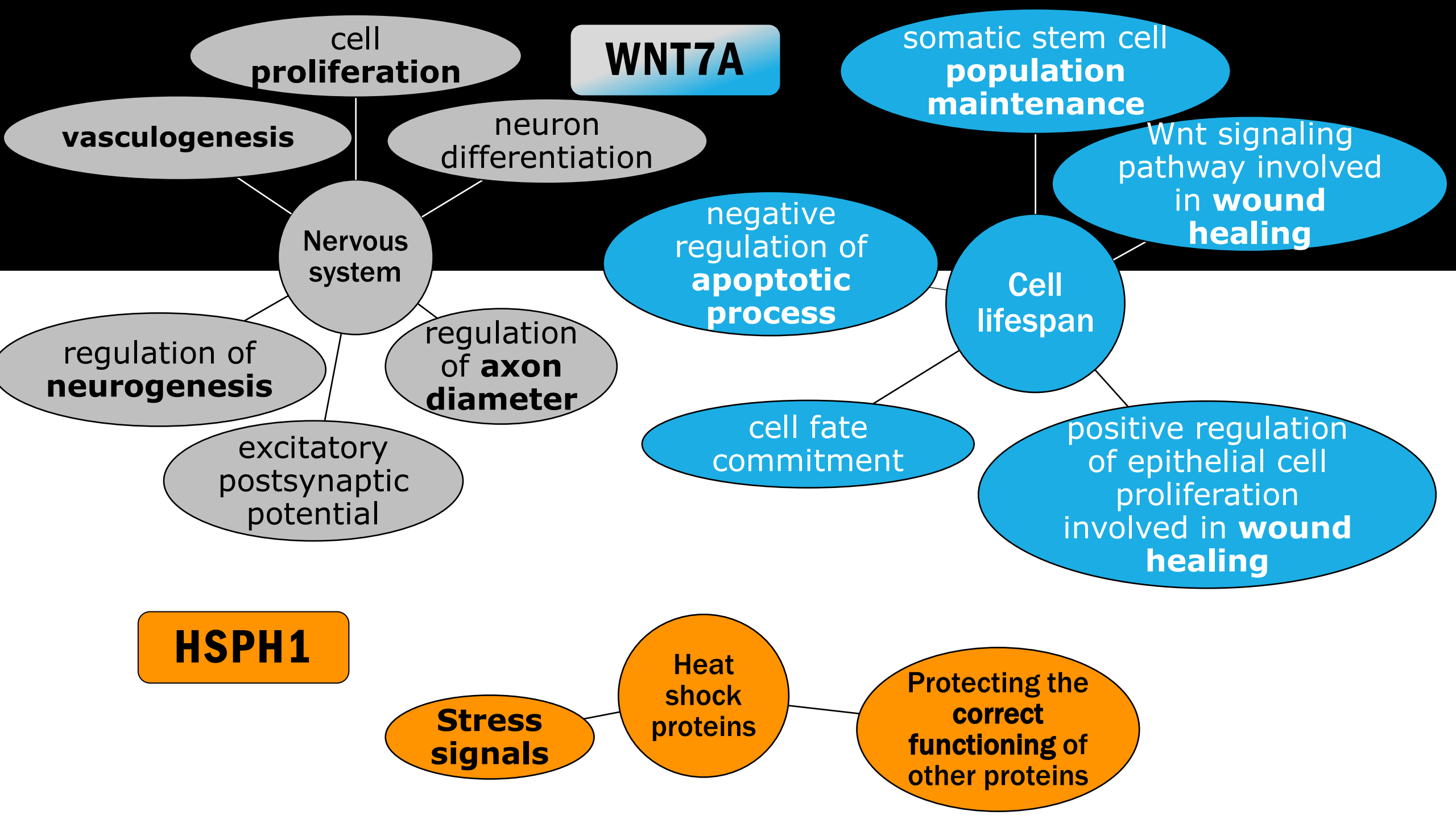
BIOLOGY BEHIND THE DATA

WNT7A

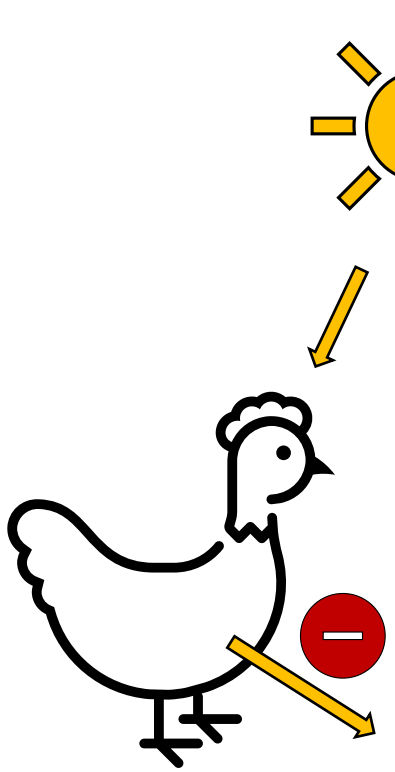
Wnt family member 7A

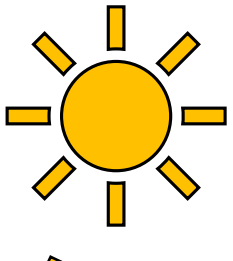
HSPH1

Heat Shock Protein family H (Hsp110) member 1


WNT7A
cell proliferation
vasculogenesis
neuron differentiation
Nervous system
regulation of neurogenesis
regulation of axon diameter
excitatory postsynaptic potential
somatic stem cell population maintenance
Wnt signaling pathway involved in wound healing
negative regulation of apoptotic process
Cell lifespan
cell fate commitment
positive regulation of epithelial cell proliferation involved in wound healing
HSPH1
Stress signals
Heat shock proteins
Protecting the correct functioning of other proteins

STORYTELLING...





Side effect

Oxidative stress

DNA damage

Stress signals

Neuron **proliferation** and **differentiation**

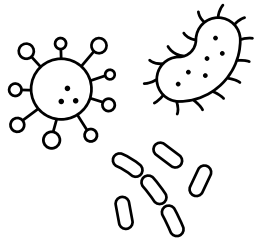
Chronic stress response

Neurogenesis

Stress signals

Immune suppression

Tissue damage



Protecting the correct functioning of proteins

Apoptotic process

Wound healing

What is the possible ***relationship*** between stress resilience and/or stress resistance and these two genes?

Future directions

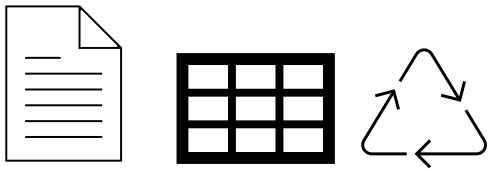
Can we use these two genes as ***markers of stress*** and therefore classify animals according to their rearing environment?

Would it be possible to use these two genes in ***breeding programs*** to increase the resistance or resilience of chickens to stress?

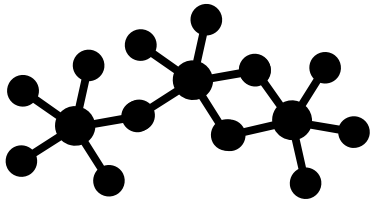
What did we learn from the implementation of Bayesian networks on genes, chickens, and stress?

Bayesian networks

- Combine expert knowledge and previous studies

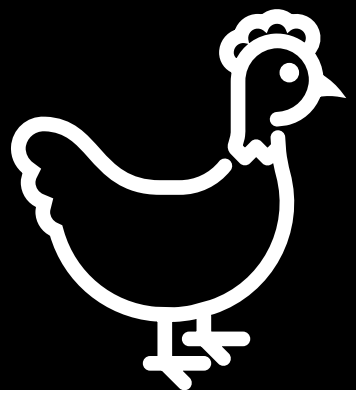


- Easy interpretation of the results



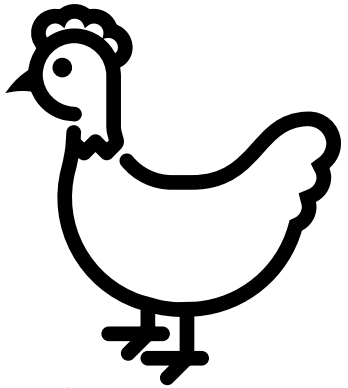
- Development of further studies

THANK YOU VERY MUCH



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 812777.

ANY QUESTIONS?



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