



RIS

Research and Information System for Developing Countries
विकासशील देशों की अनुसंधान एवं सूचना प्रणाली

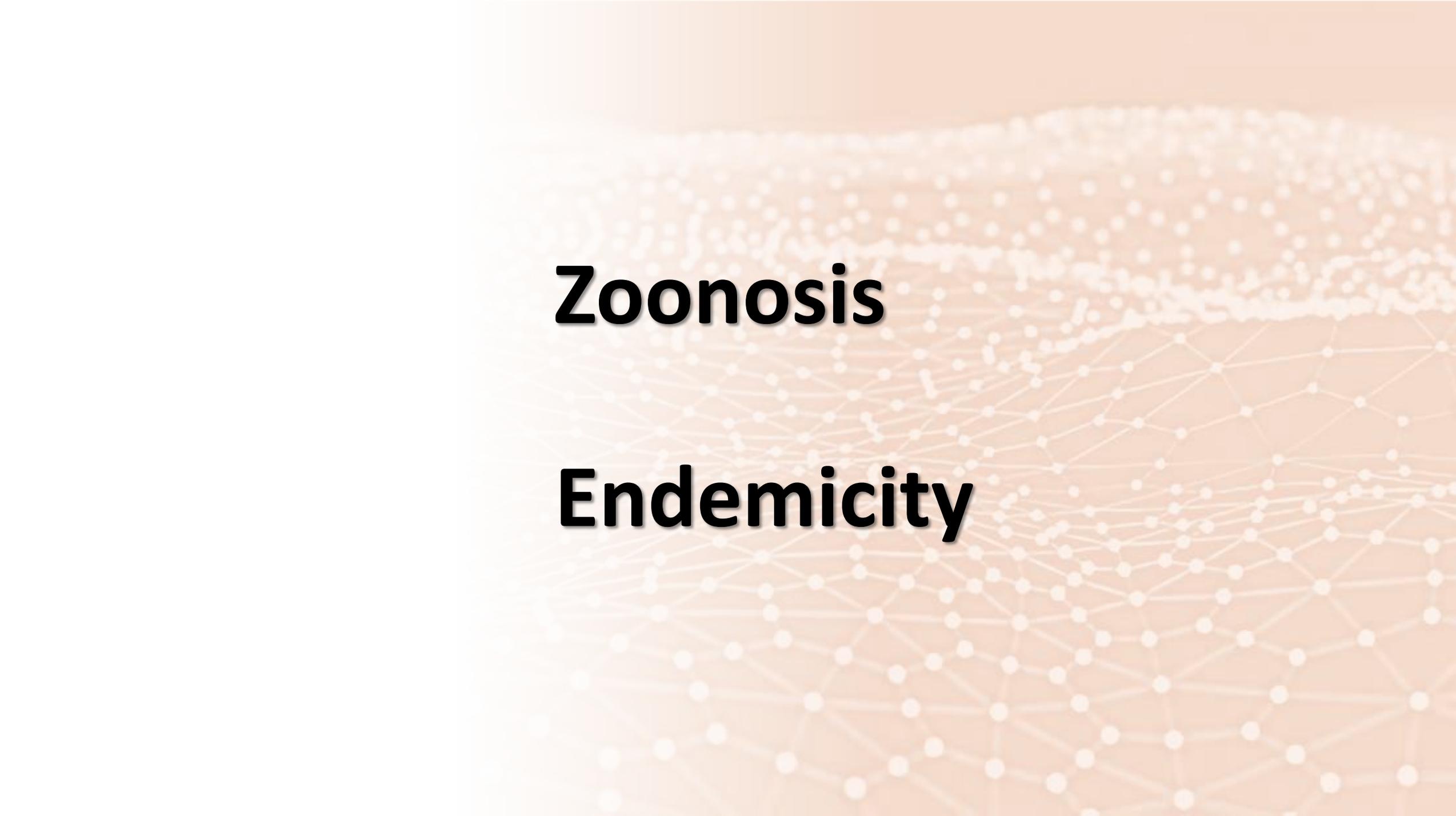
One Health & Artificial Intelligence in the IBSA context: Neural Networks for Zoonotic Prediction and Future Protection



विदेश मंत्रालय
Ministry of External Affairs

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Ministry of Agriculture and Livestock (MAPA), Brazil
IBSA Fellow

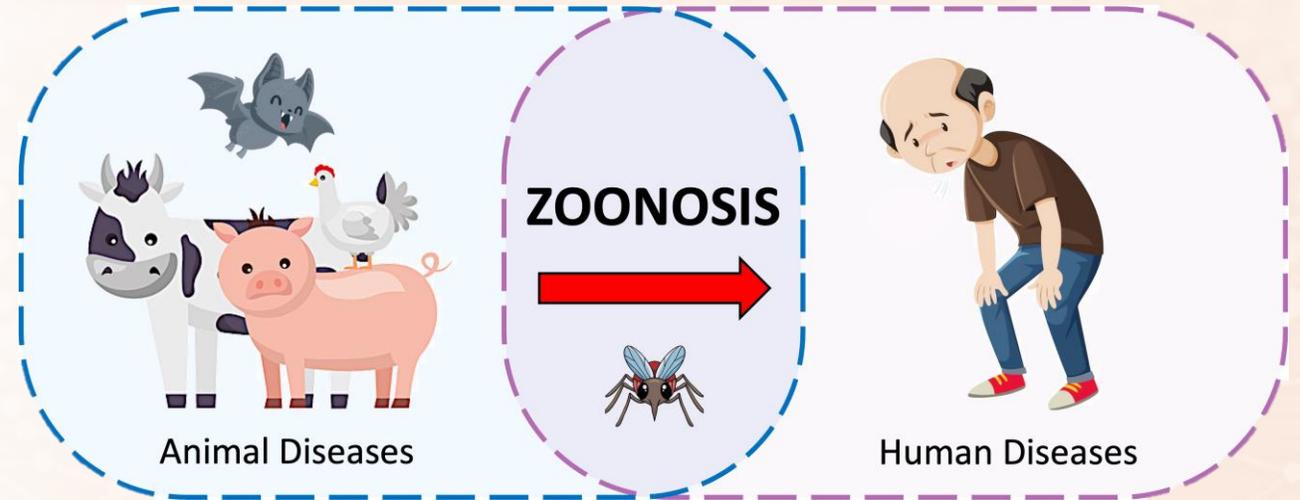




Zoonosis

Endemicity

Zoonosis



Zoonosis are infectious diseases that can be transmitted between animals and humans, or vice versa.

Endemicity is the consistent presence of a disease within a specific geographic area or population. Unlike an epidemic, an endemic disease has a relatively stable and predictable rate of infection. it implies a constant presence and refers to the baseline level of occurrence. Its impact is manageable.

Endemicity



Endemic



Pandemic

One Health: A Strategic Approach for IBSA Countries

Why One Health?

- 75% of infectious diseases are zoonotic.
- Human, animal, and environmental health are interconnected.

IBSA Context (India, Brazil, South Africa):

- High biodiversity, large livestock sectors, and dense populations.
- Shared risks: rabies, leptospirosis, avian influenza, malaria.
- Rapid urbanization and climate change amplify threats.

Strategic Relevance:

- Strengthen **South–South cooperation** in health and agriculture.
- Enable **early warning systems** and **predictive AI models**.
- Contribute to **sustainable development** and **global health security**.

How much does a disease cost?

1- Direct Costs



- Veterinary care and diagnostic procedures
- Treatments and medications
- Biosecurity and control measures
- Economic losses due to animal death or culling

2- Indirect Costs



- Reduced productivity (growth, reproduction, milk/egg/meat yield)
- Trade restrictions and loss of market access
- Increased operational expenses
- Impact on food supply chains

3- Social and One Health costs



- Public health consequences (zoonosis)
- Environmental degradation
- Loss of ecosystem
- Antimicrobial resistance impacts

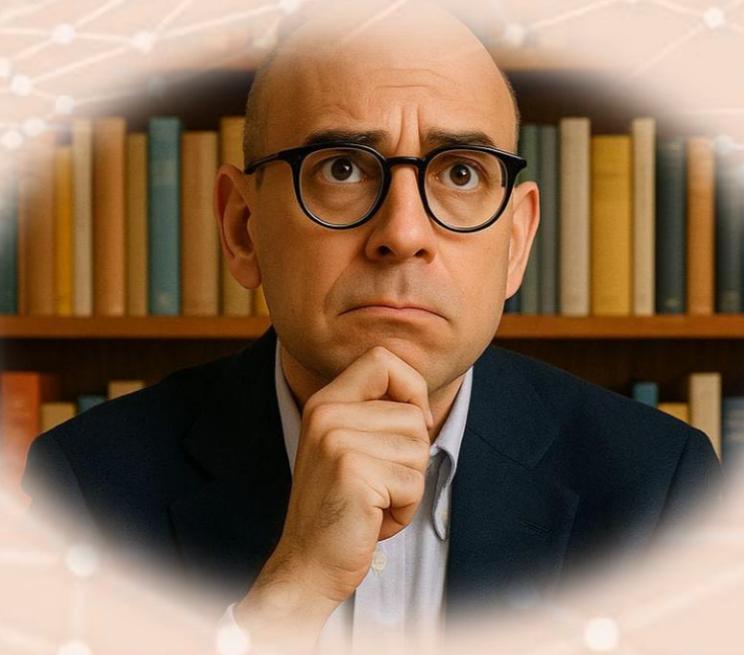
4- Strategic value of prevention



- Early detection reduces financial burden
- AI and predictive models help anticipate outbreaks
- Biosecurity and control measures
- Integrated surveillance supports One Health

Imagine a company ...

- **Average monthly revenue of ₹18 million (\approx US\\$ 220,000).**
- **Disease breakout**
- **Stop operations for one month**
- **Employees stop working**
- **Revenue disappears**
- **Who bears the cost?**



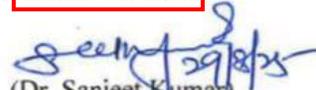
Dated: 29.08.2025

ORDER

Sub: Closing of National Zoological Park from 30.08.2025-regarding.

For the safety of visitor and to intensify surveillance of the disease the National Zoological Park shall remain closed for visitors temporarily from 30.08.2025 till further order as two of samples have been tested positive for H5N1 Avian Influenza Virus. However, all the essential services for management of animals and birds shall remain operative.

All Supervisors, Officials and Staffs are directed to follow the protocol of **Avian Influenza**.


(Dr. Sanjeet Kumar)
Director

Copy to:

1. Shri Nair Vishnuraj, Joint Director, NZP
2. Abhijit Bhawal, Veterinary Officer/In-charge Commissary Section
3. Dr. Manoj Kumar, Curator (Edn.)
4. Shri Rohit Kumar, Security Supervisor
5. Shri Rajneesh, Pandey, Work Supervisor
6. Shri Brahmanand, In-charge, Garden
7. Shri Vijay Bahadur, In-charge, Sanitary
8. All concerned staff
9. Executive Engineer, CCU/AE Civil & Electric/JE Civil & Electric: for information and necessary action.
10. Shiv Kumar Singh, Contractor BOT/Parking: for information and necessary action
11. Sadhna Singh, Contractor Clock Room: for information and necessary action
12. NERAMAC: for information and necessary action
13. Conceptz & Beyond: to upload in the website of NZP for wide information to public.
14. Office Copy



The National Zoological Park is temporarily closed from 30th Aug till further notice.

OUR MAIN GOAL IS TO

have more enriched environment for the animals, quality of animal exhibits, conservation education and sustainable management practices. We are working towards generating awareness and compassion in the society towards wildlife and to garner their support for the national conservation effort. We also thrive to play an effective role in species preservation and reducing man animal conflicts in urban landscape.

 Watch Video



Sh. Narendra Modi
Prime Minister of India





Activities in the zoo:

- Public visitation
- Environmental education
- Annual programs and events
- Reception of school groups
- Direct and indirect support for scientific research
- Training programs for animal keepers and other professionals
- Partnerships with animal welfare organizations
- Multidisciplinary team involvement
- etc.

When the Analogy Becomes Reality

- **The Delhi National Zoological Park has been closed since August 30, 2025 (reopening November 8th; the 2-month closure meant zero visitor income)**
- **In just one month, the estimated loss in ticket revenue is ₹18 million (\approx US\\$ 220,000)**
- **Hundreds of employees and indirect services were affected.**
- **Another concrete example of how zoonotic outbreaks and public health crises have direct economic consequences.**



Gripe aviária matou cisnes e patos em zoo no RS; local foi fechado

Foram coletadas amostras das aves que morreram e também da água dos lagos em que viviam

Luísa Martins e Gabriela Garcia, da CNN, em Brasília e em São Paulo

16/05/25 às 13:44 | Atualizado 16/05/25 às 13:56

Morte de cisnes e patos em zoo no RS também foi gripe aviária | BASTIDORES CNN

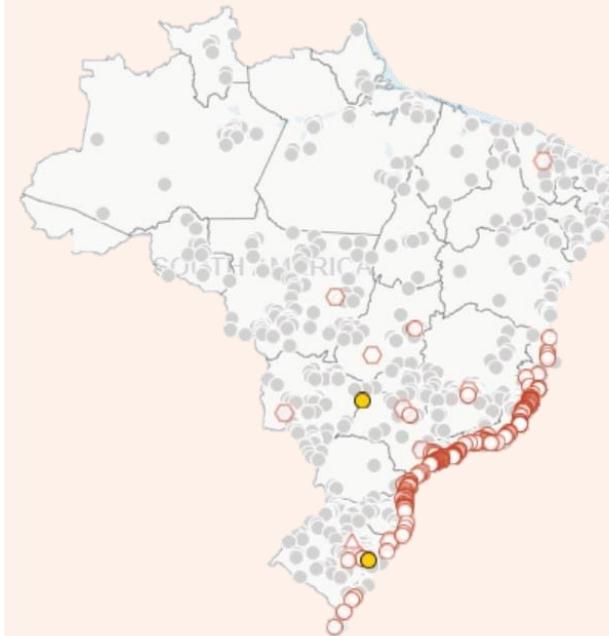


**POR LUÍSA MARTINS:
MORTE DE CISNES E PATOS
EM ZOO NO RS TAMBÉM
FOI GRIPE AVIÁRIA**



Avian flu killed swans and ducks at a zoo in Rio Grande do Sul; the site was closed.

Samples were collected from the dead birds as well as from the water in the lakes where they lived.



- Occurrences**
 - Discarded cases
 - Investigations in progress
- Closed outbreaks**
 - Commercial Birds
 - Non-commercial birds
 - Wild Birds
- Ongoing outbreaks**
 - Comcial Birds
 - Non-comercial Birds
 - Wild birds



<https://oglobo.globo.com/economia/noticia/2025/05/17/ovos-de-granja-foco-de-gripe-aviaria-estao-em-tres-estados-diz-ministerio-da-agricultura.ghtml>

Infant girl succumbs to bird flu in Andhra Pradesh

As a precaution, officials conducted a survey but found no new cases, including among the girl's family members.

Written by [PTI](#)

April 2, 2025 16:30 IST



Strains of the influenza virus that primarily infect birds, but can also infect humans.
(Image Credits: Pixabay)

<https://www.thehealthsite.com/news/h5n1-pandemic-alert-cdc-warns-of-9-mutations-in-bird-flu-virus-capable-of-infecting-humans-1176961/>

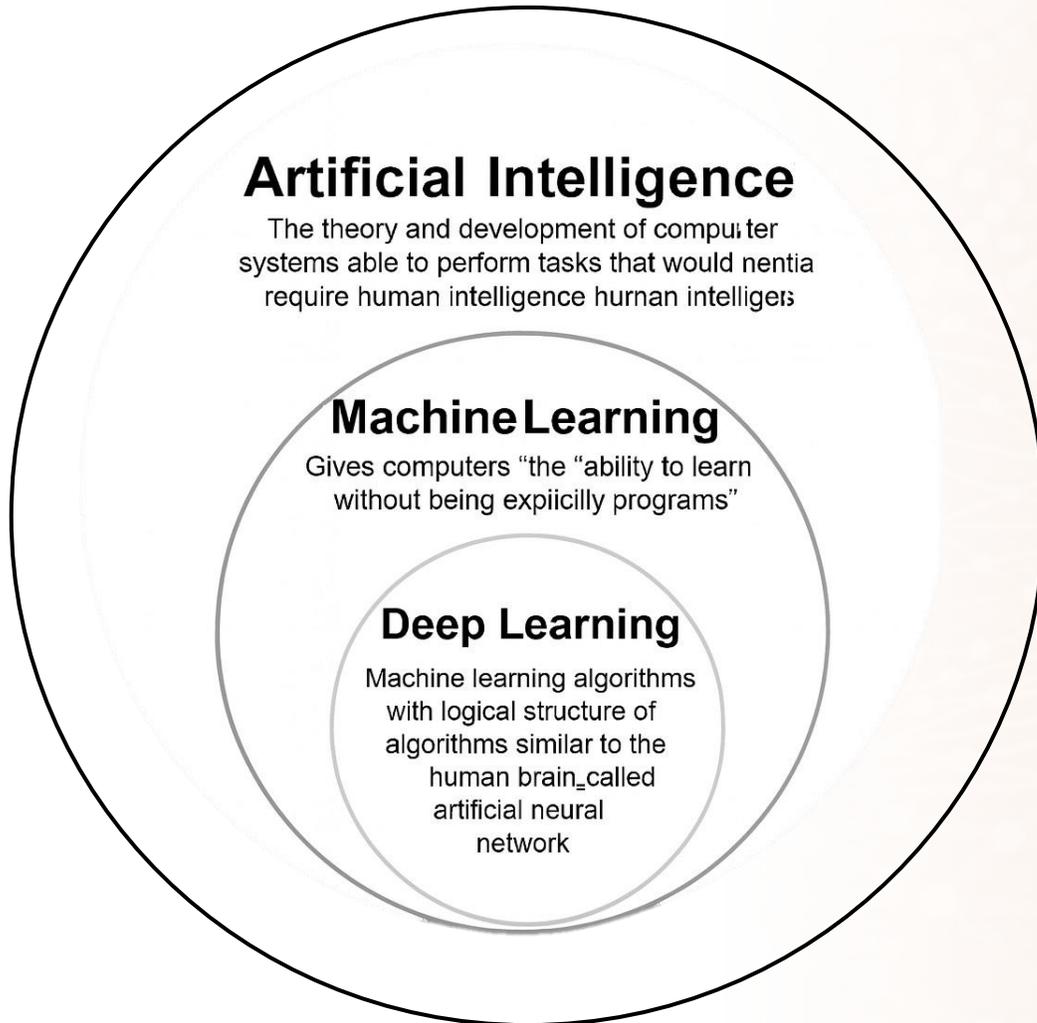


<https://timesofindia.indiatimes.com/city/meerut/state-level-kabaddi-player-dies-of-rabies-after-puppy-bite-during-rescue/articleshow/122189425.cms>

Objectives of the Research

- **Develop predictive models using Artificial Neural Networks (ANNs) applied to the One Health framework.**
- **Integrate human, animal, and environmental health indicators into a unified surveillance system.**
- **Validate models with real datasets from Brazil, India, and South Africa.**
- **Promote innovation by applying AI tools in One Health approach**
- **Support decision-making for prevention and early response.**

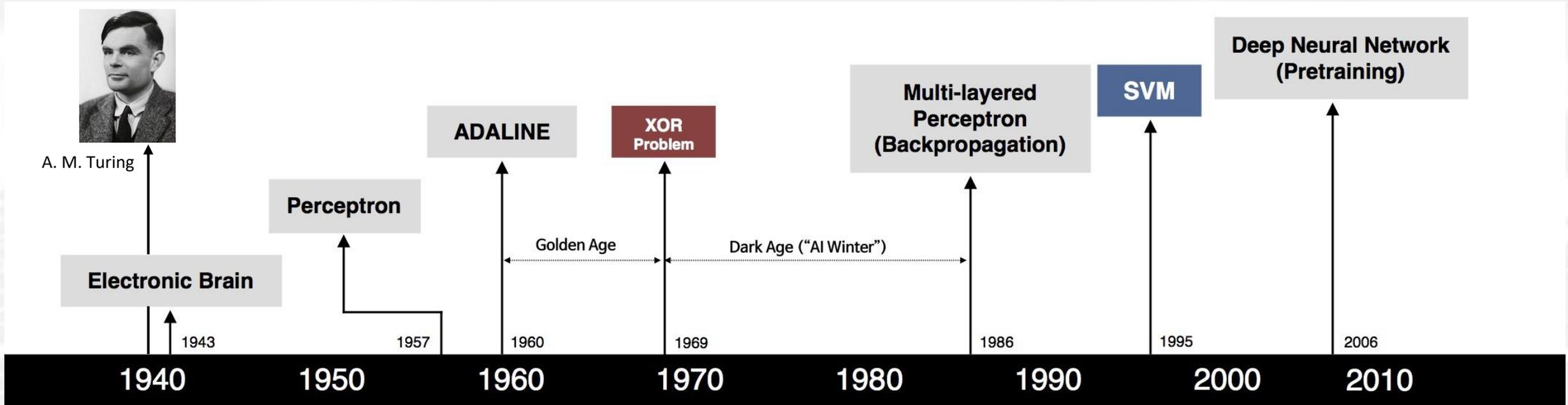
Classification diagram of ANN within the AI universe



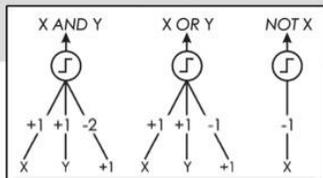
Computer Science

- Algorithms and Data Structures
- Computer Architecture and Systems
- Programming Languages
- Artificial Intelligence**
- Information Security and Cryptography
- Computer Graphics and Visualization
- Robotics and Autonomous Systems
- Cloud Computing
- Bioinformatics and Biomedical Computing
- Etc.

The history of ANNs



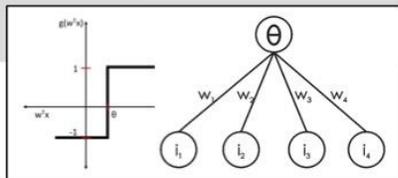
S. McCulloch - W. Pitts



- Adjustable Weights
- Weights are not Learned



F. Rosenblatt



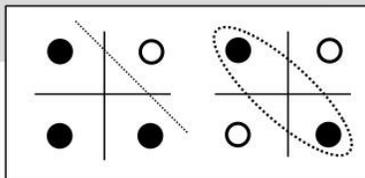
- Learnable Weights and Threshold



B. Widrow - M. Hoff



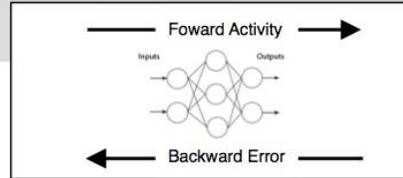
M. Minsky - S. Papert



- XOR Problem



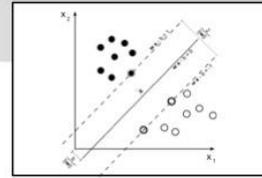
D. Rumelhart - G. Hinton - R. Williams



- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting



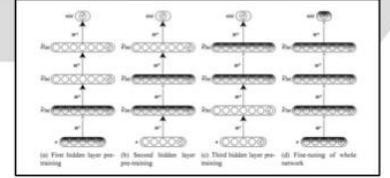
V. Vapnik - C. Cortes



- Limitations of learning prior knowledge
- Kernel function: Human Intervention



G. Hinton - S. Ruslan



- Hierarchical feature Learning

Material & Methods



Neuroshell Predictor®
Ward Systems Group, Inc.

Record Data

Historical data series

Years 2023 and 2024

Observational, analytical, and cross-sectional study

Database: 51 variables

India= 36 (States and UT); Brazil= 27 States; SA= 9 Provinces

72 rows

The “Output” variables were selected based on the diseases in common across the three Global South countries.

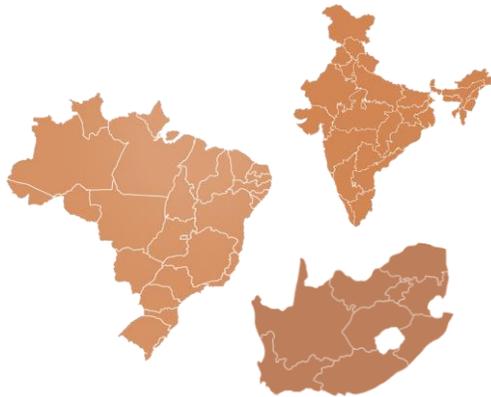
Material & Methods

Variables of interest

- Rabies
- Avian Influenza (H5N1)
- Leptospirosis
- Malaria

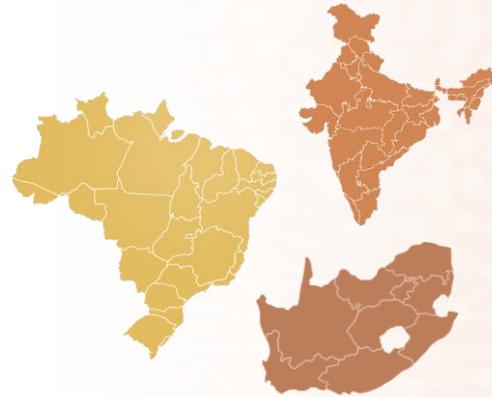


Malaria - Endemic countries



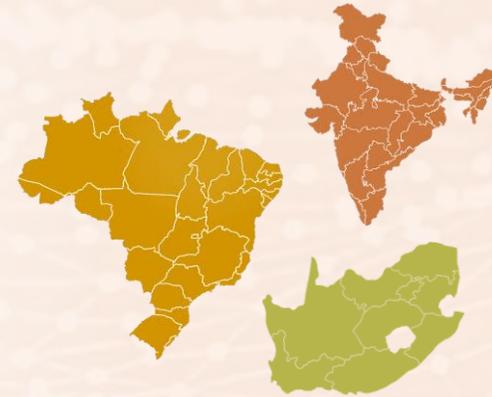
https://www.statista.com/chart/29847/malaria-cases-and-status-world-map/?srsltid=AfmBOophXezlZziUM2hNFAdhm6i-LkzllnSJPrM-EH2FjrpwV1Ve_Y

Rabies - Endemic countries



https://www.researchgate.net/publication/321874302_Review_on_Rabies_and_Vaccines

Leptospirosis - Endemic countries



https://www.researchgate.net/publication/373365120_Global_regional_and_country-level_cost_of_leptospirosis_due_to_loss_of_productivity_in_humans

Avian Influenza countries



WOAH - <https://www.woah.org/en/home/>

Material & Methods

Process steps:

Organization

Training

Testing

Training

Here you can view the first rows of the file you have loaded. Push the Display All Data button (visible only for large files) if you want to show the whole file in the data editing is available; press the Help button on the right for details. When you are satisfied that you have the right file, push the Next button to go on.

Show data

Column labels: yes Columns: 58 Data rows: 72 Select ranges

	Country	State	Abbreviation	Area (km²) %	Human Population %	2024 Population estimate %
1	INDIA	Andaman and N	AN	0.261	0.031	0.02
2	INDIA	Andhra Pradesh	AP	5.147	4.095	3.82
3	INDIA	Arunachal Prade	AR	2.645	0.114	0.11
4	INDIA	Assam	AS	2.477	2.578	2.57
5	INDIA	Bihar	BR	2.974	8.599	9.13
6	INDIA	Chandigarh	CH	0.004	0.087	0.08
7	INDIA	Chhattisgarh	CG	4.27	2.11	2.17
8	INDIA	Dadra and Nage	DNH	0.019	0.048	0.09
9	INDIA	NCT of Delhi	DL	0.047	1.387	1.53
10	INDIA	Goa	GA	0.117	0.12	0.11
11	INDIA	Gujarat	GJ	6.191	4.993	5.15
12	INDIA	Haryana	HR	1.396	2.094	2.17
13	INDIA	Himachal Prade	HP	1.758	0.567	0.53
14	INDIA	Jammu and Kasi	JK	1.334	1.013	0.9
15	INDIA	Jharkhand	JH	2.518	2.725	2.84
16	INDIA	Karnataka	KA	6.057	5.047	4.87
17	INDIA	Kerala	KL	1.227	2.76	2.57
18	INDIA	Ladakh	LA	1.868	0.023	0.02
19	INDIA	Lakshadweep	LD	0.001	0.005	0.00
20	INDIA	Madhya Pradesh	MP	9.735	5.999	6.23
21	INDIA	Maharashtra	MH	9.718	9.283	9.10
22	INDIA	Manipur	MN	0.705	0.212	0.23
23	INDIA	Meghalaya	ML	0.708	0.245	0.24
24	INDIA	Mizoram	MZ	0.666	0.091	0.08
25	INDIA	Nagaland	NL	0.524	0.163	0.16
26	INDIA	Odisha	OR	4.917	3.467	3.33
27	INDIA	Puduchery	PY	0.015	0.103	0.11
28	INDIA	Punjab	PB	1.501	7.207	7.21

Total data rows: 72 Selected rows: 72 (from 1 to 72)

Input/output selection and training

Select columns to be used as input:

Number of inputs selected: 56

- DENGUE DEATHS - 2020-2024
- Kala-azar - CASES 2020 - 2024
- Kala-azar - DEATHS 2020 - 2024
- Dermal Leishmaniasis
- 2020-2024 Chikungunya cases %
- 2020-2024 Chikungunya deaths
- Human Rabies cases (Death) - 2020-2024
- Dog Bite cases - 2022-2025 %
- Number of persons killed by animals - 2020-2024
- Malaria - Cases 2021-2024
- Malaria - Deaths 2021-2024
- Leptospirosis cases 2021- 2024
- Brucella
- Hantavirus
- Influenza A virus H1N1 pdm09

Select the column to be used as output:

- Flooded_Area_Ha %
- Relative_Humidity_%
- Temperature
- Annual Precipitation Total (mm)
- FMD 2020-2024 Positive Samples
- Mormo Animal
- DENGUE CASES - 2020-2024
- DENGUE DEATHS - 2020-2024
- Kala-azar - CASES 2020 - 2024
- Kala-azar - DEATHS 2020 - 2024
- Dermal Leishmaniasis
- 2020-2024 Chikungunya cases %
- 2020-2024 Chikungunya deaths
- Human Rabies cases (Death)
- Dog Bite cases - 2022-2025 %
- Number of persons killed by animals - 2020-2024

Total data rows: 72

Random training rows: 50, random rows for applying

Selection of ranges

Use all available rows for both learning and applying the network.

Use a selected range of rows for both learning and applying the network.

Start row:

End row:

Use one range of rows on top for learning, and apply to an out-of-sample range on the bottom for verification.

Top range for training, rows:

Bottom range for applying, rows:

Total data rows: 72

Use randomly selected sets for learning and applying.

Random training rows: or %

Random seed (1..2,147,483,646):

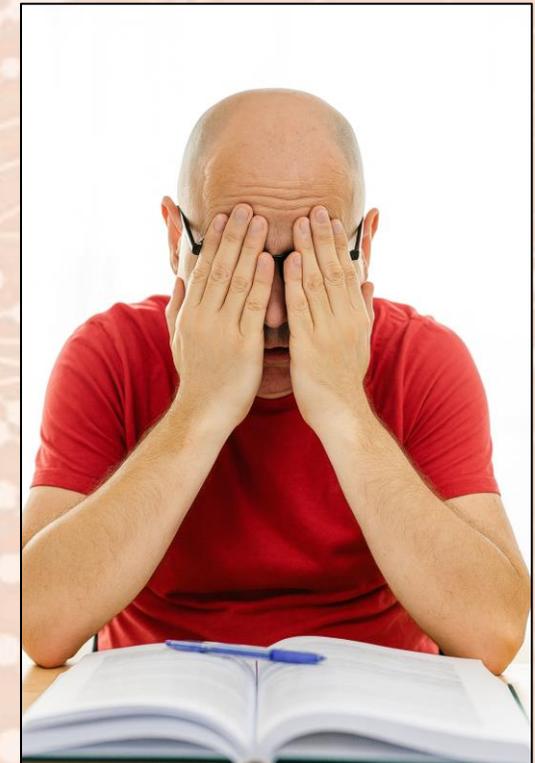
Remaining rows will become the out-of-sample set.

OK

Cancel

Help

Testing



Overview of the Neural Network Interface

Number of processed rows:	72
Number of unprocessed rows:	0
R-squared	0,792778
Avg. error	0,054611
Correlation	0,890488
MSE	0,01908
RMSE	0,138131
% in range	0,6%
% same sign	96,0%

#	Actuals	Predicted
10	0,21	0,147807
13	0,27	0,204411
24	0,14	0,144849
25	0,54	0,502029
31	0,24	0,238611
39	0,16	0,1613
42	0,23	0,230026
48	0,25	0,247416
58	0,36	0,27833
59	0,21	0,285137
61	0,33	0,266714
65	0,17	0,183434
69	0,16	0,160045
74	0,14	0,17536
77	0,23	0,233881
81	0,49	0,45751
85	0,46	0,380095
89	0,45	0,487217
90	0,23	0,224451
96	0,52	0,518386
98	0,52	0,518757
107	0,24	0,242145
111	0,10	0,102425

Importance of inputs

0,056	Basic Sanitation (%)
0,049	Temperature
0,046	Density (per km2)
0,043	Per Capita Net State Domestic Product 2024 (Dollars)
0,043	Area (km ²) %
0,039	2024 Chikungunya cases %
0,037	Annual Precipitation Total (mm)
0,035	Dermal Leishmaniasis

Information about the network currently in memory

The network was trained on:

Trained on file: C:\...ndo India, Brasil e Africa do Sul FINAL EM %.csv

Total data rows: 72 Start row: 1

Training rows: 50 End row: 72

Network structure:

Training strategy: Genetic

Number of inputs: 45

Number of hidden neurons (if Neural strategy): N/A

List of input variables:

- 0,024 "Area (km²) %"
- 0,014 "Human Population %"
- 0,037 "2024 Population estim"
- 0,045 "Density (per km2)"

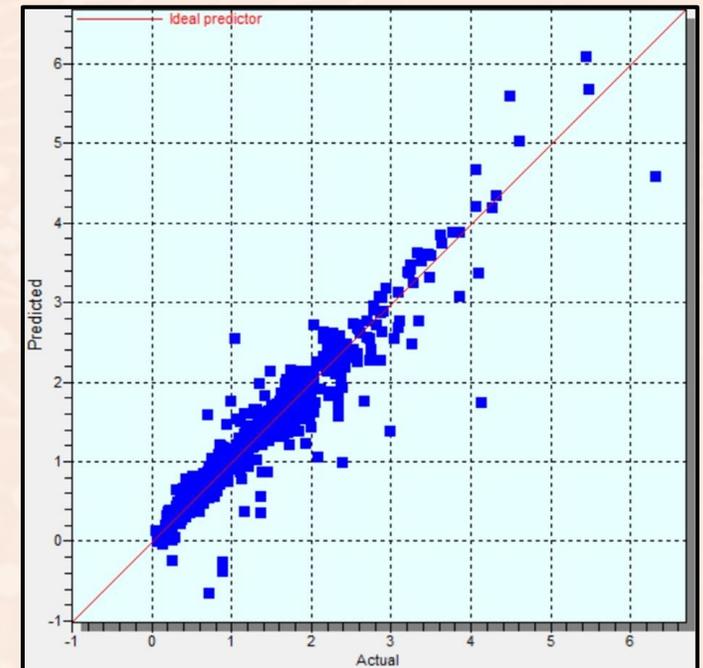
Output variable: "Human Rabies cases (Death) - 2"

Results of training session:

Training time: 9:55:09"

R-squared: 0,2580916 Generations trained (if Genetic strategy): 52750

Average error: 3,5326



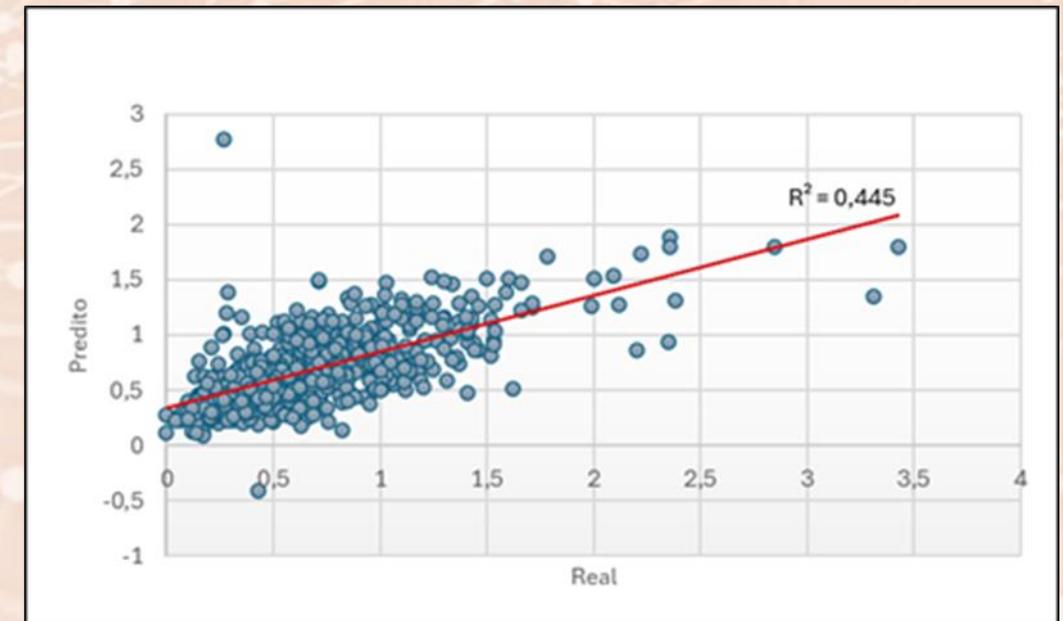
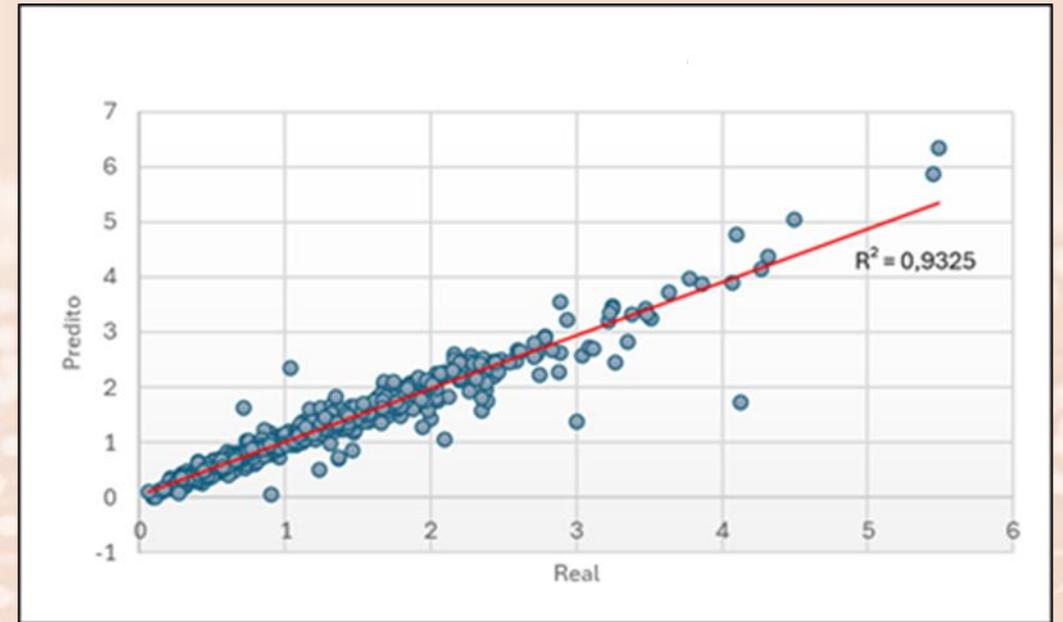
When are the models considered well-fitted?

Statistical fit indicators:

Pearson's Correlation Coefficient and
Coefficient of Determination (R^2)

R^2 = Coefficient of determination:
Measures how much of the variation in
the real data is explained by the model.

R = Correlation coefficient:
Measures the strength of the linear
correlation between predicted and
observed values.

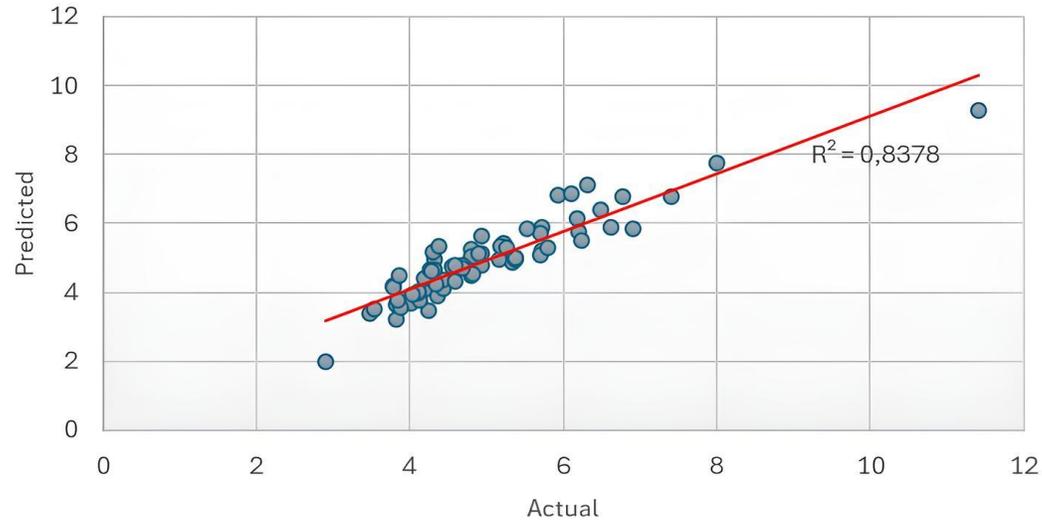


Results

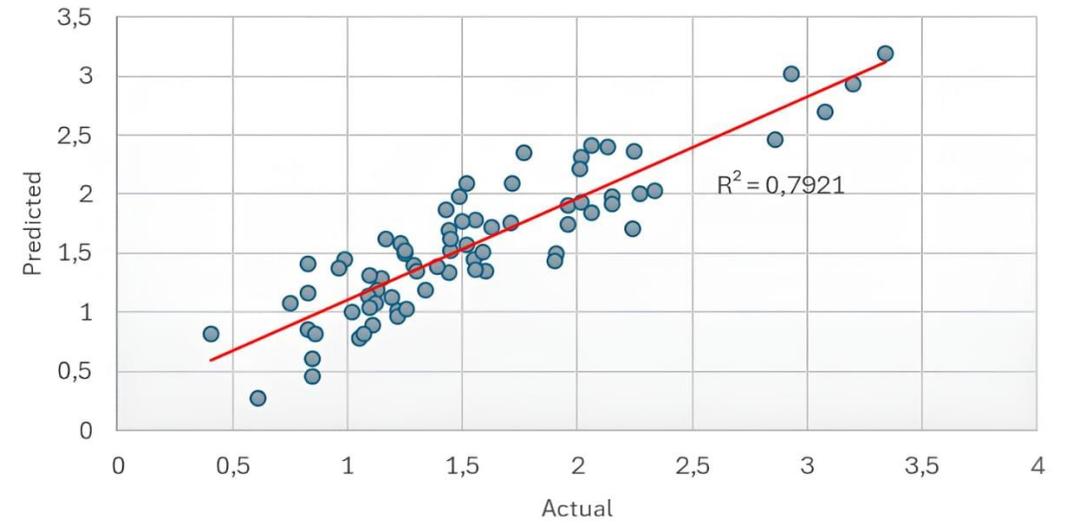
- ❑ Rabies: $R^2 = 0.83$ — strongest performance, reflecting stable determinants such as dog population dynamics, vaccination coverage, human exposure, and wildlife reservoirs.
- ❑ Leptospirosis: $R^2 = 0.79$ — driven by consistent environmental and socioeconomic indicators.
- ❑ Malaria: $R^2 = 0.71$ — influenced by climate, vegetation, and population density.
- ❑ Avian Influenza (H5N1): $R^2 = 0.23$ — low performance, suggesting underrepresented ecological drivers in available datasets.

Results

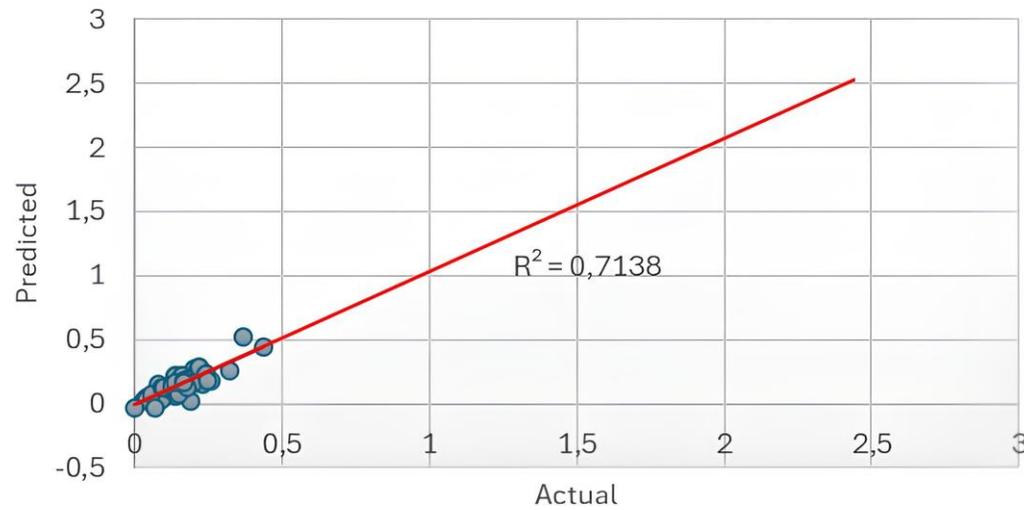
Rabies model



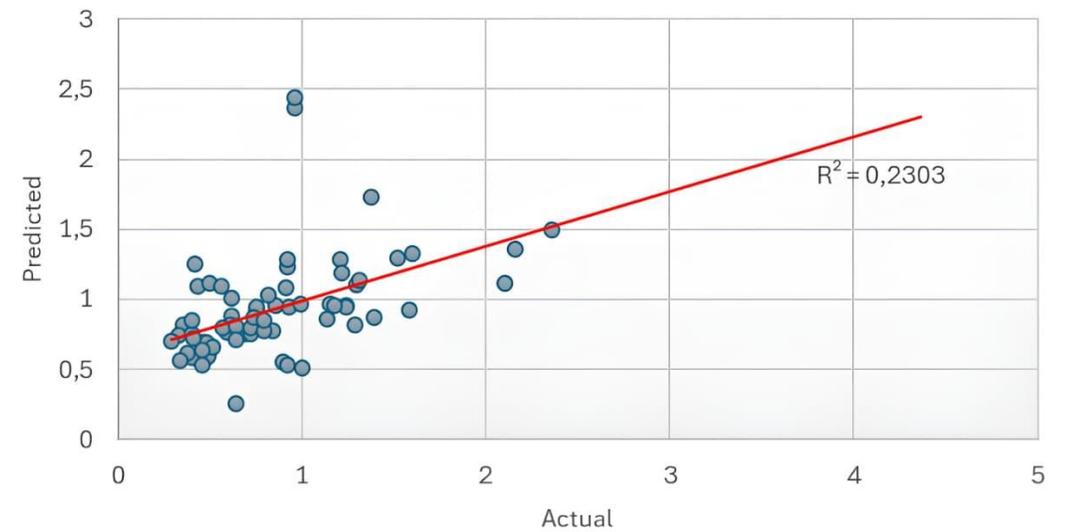
Leptospirosis model



Malaria model



Avian Influenza model



Conclusion

Artificial Neural Networks showed good performance in predicting priority zoonoses such as Leptospirosis, Rabies and Malaria **in the three IBSA countries**, by integrating environmental, animal, and human variables. The models demonstrated solid fit indices, highlighting the potential of predictive approaches to support One Health surveillance actions.

Conclusion

The Avian Influenza model showed the weakest performance ($R^2 = 0.23$) due to missing ecological and surveillance variables essential for H5N1 dynamics. This probably limited the Neural Network's ability to learn meaningful patterns, highlighting the need for better eco-epidemiological monitoring and integrated datasets to improve AI-based prediction of avian influenza.

Policy Recommendations

- Integrate Artificial Neural Networks into IBSA One Health surveillance.
- Focus predictive modeling on 4 shared zoonoses (rabies, malaria, leptospirosis, avian influenza).
- Promote South-South data sharing and joint research platforms.
- Raise awareness on the economic and health impact of zoonoses across IBSA countries.
- Align with Article 43 by strengthening South–South cooperation within IBSA to integrate AI-enabled One Health surveillance, reinforcing health systems and preparedness.

Thank you !



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