A GENERALIZED ATTENTION DEFICIT DISORDER CHAOTIC MODEL WITH SOBOLEVA HYPERBOLIC TANGENT FUNCTIONS

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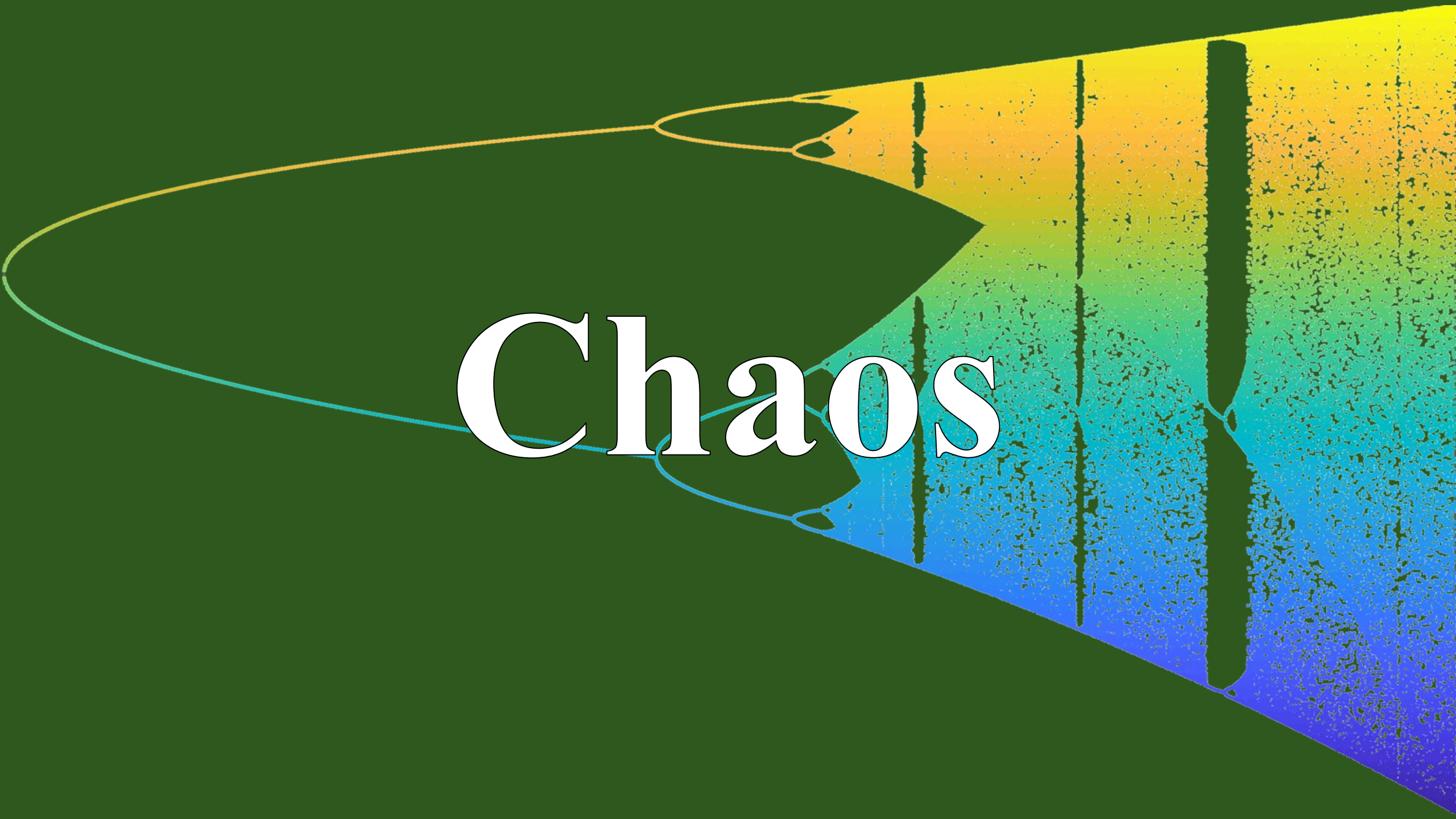
Topics

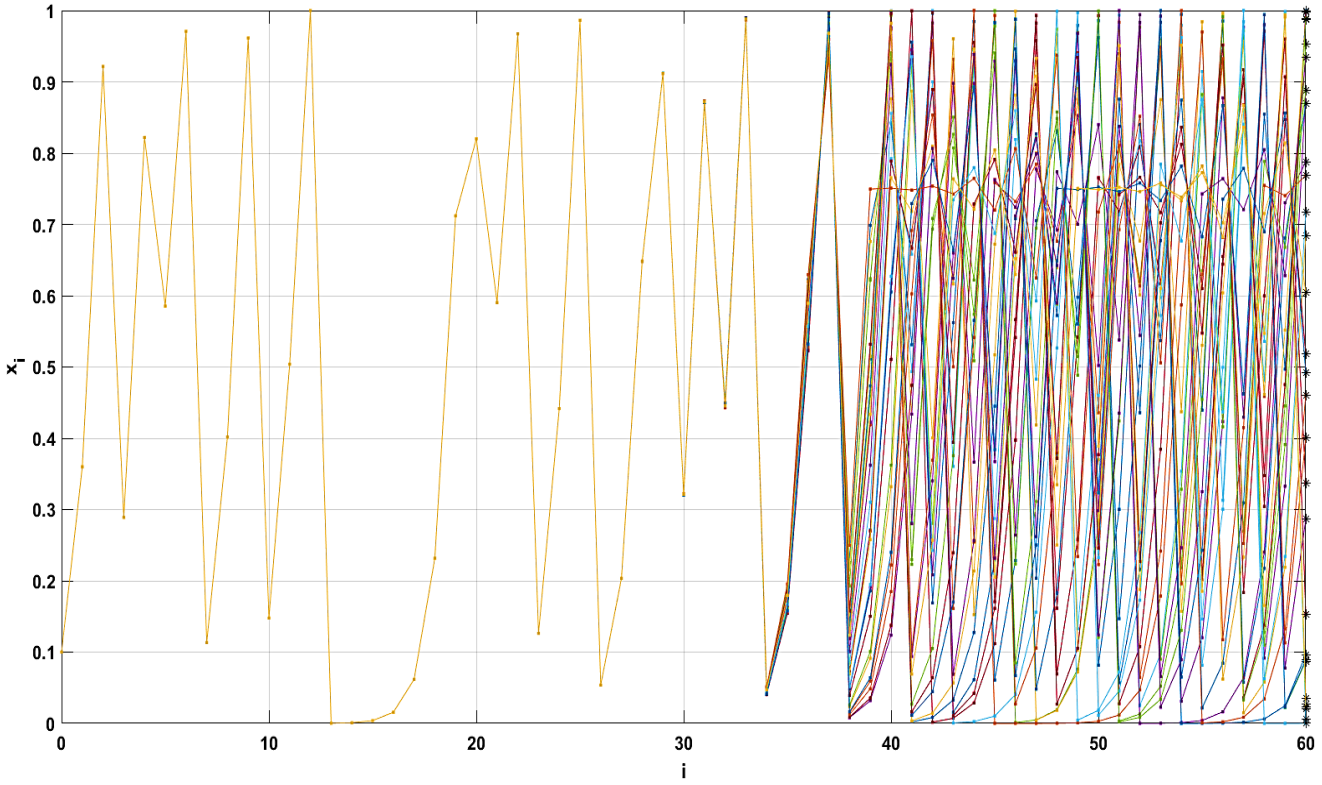
- Chaotic Neural Networks
- Attention Deficit Disorder
- Activation Functions
- Future topics

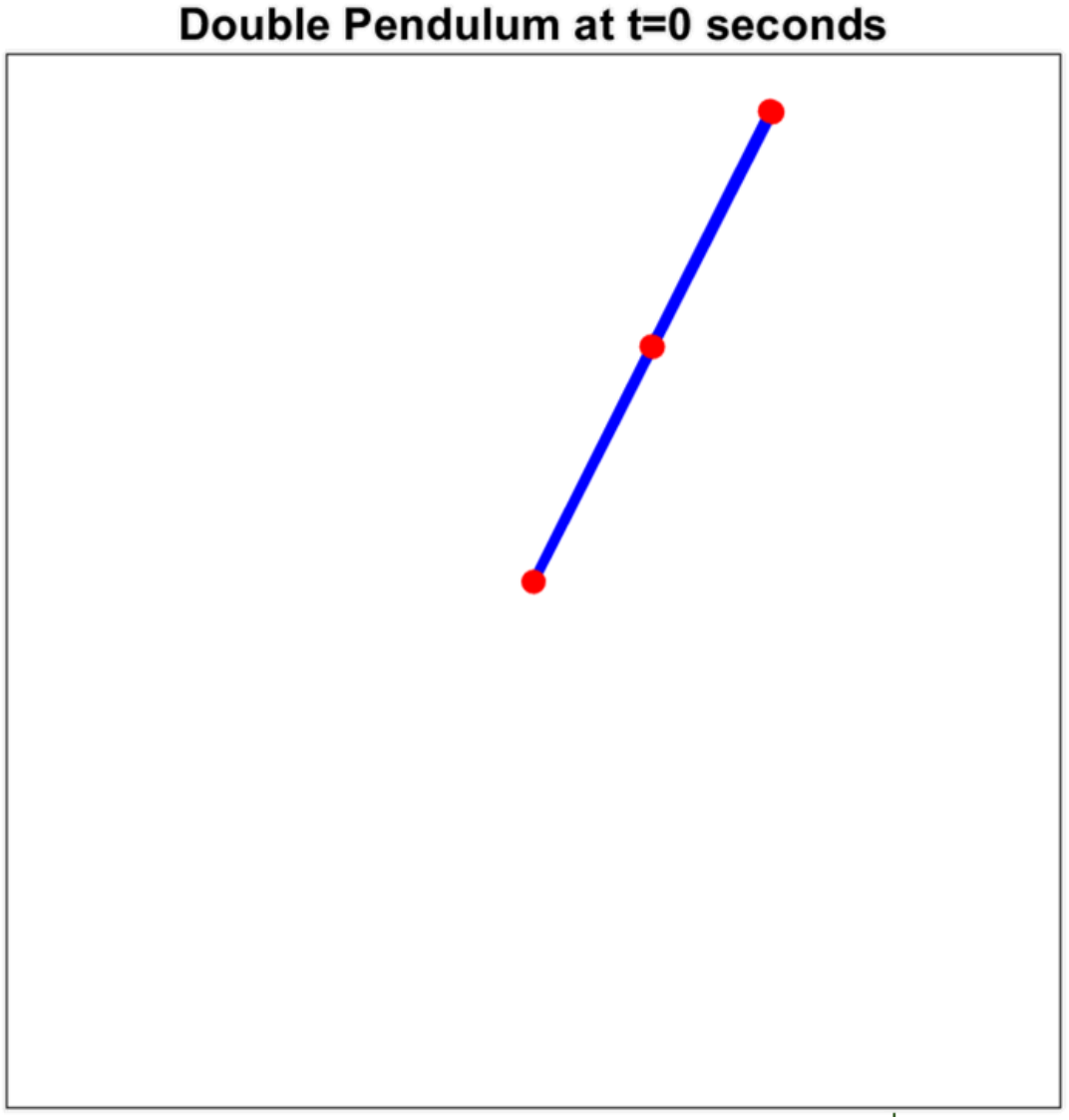

Chaos

Chaos?

$$x_{i+1} = f(x_i)$$

$$\dot{x} = f(x)$$





Chaos

Emergence in nature

- Physics
- Engineering
- Biology
- Human physiology
- Chemistry
- Economy

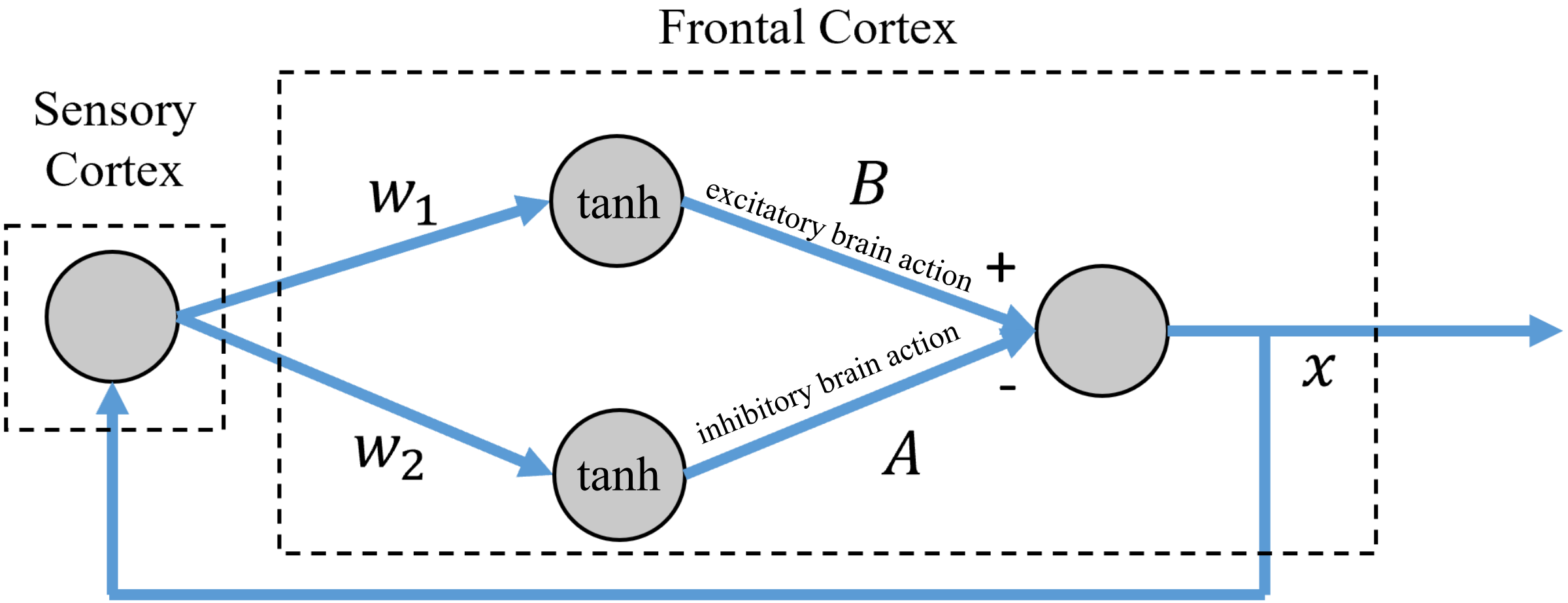
Applications

Suitable for:

- Data encryption
- Watermarking
- Secure communications
- Path Planning
- Many more

Chaotic Neural Networks

Human Physiology

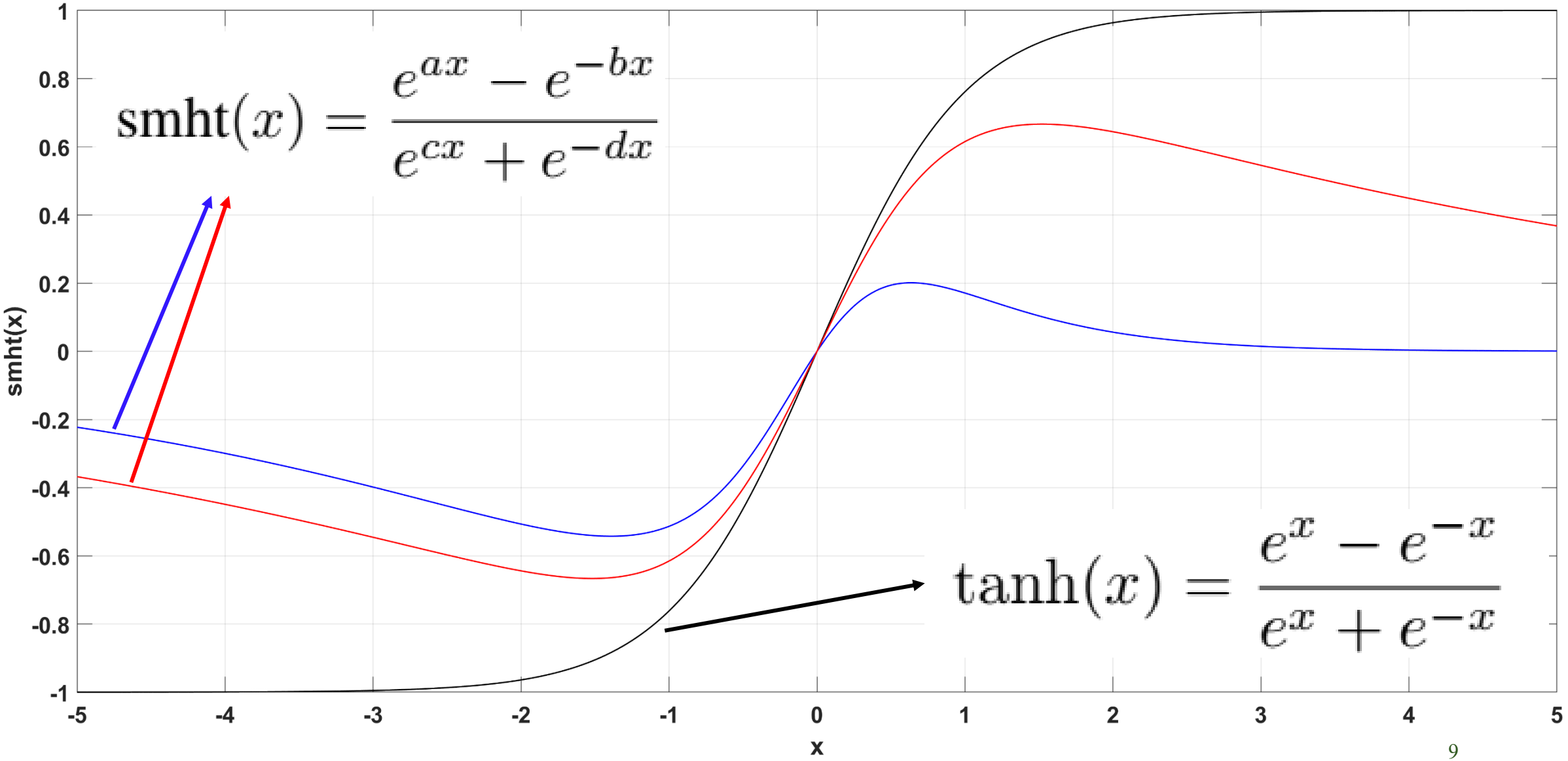


Literature – (Behavioral) Disorders

- Low dimensional NNs

- Attention deficit disorder (ADD)
- Migraine
- Seizure
- Epilepsy
- Bipolar disorder
- Coma

Soboleva Activation Function



Attention Deficit Disorder

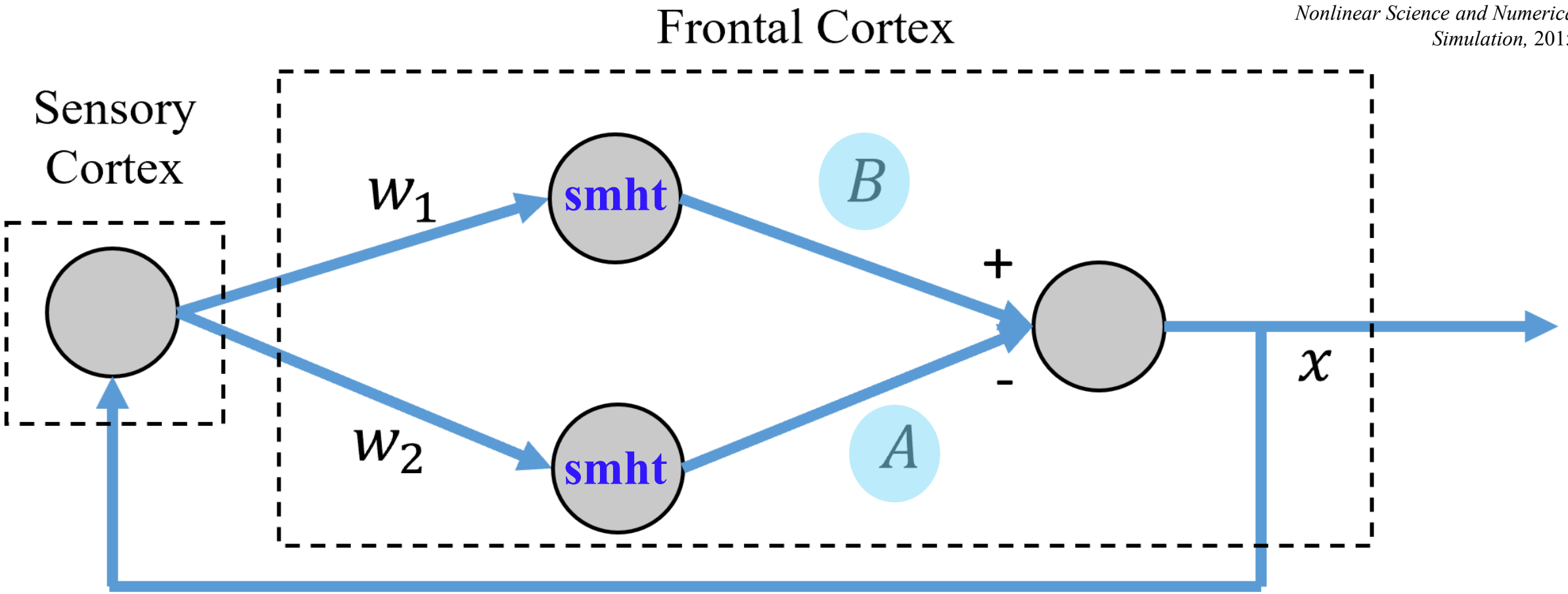
Attention Deficit Disorder

- A neurological condition
- Affects a person's ability to focus, sustain attention, and regulate behavior

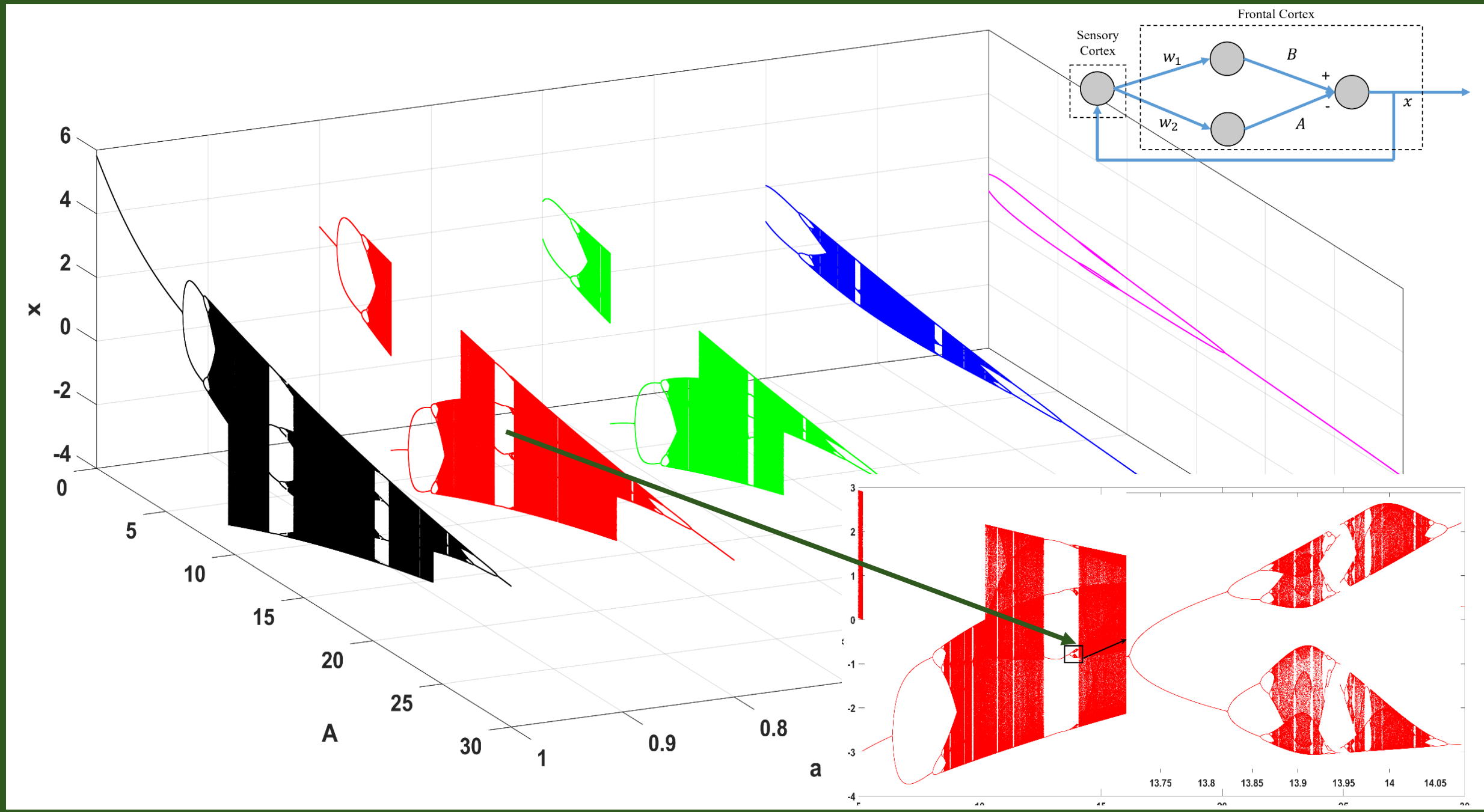
- **Inattention**: Difficulty sustaining focus, especially on tasks that require prolonged mental effort.
- **Disorganization**: Trouble keeping track of tasks, losing items, or missing deadlines.
- **Forgetfulness**: Frequently forgetting appointments or instructions.
- **Avoidance**: Tendency to avoid or dislike tasks that require sustained mental effort.

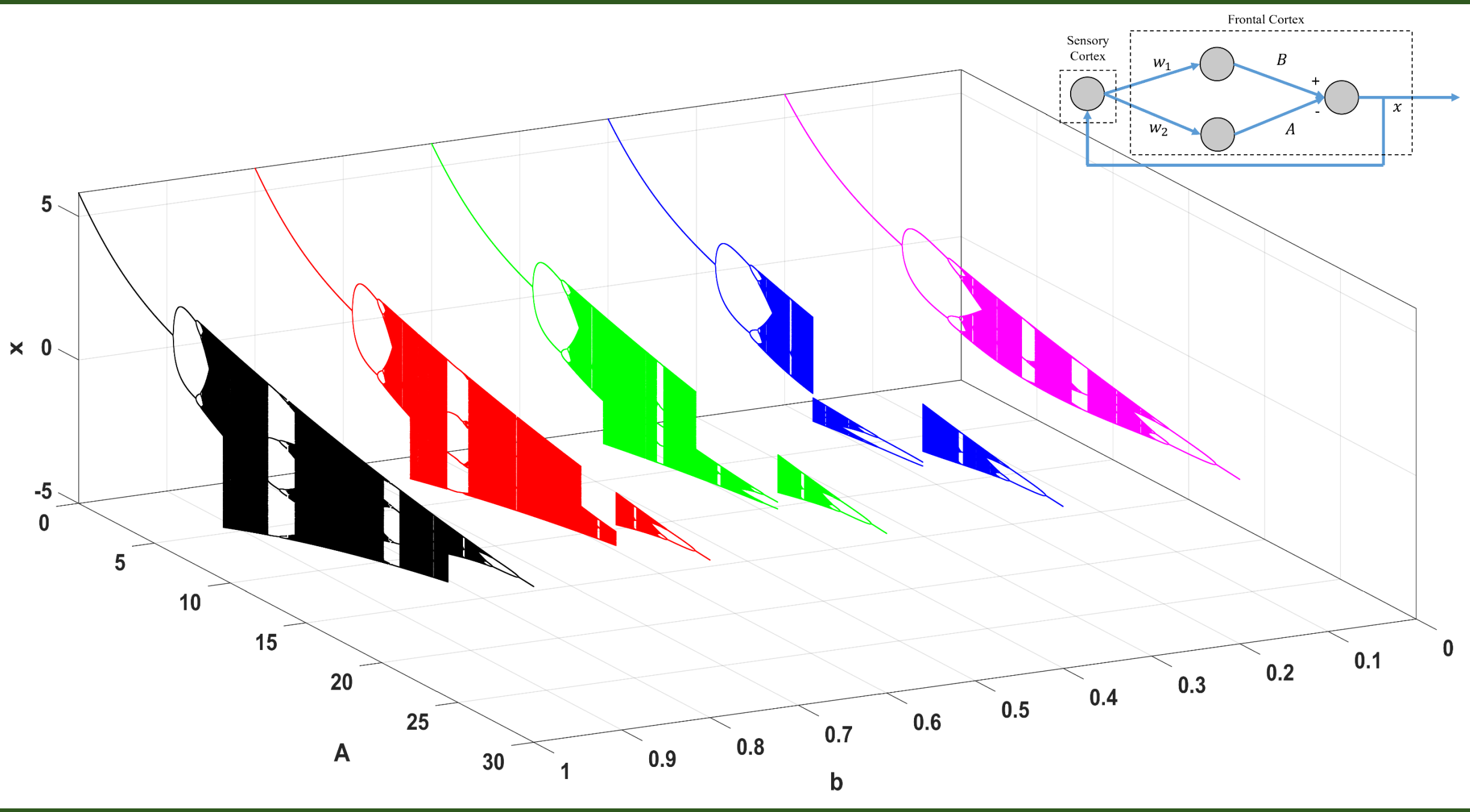
Attention Deficit Disorder

G. Baghdadi, S. Jafari, J. C. Sprott, F. Towhidkhah, and M. H. Golpayegani, "A chaotic model of sustaining attention problem in attention deficit disorder," *Communications in Nonlinear Science and Numerical Simulation,* 2015.

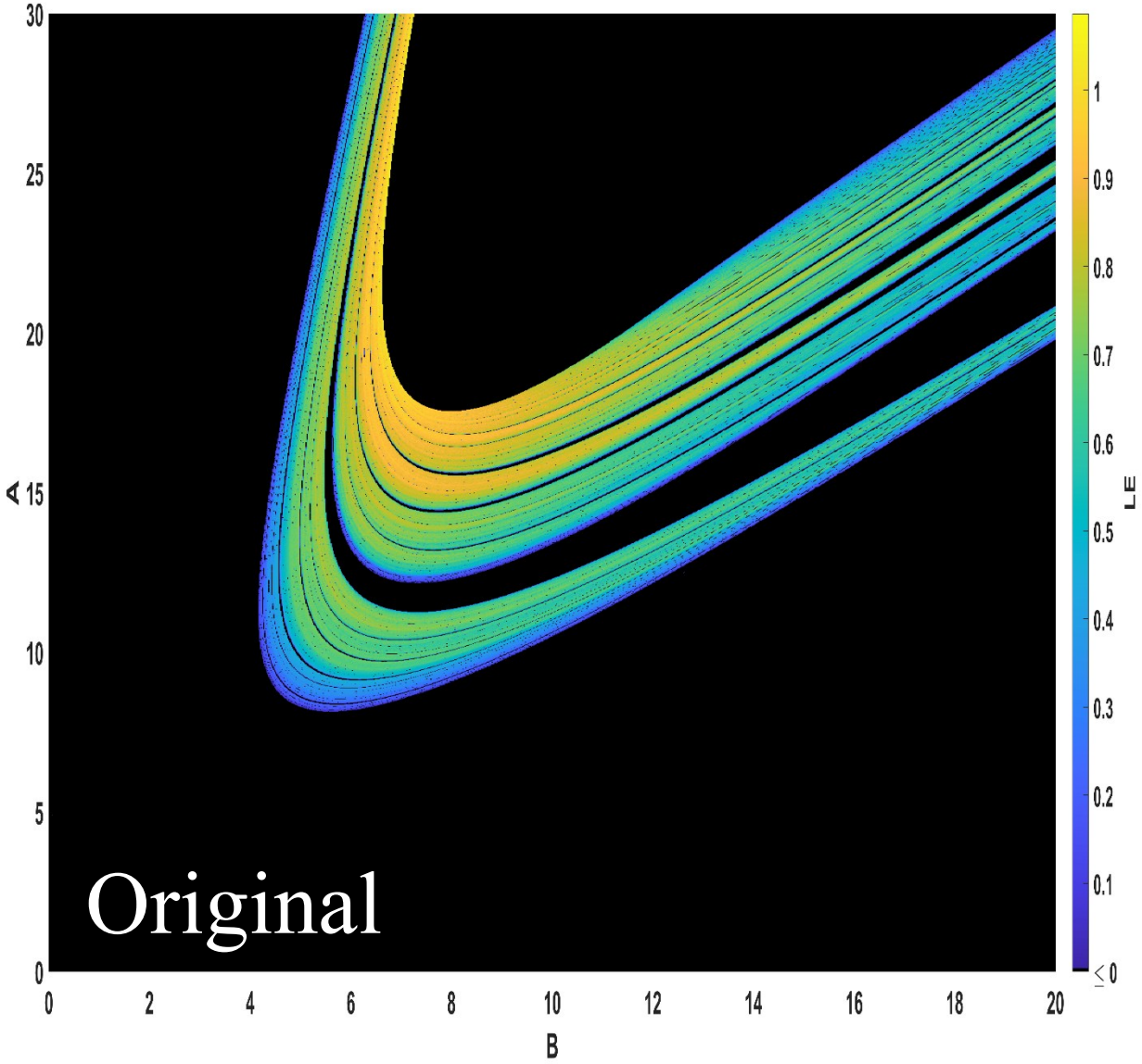


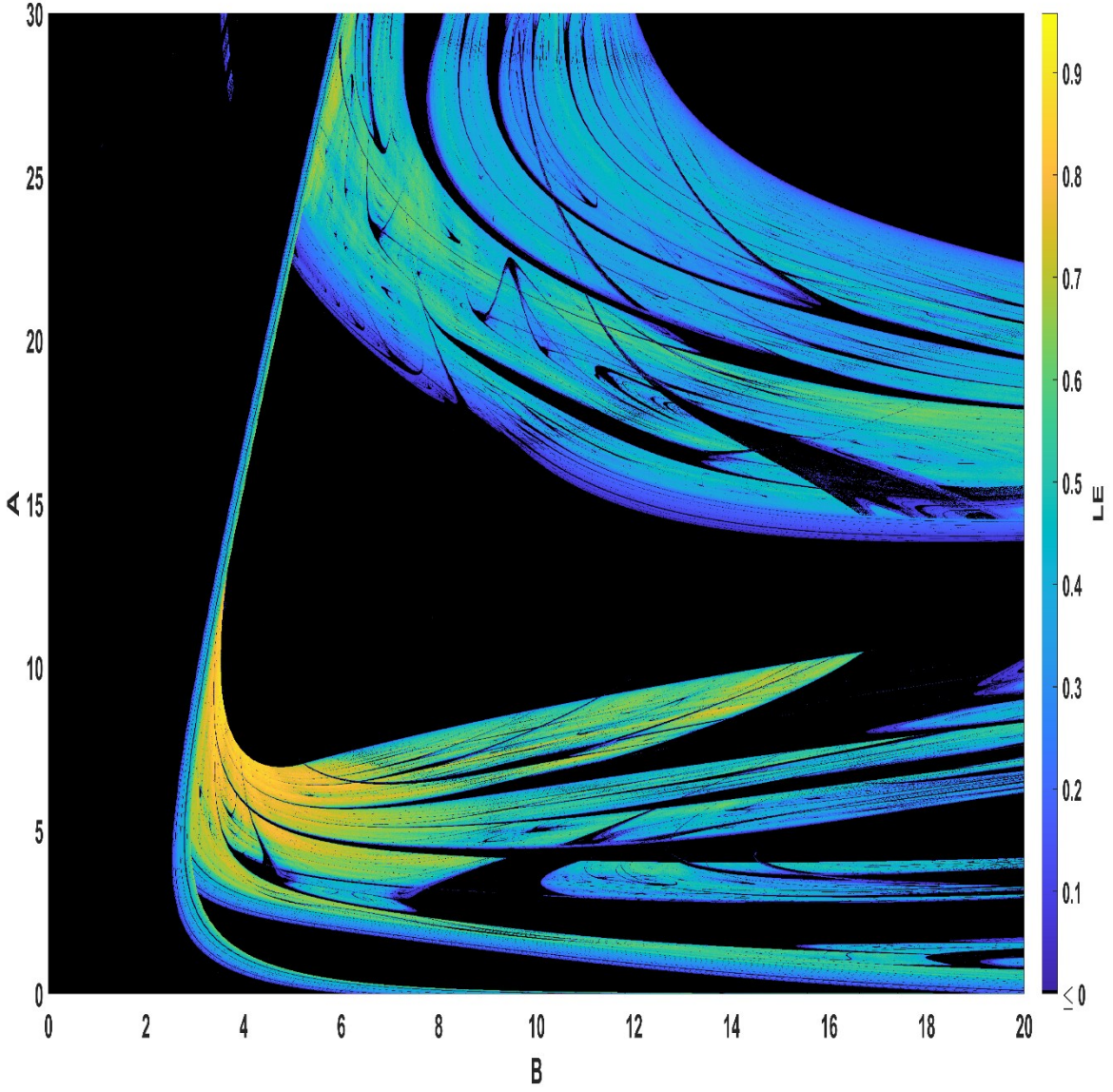
$$x_i = B\text{smht}(w_1 x_{i-1}) - A\text{smht}(w_2 x_{i-1})$$


Frontal Cortex
Sensory Cortex
w_1
w_2
B
A
+
-
x
x
6
4
2
0
-2
-4
0
5
10
15
20
25
30
A
1
0.9
0.8
a
3
2
1
0
-1
-2
-3
-4
13.75
13.8
13.85
13.9
13.95
14
14.05

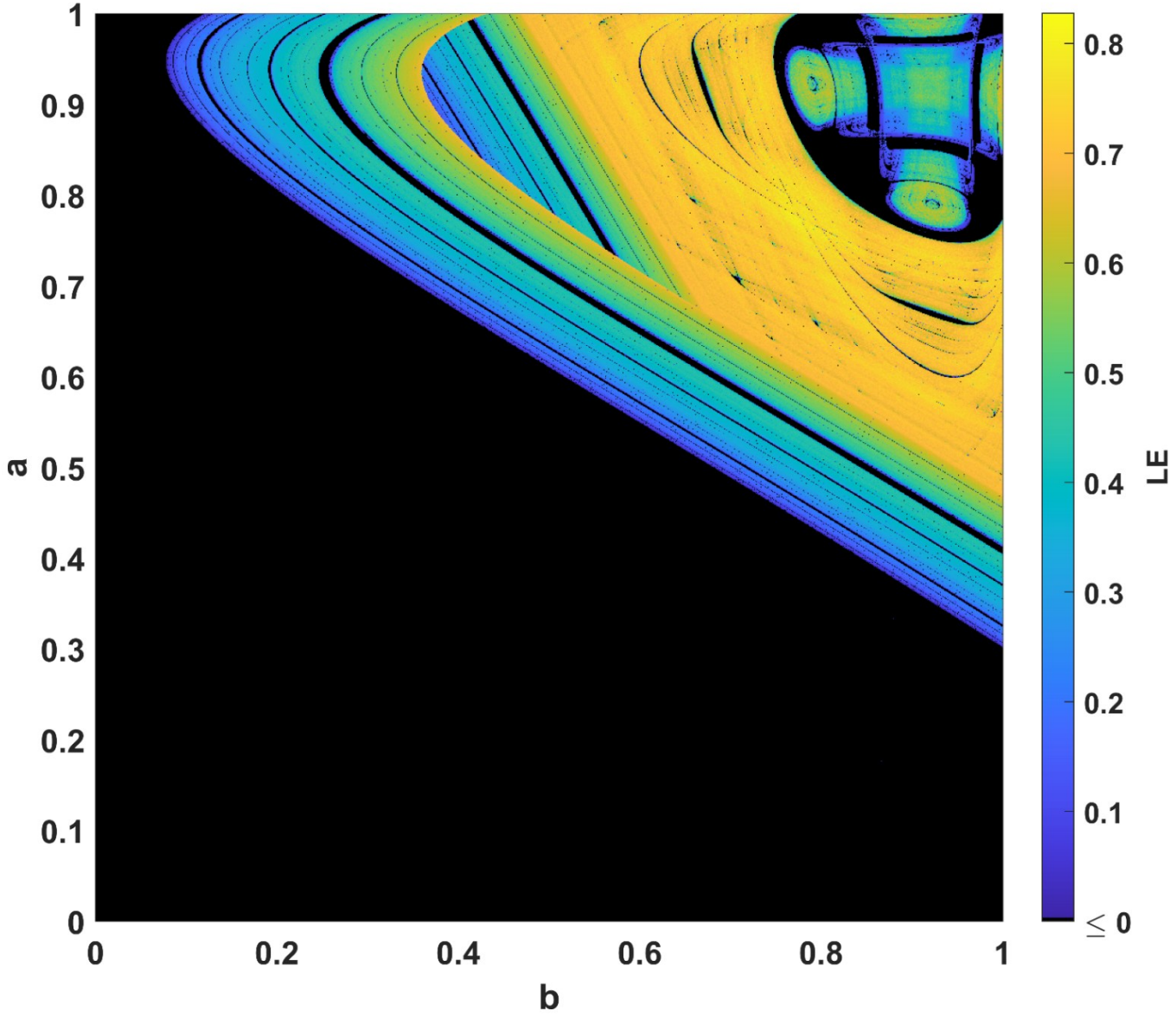

Frontal Cortex
Sensory Cortex
w_1
w_2
B
A
+
-
x
x
5
0
-5
0
5
10
15
20
25
30
A
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
b

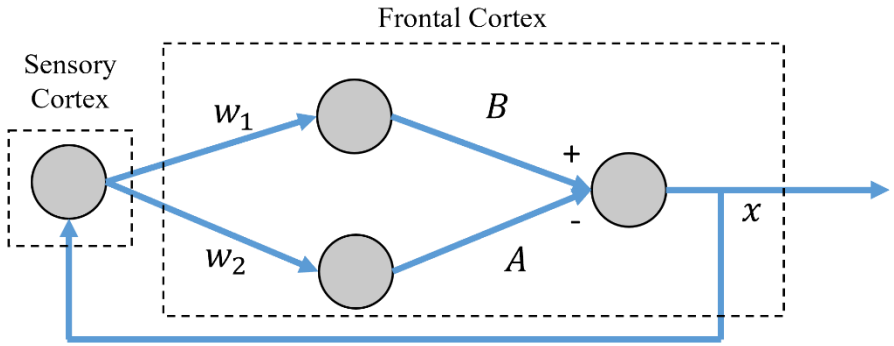
Chaotic regions





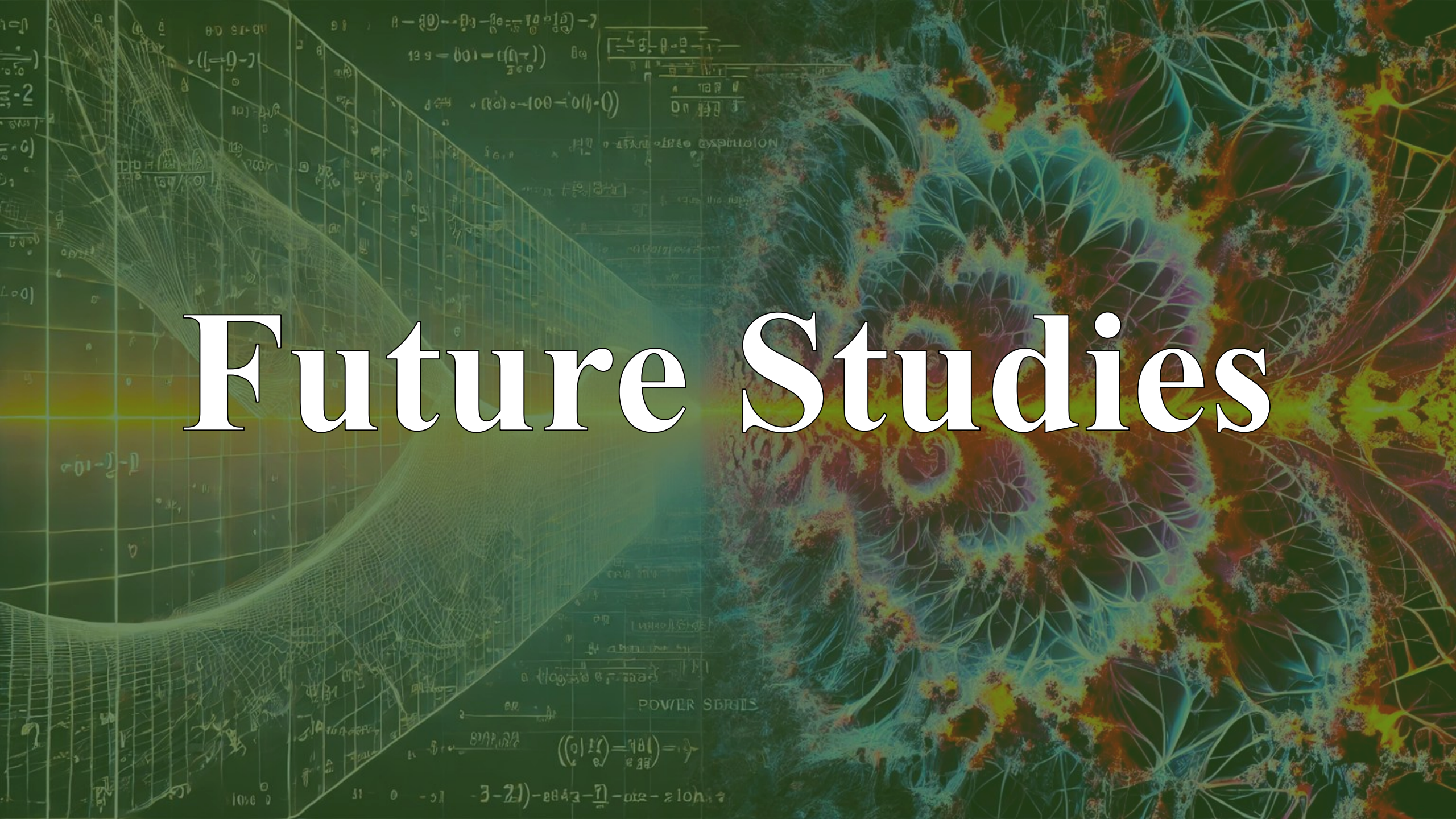
Chaotic regions





Observations

- The Soboleva function introduces four new control parameters
- The Soboleva function breaks symmetry.
- Period doubling
- Period halving
- Crisis phenomena
- Changes in the attractor size
- Antimonotonicity
- Coexisting attractors
- Intermittency
- Shrimp shapes
- Dense transitions in and out of chaos
- Wide periodic regions
- **Interpreting the phenomena of chaos, intermittency, and coexistence is not straightforward under the scope of ADD**
- **Non-symmetry: Healthy or ill behavior?**


Future Studies

Challenges

- Other activation functions
- More layers in the NN
- Other network types
- Fit to real data

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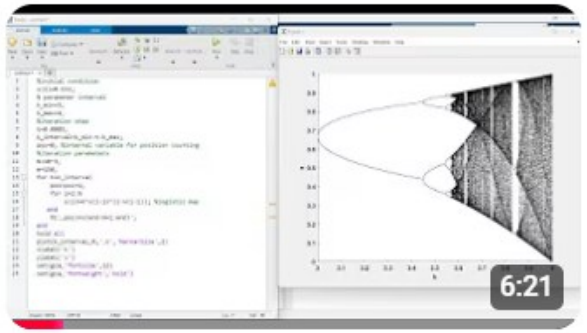

Matlab code for the Bifurcation Diagram of the Logistic Map

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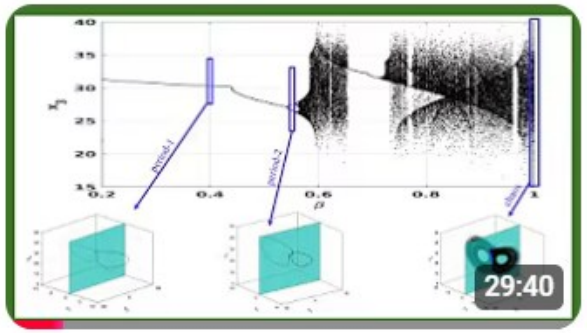

Explaining the Bifurcation Diagram for the Lorenz Chaotic System

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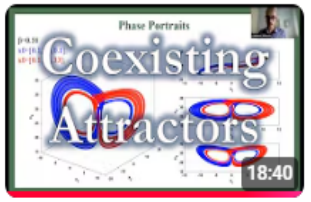

Continuation Diagrams and Coexisting Attractors in the Lorenz Chaotic System

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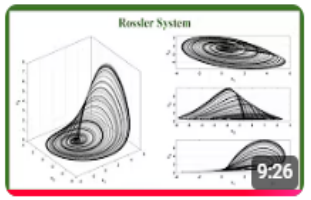

Phase Portraits for Chaotic Systems

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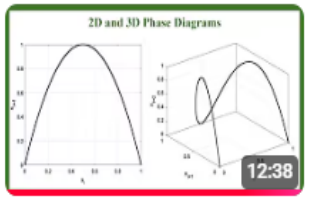

Phase Portraits for Chaotic Maps

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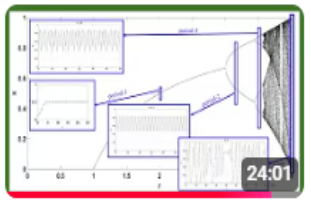

Explaining the Bifurcation Diagram for the Logistic Map

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Thank you!