



Emergent Gait Periodicity in Evolved Creatures

Benjamin Ellenberger

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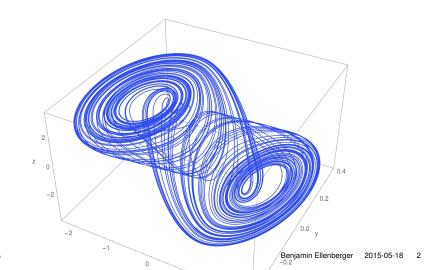
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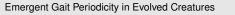
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Introduction

I introduce things.





Introduction

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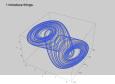


Figure: The multiscroll attractor generated by the Chua circuit without any simple limiter applied.

Introduction II

I introduce things.

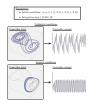


Figure: The specification of the chaotic chua controller, its internal state and output signal. The internal state of the chaotic chua controller is three dimensional because the Chua circuit's equations are defined using three dimensions. The output signal is chosen to be the z dimension of the internal state and is therefore only one dimensional. The controller state and output are shown for the unlimited condition and an example of limited condition. The example limitation leads to a period two limit cycle. If the chaotic chua circuit controller is mutated during the mutation step of the Benjamin Ellenberger 2015-05-18 simulator, the parameters are chosen from a uniform distribution out of the

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Introduction II



Figure 1 The specification of the shader Charles according its internal state and output again. The internal state of output again. The internal state of the shader Charles ordering in the internal state of the shader Charles ordering in the international because in Charles carried again and internal state and is harbored only one dimensional. The controller state internal state and is harbored only one dimension. The controller state and output are shown for the unimited constition and an example of limited condition. The carried influence is also shown for the unimited constition and an example of limited condition. The carried influence is set to see the condition. The carried instead output on large of the influence of the condition. The carried instead of using the mustation stape of the influence is set of the carried of the condition of the condition of the carried output output of the carried output of the carried output outp

¹R. L. Devaney - An Introduction to chaotic dynamical systems (1989)

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Chaotic Systems

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R. L. Devaney - An Introduction to chaotic dynamical systems (1909)

R. L. Devaney - An Introdu

Chaotic Systems

1. Chaotic system is a non-linear, dynamical system exhibiting chaotic dynamics.

Emergent Gait Periodicity in Evolved Creatures Chaotic Systems

1. Chaotic system is a non-linear, dynamical system exhibiting chaotic dynamics. -Chaotic Systems

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- 1. Chaotic system is a non-linear, dynamical system exhibiting chaotic dynamics.
- 2. Chaos means that even in a deterministic system, where the future behavior is fully determined by the initial state, a slightly varied initial state makes the system unpredictable.

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Chaotic Systems

2. Chaos means that even in a deterministic system, where the future behavior is fully determined by the initial state, a slightly varied initial state makes the system unpredictable.

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- 1. Chaotic system is a non-linear, dynamical system exhibiting chaotic dynamics.
- 2. Chaos means that even in a deterministic system, where the future behavior is fully determined by the initial state, a slightly varied initial state makes the system unpredictable.
- 3. A chaotic system must..1
 - be sensitive to the initial conditions.
 - show topological mixing.
 - have dense periodic orbits.

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Chaotic Systems

Chaotic Systems

2. Chaos means that even in a deterministic system, where the future behavior is fully determined by the initial state, a slightly varied initial state makes the system unpredictable.

- show topological mixing

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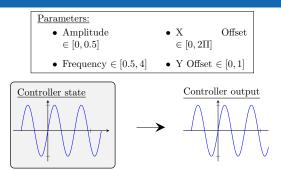


Figure: The specification of the sinusoid controller, its internal state and output signal. The internal state has the same dimensionality as the output. If the sinusoidal controller is mutated during the mutation step of the simulator, the parameters are chosen from a uniform distribution over the respective intervals.

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Figure: The specification of the sinusoid controller, its internal state and output signal. The internal state has the same dimensionality as the output. If the sinusoidal controller in mutated during the mutation skep of the simulator, the parameters are chosen from a uniform distribution over the respective intervals.

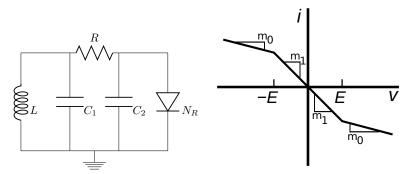
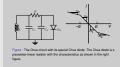


Figure: The Chua circuit with its special Chua diode. The Chua diode is a piecewise-linear resistor with the characteristics as shown in the right figure.

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Mathematica Experiments

Some crazy things I did in Mathematica.

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Mathematica Experiments

Mathematica Experiments

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Minemonics: A 3D Virtual Creature Simulator

The simulator can do everything.

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Minemonics: A 3D Virtual Creature Simulator

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-Minemonics: A 3D Virtual Creature Simulator

The simulator can do everything.

Simulator Experiments with the Model Leg

The Model Leg did everything, not me.

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Simulator Experiments with the Model Leg

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The Model Leg did everything, not me.

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Simulator Experiments with the Model Leg

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Simulator Experiments with the Model Leg

The Model Leg did everything, not me.

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Discussion

Many things want to be discussed.

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Discussion

Many Phraps word to be discussed.

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Conclusion

I conclude on what I did.

Emergent Gait Periodicity in Evolved Creatures Conclusion I conclude on what I did. -Conclusion

Outlook

What could be done next?

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Outlook

What could be done need?

Acknowledgements

I would like to thank my group!

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I would like to thank my group!

Backup Slides

Some things we could discuss if we had more time.

