Virtual Evolution Of 2D Soft Robots

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Overview

- Project scope

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- Background

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- Methodology

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- Methodology
- Results And Conclusions

Project Scope

- Automate design of shape-changing soft robots

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- Automate design of shape-changing soft robots
  - Change internal pressure

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- Non-linear FEM

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  - Change internal pressure
- Non-linear FEM
  - Restricted to two dimensions

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- Automate design of shape-changing soft robots
  - Change internal pressure
- Non-linear FEM
  - Restricted to two dimensions
  - Modelled with real material properties

Project Scope (cont.)

- Computationally efficient

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  - Use recursive grammatical encodings

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  - L-systems for cellular level

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  - L-systems for cellular level
  - CPPNs for organism level

Project Scope (cont.)

- Computationally efficient
  - Use recursive grammatical encodings
  - L-systems for cellular level
  - CPPNs for organism level
- Evolve a population to obtain best model

Background

- Soft robotics

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  - Modelling soft bodies is computationally expensive

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- Lindenmayer systems (L-systems)

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- Compositional Pattern-Producing Network - NeuroEvolution of Augmenting Technologies (CPPN-NEAT)
  - Neural networks
  - Evolved with topology augmentation

Software

- LSDyna

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  - Commercial software
  - Support

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  - High level of control
  - Robust

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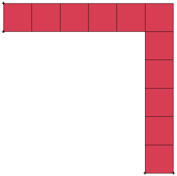

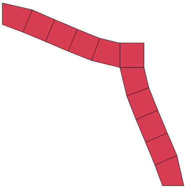

Basic Structure

- Unit cell

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- Unit cell
  - Square

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  - Modelled with Mold Star 15

Basic Structure

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  - Predefined behaviours

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Recursive Encodings

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Recursive Encodings

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  - Refer to unit cells
  - Construct soft body
  - Genotype
- CPPN-NEAT
  - Refer to whole body

Recursive Encodings

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  - Construct soft body
  - Genotype
- CPPN-NEAT
  - Refer to whole body
  - Phenotype

Proof Of Concept

- Use material properties obtained from standard testing

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- Manufacture physical model

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  - Unit cell and whole body

Proof Of Concept

- Use material properties obtained from standard testing
- Manufacture physical model
  - Unit cell and whole body
  - Print at some thickness

Proof Of Concept

- Use material properties obtained from standard testing
- Manufacture physical model
  - Unit cell and whole body
  - Print at some thickness
  - Place between glass plates

Proof Of Concept

- Use material properties obtained from standard testing
- Manufacture physical model
  - Unit cell and whole body
  - Print at some thickness
  - Place between glass plates
  - Apply internal pressure

Proof Of Concept

- Use material properties obtained from standard testing
- Manufacture physical model
  - Unit cell and whole body
  - Print at some thickness
  - Place between glass plates
  - Apply internal pressure
  - Observe behaviour

Results And Conclusions

- Improve computing time required

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- Replicable
- Adaptable
  - 3D
  - Different objective functions

Questions?