Project Title

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Overview

- Project scope

Overview

- Project scope
- Background

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- Project scope
- Background
- Results

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- Project scope
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- Results
- Objectives

Project Scope

- Automate design of shape-changing soft robots

Project Scope

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

Project Scope

- Automate design of shape-changing soft robots
  - Change internal pressure
- Non-linear FEM

Project Scope

- Automate design of shape-changing soft robots
  - Change internal pressure
- Non-linear FEM
  - Restricted to two dimensions

Project Scope (cont.)

- Computationally efficient

Project Scope (cont.)

- Computationally efficient
  - Use recursive grammatical encodings

Project Scope (cont.)

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  - Use recursive grammatical encodings
  - L-systems for cellular level

Project Scope (cont.)

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  - Use recursive grammatical encodings
  - 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 robotic bodies are computationally expensive

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- Lindenmayer systems (L-systems)

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  - Built from set of rules, axioms, variables and constants
- Compositional Pattern-Producing Network - NeuroEvolution of Augmenting Technologies (CPPN-NEAT)
  - Neural networks
  - Evolved with topology augmentation

Software

- LSDyna

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- LSDyna
  - Commercial software
  - Support

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  - Support
  - High level of control
  - Robust

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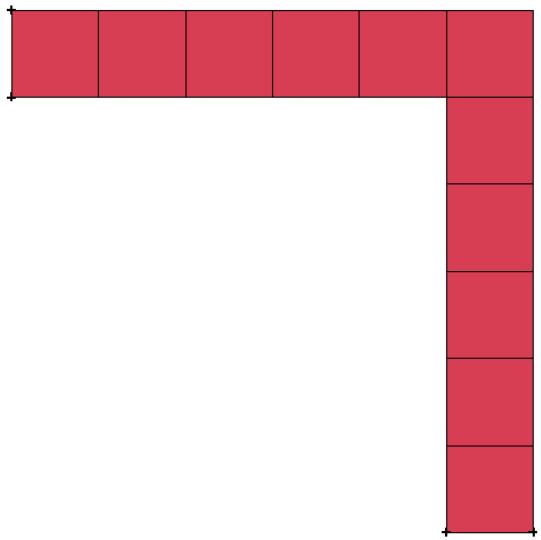

Basic Structure

- Unit cell

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- Unit cell
  - Square

Basic Structure

- Unit cell
  - Square
  - Predefined behaviours

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  - Modelled with Mold Star 15

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- Complete soft body

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- Complete soft body
  - Constructed from unit cells

Basic Structure

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- Complete soft body
  - Constructed from unit cells
  - Recursive grammatical encodings

Recursive Encodings

- L-systems

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- L-systems
  - Refer to unit cells

Recursive Encodings

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  - Refer to unit cells
  - Construct soft body

Recursive Encodings

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  - Refer to unit cells
  - Construct soft body
  - Genotype

Recursive Encodings

- L-systems
  - Refer to unit cells
  - Construct soft body
  - Genotype
- CPPN-NEAT

Recursive Encodings

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

Recursive Encodings

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

Proof Of Concept

- Manufacture physical model

Proof Of Concept

- Manufacture physical model
  - Print at some thickness

Proof Of Concept

- Manufacture physical model
  - Print at some thickness
  - Place between glass plates

Proof Of Concept

- Manufacture physical model
  - Print at some thickness
  - Place between glass plates
  - Apply internal pressure

Conclusions And Results

- Improve computing time required

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- Prove practicality of recursive encodings

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  - 3D

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- Replicable
- Adaptable
  - 3D
  - Different objective functions

Questions?