



Project Title

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22 November 2019

- Project scope

Overview

- Project scope
- Background

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- Results

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- Project scope
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- Results
- Objectives

Project Scope

- Automate design of shape-changing soft robots

- 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.)

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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 robotic bodies are computationally expensive

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- Lindenmayer systems

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- Lindenmayer systems
 - Recursive grammatical encodings
- N Cheney et al. - Unshackling evolution
- J Hiller & H Lipson - Evolving amorphous robots

Background

- Soft robotic bodies are computationally expensive
- Lindenmayer systems
 - Recursive grammatical encodings
 - Built from set of rules, axioms, variables and constants
- N Cheney et al. - Unshackling evolution
- J Hiller & H Lipson - Evolving amorphous robots

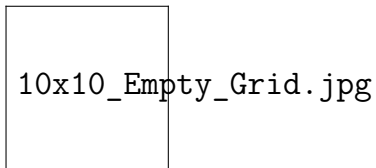
Background

- Soft robotic bodies are computationally expensive
- Lindenmayer systems
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Textbook_Cover_Pa

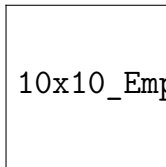
Current Objectives

- 10x10 empty grid of 2D elements

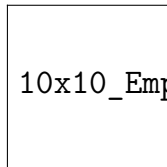


Current Objectives

- 10x10 empty grid of 2D elements
- Applying external pressure



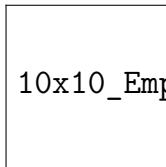
10x10_Empty_Grid.jpg



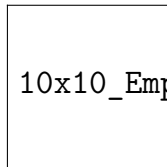
10x10_Empty_Grid_Und

Current Objectives

- 10x10 empty grid of 2D elements
- Applying external pressure
- Linear vs hyperelastic material



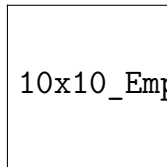
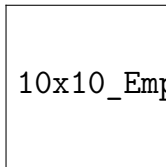
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10x10_Empty_Grid_Und

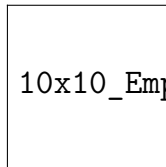
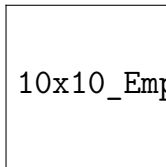
Current Objectives

- 10x10 empty grid of 2D elements
- Applying external pressure
- Linear vs hyperelastic material
 - Material status completely describable with given total strain



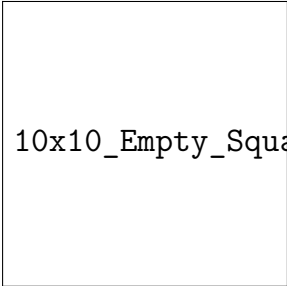
Current Objectives

- 10x10 empty grid of 2D elements
- Applying external pressure
- Linear vs hyperelastic material
 - Material status completely describable with given total strain
 - Mold-star 15



Current Objectives (cont.)

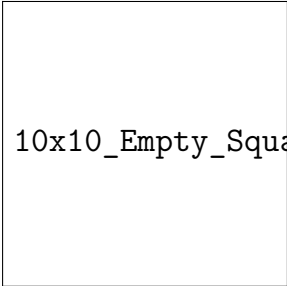
- Compare commercial software (NX 12, LSDyna, Marc Mentat)



10x10_Empty_Square_2D_Deformation.p

Current Objectives (cont.)

- Compare commercial software (NX 12, LSDyna, Marc Mentat)



10x10_Empty_Square_2D_Deformation.p

- Implementation with code from N Kim and open source software

Current Objectives (cont.)

- Compare modeled behaviour to actual behaviour

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 - Produce square
 - Place between two transparent plates
 - Apply pressure
 - Observe and compare

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- Determine which approach

Current Objectives (cont.)


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 - Commercial vs. open-source vs. own code

Current Objectives (cont.)

- Compare modeled behaviour to actual behaviour
 - Produce square
 - Place between two transparent plates
 - Apply pressure
 - Observe and compare
- Determine which approach
 - Commercial vs. open-source vs. own code
 - All have pros and cons

Further Objectives


- Define unit cell behaviour



Unit_Cell_Deformation.jpg

Further Objectives


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 Unit_Cell_Deformation.jpg

- Define recursive rules

Further Objectives


- Define unit cell behaviour

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- Define recursive rules
- Set up genetic algorithm

Further Objectives

- Define unit cell behaviour

 Unit_Cell_Deformation.jpg

- Define recursive rules
- Set up genetic algorithm
- Combine all components

Questions?