1 HOW TO ADD NEW HYPERELASTIC MODEL

New hyperelastic models can be added to the application by creating a .yaml file following the format illustrated below with an example:

```yaml
model_name: "Neo-Hookean"
model_class: "Series function based on invariants"
# Options:
# "Hookean-type"
# "Series function based on invariants"
# "Power law, exponential or logarithmic functions based on invariants"
# "Models based on stretch ratio"
description: >
  The Neo-Hookean model is a simple hyperelastic material model
  that describes nonlinear elastic behavior based on a strain
  energy function dependent on the first invariant of the
  deformation tensor.
strain_energy_function: "W = C_{10}(I_{1} - 3)"
# Options:
# Strain Energy Function for Invariant or Stretch Based
# Strain Measure for Hookean-type.
number_of_parameters: 1
material_constants:
  - name: C10
    display_format: C_{10}
    bounds: [0.001, inf]
info_constraints: ""
deformation_modes:
  uniaxial:
    expression_nominal: "2*C10*(lamb - 1/lamb**2)"
    expression_cauchy: "2*C10*(lamb**2 - 1/lamb)"
  biaxial:
    expression_nominal: "2*C10*(lamb - 1/lamb**5)"
    expression_cauchy: "2*C10*(lamb**2 - 1/lamb**4)"
  pure_shear:
    expression_nominal: "2*C10*(lamb**2 - 1/lamb**2)"
    expression_cauchy: "2*C10*(lamb - 1/lamb**3)"
simple_shear:
    expression_nominal: "2*C10*gamma"
```

📌 **Important Notes:**

- **model_name** is the name that will appear in the model selection screen.
- **model_class** is used to organize the models into categories in the interface.
- **description** is a brief explanation of the model, displayed to help users choose.
- **strain_energy_function** should be provided in LaTeX-style formatting for correct display in the GUI.
- **material_constants** must include at least the name and bounds. The display_format can use LaTeX formatting (e.g., C_{10}) to be shown correctly to the user.
- **deformation_modes** must contain the symbolic expressions used for stress calculation in each deformation mode:
  - Use lambda (or lamb) as the stretch variable.
  - Use gamma for simple shear.
  - Expressions should be written in **Python-evaluable format** using *, **, /, etc.

✅ File Location

All .yaml files for hyperelastic models should be placed in the following folder:

- HyperSmart/src/hyperelastic_models/

The program automatically scans this folder and loads all valid models.

2 📘 How to Derive Expressions for Each Pure Deformation Mode

To define a new hyperelastic model, you'll need to provide symbolic expressions for the **Nominal** and **Cauchy** stress for each relevant pure deformation mode (Uniaxial, Biaxial, Pure Shear, and Simple Shear).

A complete explanation of how to derive these expressions — starting from the **Strain Energy Function** — is presented in the **UserGuide.pdf**, located at:

- HyperSmart/docs/UserGuide.pdf

This PDF contemplates the case of invariant-based, stretch-based, mixed and Hookean-type hyperelastic models.