Powder Compaction Simulation
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Introduction
- Powder compaction process is widely used in industry
  - Pharmaceutical: tablets
  - Food: sugar cube
  - Metal: powder metallurgy
  - Energetic material: industrial explosives

- Powders exhibit complex behavior during compaction process
  - Change in location: rearrangement, jamming
  - Change in shape: elastic and plastic deformation
  - Reduce cost and time for experimental efforts

Objectives
- Microstructure evolution
  - Elastic powder bed
  - Plastic powder bed (new)
  - Visualized particle behavior

Methodology
- Powder bed:
  - Purdue super computer: Conte
- Single Particle:
  - nanoHUB: nanohub.org

Formulation
- Elastic deformation:
  - Hertz theory [2]:
    - Independent contact: \( F \propto r^{3/2} \)
  - Nonlocal theory [3]:
    - Nonlocal contact: \( F \propto (\gamma + 4 \gamma_c N)^{3/2} \)
    - \( \gamma \): overlap of local contact particles
  - Plastic deformation:
    - Plastic theory [4]: \( F \propto 1 + 1.2\gamma m \)
    - \( m \): inverse of strain hardening exponent

Technique
- Nondimensional pressure: \( \gamma \) = Young's modulus
- Relative density: Density when powder is poured into container
  - Apparent density of non-porous material [6]

Results
- Pressure-deformation relationship by different theories
  - Elastic deformation: Parallel plate pressure
  - Hertz theory: window pressure

Conclusion and Future work
- This is a free tool for modeling powder compaction.
- Develop new compaction process with low cost
- Teach powder compaction process with visualized behavior
- More deformation mechanisms will be added in the tool
- Smaller particle size: nano-powders [5]
- User-defined powder bed

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