Motivation
Granular material mixing and segregation plays an important role in many industries ranging from pharmaceuticals to agrochemicals. Predictive engineering design of industrial powder blenders remains underdeveloped due to the lack of quantitative modeling tools.

Objective
Develop a predictive model of granular material mixing and segregation for industrial equipment.

Macroscopic scale model
Predicts: advective flow field
Depends on:
- system geometries
- particle properties
- local material concentration
- local shear rate and solid fraction
- Method used: DEM / Experiments

Microscopic scale model
Predicts: local diffusion / segregation rates
Depends on:
- particle properties
- local material concentration
- local shear rate and solid fraction
- Method used: DEM / Experiments

Diffusion correlations (3-D)

\[ D_{ij} = \text{an anisotropic tensor instead of an isotropic value} \]
- \( D_{xx} \) and \( D_{yy} \) are an order of magnitude smaller than the diagonal components \( D_{xx} \) and \( D_{yy} \)

Segregation correlations (2-D)

Percolation is one of the most important mechanisms causing segregation
- \( \gamma_{ij} \) acts in the direction of gravity

\[ \gamma_{ij} = \text{can be calibrated from DEM simulations or experiments} \]

Results
2-D rotating drum - mixing
- Compared with published DEM simulations of binary mixing in a lab-scale rotating drum
- All the parameters were derived directly from the published work
- Predictions compare well quantitatively to DEM results

2-D conical hopper - segregation
- Compared with published experiments of binary segregation of glass beads in different conical hoppers from Ketterhagen et al. (2007, Chem Eng Sci, Vol. 62)
- All the parameters were calibrated directly from the published work
- Predictions from the multi-scale model compare well quantitatively to experiments