Machine learning to predict mesenchymal stem cell efficacy for cartilage repair

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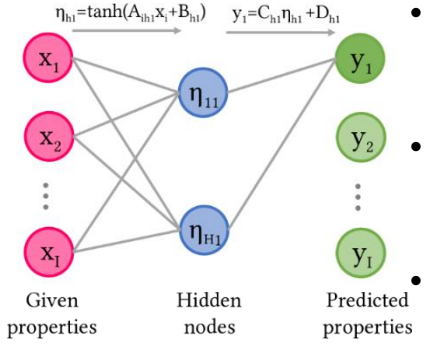
Background

- Cartilage damage affects millions of people worldwide
- Mesenchymal stem cell (MSC) therapy is promising, but still inconsistent in efficacy
- Lack of guidelines to strategize MSC therapy for optimal therapeutic efficacy

Dataset establishment

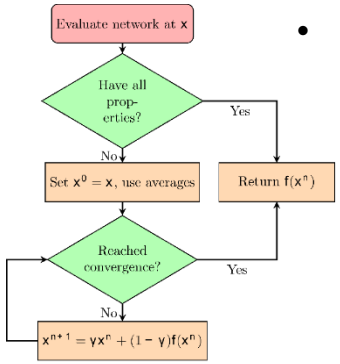
- Input properties: Cell and treatment related factors (e.g. cell source, cell number, defect size)
- Output properties: therapeutic outcomes (e.g. repair scores)

Neural network formalism



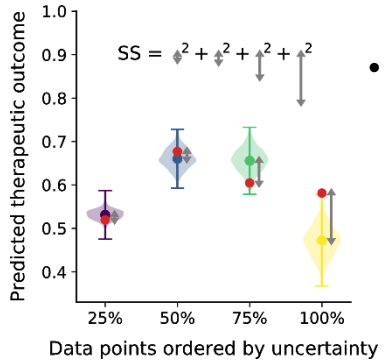
- Cross-validation using the coefficient of determination (R^2)
- Selection of 7 input properties to formulate the model based on R^2
- Two unique features

Handling incomplete data



- Iterative filling of incomplete data entry by considering the underlying correlations across different properties maximizes the usage of entire database

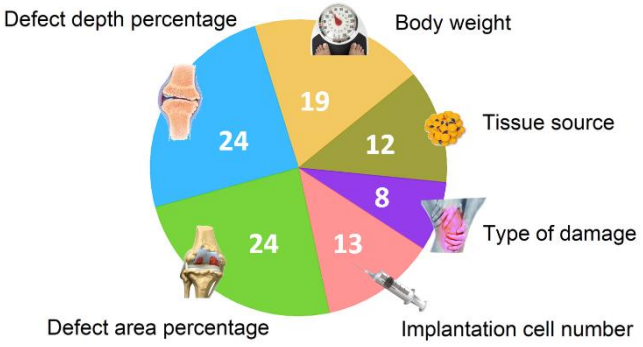
Computing prediction uncertainty



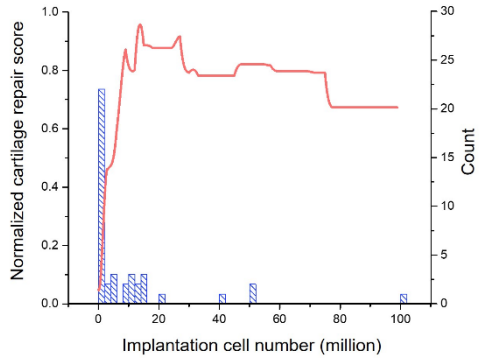
- Enabling precise prediction based on small database by focusing on predictions with low uncertainties

Results: machine-learned quantitative guidelines for MSC therapy

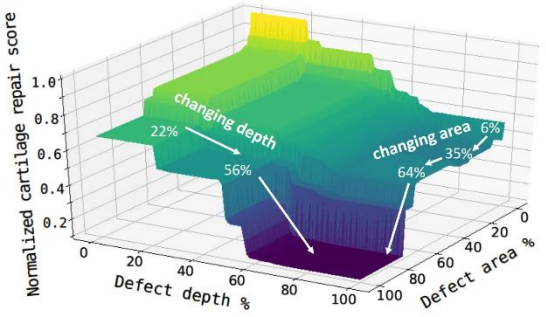
- High impact factors for MSC therapy efficacy



- Implantation of 17 – 25 million MSCs is predicted to result in optimal cartilage repair



- Critical cartilage damage thresholds which impair MSC therapy efficacy are predicted:



- 22% and 56% in defect depth
- 6%, 35% and 64% in defect area