



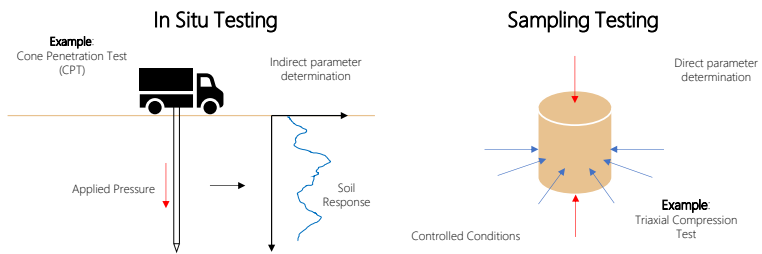
# Automated parameter determination in geotechnical engineering

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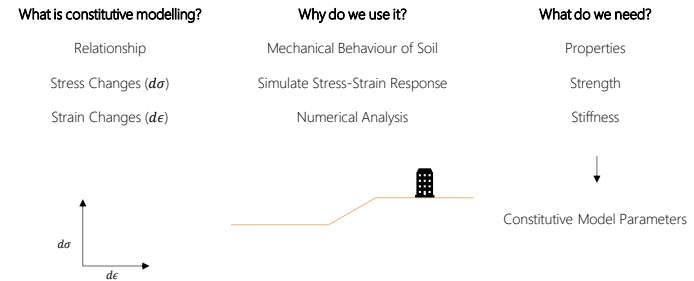
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## 1. Introduction

### Experimental Testing



### Constitutive Modelling





Constitutive Modelling

<p><b>Simple model</b></p> <p>Mohr Coulomb</p> <p>Amount of input parameters = 5</p>	<p><b>Advanced model</b></p> <p>Hardening Soil Small</p> <p>Amount of input parameters &gt; 10</p>
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Parameter determination = challenging



Graphs

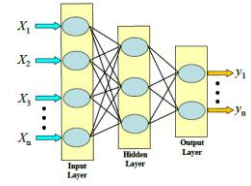
<p><b>What are graphs?</b></p> <p>Relations</p> <p>Objects</p> <p>Network</p>	<p><b>Why do we use it?</b></p> <p>Visualise complex problems</p>	<p><b>Applications:</b></p> <p>Navigation</p> <p>Communication</p> <p>Computer science</p>
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Graphs

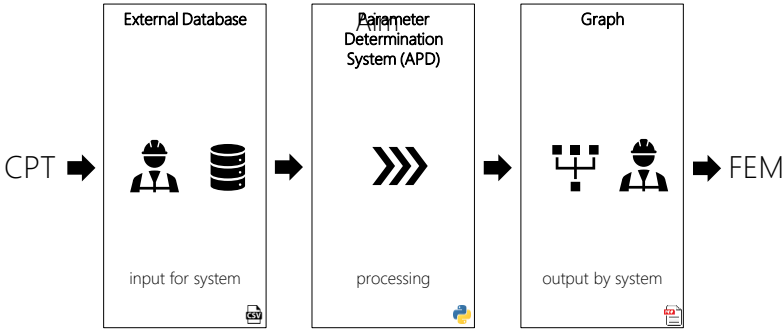
Application in geotechnical engineering: Artificial Neural Networks (ANNs)

- Biologically inspired
- Relationship between input and output
- Without any prior knowledge
- Lack of transparency ("black box")
- Not preferred (aim: "clear-box")





# 2. Aim & Objectives

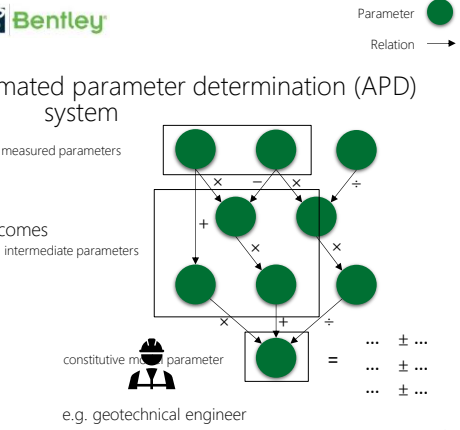


2. Aim & Objectives | 10



Objectives for the automated parameter determination (APD) system

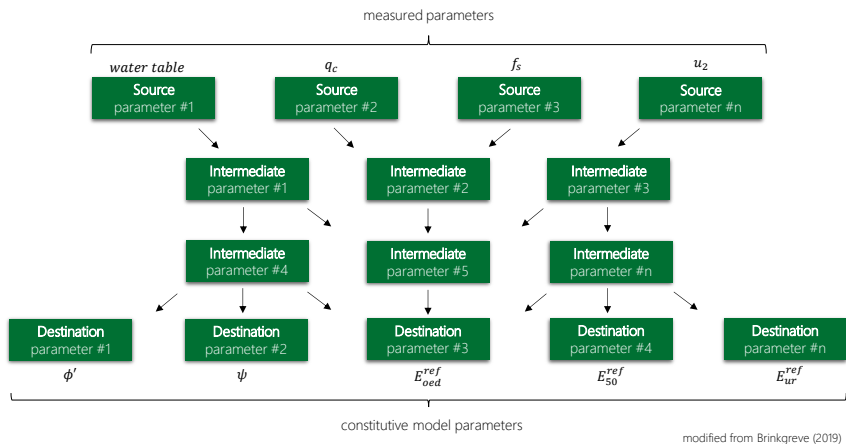
1. Generating **paths**
2. Performing **calculations**
3. Treating **multiple** parameter outcomes
4. Accounting for **uncertainties**
5. Ensuring **adaptability**
6. Ensuring **transparency**



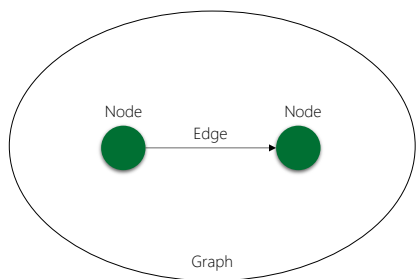
2. Aim & Objectives | 11



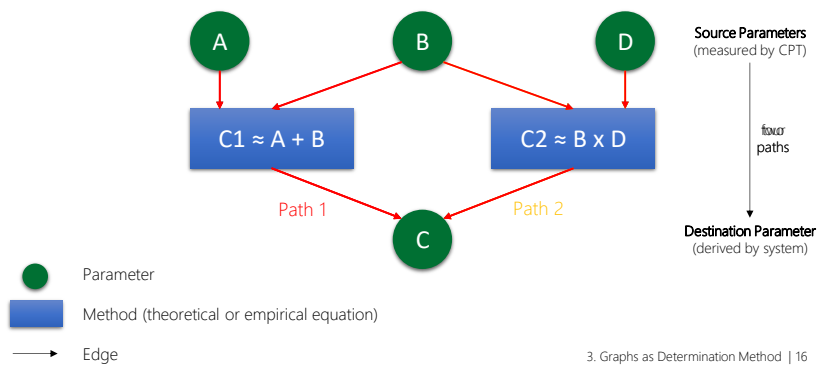
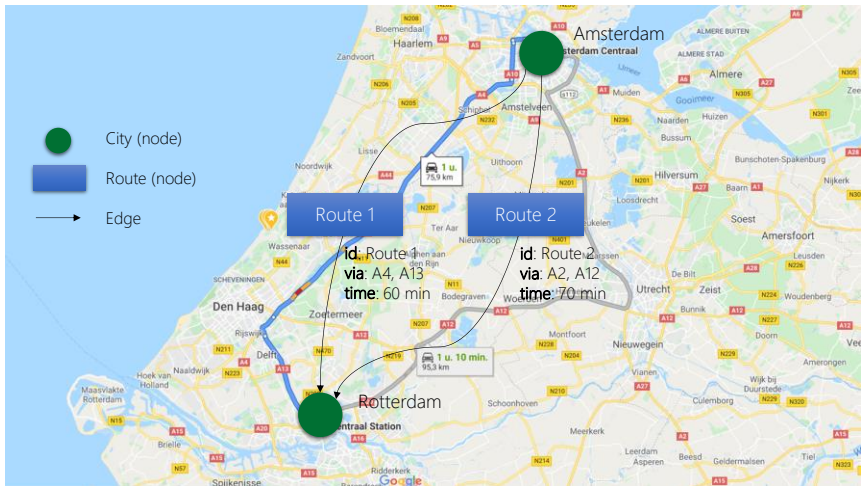
# 3. Graphs as Determination Method



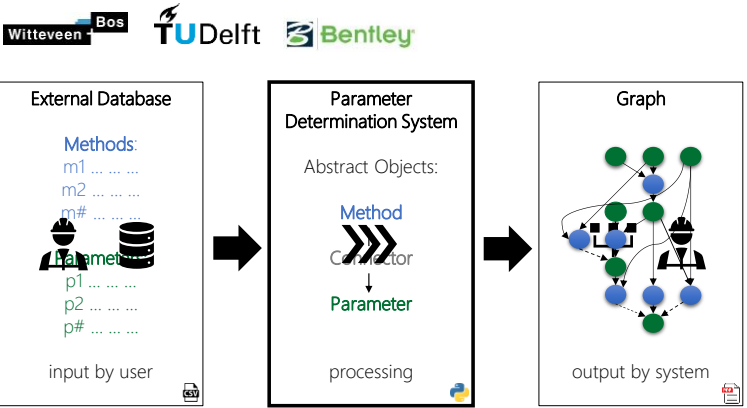
Graphs



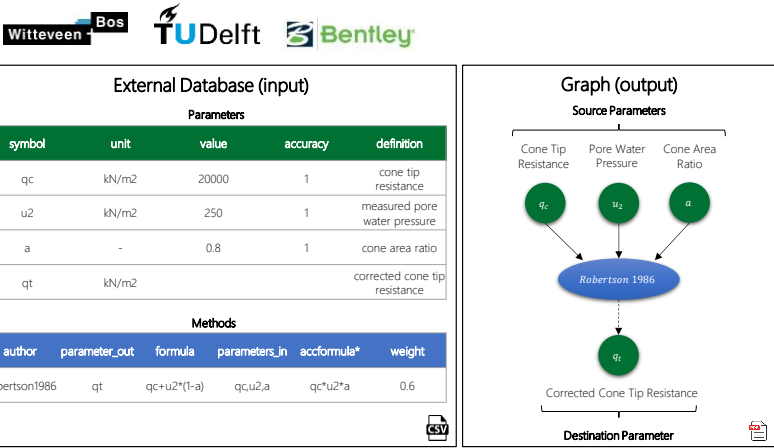
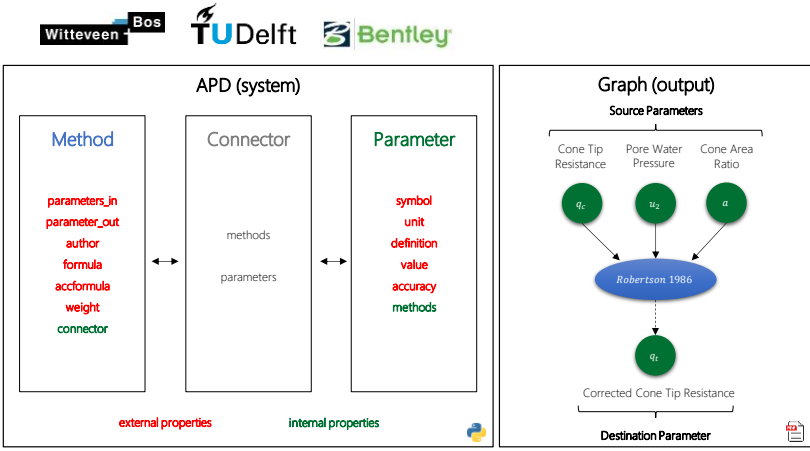
3. Graphs as Determination Method | 14



3. Graphs as Determination Method | 16



3. Graphs as Determination Method | 17



Witteveen Bos TU Delft

### 4. Proof of Concept





## 6. Follow-up Work

**Collaboration** between Witteveen+Bos, TU Delft, Bentley Systems, TU Graz: validation and extension of APD

- **Modules added to APD:** reading and interpreting CPT, soil layering, parameter determination from APD, connection with FEM model in PLAXIS
- **Graduates at TU Delft and promovendus at TU Graz:** parameter uncertainty based on statistical distributions and extension to fine-grained soils