

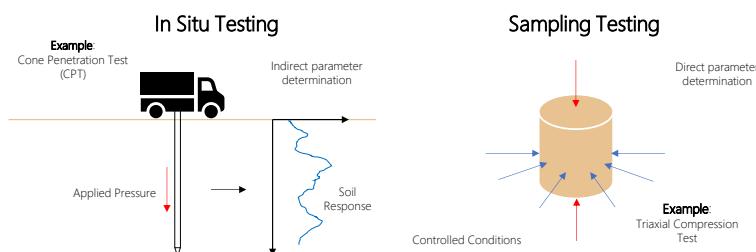


Automated parameter determination in geotechnical engineering

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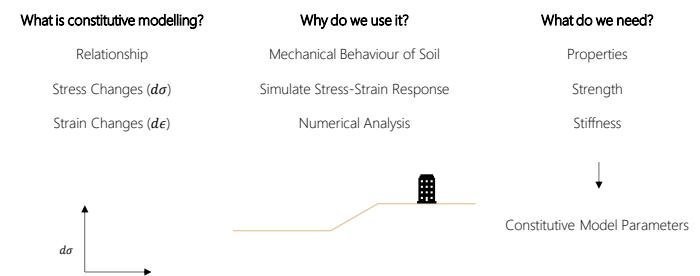
1. Introduction

Experimental Testing



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Constitutive Modelling



1. Introduction | 4



Constitutive Modelling

Simple model

Mohr Coulomb

Amount of input parameters = 5

Advanced model

Hardening Soil Small

Amount of input parameters > 10

Parameter determination = challenging

Empiricism from **in situ test** results

Rising complexity of **constitutive models**

More efficient
parameter determination system

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Graphs

What are graphs?

Relations

Objects

Network



Why do we use it?

Visualise complex problems



Applications:

Navigation

Communication

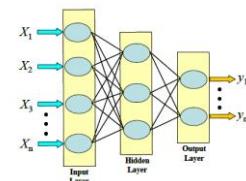
Computer science



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")

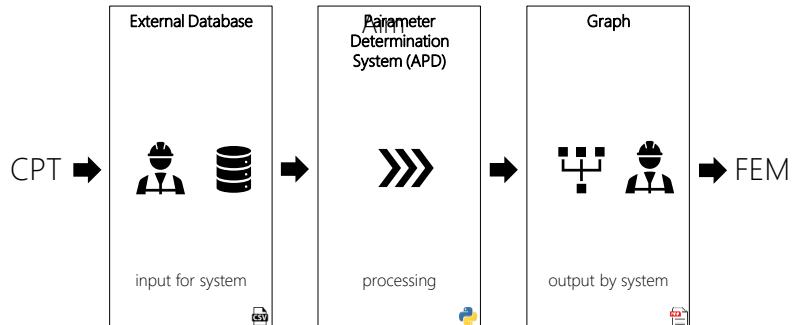


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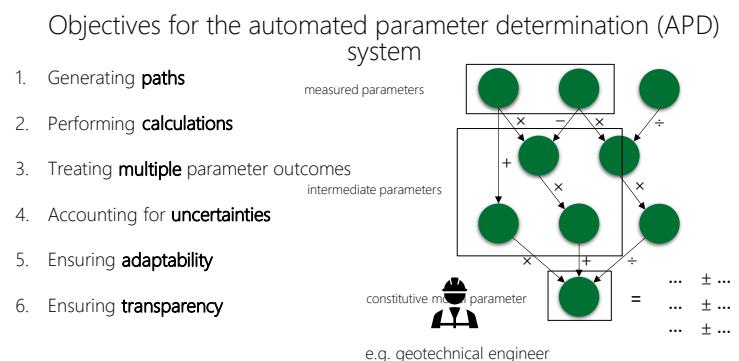
1. Introduction | 8



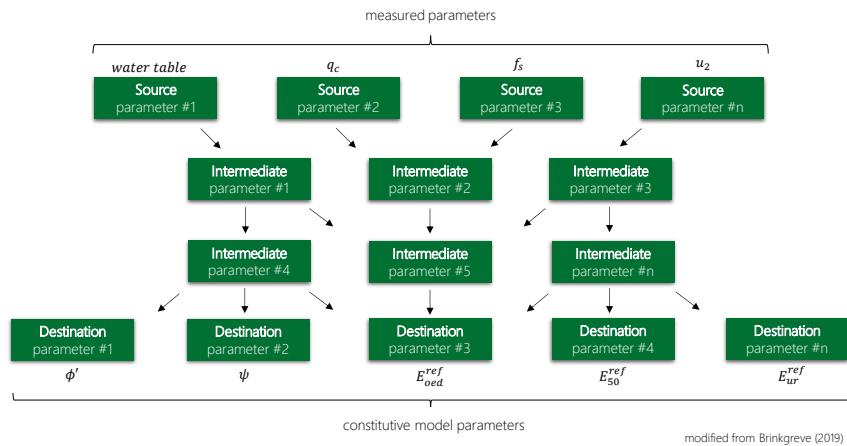
2. Aim & Objectives



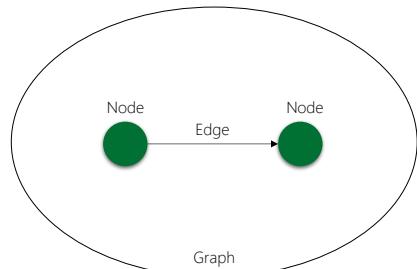
2. Aim & Objectives | 10

 Parameter
Relation →


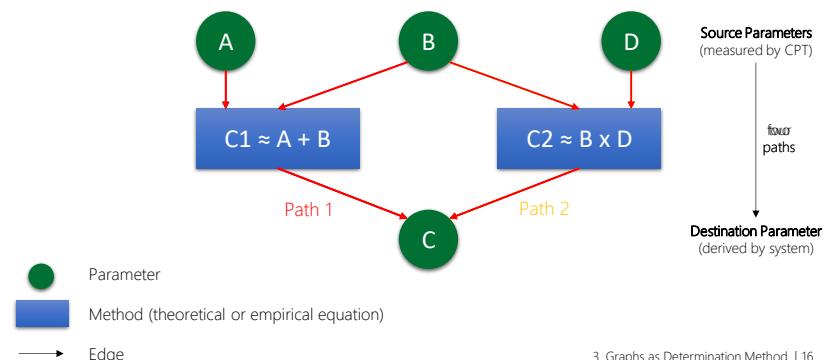
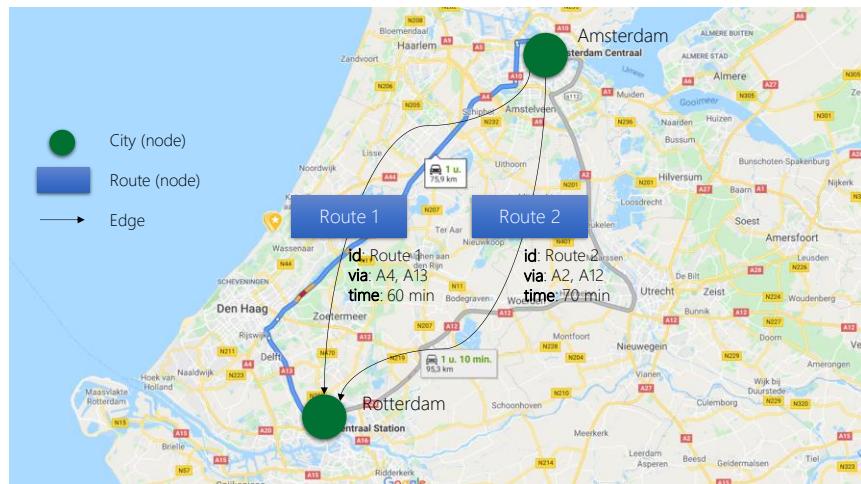
3. Graphs as Determination Method



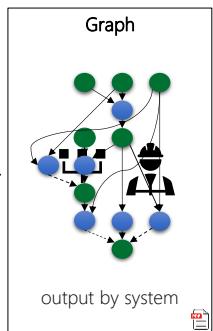
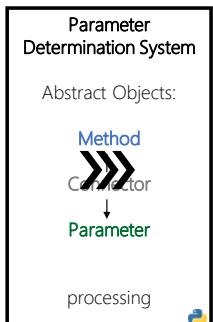
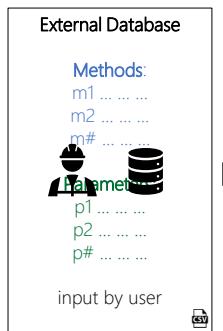
Graphs



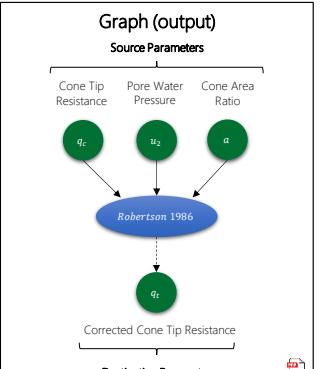
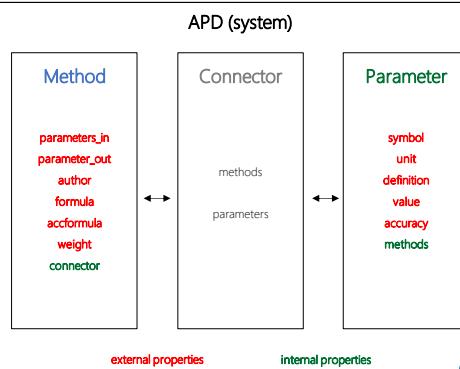
3. Graphs as Determination Method | 14



3. Graphs as Determination Method | 16



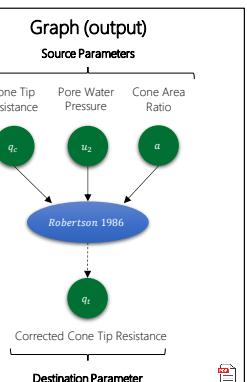
3. Graphs as Determination Method | 17



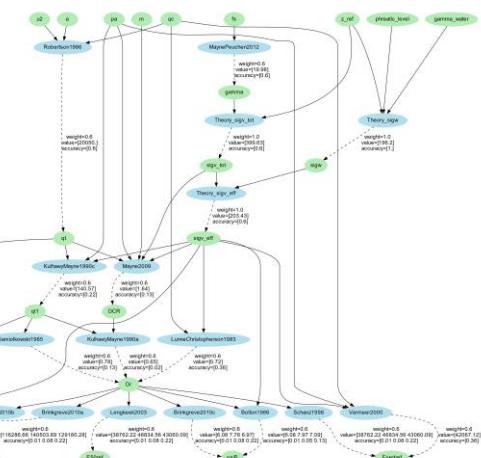
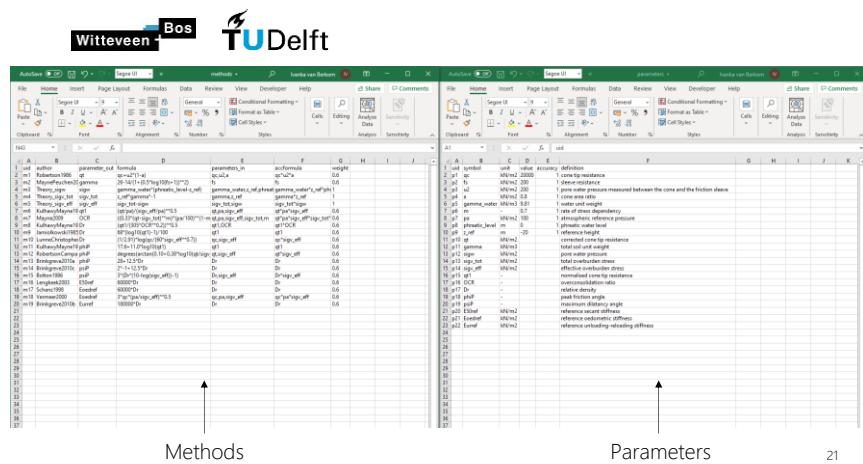
External Database (input)

Parameters				
symbol	unit	value	accuracy	definition
qc	kN/m ²	20000	1	cone tip resistance
u ₂	kN/m ²	250	1	measured pore water pressure
a	-	0.8	1	cone area ratio
q _t	kN/m ²			corrected cone tip resistance

Methods					
author	parameter_out	formula	parameters_in	accformula*	weight
Robertson1986	q _t	qc+u ² (1-a)	qc,u ₂ ,a	qc <u>2</u> *a	0.6



4. Proof of Concept

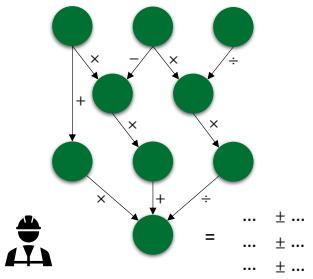


Parameter Relation →

5. Conclusions

- ## Functionalities of APPD

 1. Generates **paths**
 2. Performs **calculations**
 3. Deals with **multiple** parameter outcomes
 4. Accounts for **uncertainties**
 5. Ensures **adaptability**
 6. Ensures **transparency**



e.g. geotechnical engineer

5. Conclusions | 24



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

6. Follow-up Work | 26