Creating ‘Civil Engineer 4.0’

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- Fellow of Institution of Civil Engineers
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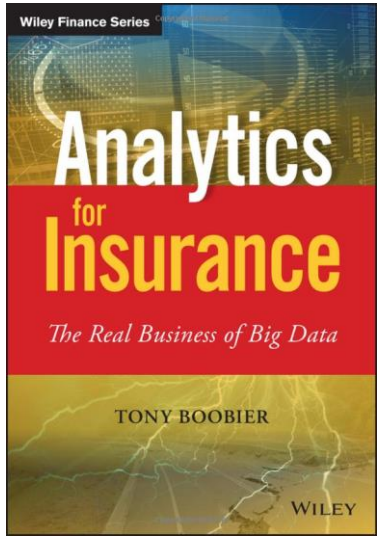
- Independent consultant, mentor and industry commentator
- Author of '*Analytics for Insurance : The Real Business of Big Data*'



We will cover:

Introduction to Data and Analytics

Competences for ‘Civil Engineer 4.0’

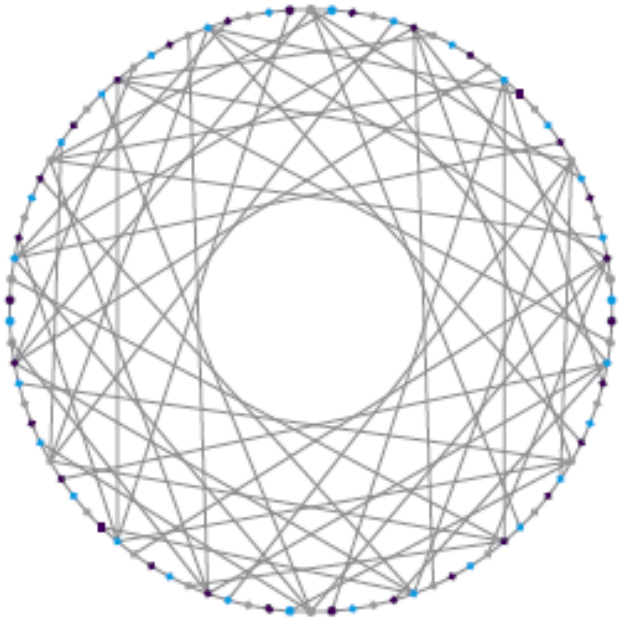
Universities, Data Science and Programming

What can universities do to prepare undergraduates for civil engineering of the future ?

But isn’t there is a Bigger Question to be Asked ?

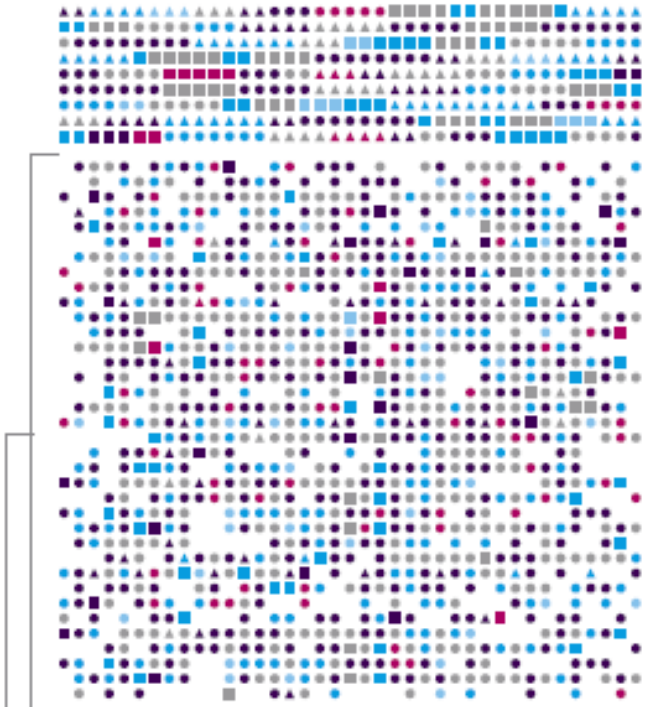
What can society do to prepare humans for the future?

Civil Engineering in an Era of Big Data



1 trillion

connected objects and devices on the planet generating data by 2015



2.5 billion

gigabytes of data generated every day

80%

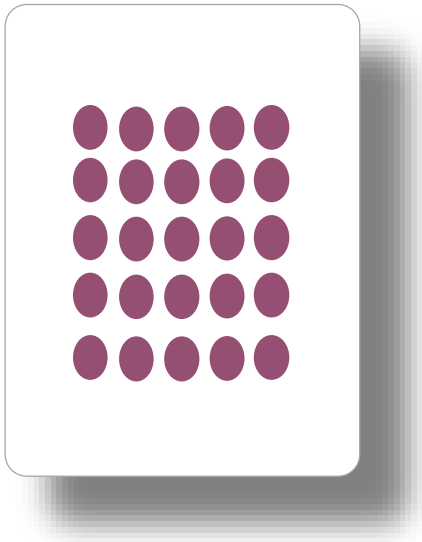
of the world's data is unstructured. Audio. Video. Sensor data. Social media. All represent new areas to mine for insights.

Ref IBM Annual Report

Big Data: Fueling the Engineering Enterprise

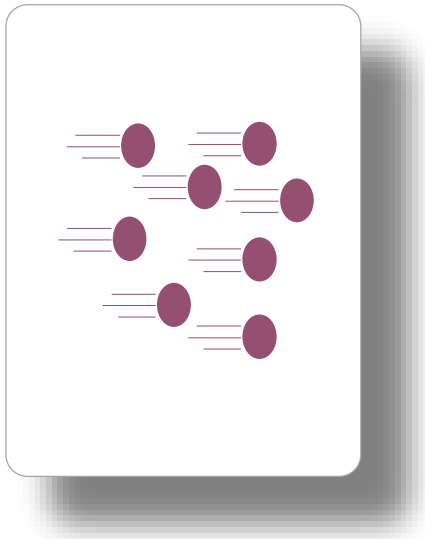
The characteristics of big data: the 4V's

Volume



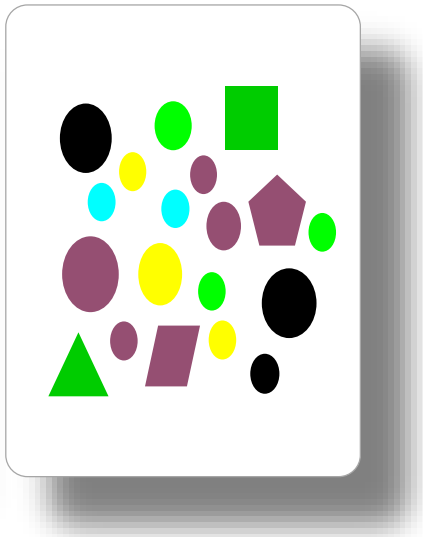
Data at Rest

Velocity



Data in Motion

Variety



Data in Many Forms

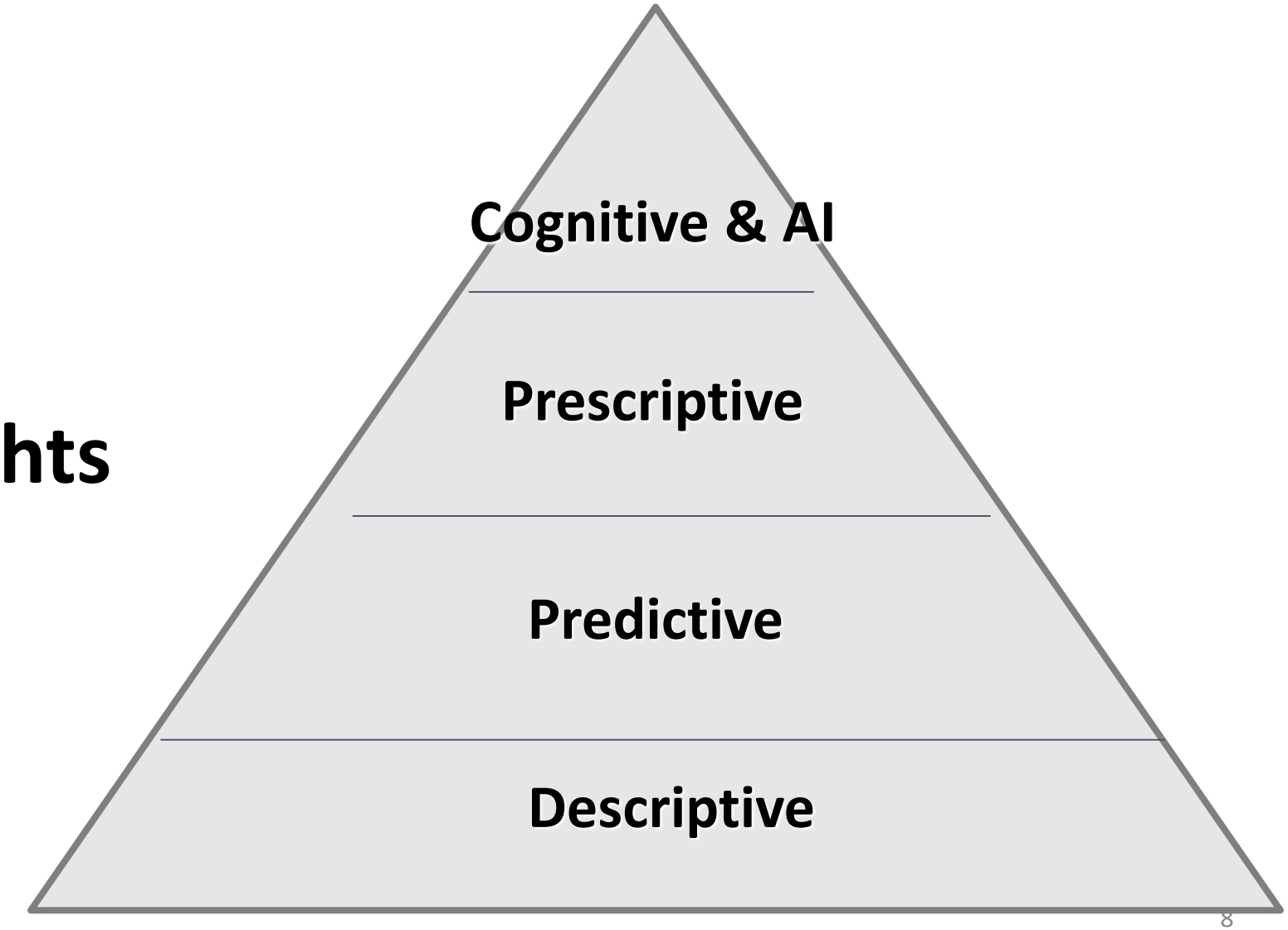
Veracity

Data in Doubt

Ref IBM

We are in the Fourth Age of Analytics

Analytics create Actionable Insights

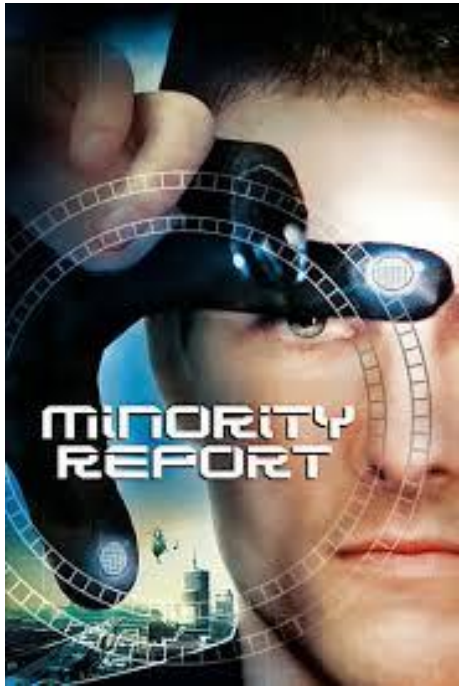


By 2020…

‘50% of all businesses will be making decisions using artificial intelligence and prediction’

Gartner Analysts

AI – Science Fact or Science Fiction?



Within 10 Years, according to 500 eminent scientists

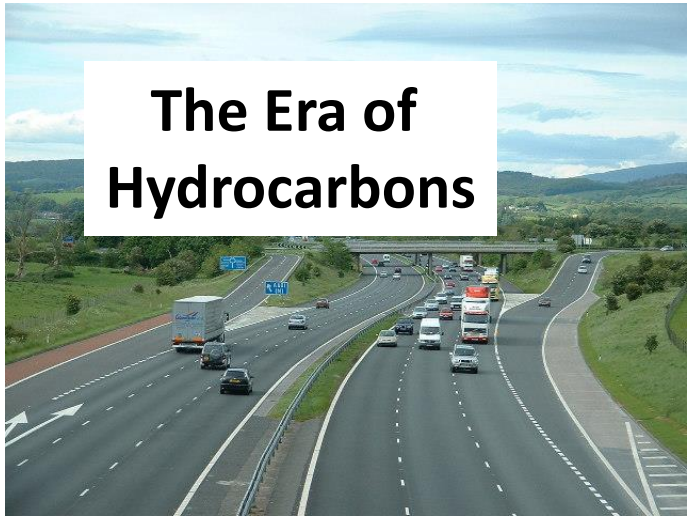
- We will create **machine simulation of human thought,** say 11%
- Machines will be able to **learn like humans,** say 5%

This is within the 'career lifespan' of your undergraduates

Ref: *Muller, Vincent C and Bostrom, Nick (2016). 'Future Progress in artificial intelligence: A survey of Expert Opinion'. Synthesis Library; Berlin; Springer).553-571

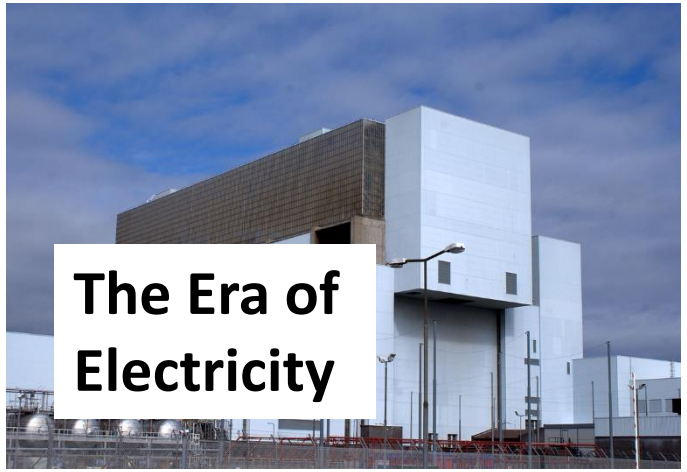
What do we mean by ‘Civil Engineer 4.0’ ?

Stephenson



George Wimpey

Fluor



‘Civil Engineer 4.0’

Civil Engineering : An Industry in Transformation?

- Poor digital infrastructure
- No authority to change
- Lack of training
- Security concerns
- Economic climate
- Ageing workforce
- Company buying cycles

Ref ‘Technology Consumption: are Engineers Ready to Make the Leap and Reap the Rewards?’ New Civil Engineer and Bentley Systems

Construction of the Future

Procurement
Contracts
Payments
Governance

Sustainability
Planning
Property and Asset Development

Regulation
Legislation
Health and Safety

BIM

3-D

Augmented reality

Digitalised employee management

Drones and remote imagery

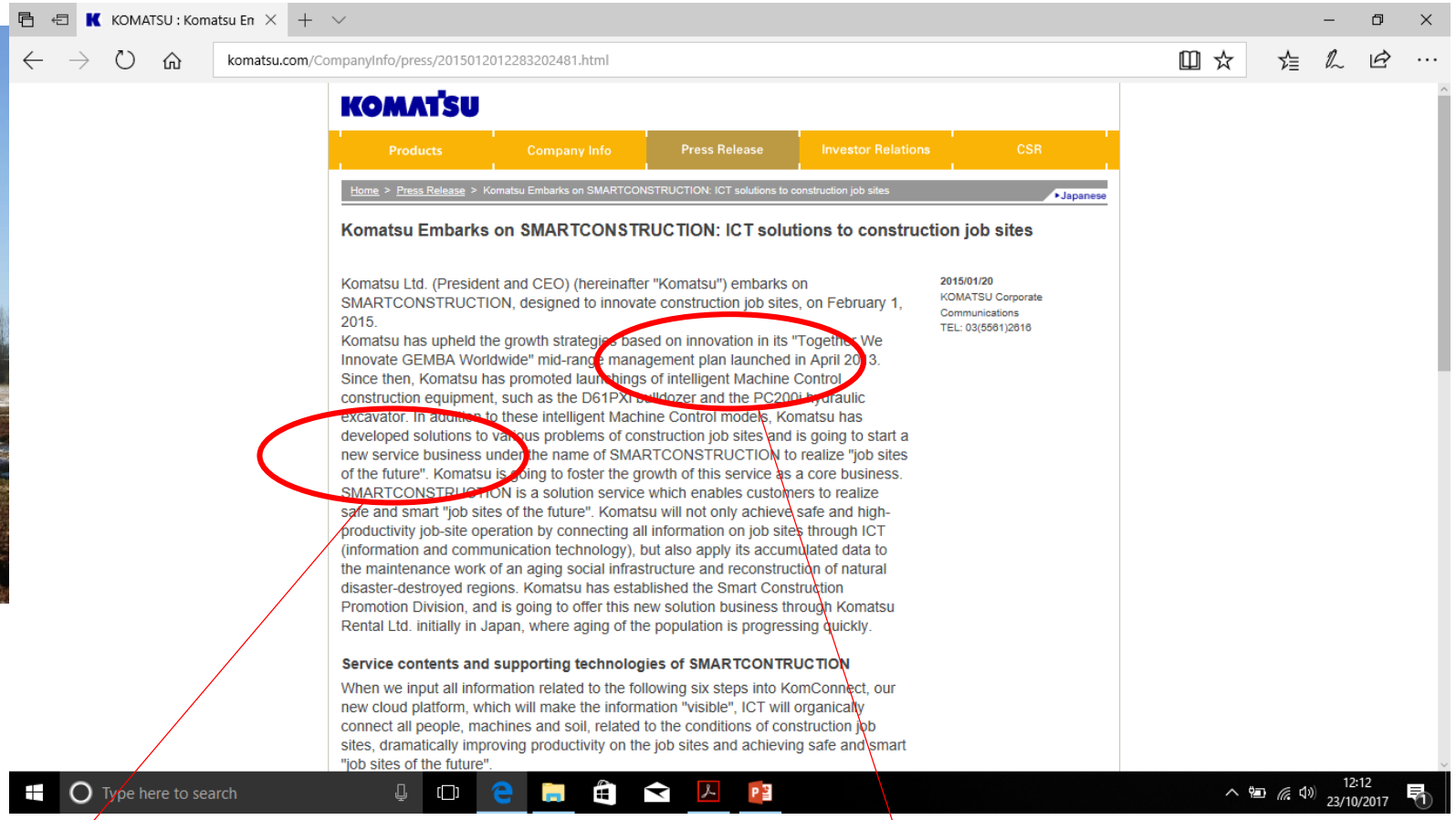
Smart Construction

Research
Design
Product development
Innovation
Talent management

Construction management
Roles and services
Cost Planning
Profit optimisation

Technology
Data Collection
BIM
Analytical Insight
Predictability

Example: What is ‘Smart Construction’ ?



KOMATSU : Komatsu En

komatsu.com/CompanyInfo/press/201501201228320248 1.html

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Komatsu Embarks on SMARTCONSTRUCTION: ICT solutions to construction job sites

2015/01/20
KOMATSU Corporate Communications
TEL: 03(5561)2616

Komatsu Ltd. (President and CEO) (hereinafter "Komatsu") embarks on SMARTCONSTRUCTION, designed to innovate construction job sites, on February 1, 2015.
Komatsu has upheld the growth strategies based on innovation in its "Together We Innovate GEMBA Worldwide" mid-range management plan launched in April 2013. Since then, Komatsu has promoted launchings of intelligent Machine Control construction equipment, such as the D61PXi bulldozer and the PC200i hydraulic excavator. In addition to these intelligent Machine Control models, Komatsu has developed solutions to various problems of construction job sites and is going to start a new service business under the name of SMARTCONSTRUCTION to realize "job sites of the future". Komatsu is going to foster the growth of this service as a core business. SMARTCONSTRUCTION is a solution service which enables customers to realize safe and smart "job sites of the future". Komatsu will not only achieve safe and high-productivity job-site operation by connecting all information on job sites through ICT (information and communication technology), but also apply its accumulated data to the maintenance work of an aging social infrastructure and reconstruction of natural disaster-destroyed regions. Komatsu has established the Smart Construction Promotion Division, and is going to offer this new solution business through Komatsu Rental Ltd. initially in Japan, where aging of the population is progressing quickly.

Service contents and supporting technologies of SMARTCONTRUCTION

When we input all information related to the following six steps into KomConnect, our new cloud platform, which will make the information "visible", ICT will organically connect all people, machines and soil, related to the conditions of construction job sites, dramatically improving productivity on the job sites and achieving safe and smart "job sites of the future".

Type here to search

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23/10/2017

‘Job sites of the future’

‘Intelligent machine control’

Four Key Building Blocks of Industry Transformation

Appropriate Technology

Vision of the Future

Talent Management

Our Focus for Today

Leadership

4

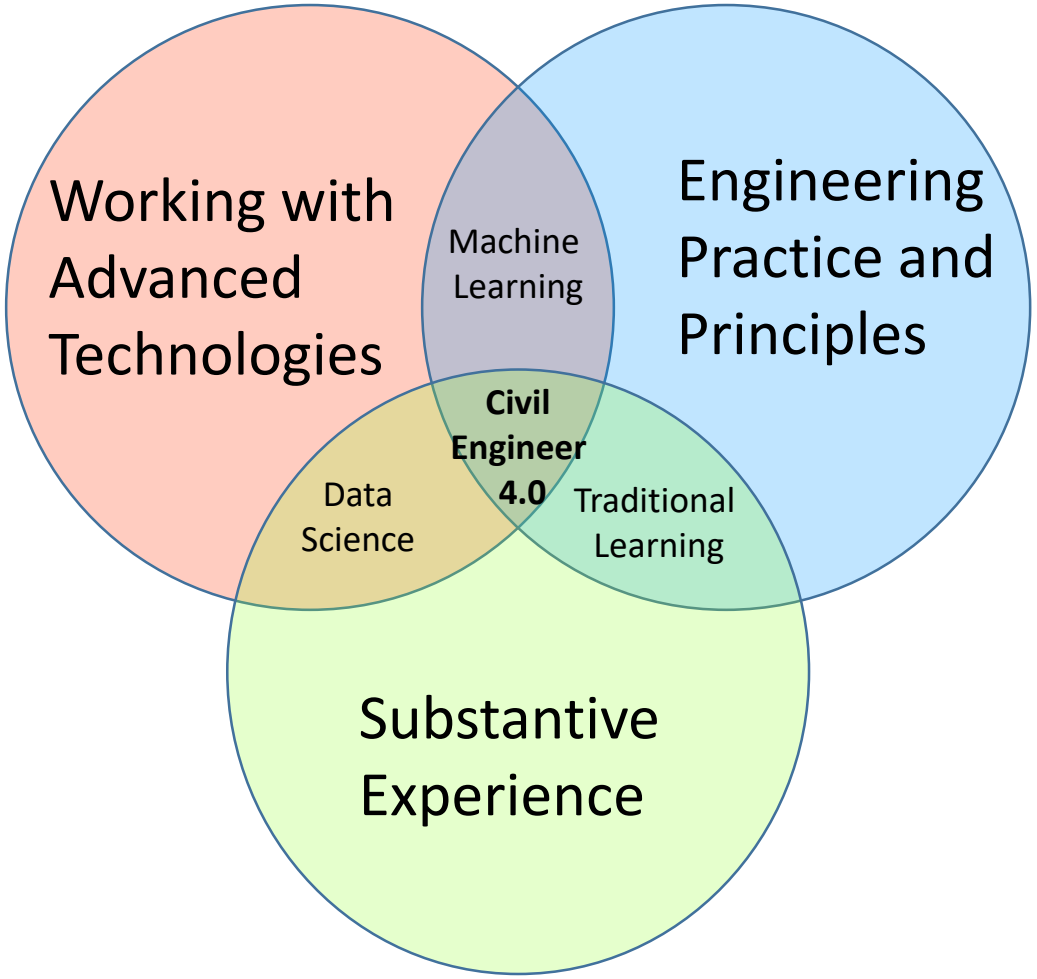
The Need for ‘Vision’

‘The art of directing the great sources
of power in nature
for the use and convenience of man’

Institution of Civil Engineers Charter

‘The art of directing the great sources
of power in data
for the use and convenience of man’

‘Civil Engineer 4.0’ will Require New Capabilities

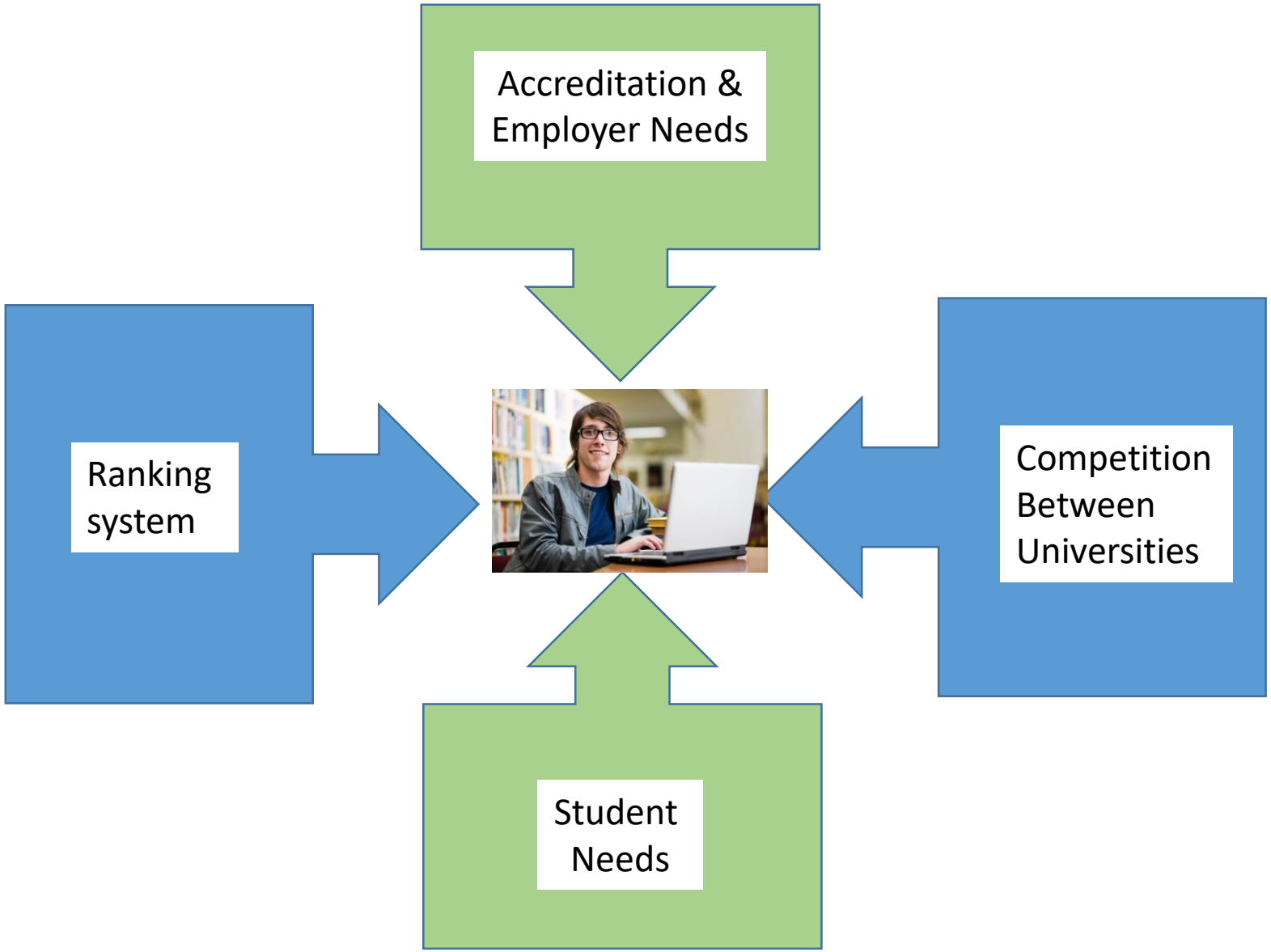


‘Civil Engineer 4.0’ needs New Attributes

Is Currently	Will Also Need to Be
Use of general and specific knowledge to apply techniques	Increased knowledge of data-driven techniques in construction
Apply theoretical and practical methods of construction	Ability to apply specific data driven solutions including robotics
Demonstrate technical and organisational skills	Ability to co-work with advanced systems
Demonstrate a personal commitment to professional standards	Industry ambassador, ethical champion and effective communicator

Example

How Can Universities Respond?



Multi-Faceted Knowledge Management for a New Era

- 3-D virtual learning
- Video tuition
- Gaming
- Face to face training
- Self-paced learning
- Webinars
- eLearning
- Social learning
- Mentoring

+

Practical Experience

=

The future of education will comprise a high degree of personalization and customization

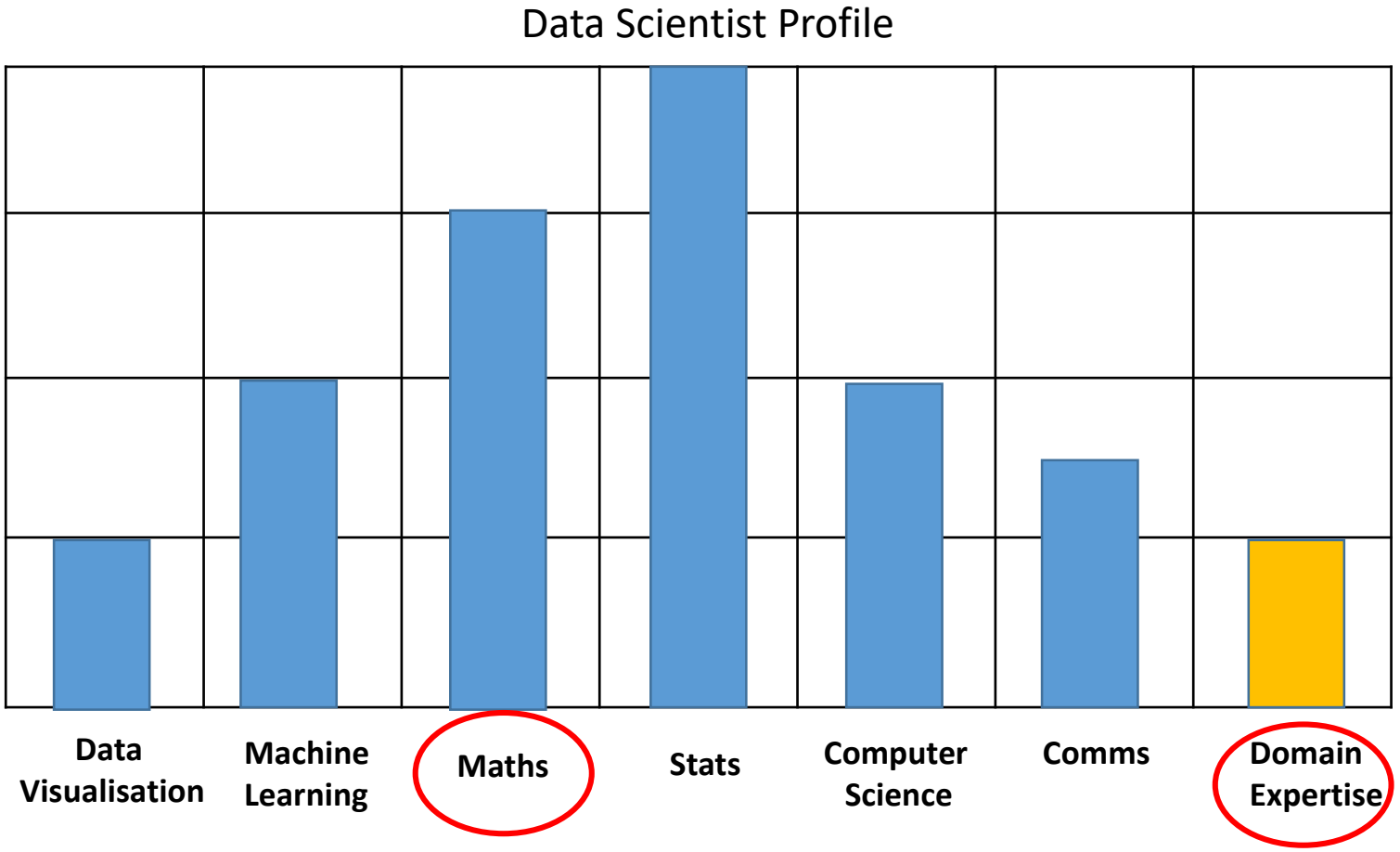
The Challenge of Programming

Is it easier for a data scientist to become a civil engineer; or a civil engineer to become a data scientist?

Or is there potential for some sort of hybrid profession?

Data Scientist Skillsets

‘A person employed to analyse and interpret complex digital data especially in order to assist a business in its decision-making’



Ref: Schutt & O’Neil, 2013

The Hierarchy of Data Science

Data Science and Analytics Framework category	Function	Sample occupation
Data scientist	Creates sophisticated data models and derives new insights	Economist
Data analyst	Uses modelling techniques to solve business problems	Business Intelligence Analysts
Data system developer	Builds and organisations data structure	Systems analyst or administrators
Analytic manager	Oversee analytical data operators and communicates findings to execs	Chief analytics officer
Functional analyst	Uses data to inform specific decisions	Financial analyst
Data driven decision maker	Uses data to inform strategic and operational decisions	Project manager, engineer

Ref: Data Science and Analytics Framework
After Miller and Hughes 2017

Civil Engineers and Data Scientists : Salary Discrepancy

Data Science and Analytics Framework	Average salary (US $)
Data driven decision maker	$ 80,265
Functional analyst	$ 91, 467
Data system development	$ 69,162
Data Analyst	$ 78, 533
Data scientist & advanced analytics	$ 94,576
Analytics managers	$ 105,909

The average pay for a US Civil Engineer is $63,457 per year.
The average pay for a UK Civil Engineer is £30,558 ($39,000) per year.

Ref: After Miller and Hughes 2017
https://www.payscale.com/research/UK/Job=Civil_Engineer/Salary

‘None of the civil engineers I know code or are even inclined to code.’

‘Their knowledge of statistics is very 101 and they have zero knowledge on how to conduct a data science or machine learning project.’

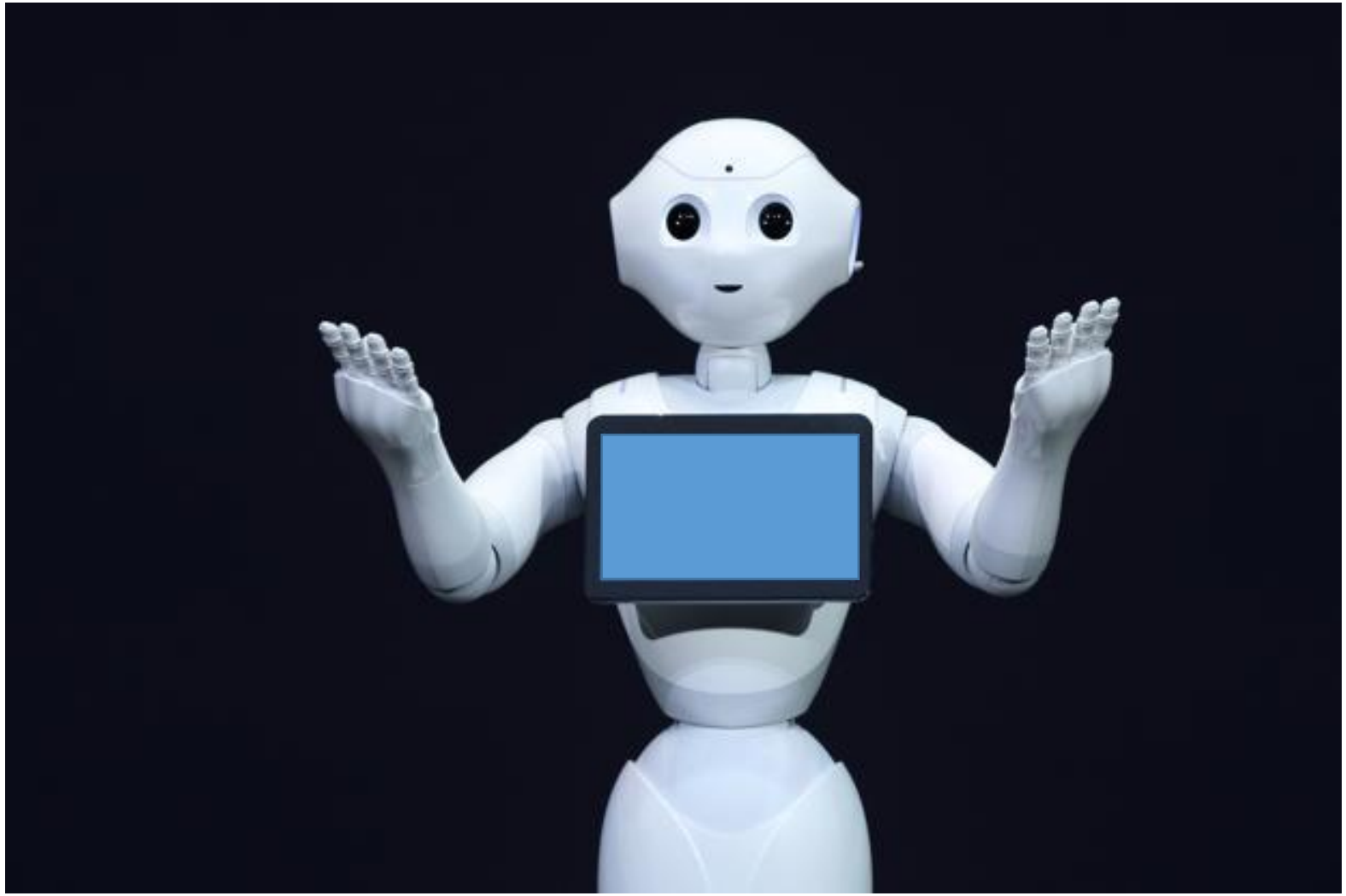
Do we need to rethink how technology is taught on Civil Engineering courses?

Ref: https://www.quora.com/Can-civil-engineer-work-as-a-data-scientist

What will the Future of Civil Engineering Look Like ?

- Civil engineering as a profession or industry doesn’t exist in isolation
- ‘Civil Engineer 4.0’ requires courses to reflect the new marketplace
- ‘Brain Drain’ for the Civil Engineering industry, or ‘Brain Gain’?
- Will engineering courses need to be ‘Re-Engineered’?

What will the Future of Civil Engineering Lecturing Be ?



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