Lecture 8: Designing complex systems as interaction spaces

Case studies on applying theory to hard HCI problems

Overview of the course

- Theory driven approaches to HCI
- Design of visual displays
- Goal-oriented interaction
- Designing efficient systems
- Designing smart systems
- Designing meaningful systems (guest lecturer)
- Evaluating interactive system designs
- **Designing complex systems**

What are some things that make designs complex?

- How complex is the domain?
- How many different tasks might a user perform?
- How well defined are the outcomes? (Wicked problems, L3)
- How easy is it to understand each part?
- When the parts are put together how easy is to guess the behaviour?
- Does the system do things when the user isn’t there? (Attention Investment from L3)

Designing tasks vs interaction spaces

Consider a (slightly silly) API for sending a message:

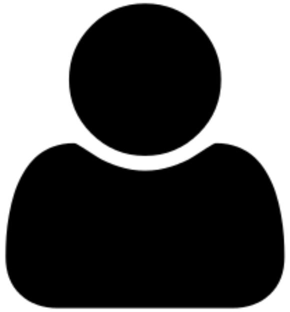
```
(1)  sendTheRightMessage()
(2)  sendMessage(Enum message)
(3)  sendMessage(String message, Urgency status)
```

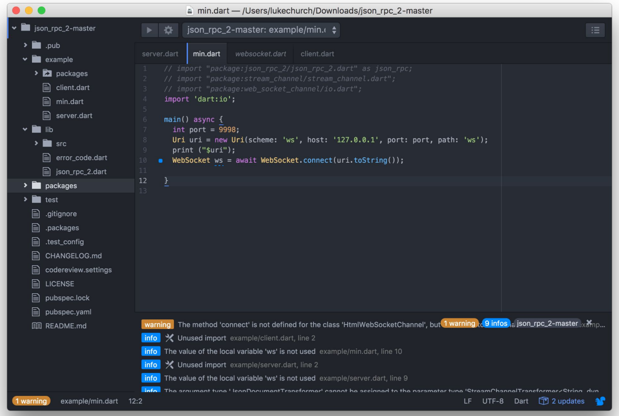
- Naive design would produce (1). Complex systems tend to be built out of reusable components that the users configure (2,3)
- Building this kind of system involves discussing tradeoffs as well as detailed design decisions
- This is the kind of interaction space that most of you will build: **Programming languages, APIs, AI systems**

Broad brush techniques

- Descriptions of specific actions result in a ‘death by detail’
- Don’t describe specific actions with an interface
  - Describe interaction with a level of *analytical distance* from the interface
  - Use an *analytical frame* which is a way of structuring a description of an interaction
  - The description can then be compared to an ideal for a domain to become a critical perspective (see Lecture 1)
- The right level of detail resembles an object-oriented design pattern, but for *human behaviour* rather than software.

Cognitive Dimensions of Notations (CDNs): Analytical Frame



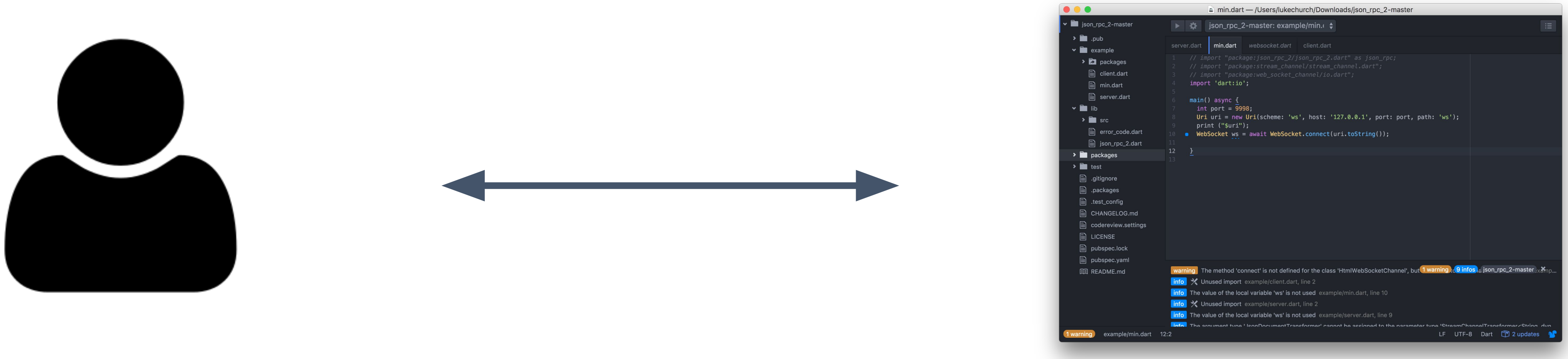


A user

Performs an *activity*

Interface containing *notations*, described along a number of *dimensions*

Cognitive Dimensions of Notations (CDNs): Analytical Frame

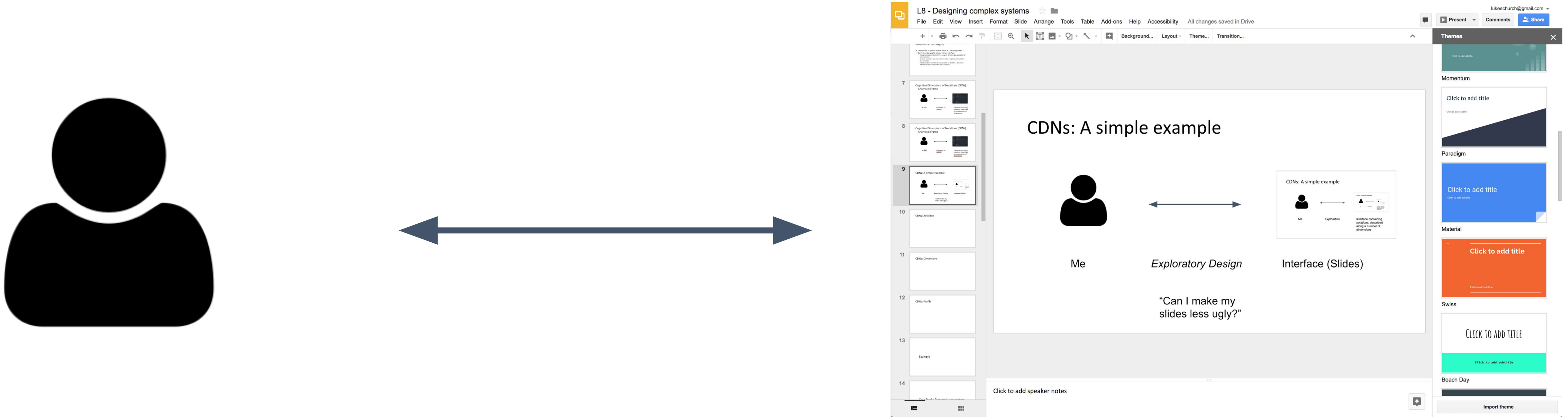


A user

Performs an *activity*

Interface containing *notations*, described along a number of *dimensions*

CDNs: A simple example



Me

Exploratory Design

Interface (Google Slides)

“Can I make my slides less ugly?”

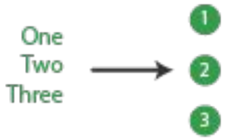
CDNs: A simple example (Demo)

- One described change “Make the font of the headings Comic Sans”
  - Select the first slide, change the font
  - Select the second slide, change the font
  - Yawn.
- This is repetition *Viscosity*, many operations to perform one change
- Design maneuver: Introduce an *Abstraction* (master slide), decreases *Viscosity*, but increases *Premature Commitment*
- NB: CDNs analysis is meaningless independent of an interface.

CDNs: Activities

EXPLORATION
Manipulating both information and structure
Exploration involves manipulating, and changing, both the content and the structure of the information

MODIFICATION
Changing structure only
Modification is changing the structure of the information, but keeping the content the same. Also known as 'refactoring'

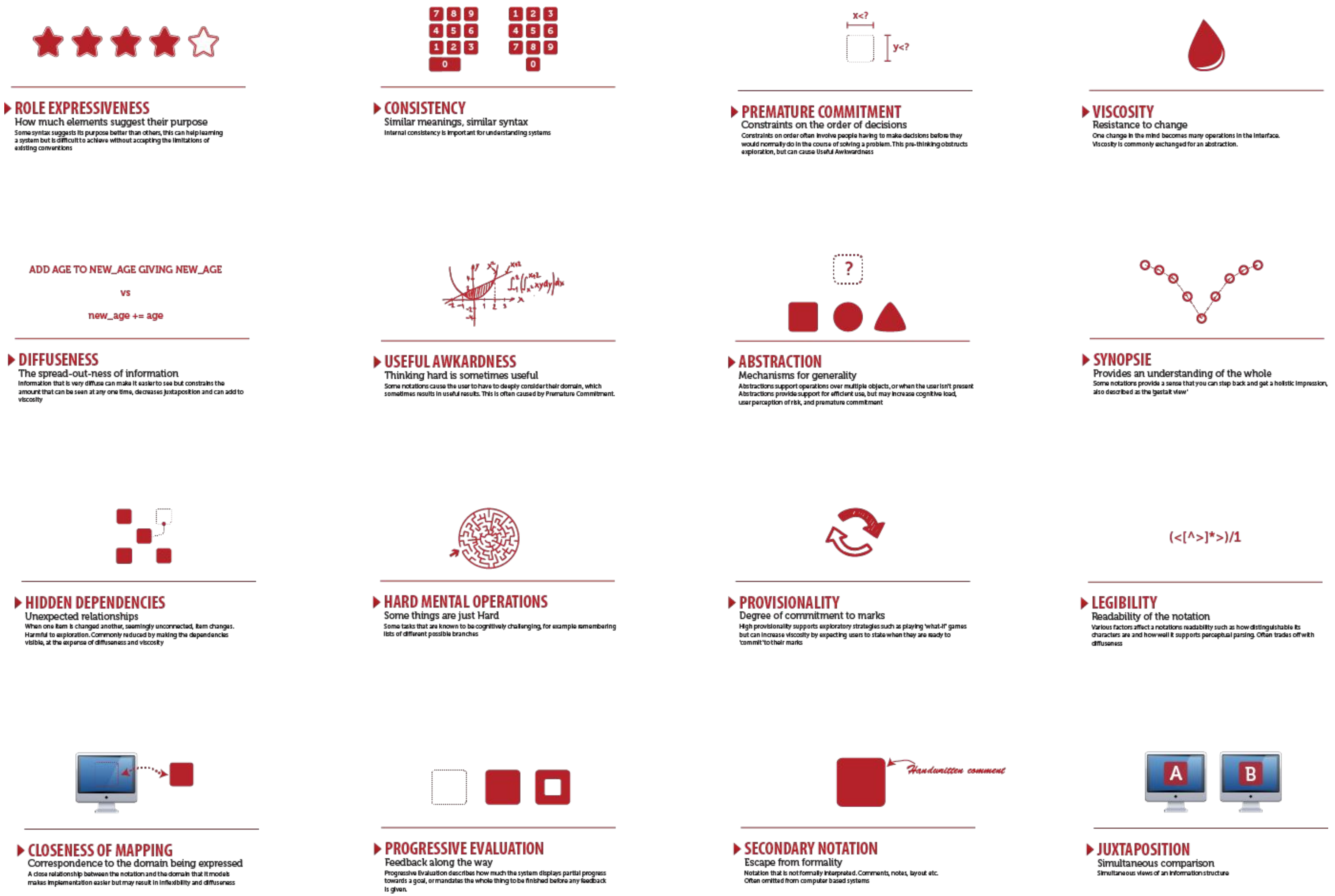


TRANSCRIPTION
From one notation to another
Transcription involves copying information from one notational form to another, often between different media as well

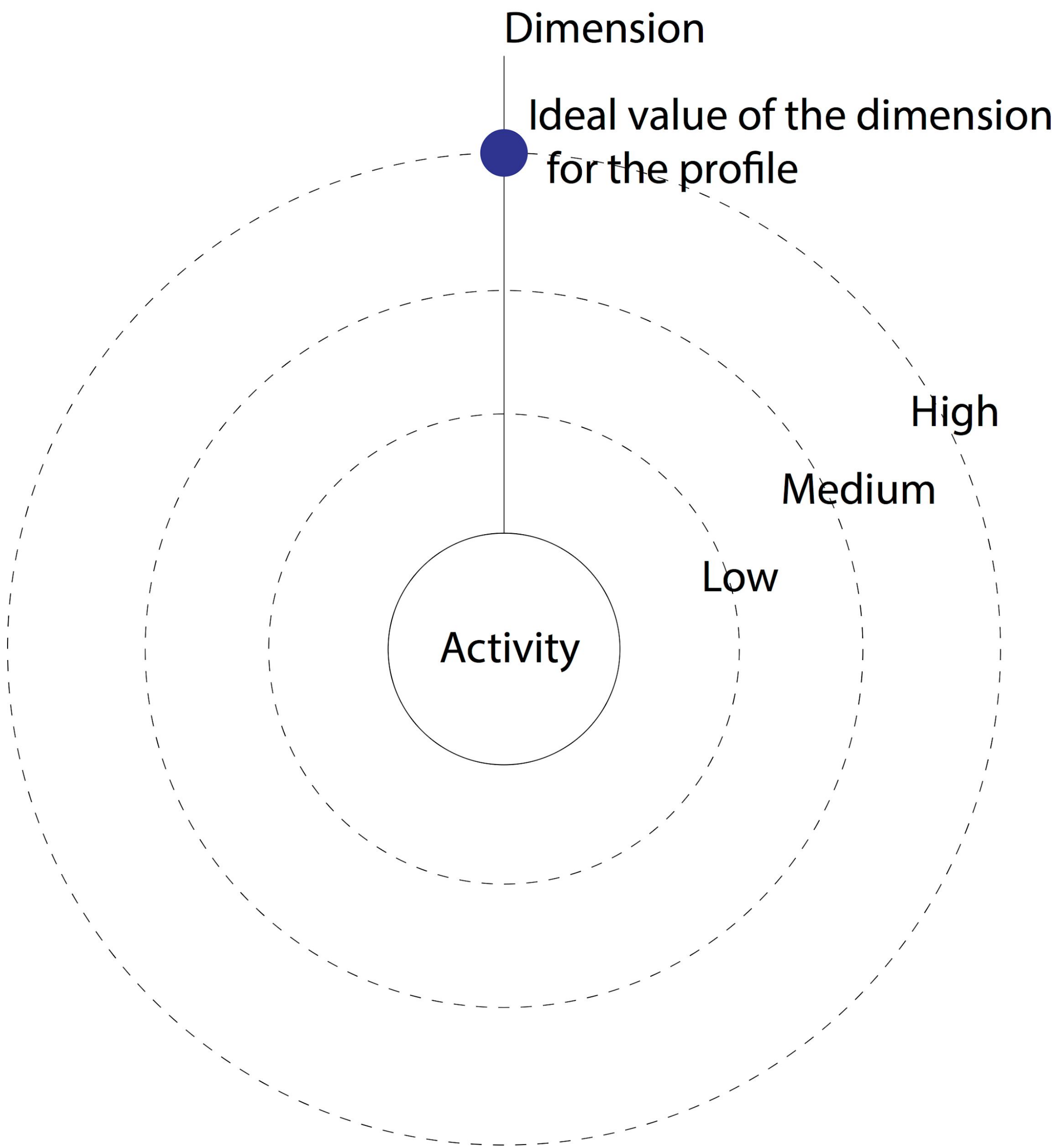
INCREMENTATION
Adding one more
Incrementation is adding new content, but leaving the information structure alone

READING
Seeking information or gist
Reading doesn't involve changing the content or structure, but finding information either for detail or an overview

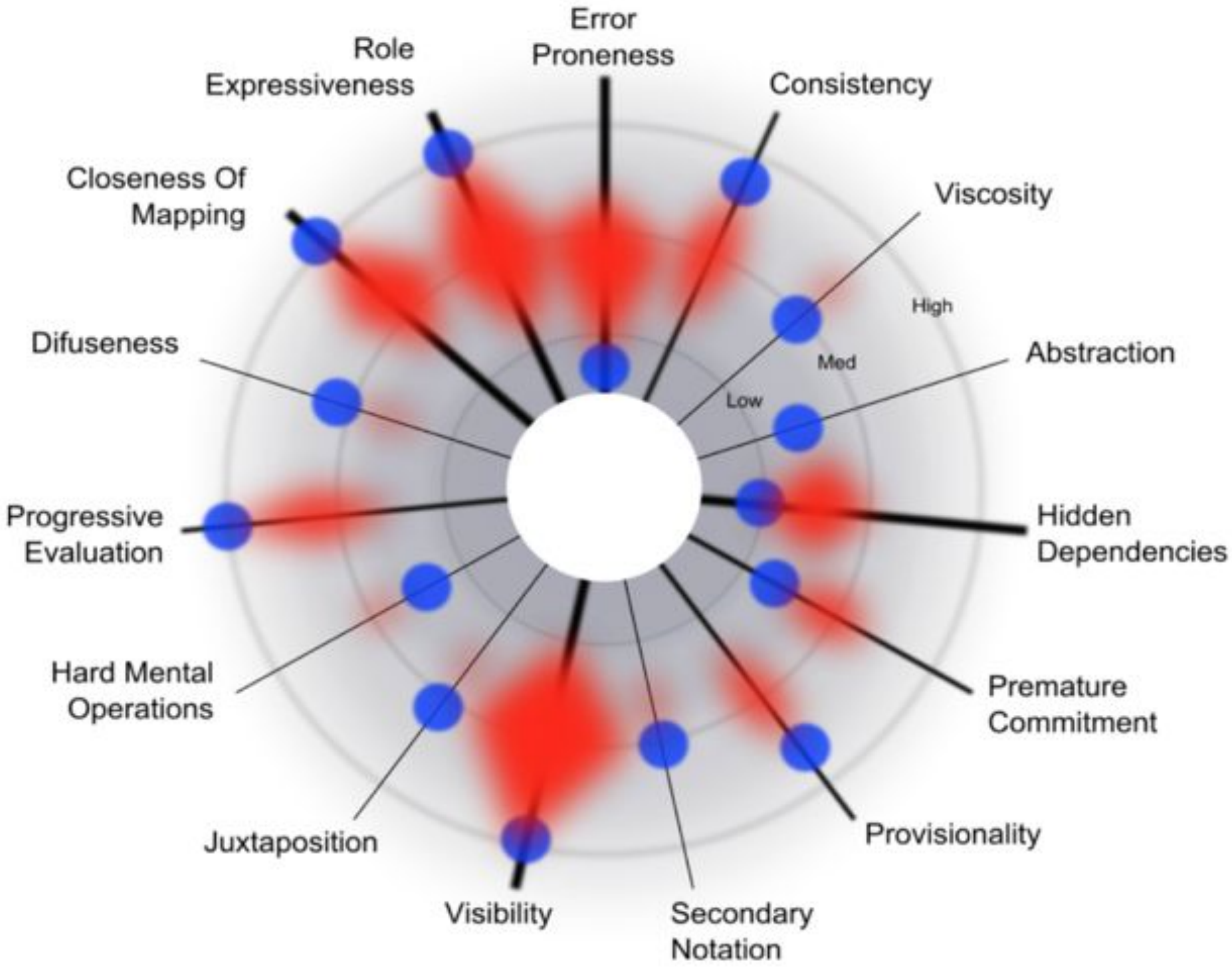
CDNs: Dimensions



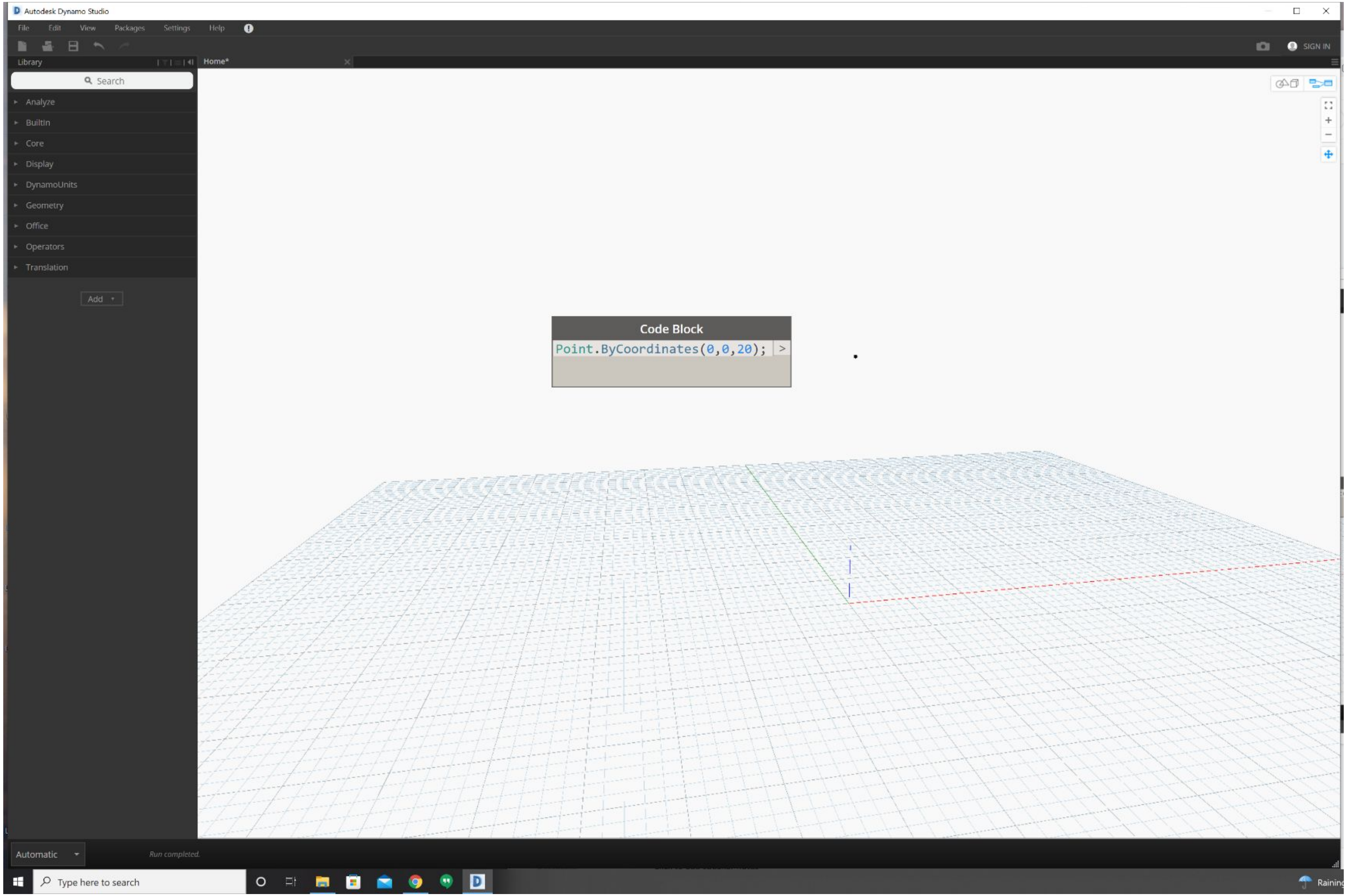
CDNs: Profile



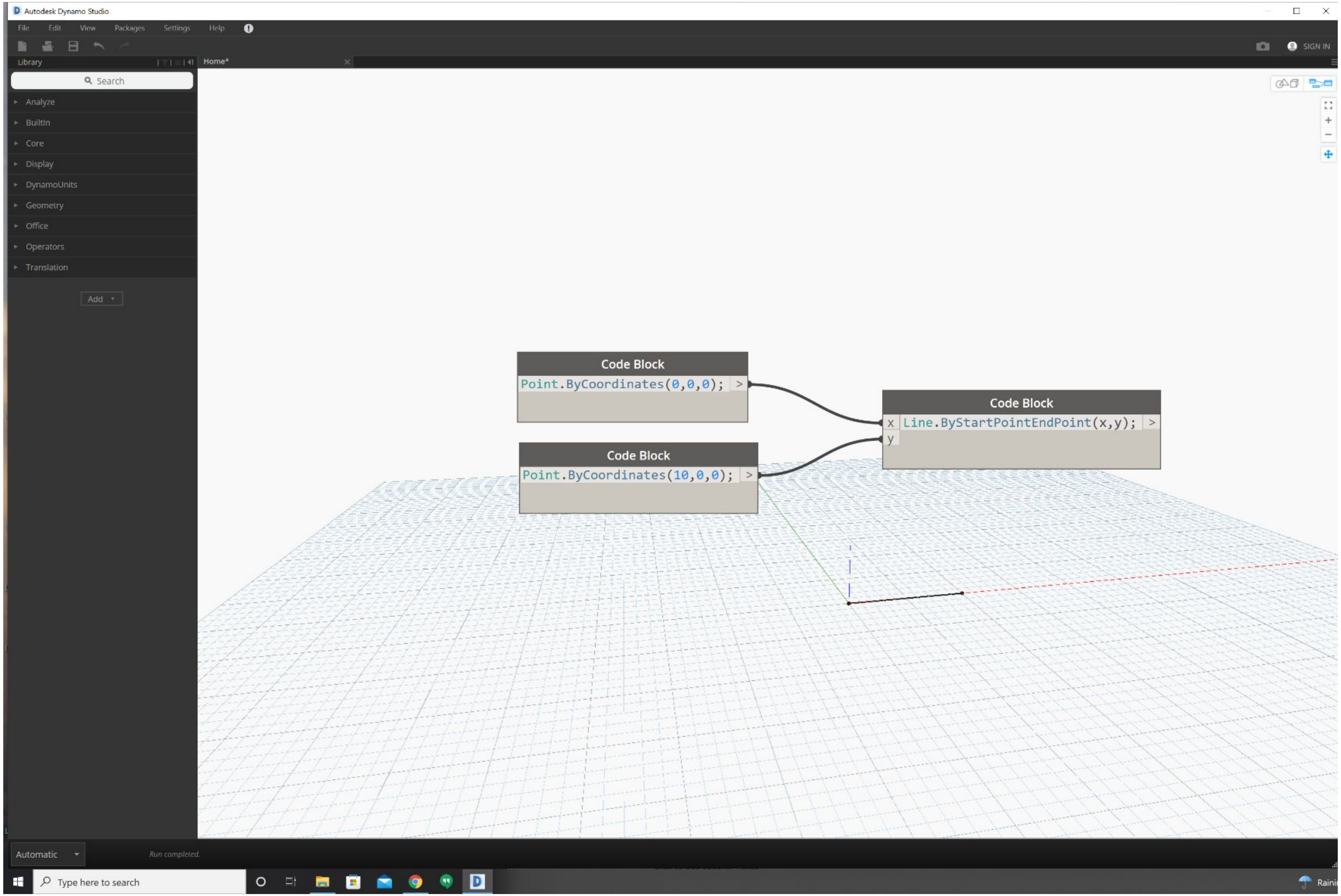
CDNs: Profile



Case Study: Dynamo’s type system



Autodesk Dynamo Studio
File
Edit
View
Packages
Settings
Help
SIGN IN
Library
Home*
Search
Analyze
BuiltIn
Core
Display
DynamoUnits
Geometry
Office
Operators
Translation
Add
Code Block
Point.ByCoordinates(0,0,20);
Automatic
Run completed.
Type here to search



Autodesk Dynamo Studio
File
Edit
View
Packages
Settings
Help
SIGN IN
Library
Home*
Search
Analyze
BuiltIn
Core
Display
DynamoUnits
Geometry
Office
Operators
Translation
Add
Code Block
Point.ByCoordinates(0,0,0);
Code Block
Point.ByCoordinates(10,0,0);
Code Block
Line.ByStartPointEndPoint(x,y);
x
y
Automatic
Run completed.
Type here to search

Dynamo

- Language for exploring building designs
- Includes a constructor **`Point(x, y, z)`** and array literal syntax [1,2]

Design question for discussion:

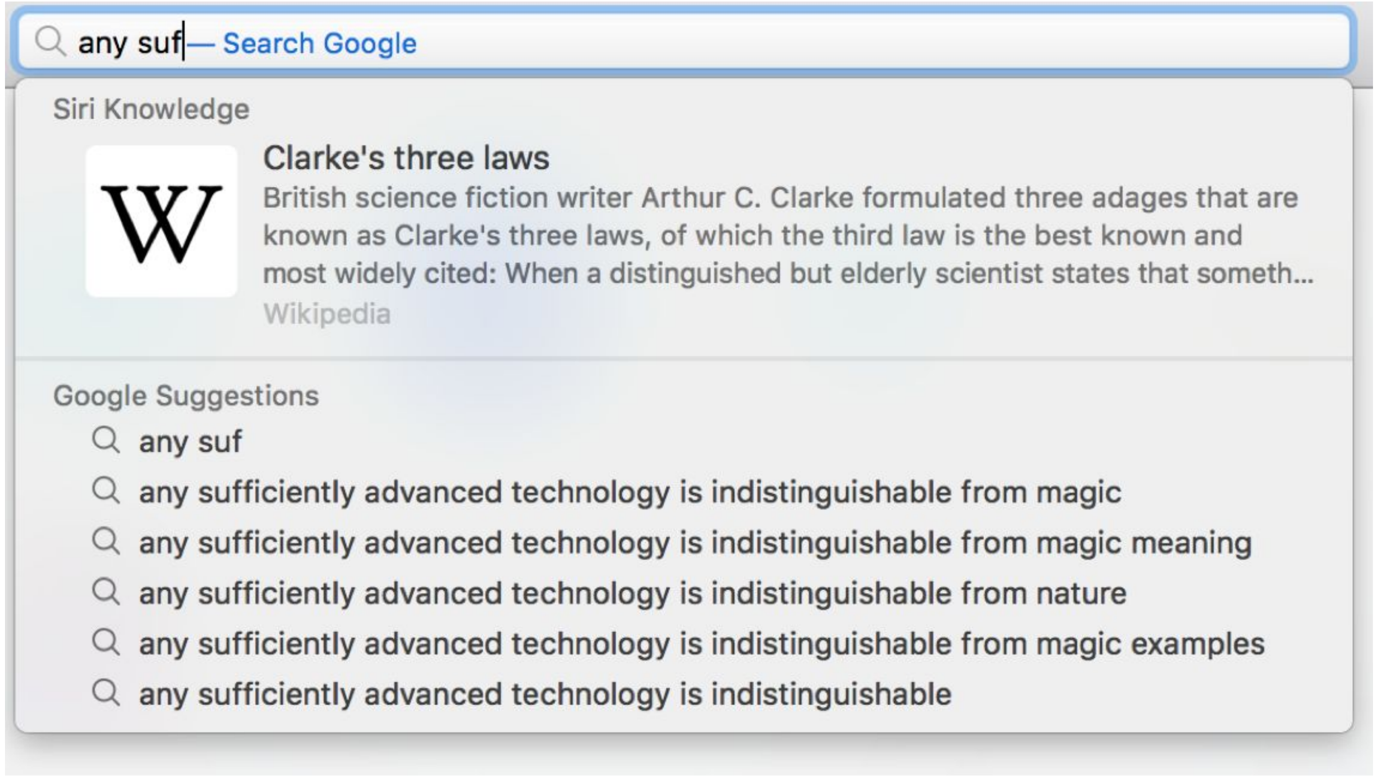
“What should **`Point([0, 1, 2], 10, 10)`** do?”

- What activities are important?
- How important: Viscosity? Premature commitment? Hidden Dependencies? Abstraction hunger?

Intelligent systems as interaction spaces

"Any sufficiently advanced technology will be indistinguishable from magic"

- Arthur C. Clarke, 1962



AI can feel like magic

Individual interactions with AI systems often seem quite trivial to perform, even if we don't know how we go about doing them.

Because we don't know how they work, if something goes wrong there's no obvious way of intervening

(Personal images)

AI can feel like *scalable* magic

Having developed the capability to perform the task once, without human attention, we can now achieve results that would otherwise be impossible.

E.g. ‘find all the cats on the internet’

(images from Pexel, CC0)

AI can feel like scalable magic

Applying the same technique to animal behaviour analysis

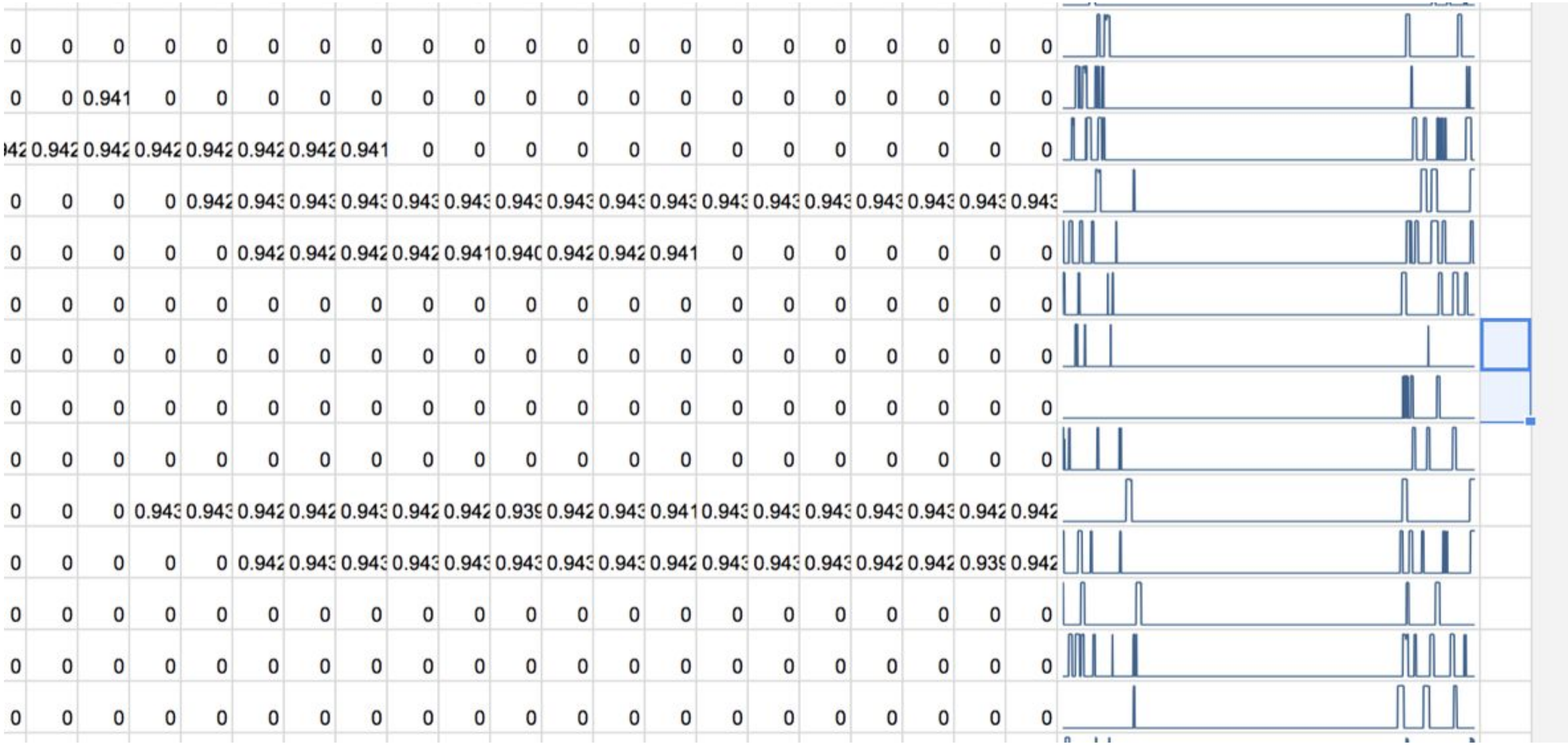

```
{
  "labelAnnotations": [
    {
      "description": "black",
      "score": 0.9555818
    },
    {
      "description": "black and white",
      "score": 0.9473888
    },
    {
      "description": "monochrome photography",
      "score": 0.90905684
    },
```



```
{
  "labelAnnotations": [
    {
      "description": "hedgehog",
      "score": 0.9818773
    },
    {
      "description": "erinaceidae",
      "score": 0.9702047
    },
    {
      "description": "domesticated hedgehog",
      "score": 0.9429917
    },
```


(Personal images)

AI can feel like scalable magic



0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0.941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
942	0.942	0.942	0.942	0.942	0.942	0.942	0.941	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0.942	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.943
0	0	0	0	0	0.942	0.942	0.942	0.942	0.941	0.940	0.942	0.942	0.941	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0.943	0.943	0.942	0.942	0.943	0.942	0.942	0.939	0.942	0.943	0.941	0.943	0.943	0.943	0.943	0.943	0.942	0.942
0	0	0	0	0	0.942	0.943	0.943	0.943	0.943	0.943	0.943	0.943	0.942	0.943	0.943	0.943	0.942	0.942	0.939	0.942
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

How do you trust magic?
How do you control it?

If this was the result you saw - would you believe it?

A simple example of programming with ML

- Research in 2011 by Sumit Gulwani at Microsoft Research
- “Synthesises a program from input-output examples”
  - How do you choose the examples? (Premature commitment?)
  - How do you know what will happen? (Progressive evaluation?)
-
- Now Excel FlashFill
  - Paste a list of semi-structured text data into the left column
  - Type an example transform result in top cell to the right, then <Enter>
  - Press <Ctrl+E>

Conversational agents

- Do they build a user model, goal model or task model?
- Will this be more or less complex than FlashFill?
- How can you see it the model?
  - i.e. what is the notation?
- How could you modify the model?
  - … in response to errors (yours, or the system's)
  - … if you change your goals?
- Does having a 'body' help?
  - (remember metaphor)

Amazon Echo / Alexa agent

Human issues in machine learning

- Ethics and accountability
    - automating and/or justifying bias and prejudice
- Digital humanities
    - treating text and images as meaningful and sophisticated
    - (rather than just statistical fodder)
- Reward
    - who does the intellectual ‘work’ of providing training corpus content, data labelling, how are they paid, and where do the profits go?

Some [other] current research problems

VR and AR still use visual correspondence

Microsoft Hololens

Programming, or direct manipulation?

- Many Internet of Things (IoT) devices have physical switches etc
  - But how do you define configuration, policy, future action?
  - Now we need a notation - or a programming language
- Remember behavioural economics and attention investment
  - Even around your house, bounded rationality happens

Philips Hue Light control

Global challenges

- Is knowledge infrastructure built to ...
  - … prioritise low income populations
  - … advance Sustainable Development Goals (human rights, education etc)?

Africa's Voices Foundation / Cambridge Global Challenges Initiative

Further interest...

- Part II: Project
- Part II/Part III Computer Music (not in 2022)
- Part II/Part III Advanced Graphics
- Part III: Interaction with Machine Learning
- Research Skills: Working with artists and designers; How to interpret experimental results; Introduction to qualitative research methods; How to design surveys; Assessing the quality of experience