





What is AI?



- Field of science concerned with the study and design of intelligent machines
- Goal: to build machines capable of performing tasks we define as intelligent
 - E.g., reasoning, learning, planning, problem-solving, remembering, and perception
- Divided into:
 - **Strong:** build machines with General Intelligence leading to consciousness (Searle, 1980).
 - **Weak:** focus on specific specialised intelligent tasks – e.g., speech processing (Velik, 2012).



Key terms



- **Machine learning (ML)** = core branch that aims to give computers the ability to learn without explicit programming (Samuel, 2000)
 - Capability of a machine to improve performance through exposure to data and experience
- **Artificial neural networks (ANN)** = type of ML technique that simulates structure and function of neuronal networks in the brain (Alonso & Mondragón, 2011) 
- **Natural Language Processing (NLP)** = capability of machines to interpret and process human language (Manning & Schütze, 1999).

Key terms

- **Machine Perception and Sensing** = computers with hardware and software to recognise images, sounds, touch, and smell that enhances interactivity with humans



- **Affective computing** = emotion recognition by machines, emotion modelling, and expression of emotions by robots and virtual agents (Picard, 1997)

- **Virtual reality (VR)** = allows the user to become immersed within and interact with computer-generated simulated environments (Rizzo et al., 1997)



Key terms

- **Augmented reality (AR)** = combines virtual reality with the real world by superimposing computer-generated graphics with live video imagery (Craig, 2013).



- **Brain-Computer Interfaces (BCIs) & Implants:** devices that provide direct communication between the brain and external hardware (i.e., a computer).

- **Robotics** = machines that move around in the real world.



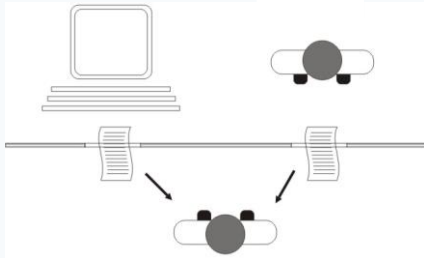
AI – Brief Background

Alan Turing (1950)

- Mathematical and computer scientist.
- The way we carry out a computation (i.e., work something out), a computer could also do in the same way by following a series of rules in a step-by-step manner and manipulate symbols according to these rules.
- To examine this he devised the imitation game:
 - Method for judging intelligence of machines and whether machines are capable of “thinking.”



AI – Brief Background



- Thinking defined in terms of output: verbal behaviour
- If a human and a machine perform the same, the material is irrelevant; only the function matters

First AI use in Psychiatry

- **ELIZA** (Weizenbaum, 1966, MIT)
 - Would process inputs and engage in discourse following rules and directions of a pre-programmed script
 - Modelled to imitate the empathic communication style of psychologist Carl Rogers (Rogers, 1959)
 - Considered one of the first chatterbots

First AI use in Psychiatry

- Most famous script: **DOCTOR**
- Simulated psychotherapist: used rules, dictated in the script to respond with non-directional questions to user inputs.

```
File Edit Options Buffers Tools Help
I am the psychotherapist. Please, describe your problems.
Each time you are finished talking, type RET twice.
I have a terrible headache.
Maybe you should consult a doctor of medicine, I am a psychiatrist.
Okay, I'll do that then.
Can you elaborate on that?
What are you talking about? No I cannot elaborate. See you later.
Why do you say that?
How you're just talking nonsense!
What makes you believe now I am just talking nonsense?
You are not making any sense.
Perhaps your plans have something to do with this.
*** doctor (Doctor File) -- Li--Top
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First AI use in Psychiatry

- Colby (1970s): developed program called **PARRY**
 - Simulated a person with paranoid schizophrenia
 - It would converse via text interface
- Expert psychiatrists were unable to distinguish between PARRY and real patients with paranoid schizophrenia (Teuscher & Hofstadter, 2006).

AI in Psychology: Why is it being considered?

- ~264 million people affected by depression
- Bipolar affects ~45 million people
- Schizophrenia affects over 20 million people
- ~50 million people have dementia
- Number of licenced clinicians is not sufficient to deal with these demands
 - Particularly for safe and timely care

Source: James et al. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, 392(10259), 1789–1858.

AI: Current Use

- Machines that learn, understand, and reason to assist clinical decision-making, testing, diagnosis, and care management
- Interactive mobile health applications (apps) that learn the patterns and preferences of users
- Assists with detection of health risks and inform interventions.
- Virtual humans to interact with care seekers and provide treatment recommendation

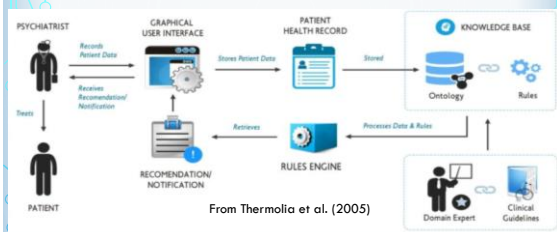
AI use in Mental Health Care

- **Expert systems:** Became implemented in Clinical Decision Support Systems (CDSS):

- “Any electronic system designed to aid directly in clinical decision making, in which characteristics of individual patients are used to generate patient specific assessments or recommendations that are then presented to clinicians for consideration” (Kawamoto et al., 2005).

- They make use of imputed information from domain experts, clinical guidelines, and data from and about the patient from a variety of sources.

Example CDSS



Kurian et al. (2009): Patients with major depressive disorder treated by physicians employing CDSS had significantly greater symptom reduction, based on the Hamilton Depression Rating Scale than patients treated with usual care

Expert Systems and CDSS: Evaluation

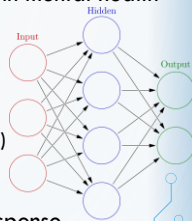
- Use evidence-based guidelines prescribing one-size-fits-all or standardised sequence of options
 - But patients in the real-world show individualised characteristics
 - Not all elements of persons life considered
 - Sometimes based on out-of-date guidelines
 - Suffer from *Knowledge Engineering* problem
 - No matter how many rules, there are always exceptions

Expert Systems and CDSS: Evaluation

- Have recently moved beyond knowledge-base rules and now perform data-driven probabilistic inference (Bellazzi & Zupan, 2008)
- Much more flexible and individualised.
- “Learn” from clinical data and their mistakes (Bennett & Doub, 2010).

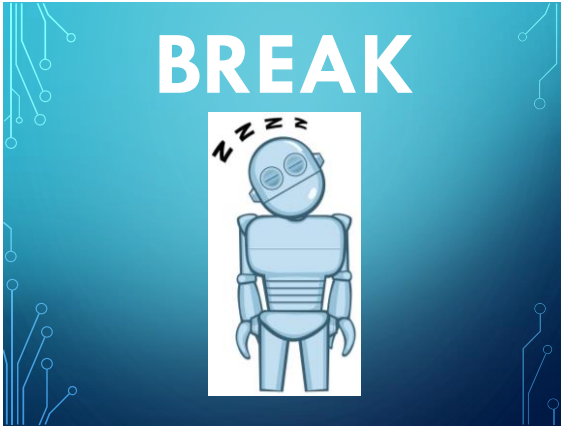
Artificial Neural Networks

- Have been tested as statistical method for accomplishing practical tasks in mental health
- Predicting lengths of psychiatric hospital stay (Lowell & Davis, 1994)
- Determining costs of psychiatric medication (Mirabzadeh et al., 2013)
- Predicting OCD treatment response (Salomoni et al., 2009).



Virtual Reality (VR)

- Patient can interact with a Virtual Human (VH) who answers questions about clinical issues, discuss treatment options, guide through self-assessment questionnaires, etc.
- Situated at a clinic to conduct initial interview to start creating treatment plan followed by live clinician.
- Can be used in exposure therapy to help patients deal with specific phobias (e.g., social anxiety)





AI in Emotion Recognition

- **Is there a link between non-verbal and clinical conditions?**
- Depressed patients usually maintain less mutual gaze (Waxer, 1974), show nonspecific gaze (Schelde, 1998), and avert gaze (Perez & Riggio, 2003)
- Emotional expressivity, such as the frequency or duration of smiles also diagnostic of clinical state (Bylsam et al., 2008; Fairbanks et al., 1982; Perez & Riggio, 2003; Schelde, 1998).
- But – does everyone with depression always ‘look sad?’





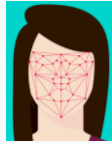
Link between behaviour and clinical conditions

- Total quantity of expression is not important, but their dynamics.
 - E.g., depressed patients may frequently smile, but these are shorter in duration and seen as less genuine (Kirsch & Brunnhuber, 2007) than in nonclinical populations.
- Social anxiety and PTSD also have heightened emotional sensitivity and more energetic responses, including hypersensitivity to stimuli (e.g., more startle responses and greater tendency to display anger) (Kirsch & Brunnhuber, 2007)
- Fidgeting often reported with greater frequency in clinical populations – e.g., tapping or rhythmically shaking hands or feet and has been reported in both anxiety and depression (Fairbanks et al., 1982).



AI in Emotion Recognition

- Multi-modal approaches now used, usually combining visual (facial expression) and audio (speech content and prosody) channels.
- Physiological signals also incorporated to increase recognition accuracy, primarily signals reflecting activity of the autonomic nervous systems (arousal).



Case Example

- **SimSensei:** VH interaction capable of sensing and interpreting real-time audio-visual behavioural signals
- Reacts to inferred state of user through analysis of behavioural signals from facial expressions, body gestures, and vocal parameters
 - Aims to identify behaviours associated with anxiety, depression, or PTSD.



Case Example

- **SimSensei**
- Aims to combine advantages of traditional web-based self-administered screening (Weisband & Kiesler, 1996), which allows for anonymity, with anthropomorphic interfaces to foster beneficial social effects of face-to-face interaction (Kang & Gratch, 2012)
- Some research found participants reported willingness to disclose, willingness to recommend and general satisfaction with the system (Lucas et al., 2014; Morency et al., 2015)
- Other research found no significant difference in felt rapport (as reported by the users) between face-to-face interactions with another human and the final AI system (DeVault et al., 2014; Morency et al., 2015)

AI Speech Detection

- Speech detection technology on mobile devices has been proposed as part of an immediate crisis intervention tool.
- E.g., smart speakers (Siri, Google home, etc.) could connect people directly to support services if they say certain phrases associated with self-harm.
- However, the ability of these systems to quickly and accurately respond has been criticised.....
 - E.g., reports of a statement about "jumping off a bridge" inadvertently returning directions to a bridge.
- Listens to conversations, in homes or hospital, to automatically call for help when a person is in need of assistance.



Robotics in Mental Health Care

- Socially interactive companion robots to assist those with mental health concerns both in clinical and home settings (known as socially assistive robots).
- They have many sensors to perform certain tasks, which can be used to provide data for clinical decision-making in the same way as smart homes.
- E.g., PARO an interactive robotic seal intended as a socially assistive robot (SAR) (Shibata & Wada, 2011).



Picture sourced from PARO Robots website:
<http://www.parorobots.com/index.asp>

Robotics in Mental Health Care

- For those with autism (Scassellati et al., 2012), various studies have utilised interactive robots to explore aspects such as sensory overload (Dautenhahn et al., 2009) and social engagement deficits (Pioggia et al., 2007).
- Marino et al. (2019): Used a RCT to test the role of a human-assisted social robot as an intervention mediator in a socio-emotional understanding protocol for children with ASDs.
- Children randomly assigned to ten sessions of CBT intervention in a group setting either with or without the assistance of a social robot.
- Pre- and post-intervention assessments were conducted using the Test of Emotional Comprehension (TEC) and the Emotional Lexicon Test (ELT).
- Substantial improvements were found through the use of the human-assisted social robots.

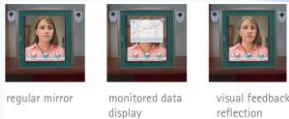


Ambient Persuasive Technology

- Systems embedded within an everyday environment to aid behaviour/lifestyle change (Kaptein et al., 2010).
- Persuasive Mirror (Mattheij, et al., 2015; Nakajima & Lehdonvirta, 2013; Nakajima et al., 2008)
 - Mirror with technology allowing the users to see a simulated reflection or other images.
- Aim = to use psychological concepts such as reward and punishment, positive and negative preferences, and positive reinforcements to amend behaviour.

Ambient Persuasive Technology in Mental Health Care

- Can be configured to provide representational feedback of the user's recent behaviours and create awareness of behaviour consequences – e.g., unhealthy eating habits or smoking (del Valle & Opalach, 2005)


- What about suitability for use with certain types of mental health concerns? – e.g., someone who already experiences hallucinations?
- Is this type of behaviour modification appropriate to begin with?
 - Likely already experience feelings of shame or self deprecation – could trigger or lead to worsening of condition.

Technology and Psychology: Impact of COVID-19

- Additional concerns inflicting those already experiencing clinical conditions
- Psychological impact on the general population
- Need to make use of technology and transfer to remote therapy at rapid pace in order to connect with patients:
 - But implications of this include: digital skills, access to technology, concerns with online safety, difficulty opening-up/building rapport

**Every encounter we have
with technology results in
data being collected – a trace
of our interaction**

**How is (and how could) this
data be used in research and
real-world application?**

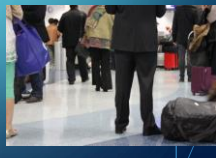
THE IMPACT OF BIG DATA

- Big data: The accumulation and analysis of extremely large datasets.
 - Already used for Health and Administrative Research (e.g., SAIL Databank, Swansea, ADRC-W, Swansea & Cardiff).
 - For policing purposes: Social media, law enforcement datasets, surveillance and tracking technology.
- AI already scans and analyses Twitter and other social media platforms to identify individuals prone to radicalization.



PREDICTIVE POLICING RESEARCH

- Using CCTV from an airport in Zurich, researchers examined whether criminal investigators/police officers of varying experience, and two comparison groups: psychology students and fresh police recruits could spot a bag thief before they committed the crime.
- Findings: The police officers and detectives performed better than students and novice police officers, suggesting people can learn the signs of a thief about to commit a crime.
- CCTV is already effective in *solving* crimes, but this along with an officers experience may help *predict* crime.



Koller, Wetter, and Hofer, (2016)
Applied Cognitive Psychology.

BIG DATA AND PUBLIC SURVEILLANCE

- Facial recognition software and location tracking through smartphones is already being used for monitoring purposes.

According to the 100 year study on AI by Stanford University, "Cities have already begun to deploy AI technologies for public safety and security. By 2030, the typical North American city will rely heavily upon them. These include cameras for surveillance that can detect anomalies."



AI and Big Data in public mental health surveillance

- Reports from high profile criminal activity cases (e.g., mass shootings, terror attacks) suggest culprits had mental health disorders (e.g., paranoid schizophrenia, clinical psychopathy)
- They may have had dealings with the law/criminal record
- Could AI be used to search criminal databases, monitor payment card transactions and identify texts on social media platforms that may be suggestive of a person's intent to carry out a serious crime.

AI and Big Data in public mental health surveillance

- But not everyone with a mental health condition commits a crime
- Not all criminals have a mental health condition
- Justification for removing someone from society before they do something?
- Should everyone's activity be monitored for such signs?
- If so, who and how should this be done?

AI and Big Data in public mental health surveillance

- Same applies to monitoring signs of mental health in general
- E.g., A social media post that suggests a person is depressed.
- Should a pop-up appear on the screen offering them help?
- The assumption underlying all NLP to the recognition of depression through texts is that the language used by the person is indicative of their psychological state.
- Language is indicative of subjective experience
- But it is so complex that it is not simply a mirror of our mind.
- Language is used rhetorically, to manipulate others, and to reflectively examine itself, such as in the case of humour.

BREAK