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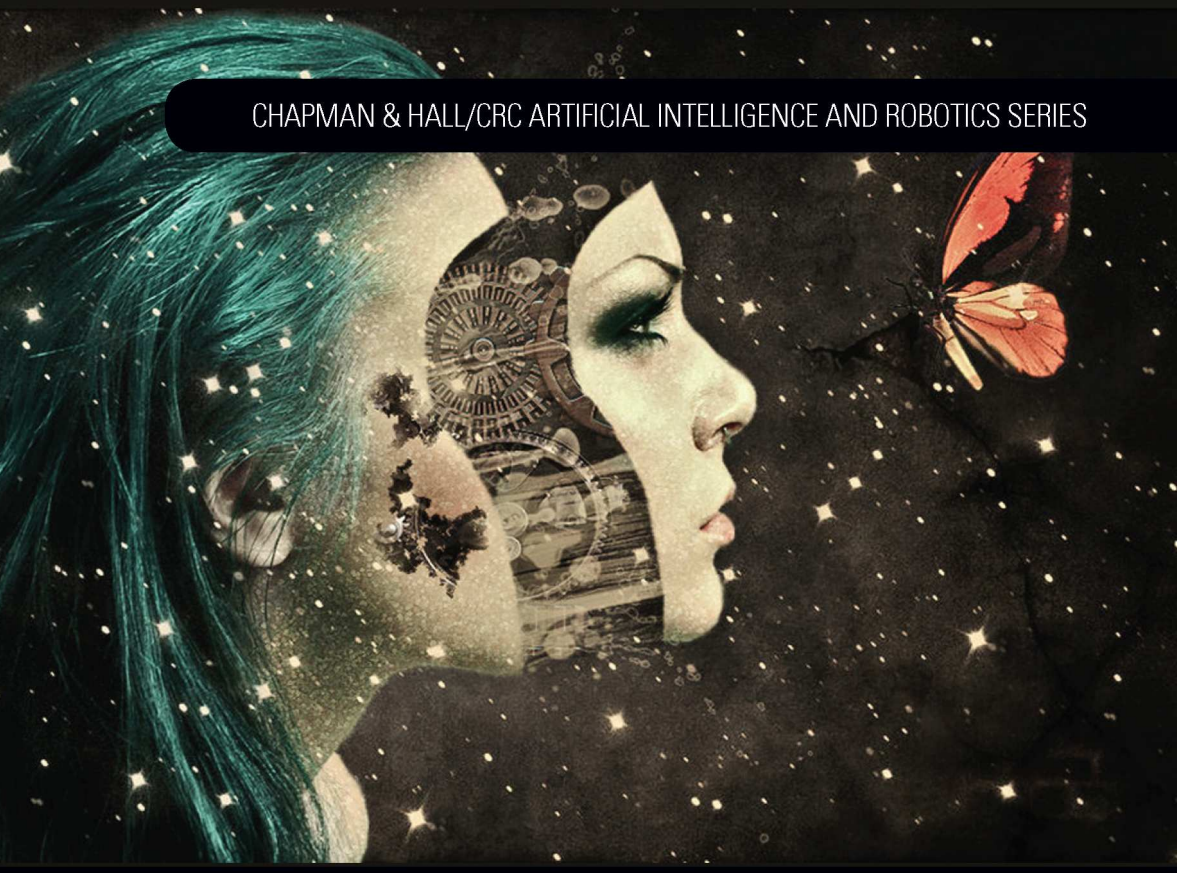

Virtual Humans

Today and Tomorrow

David Burden
Maggi Savin-Baden

CRC Press
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Virtual Humans
Today and Tomorrow

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Suppose that sometimes he found it impossible to tell the difference between the real men and those which had only the shape of men, and had learned by experience that there were only two ways of telling them apart… first, that these automata never answered in word or sign, except by chance, to questions put to them; and second, that though their movements were often more regular and certain than those of the wisest men, yet in many things which they would have to do to imitate us, they failed more disastrously than the greatest fools.

René Descartes
The Philosophical Writings of Descartes: Volume 3, The Correspondence
(Trans. J. Cottingham., R. Soothoff., D. Murdoch., A. Kenny. Cambridge, UK: Cambridge University Press, 1991)

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To our partners, Deborah and John,
the least virtual humans we know.

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Maggi Savin-Baden is Professor of Education at University of Worcester and has researched and evaluated staff and student experience of learning for over 20 years and has gained funding in this area (Leverhulme Trust; JISC; Higher Education Academy; MoD). She has a strong article record of over 50 research articles and 16 books, which reflects her research interests on the impact of innovative learning, digital fluency, cyber-influence, pedagogical agents, qualitative research methods, and problem-based learning. In her spare time, she runs, bakes, climbs, and attempts triathlons.

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Introduction

Virtual Humans are typically seen as human-like characters on a computer screen or speaker with embodied life-like behaviours, which may include speech, emotions, locomotion, gestures and movements of the head, eyes or other parts of an avatar body. At one end of the scale are smart-speaker and virtual assistant systems, such as Siri, Alexa and Cortana, the chatbot-based virtual coaches found in several mobile phone applications and the customer service chatbots which are becoming increasingly prevalent on the Internet. More developed examples include virtual tutors, virtual life coaches, digital twins and virtual personas, and even the non-player characters in some computer games. At the other, more sophisticated, end of the scale are the virtual humans of science fiction, from *Iron Man*'s J.A.R.V.I.S and *Red Dwarf*'s Holly to *Star Trek Voyager*'s Emergency Medical Hologram. All portray themselves as human, and offer differing degrees of human capability, and, indeed, humanness.

This book argues that virtual humans are a phenomenon of the twenty-first century, and while some people have debated their impact on society, few have researched them in-depth. It presents an overview of current developments, research and practice is this area thus far, offering a fair and honest overview of the issues, outlining the risks, not exaggerating the claims but providing evidence and research. It will review current practices at a time when education is changing rapidly with digital, technological advances. It will outline the major challenges faced by today's developers, teachers and researchers, such as the possibility for using virtual humans for teaching, training and practice. The book will situate many of the discussions around related applications with which the general reader may be aware (for example, Siri, Cortana and Alexa, as already mentioned), and draw examples from speculative and science fiction (from *Pygmalion* and *Prometheus*, in classical mythology, to *Battlestar Galactica*, *Her* and Channel 4's *Humans*).

The book is not particularly concerned with the use by physical humans of avatars in, for example, virtual worlds (another use of the term virtual human). However, such situations can put the virtual human and physical human on an equal footing within a virtual environment.

The first section of the book, *Part I: The Landscape,* outlines understandings of virtual humans and begins by providing much needed definitions and a taxonomy of artificial intelligence. This section includes *Chapter 1: What Are Virtual Humans?*, which presents an introductory analysis of the traits which are important when considering virtual humans, argues for a spectrum of virtual human types, and evaluates the common virtual human forms against that spectrum. The second chapter, *Chapter 2: Virtual Humans and Artificial Intelligence*, broadens this discussion by engaging with the issue that there is a range of perspectives about what counts as artificial intelligence (AI) and virtual humans. Thus, this chapter presents a virtual humans/AI landscape and positions the different terms within it, as well as identifying three main challenges within the landscape that need to be overcome to move from today's chatbots and AI to the sort of AI envisaged in the popular imagination and science fiction literature.

The second section of the book, *Part II: Technology*, explores approaches to developing and using relevant technologies, and ways of creating virtual humans. It presents a comprehensive overview of this rapidly developing field. This section begins with *Chapter 3: Body*, which examines the technologies which enable the creation of a virtual body for the virtual human, explores the extent to which current approaches and techniques allow a human body to be modelled realistically as a digital avatar and analyses how the capability might develop over the coming years. The chapter also explores the senses, and examines how human (and other) senses could be created for a virtual human. *Chapter 4: Mind* complements the study of the 'body' and 'senses' in Chapter 3 by examining the different technologies and approaches involved in the creation of the mind or 'brain' of a virtual human. The chapter will consider current research in the areas of perception, emotion, attention and appraisal, decision-making, personality, memory, learning, and meta-cognition, and anticipates the future directions that may develop over the coming decade.

The next chapter, *Chapter 5: Communications*, explores how the senses and abilities created for a virtual human can support language and non-verbal communications. *Chapter 6: Architecture* then reviews some of the leading architectures for creating a virtual human. The range considered will show the breadth of approaches, from those which are theoretical, to

those that have emerged from being engineering-based, to those inspired by neuroscience. The final chapter in the section, *Chapter 7: Embodiment*, begins by examining the current and significant research around the concept of embodiment, and some of the challenges to it. The importance of 'grounding' will also be discussed. The possibilities for the use of virtual worlds to provide that space for embodiment and grounding will then be presented, and its implications for virtual human development assessed. *Chapter 8: Assembling and Assemblages* considers how all the elements considered so far can be used to build a virtual human and describes some of the more common types of virtual human which could be encountered now or in the future. It then uses several different lenses to assess the 'humanness' of such virtual humans, and whether a virtual human needs to be more than the sum of its parts.

Part III: Issues and Futures is the final section of the book, which examines issues such as identity and ways of dealing with the complexities and ethical challenges of these liquid technologies. It also examines possible futures, including digital immortality. It begins with *Chapter 9: Digital Ethics* which explores some of the ethical, moral and social issues and dilemmas which virtual humans introduce. It also examines what it means to undertake ethical research in the context of virtual humans and examines issues, such as technical ethics, design ethics, legal issues and social concerns, including honesty, plausibility and the nature of consent. The next chapter, *Chapter 10: Identity and Agency*, explores the notion of virtual humans from a broad perspective by examining studies into identity and agency in virtual reality, immersive environments and virtual worlds.

Chapter 11: Virtual Humans for Education examines the current and possible future impact that virtual humans could have on education and analyses the potential impact of virtual humans on education in terms of new developments and uses of virtual humans for guiding and supporting learning. Building on the issues of relationships, *Chapter 12: Digital Immortality* explores the emotional, social, financial and business impact that active digital immortality could have on relations, friends, colleagues and institutions. This chapter presents recent developments in the area of digital immortality, explores how such digital immortals might be created and raises challenging issues but also reflects on the ethical concerns presented in Chapter 9. The final chapter, *Chapter 13: Futures and Possibilities*, considers what the impact of virtual humans might be, and what significant related developments might take place, within three successive timeframes: 2018–2030; 2030–2050; and 2050–2100 and beyond. The chapter

then examines how the three main challenges to the developments of virtual humans identified in Chapter 2, namely improving humanness, Artificial General Intelligence (AGI) and Artificial Sentience (AS) might be addressed in order to move from virtual humanoids to 'true' virtual humans, and even virtual sapiens.

This book focusses on the virtual human technologies that are available currently or will be available by 2020. It is not concerned with more speculative concepts, such as brain interfaces and mind uploads, 'evil AIs' and the technological singularity, although some of these will be discussed in Chapter 13. This book is also not concerned with robots, i.e., physical bodies controlled by computer programs. Instead, it is suggested here that any suitably developed virtual human should be able to slip in and out of a robot body in the same way as it might take control of an avatar, and the unique challenges of robotics are fundamentally electro-mechanical ones.

With existing technologies, it is possible to create some form of proto-virtual human, a virtual humanoid which can exhibit some of the characteristics of a physical human, and may even deceive people in some areas, but which, as a holistic digital copy of a physical human, falls short.

However, it is only through starting to build and create virtual humans that are more than simple chatbots or personal assistants that researchers, engineers, ethicists, policymakers and even philosophers will be able to investigate and begin to understand the true challenges and opportunities that the creation of fully realistic and perhaps sentient virtual humans might create. If such virtual humans do become a possibility during this current century, then their impact on human society will be immense.

virtualhumans.ai Website

Supporting material for this book, including links to virtual human images, videos, applications and related work and papers, can be found on the website at www.virtualhumans.ai.

I

The Landscape

INTRODUCTION

Part I sets the bounds to this book. Many similar terms are used for artefacts, which are, to some greater or lesser extent, virtual or digital versions of a physical human. These range from chatbots, conversational agents and autonomous agents to virtual humans and artificial intelligences. There is also a blurring between the digital and physical versions of virtual humans, the latter being represented by robots and androids. Somewhere between the two sit the digital entities which are linked to specific physical platforms such as Siri and Alexa.

Chapter 1 will consider some of these different manifestations of virtual humans and identify a set of traits which can be used separate virtual humans from other software systems, and to compare and contrast different versions of virtual humans. This leads to a working definition of a virtual human and also to the identification of lower-function virtual humans – termed virtual humanoids, and higher function virtual humans, which are the true equivalent of physical humans and have been termed virtual sapiens. The chapter closes with an examination of several key use cases of virtual humans which will be considered throughout the book, namely those of chatbots, conversational agents and pedagogic agents.

Chapter 2 will consider the broader software landscape within which virtual humans exist. In particular, the chapter will look at the landscape of artificial intelligence, which, in the late 2010s, is a term which is being much abused and being applied to everything from data analytics to self-driving cars. This landscape will be used to help place the concepts of virtual humanoids, virtual humans and virtual sapiens, and to identify the three big challenges facing virtual human development. Chapter 2 will conclude by looking at how virtual humans are represented in the popular media – on film, TV, in books, on the radio, in both computer and roleplaying games and even on stage. Whilst science-fiction cannot give much guidance on how to actually build a virtual human, it can help identify what it would be like to live and work with them, highlight moral and ethical issues, and even give some useful insights into possible ontologies and terminology.

CHAPTER 1

What Are Virtual Humans?

INTRODUCTION

Virtual Humans are human-like characters, which may be seen on a computer screen, heard through a speaker, or accessed in some other way. They exhibit human-like behaviours, such as speech, gesture and movement, and might also show other human characteristics, such as emotions, empathy, reasoning, planning, motivation and the development and use of memory. However, a precise definition of what represents a virtual human or even 'artificial intelligence' (AI) is challenging. Likewise, establishing the distinctions between different types of virtual human, such as a chatbot, conversational agent, autonomous agent or pedagogic agent is unclear, as is how virtual humans relate to robots and androids. This chapter presents an introductory analysis of component parts of a virtual human and examines the traits that are important when considering virtual humans. It examines existing definitions of a virtual human before developing a practical working definition, and argues for a spectrum of virtual human types, and presents some common examples of virtual humans.

WHAT IS A VIRTUAL HUMAN

A virtual human is, fundamentally, a computer program. In the far future, it may be something else, but for the foreseeable future, a virtual human is simply code and data which has been designed, and may be evolving, to give the illusion of being human.

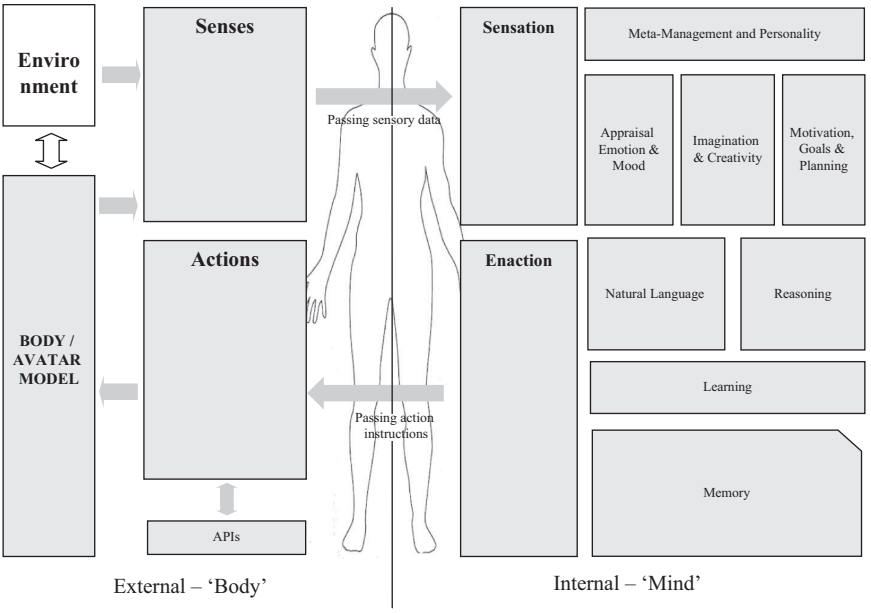

FIGURE 1.1 Elements of a virtual human.

Figure 1.1 provides a very basic schema of the possible elements of a virtual human program and its environment. Not all of these elements would be expected to be present in every virtual human (as will be seen, some are very challenging to implement), and not every element needs to be present to the same degree. The diagram will be developed more fully in Part II and all the component parts considered in some detail.

The main elements are:

- A body, which may be a digital avatar or simply a microphone and speaker or text-chat interface
- A set of senses and the ability to detect sensations
- The ability to appraise sensation triggers and respond to them, including showing emotion and changing mood
- The ability to plan to achieve goals, ideally set by some internal motivation
- The ability to reason and problem solve
- The ability to show imagination and creativity

- The ability to communicate in natural human language
- The ability to learn
- The ability to remember and access memories
- The ability to manage all the above, which may be reflected in a personality
- The ability to enact its decisions through taking actions with its 'body'
- Application Programming Interfaces (APIs) to other systems
- An environment in which to exist and interact with

EXISTING DEFINITIONS OF VIRTUAL HUMAN

There are many definitions of 'virtual human' in the literature, and just a few are considered here. Rickel defines virtual humans as autonomous agents that support face-to face interaction in virtual environments (Rickel et al., 2002). The difficulty with this definition is that it is unclear what an autonomous agent or a virtual environment is, and implies a relatively limited scope of action, and an emphasis on only face-to-face interaction. The definition is more appropriate to a non-player-character within a computer game than recognising the wider and more capable forms that a virtual human could take.

Chatbots.org, a leading hobbyist website on chatbots, identifies 161 different terms for human-like conversational agents (Van Lun, 2011). The website defines virtual humans as automated agents that converse, understand, reason and exhibit emotions. They possess a three-dimensional body and perform tasks through natural language-style dialogues with humans.

This offers a broader range of capabilities for the virtual human, and the explicitness of face-to-face interaction has been replaced by a more general 'natural language' definition and the need to be in a virtual environment has been removed.

Traum defines virtual humans as artificial agents that include both a visual body with a human-like appearance and range of observable behaviours, and a cognitive component that can make decisions and control the behaviours to engage in human-like activities (Traum, 2009).

This definition moves beyond the focus on dialogue and interaction, and highlights that a broader range of human activities and behaviours may be involved.

FROM SELF-DRIVING CAR TO VIRTUAL HUMAN

A useful way to help consider what is and is not a virtual human is to think of a modern self-driving car. Such a car will have sophisticated sensors (senses), complex decision-making algorithms acting on a sub-second basis and dealing with, ostensibly, moral issues, for example, to stay on course and collide or to swerve and risk hitting a mother and baby. It will also have a high level of autonomy within its domain, for example, the 'driver' chooses where to go, but the car chooses the route and is controlling the steering wheel. However, while the car is unlikely to be seen as a virtual human, it may be called intelligent (indeed, this field of research is often known as 'intelligent vehicles'). The question, though, is what happens if the car is given a natural language interface for defining the route and discussing road conditions with speech input and output? It then appears to be more human, but possibly a long way from David Hasselhoff's KITT car in the *Knight Rider* TV series. With the addition of some virtual assistant capability, such as access to your diary and emails, and access to the web and Wikipedia, it begins to be more than just a car, and a lot closer to the KITT model. From there, it would be possible to create a personality, emotion and motivation, along with a head-and-shoulders animated avatar on the pop-up screen in the car so that you have a *Red Dwarf* Holly-like character to whom you can relate and talk. Yet what then changes if an android robot is placed in the driver's seat? It's a purely mechanical device slaved to the car's virtual human-like interface—but there is now not only the issue about whether the car and the character are separate, but also whether the humanness resides in the car or the android. Perhaps, it needs the android to get out of the car and say 'Drive yourself' for us to consider it truly human!

As this example shows, the boundaries between what is and what is not a virtual human are fluid, as is whether it is a good (accurate, effective, useful) or bad (inaccurate, ineffective, useless) virtual human. However, the traits described below should help to identify just how 'virtual human' something is.

THE TRAITS OF A VIRTUAL HUMAN

In defining a virtual human, it is useful to examine the different traits which could be used to differentiate a virtual human from other forms of computer program that may be either showing intelligence or are based on some human characteristic. In some cases, such traits may relate directly to the elements shown in Figure 1.1, but others may be more holistic. The traits considered here, and often presented as dichotomies, are:

- Is it physical or digital?
- Is it manifest in a visual, auditory or textual form?
- Is it embodied or disembodied?
- Is it humanoid or non-humanoid?
- Does it use natural language or command-driven communication?
- Is it autonomous or controlled?
- Is it emotional or unemotional?
- Does it have a personality?
- Can it reason?
- Can it learn?
- Is it imaginative?
- How self-aware is it?

Physical or Digital?

The first of these traits is whether the entity is defined by a physical or digital presence. In much popular literature, for example, replicants in *Blade Runner* or Kryten in *Red Dwarf*, physical androids are considered virtual humans. Whilst possessing a presence in some form of humanoid or non-humanoid physical robot body may well be useful at times to a virtual human, the essence of the virtual human is in its digital form. This is particularly salient when, represented as an avatar within a virtual world, it is able to present itself as just as 'human' as any avatar controlled by a physical human.

It should be noted that many authors refer to software-based virtual humans as 'digital humans' (for example, Jones et al., 2015 and Perry, 2014), but the term 'digital humans' is also used in other areas, such as filmmaking (Turchet et al., 2016) and ergonomic design (Keyvani et al., 2013) to refer only to the creation of the 'body' of the virtual human, and not of any higher functions. Hence, there is a preference in this work for the term 'virtual human'.

Visual, Auditory or Textual?

Having defined the virtual human as essentially a digital construct, it is questionable as to whether it matters how the virtual human is manifest within the digital domain. For example, the virtual human could be

presented as a two-dimensional (2D) head-and-shoulders animated avatar (for example, the Sitepal system – www.sitepal.com), as a three-dimensional (3D) avatar within a virtual world, such as 'Second Life' (www.secondlife.com), as a voice on the phone, home speaker or a Skype call, or as a participant within a text-based chat room. It is argued here that the virtual human should be independent of its digital (or physical) manifestation. Indeed, it is the possibility for fluidity between different forms that could be an important capability for the future. However, in order to be recognised as a virtual human, the entity must have some ability to communicate through one of these, or closely related modes. Yet, even the most basic computer program can have a text interface, so having such interfaces is not a sufficient condition to define a virtual human (Figure 1.2).

Embodied or Disembodied?

Whilst closely linked to the issue of manifestation, there is also the matter of whether the virtual human needs to be embodied, digitally or physically. One belief in cognitive science is that 'intelligence' needs to be embodied (Iida et al., 2004); it needs the sensation, agency and grounding of having a 'body' within a rich and changing environment in order to develop and experience 'intelligence'. Whilst these issues will be discussed in more detail in Chapter 7, there does appear to be a case that an entity which never has some form of embodied manifestation may never be able to become a 'true' virtual human—although it could still be a very smart computer or artificial intellect, a so-called artilect. If being embodied is a requirement of a virtual human, the implication would be that many of the 'virtual human' computers of science fiction (Hal, Orac, J.A.R.V.I.S, Holly) would be better considered as artilects, not virtual humans.

(a) (b)

FIGURE 1.2 (a) 2D and (b) 3D virtual human avatar.

Humanoid or Non-Humanoid?

The next concern is whether the entity has a humanoid form. Myth and popular literature contains numerous examples of humans able to take on animal and other forms, such as lycanthropes and Native American skin-walkers; so just because a virtual human can represent itself as something other than human does not mean that it cannot be a virtual human. If the entity's core personality, default appearance, actions and thought processes are those of a human, then it should be considered as a virtual human. However, if the entity only ever represented itself in a particular animal form in appearance, deed and thought, then it should be termed a virtual animal.

Natural Language or Command-Driven Communication?

A key capability for almost any human is the ability to communicate through 'natural language', be that through voice, signing or other mechanisms. This implies a relatively free-flowing conversation using accepted vocabulary and grammar, and with the ability to track the context of the conversation and make appropriate responses to the utterances of others. Indeed, it is often seen as a sign of mental impairment, whether from mental health problems, such as dementia or a temporary state, like drunkenness, when a person is not able to communicate to this standard. The free-flowing conversation requirement precludes the inclusion systems based on simple command-based exchanges. So, to be considered a virtual human, an entity must be able to do more than merely respond to a set of commands. There are gray areas where commands give way to natural language. Entities such as Siri and Alexa could readily be thought of as virtual humans despite their natural language conversational ability being limited, since the natural, human, inclination towards anthropomorphism can readily see them as 'human'. The Turing Test (Turing, 1950), and related Loebner Prize (Floridi et al., 2009), which will be discussed in more detail in Chapter 2, have become useful ways of evaluating the natural language conversational ability of chatbots. Yet, it is unlikely that having a good natural language capability, as in a good chatbot, is a sufficient condition for being a virtual human, although it may well be a necessary one.

Autonomous or Controlled?

Despite some of the current philosophical and neurological debates about freewill (for example, Caruso, 2013), it is generally accepted that a human has autonomy for most practical purposes, although such autonomy is

limited by laws and social, moral, and ethical frameworks. A true virtual human should also therefore be expected to have a similar degree of autonomy and be bound by similar frameworks. Whilst a virtual human may not initially exhibit the same level of autonomy as a physical human, its level of autonomy should still be extensive within the scope of its coding.

A further consideration is how much intrinsic motivation the virtual human possesses. Autonomy often exists within a well-defined set of tasks, for instance, a self-driving car choosing a route and then a more complex set of second-by-second decisions over speed and direction, based on a rapidly evolving and complex environment, need to be made. Once the journey is completed, the car just waits for its next command or possibly drives itself off home to its garage to recharge. A true virtual human, though, should always be operating in a relatively autonomous way. Once it finishes one task, it needs to decide on its next one. Such decisions should be driven by a set of long-term goals, by motivation, as they are in physical humans.

Emotional or Unemotional?

Demonstrating and responding to emotions is certainly seen in popular culture as being evidence of humanity (for example, the Voight-Kampff test in *Blade Runner*), and the lack of emotions is often taken as an indication of a disturbed or even psychotic personality. Certainly, within the literature (for example, Mell, 2015; Mykoniatis, 2014), the ability for a virtual human to be able to show and respond to emotions is seen as an important feature. One of the key questions is to what extent the virtual human is 'faking it' – does it 'feel' emotion or empathy – or is it just exhibiting the features and responses that we associate with those traits? Often, though, it is the emotional response of the human party to the virtual human's condition that can be just as important (for example, Bouchard et al., 2013). So, if an emotional reaction is elicited in a physical human to a virtual human showing emotion, then do the mechanisms through which that emotion was generated matter? Since surely almost any emotion portrayed on stage or in film is artificial as well?

Presence of a Personality?

In considering the possible traits of a virtual human, the word 'personality' is often used. Personality can be defined in a variety of ways, and personality theories include: dispositional (trait) perspective, psychodynamic, humanistic, biological, behaviourist, evolutionary and those based on

social learning. This suggests that a virtual human should also appear to behave, feel and think in a unique and individual way, not identical to any other virtual human (except, possibly, clones of itself) or even to any other physical human. If the virtual human does not show a unique personality, or indeed any personality, then it is possibly not worthy of the term. However, there is again the danger of anthropomorphism, people will quite readily attribute personalities to very obviously non-human objects, from cars to printers, and it is important to be cautious about whether any perceived personality is just being implied by the observer or is actually present within the system.

Ability to Reason?

Reasoning here is used to refer to the ability to accept a set of inputs and make a sensible decision based on them. Reasoning can include theories about moral reasoning, as suggested by Kohlberg (1984), as well as models of novice to expert reasoning used in professional education (Benner, 1984). Reasoning is also taken here as including problem-solving, which is a more constrained version of the reasoning ability. At its lowest level within a virtual human, the reasoning may be as simple as identifying that if a website customer has enquired about lighting, then they should be shown all the desks, tables and floor lamps in stock. In a more developed virtual human, it would be expected that the reasoning capability is beginning to match that of a human – in other words, given the same inputs, it will make a similar decision to a human, even though the number of factors, or their relation to the output, might be more complex, or there may be high degrees of uncertainty involved, so called fuzzy or even wicked problems.

Can It Learn?

One common definition of an intelligent system is that of having the capacity to learn how to deal with new situations (Sternberg et al., 1981). Intelligence is not so much about having the facts and knowledge to answer questions (a more popular view of what intelligence is), but rather an adaptive ability to cope with new situations, often by applying patterns and knowledge (reason) previously acquired. As such, the ability to learn (in a whole variety of different ways and applied to a whole variety of different situations) must be an important trait for a virtual human.

One of the ultimate goals of AI research is so-called Artificial General Intelligence (discussed in more detail in Chapter 13), a computer system that exhibits a very generalized and human form of such learning and

adaptability. For current practical purposes, it could be expected that a virtual human would show some ability to learn and adapt within the scope of its programming.

Is It Imaginative?

As will be discussed in Chapter 4, there are a lot of computer programs which demonstrate creativity, using parametrics, neural networks, genetic algorithms or other approaches to create pieces of music, paintings, poems or other works of art. There is, however, a difference between creativity and imagination. The imagination trait is more about an internal ability to visualise something, something which may not exist or at least has not been sensed, and perhaps to take an existing trope and change its parameters to create a whole new experience. The 'creative' element is then more about taking this piece of imagination and using craft, skills and 'creativity' to make it manifest and bring it into the social domain. So, the important trait is probably that of imagination, with creativity coming from combining imagination with other traits, such as reasoning (what colour where) and learning (how did I do this last time).

Sentient or Non-Sentient?

In common discourse, sentience can be viewed as an equivalence of 'thinking': Does the machine have a cognitive function? Is it sentient? There is also some potential overlap with free will and autonomy. A further definition of sentience aligns it with consciousness, but defining that is similarly fraught with problems. Indeed, the question of what consciousness means in terms of the way that we have subjective, phenomenal experiences is often described as the 'hard problem'. Such consciousness implies some form of self-awareness and internal narrative, for example Nagel's 'What Is It Like to Be a Bat?' (Nagel, 1974). Achieving sentience using current technologies is beyond the present capabilities for a virtual human. However, an aspiration to develop some form of internal self-awareness and internal narrative and dialogue would seem to be desirable, and whether that results in, or can enable, some form of true sentience is probably a key philosophical and research question for our times.

DEMONSTRATING INTELLIGENCE?

It should be noted that in the 10 traits above, 'intelligence' has been deliberately omitted. There is no real agreement as to what an 'intelligent' system is, just as there is no agreement about what counts as human intelligence.

Intelligence has been defined as everything from logic to leadership, and from emotional knowledge to problem solving. Indeed Legg and Hutter (2007) list 71 definitions for 'intelligence' and 'artificial intelligence'. What are taken as indicators of intelligence are considered to be well enough covered by a combination of the other traits, particularly learning and reasoning.

A VIRTUAL HUMAN PROFILE

In Figure 1.3, the 10 traits that have been described above are represented graphically. A high rating for a trait would be marked by a point towards the outer edge of the decagon, and a low rating towards the centre. Joining each point by a line (as shown in Figures 1.4 and 1.5) then provides a radar-plot or spider-diagram style profile for a particular instance or type of virtual human. It should be noted, though, that some traits need to be far more developed than others to be treated as some form of virtual human. For instance, an entity with even a relatively low level of personality, natural-language or emotion is more likely to be taken as a virtual human than one with a very high degree of reasoning or learning ability but which does not show any of the other traits. Almost any level of self-awareness would also put an entity well on the way to being thought of as a virtual human.

It should also be noted that the 'digital or physical' trait described earlier has not been added to the chart as: (a) it is a very binary trait – the

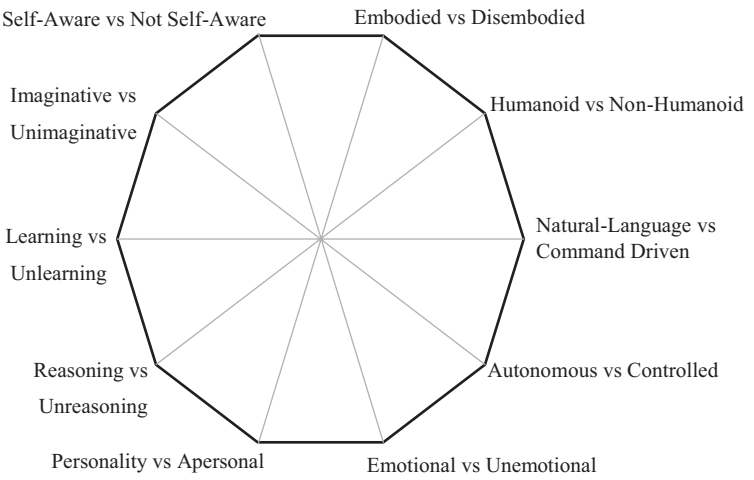

FIGURE 1.3 Traits of virtual humans.

entity is either presenting as pixels on a screen or as a lump of metal or organic material, (b) in defining virtual humans, their digital nature has already been asserted, and (c) any developed virtual human would be able to move in and out of (or rather commandeer) a physical representation, as required.

Just from the examples discussed so far, it is clear that the term 'virtual human' could represent a wide spectrum of capabilities. In its most typical manifestation, a virtual human:

- Manifests itself in a visual, auditory, textual or similar form,
- May have some embodiment within a virtual world,
- Presents itself as primarily humanoid in manifestation and behaviour,
- Will have a natural language capability,
- May exhibit a degree of autonomy,
- May have an ability to express, recognise and respond to emotions,
- May exhibit some aspects of a personality,
- May have some ability to reason in a human-like way,
- May, possibly, exhibit some elements of imagination, and
- May even have a self-narrative, but is unlikely to have any indications of sentience.

VIRTUAL HUMANOIDS AND VIRTUAL SAPIENS

To aid later analysis, it is perhaps useful to define terms for virtual humans which are biased to the simpler or more complex ends of the spectrum, so that there is a clearer understanding of what is being discussed. Two new terms are proposed.

At the lower, less functional, end of the spectrum is the 'virtual humanoid'. This could be defined as a digital entity which:

- Can manifest itself in a visual, auditory, textual or similar form,
- Need not have any sense of embodiment within a virtual or physical world,
- Is primarily humanoid in manifestation and behaviour,

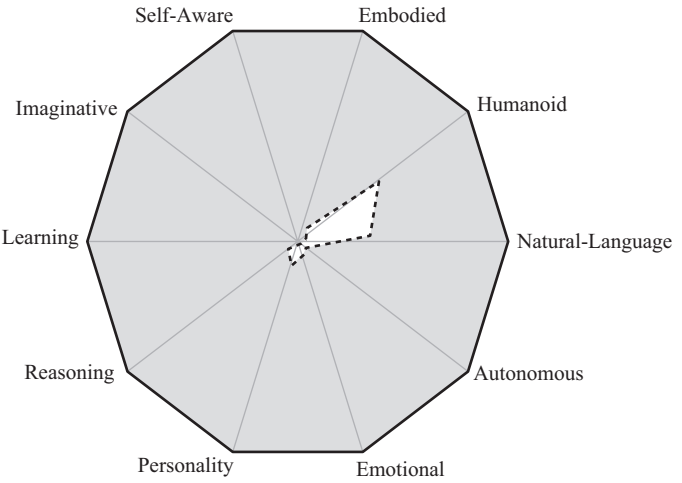

FIGURE 1.4 Profiles of virtual humanoids (dashed line), virtual sapiens (solid line – effectively the complete edge of the decagon) and virtual humans (the shaded space in between).

- Can respond to commands, but does not have to exhibit a developed natural language capability,
- Does not need to exhibit any autonomy,
- Does not need to express or recognise emotion,
- Does not need to exhibit a (unique) personality – most of its personality being implied by anthropomorphism,
- Does not need to show any significant ability to reason,
- Does not need to show any imagination, and
- Does not need to have any indications of internal narrative or sentience.

At the upper (most developed) end is the 'virtual sapien', a digital entity which:

- Can manifest itself in a visual, auditory, textual or similar form,
- Will have embodiment within a virtual or physical world,
- Is primarily humanoid in manifestation and behaviour,

- Has a highly developed natural language capability,
- Exhibits a high degree of autonomy and intrinsic motivation,
- Can express, recognize and respond to emotions,
- Exhibits a unique personality,
- Can reason in a human-like way,
- Exhibits elements of the use of imagination, and
- Has self-awareness and may have some indications of sentience.

The two new definitions are shown as profiles in Figure 1.4, with virtual human as the more overarching term.

It should be noted that the lines between a virtual humanoid, virtual humans (the all-embracing term), and virtual sapiens are significantly blurred, and on many measures, it is a matter of degree rather than of absolutes.

TOWARDS A WORKING DEFINITION

Whilst such graphics as Figures 1.3 and 1.4 can be valuable tools, it is also useful to have a simple working definition of what a virtual human is. The consideration of personality above – thinking, feeling, and behaving in an individual way – certainly goes some way to providing a more concise working definition:

> *A virtual human is a digital entity (or perhaps, more generally, a program, algorithm or even a process) which (looks) thinks, feels and behaves like a human.*

On this basis, a virtual humanoid could be considered as a digital entity which just looks and, to a certain extent, behaves like a human, whilst virtual sapiens is a digital entity which could pass for a human in an extended unrestricted evaluation.

There is indeed a very strong temptation to choose a behaviouristic definition of a virtual human, typified, perhaps, by Turing's original 'imitation game' (Turing, 1950). Behaviourist definitions have, though, been frequently challenged (for example, Searle, 2014), and Chalmer's arguments about philosophical zombies (Chalmers, 1996) explore similar issues.

So, perhaps, more useful working definitions are:

- *Virtual Humanoids* – Simple virtual humans which present, to a limited degree, as human and which may reflect, in a limited way, some of the behaviour, emotion, thinking, autonomy and interaction of a physical human.
- *Virtual Humans* – Software programs which present as human, and which may have behaviour, emotion, thinking, autonomy and interaction modelled on physical human capabilities.
- *Virtual Sapiens* – Sophisticated virtual humans which achieve similar levels of presentation, behaviour, emotion, thinking, autonomy, interaction, self-awareness and internal narrative to a physical human.

Note: The term digital entity has been used above, but perhaps a stricter and more general definition would be an informational entity, as it then avoids the limitation on form that 'digital' (and also program) could imply—for example, ruling out some biological possibilities and even intelligent windows, as in *Permutation City* (Egan, 1994). The term 'infomorph' (Muzyka, 2013) has been used for such an informational entity. The term 'artilect', introduced earlier, would then represent a relatively well developed infomorph.

EXAMPLES OF VIRTUAL HUMANS

Having set the scope for what represents a virtual human, it is useful to look at some examples of virtual humans placed more at the virtual humanoid end of the spectrum, which can be encountered in today's world. It is also helpful to consider how the terms used for them, such as chatbots, autonomous agents, conversational agents and pedagogical agents, should be understood against the definitions and profiles developed above. Further examples will be considered in Chapter 8.

Chatbots

Chatbots is a generic term for describing a piece of software that mimics human conversation. It emphasises the conversational capability but says nothing about any other elements of the virtual human. A system like Siri or Alexa that does not really engage in conversation is probably not even a chatbot, rather being a question-answering or

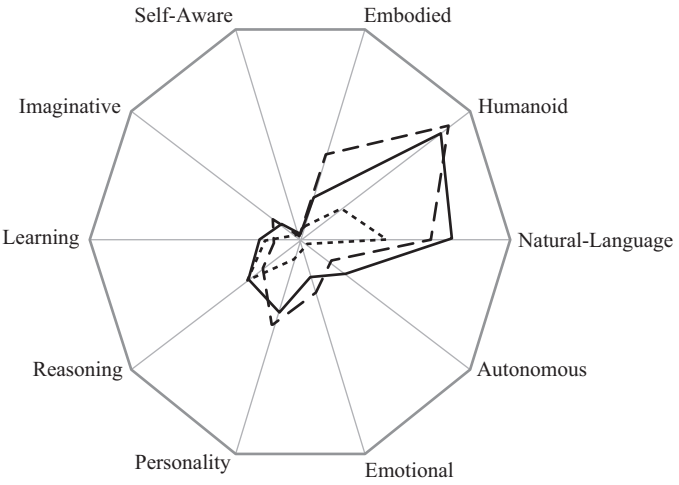

FIGURE 1.5 Mapping current virtual human types: chatbots (dashed), conversational agents (dotted), and pedagogical agents (solid).

command-taking system, but would fit within the virtual humanoid definition. Importantly, the term chatbot does not imply anything about sentience or intelligence, it is just a system attempting to mimic human conversation.

Chatbots can be thought of as rudimentary pieces of software that aim to create the illusion of a human. They rely on a pre-existing corpus of information that is used to respond to human questions and stimuli. Basic chatbots do not have the ability to identify the progressions of a conversation, nor to adapt responses based on previous answers given by the chatbot or as input by the human user, and nor may they aim to assist in the completion in any particular task. A simple chatbot aims to identify each human input (through pattern matching or keyword searching) and respond with the appropriate answer retrieved from a store of responses with little processing of context. Examples of this kind of chatbot can be found incorporated into toys, such as 'Hello Barbie' (Rhodan, 2015), which allows children to have pseudo conversations with a doll.

Autonomous Agents

Autonomous agent is a very broad term that has been used for well-developed chatbots, with elements of the virtual human (Bogdanovych, 2005), for massively replicated software entities running in a crowd

simulation (Pelechano et al., 2007), and for software programs carrying out very specific but autonomous tasks—for example, stock trading (Subramanian et al., 2006). As such, the use of the term in relation to virtual humans is perhaps best avoided.

Conversational Agents

Conversational agents (Cassell, 2000) are virtual humans whose task is to provide a conversational interface to a particular application, rather than through command line instructions or the clicking of icons or menu items, for tasks ranging from making travel bookings and buying furniture to interrogating sales and marketing data.

These 'agents' can be represented textually, orally or in conjunction with an avatar (or all three), and, like chatbots, may also exhibit some of the behaviours and characteristics of humans, such as speech, locomotion, gestures and movements of the head, eye or other parts of the body (Dehn and Van Mulken, 2000). However, their role goes beyond simply maintaining a conversation with no particular goal. The level of sophistication of these types of agent can thus determine their utility within differing contexts.

Across the services, manufacturing and raw materials sectors of industry, conversational agents have been used to increase the usability of devices and as methods to assist the retrieval of information. For example, numerous websites have utilised agents as virtual online assistants to improve access to information, such as 'Anna' on the Ikea website or the shopping assistants from H&M or Sephora accessed through the KiK service (KiK Interactive Inc., 2016).

Similarly, smartphone and tablet interfaces now include options to use personal assistant applications such as 'Siri', 'Cortana' or 'Google Now' to assist users in searching for information, starting applications and performing routine tasks, such as sending messages. Other software, such as Amazon's 'Alexa', incorporated into their 'Echo' device, allow the control of various household smart devices such as fridges and heating systems. These agents, while being helpful, do not necessarily have a high level of contextual awareness, and so, whilst being effective at assisting with simple tasks, such as information retrieval or acting on simple commands (for example, Alexa), agents are not always positioned to provide guidance.

Conversational agents are likely to possess a defined goal and set of capabilities. Granting them additional open-ended conversational

capabilities, emotions or motivations could be counterproductive for such agents in achieving their goal, and, therefore, damaging to their owner. Most conversational agents are towards the lower end of the virtual humans' spectrum, although they may have well-developed natural language capabilities; they are invariably, but not exclusively, more task orientated than chatbots.

Pedagogical Agents

Virtual humans used in education are more commonly referred to as pedagogical agents, or sometimes more narrowly, as virtual tutors. The function of pedagogical agents is to aid learners during the learning process. These agents aim to support learners by providing easier access to relevant information and to improve motivation (for example, Bowman, 2012; Schroeder and Adesope, 2014). As will be discussed later in this book, the sophistication of an agent dictates its role and the types of interactions achievable with humans.

The literature presents a number of examples of pedagogical agents that have been used successfully in learning and educational contexts. However, these have been predominantly focused on agents that may not have an understanding of dialogue or of the progression of conversations between the individual and the agent. Hasler, Touchman and Friedman (2013) found that in a comparison of human interviewees with virtual world pedagogical agents (in non-learning situations), pedagogical agents and human interviewees were equally successful in collecting information about their participants' real-life backgrounds. Pedagogical agents, being neither human interviewees nor text-based surveys, therefore pose an interesting opportunity for the educator seeking to facilitate student discussion.

Virtual Mentors

Virtual Humans can have varying levels of perceived understanding of any topic, which can be adequate for low level tasks, such as helping to access databases of knowledge. However, a deeper understanding of the content of any discussion between user and virtual human, combined with increased personalisation options, can allow the virtual human to act as a mentor and provide guidance, rather than merely simple access to information. There are many examples of such virtual mentors, particularly in the mobile space (where the interaction can seem particularly intimate and personal) including Wysa (https://www.wysa.io/) and Woebot (https://woebot.io/).

Figure 1.5 shows how some of these examples map onto the virtual human profile.

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING AND VIRTUAL HUMANS

There does appear to be a current tendency to attribute any 'clever' computer algorithm to be an example of artificial intelligence. It was IBM's success with Watson in the Jeopardy challenge in 2011 that appears to have started this trend. In popular literature, an AI is usually taken to mean a high-functioning virtual human or other software entity, with signs of sentience – referred to here as 'virtual sapiens'. Media and press reports often suggest that AI is more developed than it actually is, and it is important to be able to distinguish between clever algorithms, some form of well-developed virtual human, virtual sapiens and what might be, ultimately, termed as an artificial sentience This will be considered in more detail in Chapter 2.

Discussions around artificial intelligence often bring in the concept of machine learning and, in particular, neural networks. Machine learning is defined here as a computer system that can learn to make decisions based on the examination of past inputs and results, so that its future decisions optimise some parameter, such as recognising faces in photographs. Whilst a machine learning system could well be *part* of a virtual human, it is certainly insufficient to be a complete one. If the term 'machine learning' is actually used to mean a neural network-based system, then it is probably not a necessary one either.

CONCLUSION

This chapter has sought to establish the bounds of what is meant by a virtual human and identify some key traits which can be used to identify the differing forms and capabilities of virtual humans. A key point is that a virtual human operates primarily within the digital domain, although it may sometimes have access to a robot body. The term virtual humanoid has been introduced for a low-functioning virtual human (more akin to simple chatbots and conversational agents), and the term virtual sapiens for the highest level of virtual humans that show signs of self-awareness and 'sentience'. Examples of virtual humans in the forms of chatbots, conversational agents, pedagogic agents and virtual mentors have been described.

In Chapter 2, the relationship between virtual humans and 'artificial intelligence' will be explored in more detail, and the ways in which virtual humans have been portrayed in the media and arts will be surveyed to help better understand the public perception of virtual humans.

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