Information technology in a global society
Case study: A Doll Called Alicia

For use in May and November 2018

Instructions to candidates

- Case study booklet required for higher level paper 3 information technology in a global society examinations.

Foreword

The ITGS case study, *A Doll Called Alicia*, is the stimulus material for the research investigation required for May and November 2018 higher level paper 3. All of the work related to the case study should reflect the integrated approach explained on pages 15–17 of the ITGS guide.

Candidates should consider *A Doll Called Alicia* with respect to:
•   relevant IT systems in a social context
•   both local and global areas of impact
•   social and ethical impacts on individuals and societies
•   current challenges and solutions
•   future developments.

Candidates are expected to research real-life situations similar to *A Doll Called Alicia* and relate their findings to first-hand experiences wherever possible. Information may be collected through a range of activities: secondary and primary research, field trips, guest speakers, personal interviews and email correspondence.

Responses to examination questions **must** reflect the synthesis of knowledge and experiences that the candidates have gained from their investigations. In some instances, additional information may be provided in examination questions to allow candidates to generate new ideas.

[Source: © International Baccalaureate Organization 2018]

Overview

Margaret Zepher is the founder and chief executive officer (CEO) of *MAGS*, a large IT software company. As a computer professional, Margaret's ultimate goal is to develop ethical software solutions that can be used to enhance people's lives, but as the CEO of *MAGS* she is also
5   required to develop products that are going to be profitable.

MAGS offers a suite of cloud-based software services for communication, collaboration and office productivity, which can be used on a range of devices from cellphones to desktop computers. However, Margaret sees that incorporating recent advances in artificial intelligence (AI) into its software would allow *MAGS* to gain greater penetration into its
10   existing markets and diversify into new ones.

AI developments

Margaret has studied various uses of AI, such as natural language processing in smartphone tools like Siri and Cortana, voice recognition in chatbots and helpdesk systems, subtitles for films, and language translators such as Google Translate. She has also looked at AI-based
15   pattern recognition that is being used in various applications, such as handwriting recognition, image recognition and face recognition. Margaret can see great potential in this evolving technology.

Margaret recognizes that these products, which are based on machine learning, have had varying levels of success and believes future developments will focus on the use of deep
20   learning and emotional artificial intelligence (see **Figure 1**).

**Figure 1: The timeline of artificial intelligence, machine learning and
deep learning**
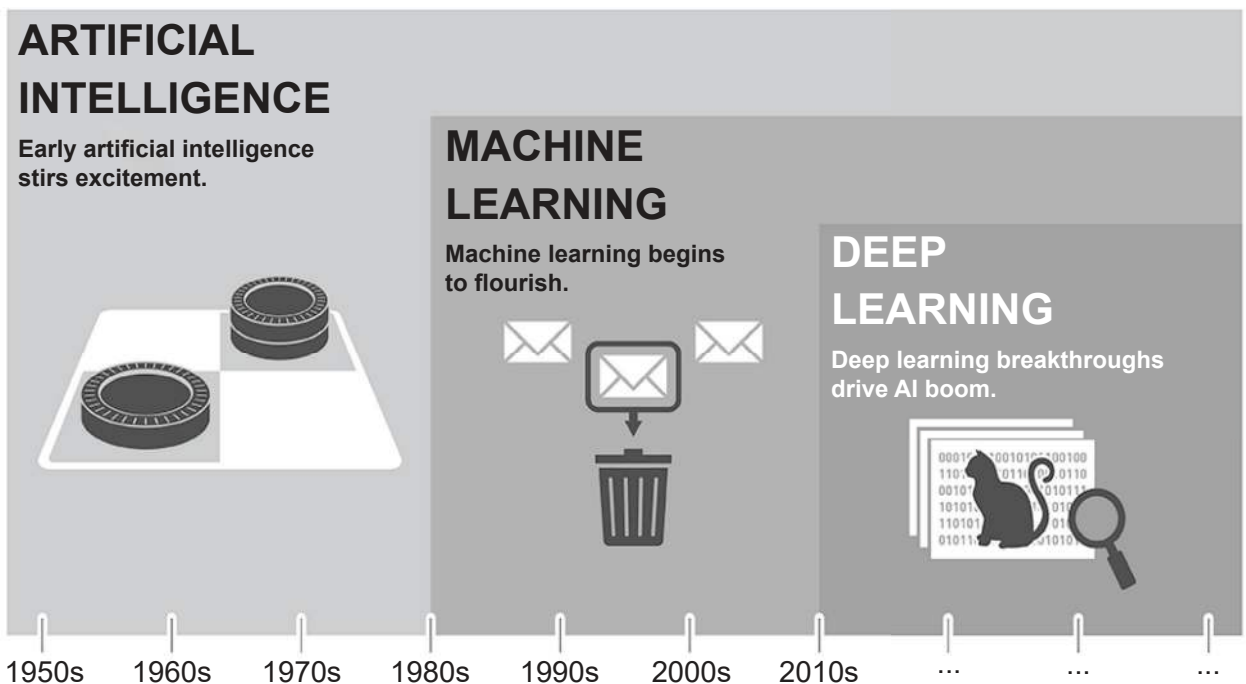
[Source: www.blogs.nvidia.com]

Current situation

Margaret has been following the news, and in recent years has seen that other companies are developing robotic toys with consumer-grade artificial intelligence. Remembering her favourite childhood doll, Margaret can see the potential of a doll that would use cloud-based AI software
25   to provide features that can be personalized to the child that uses it. As a first step Margaret intends, in partnership with a toy manufacturer *Vellieplay*, to develop a doll called Alicia with embedded AI software that is linked to the cloud. The doll would learn to respond to the child and could eventually become the child's companion. In the future, the AI software will not just be limited to the doll, but will be further developed for use in *MAGS*'s other products, as well as
30   in products developed by other companies.

Margaret has a trusted team of experts within *MAGS* and will work with them to develop Alicia. The team members and their responsibilities are outlined below:
- Nia Clifford, the chief legal officer (CLO), who advises on any legal implications that may arise from the use of *MAGS*'s products.
35   - Sonia Oliver, the business development officer (BDO), who oversees the business strategy and ensures that the products developed are well designed and are marketable.
- Mark Danbung, the chief technical officer (CTO), who oversees the technological side of product development. He will need to set up a specialized AI department in addition to the other teams he manages.

40 **The first meeting**

At the team's first meeting, Mark introduced the key AI concepts. There was a long discussion, as everybody seemed to have a slightly different understanding of these key concepts, but eventually the team agreed on the working definitions below. These working definitions will be used in this case study.
45   - **Machine learning** uses a supervised environment to teach the computer and requires human intervention. For example, for image recognition the computer would receive feedback from humans to confirm that the image was identified correctly.
- **Deep learning** is an advanced form of artificial intelligence, where computers are able to automatically collect feedback from the results of their processing and improve their
50   performance by using this to refine the algorithms they use. Deep learning occurs in an unsupervised environment with no human intervention.
- **Neural networks** are used by deep learning. They aim to mimic the way that the human brain processes raw data into meaningful information so that it can learn more effectively. This is particularly useful when incomplete data is available and the software needs to use
55   deep learning techniques to provide **pattern recognition**.

Margaret's plan to work in partnership with *Vellieplay* to develop Alicia by embedding AI into a version of *Vellieplay*'s top-selling doll was approved at the meeting. It was anticipated that Alicia would be launched in December 2019.

Alicia will be able to remember previous conversations, such as whether the child has brothers
60   and sisters or when they last played together. These interactions will be sent to the cloud and will be used by deep learning to "train" the AI algorithms. For example, Margaret hopes that eventually the AI software in Alicia will be able to recognize when the child is upset, rather than playful, and adopt a more nurturing or soothing response that would be appropriate to the child's needs at that time.

65 Training and operation

At the meeting, Mark presented a sketch of his initial ideas on how deep learning would work in Alicia (see **Figure 2**). He will need to carry out further research in order to devise an implementation plan that will meet his deadline of December 2019.

Figure 2: The relationship between machine learning and deep learning in Alicia
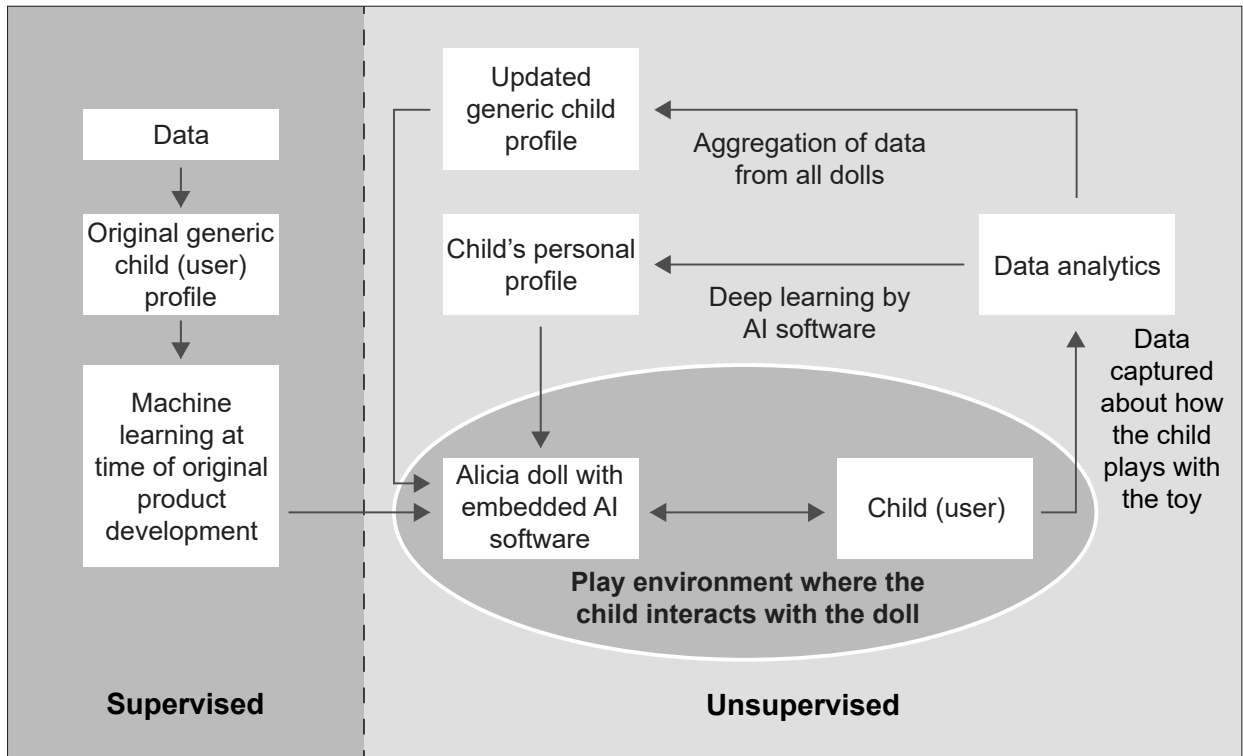
[Source: © International Baccalaureate Organization 2018]

Alicia will start with a generic profile, based on data collected in the supervised environment,
70 which can be customized according to the child's age, gender, nationality and mother tongue. This data will consist of the records of the behaviour of a wide variety of children that researchers have already collected, and will be expanded over time with the records of the children who interact with the doll.

During the "training" of Alicia, the deep learning AI software, containing natural language
75 processing, pattern recognition for vision and emotional AI, will learn by being presented with a variety of situations. It will detect environmental factors, such as location and the time of day, as well as the nature of the child's verbal and non-verbal communication, so that it can make the most appropriate response.

All of the child's interactions with Alicia will be recorded and uploaded onto the cloud-based
80 AI servers, where they will be used in the further training of the deep learning AI software in the unsupervised environment. These interactions with Alicia will have two purposes: the first purpose is to create and update the child's digital profile, and the second is to aggregate the data from all of the Alicia dolls sold in order to update the generic profile that will be provided with new Alicia dolls. This could lead to a greater range of profiles for future dolls, which could
85 shorten the time it would take to train Alicia.

Turn over

Each Alicia doll will therefore become personalized to the child, with a configuration based on the child's interactions with the doll. This will mean that different dolls will react differently to similar patterns of behaviour displayed by different children.

90   If the AI software within the doll itself cannot determine an appropriate response to the child's behaviour, the doll will link to the AI software in the cloud, transfer the data associated with the behaviour to the cloud and wait for it to be processed by the cloud-based AI software. The cloud-based software will then send an appropriate response back to the doll, which will be used to interact with the child. The response will then be added to the digital profile within the child's Alicia doll.

95   When Alicia is not connected to the cloud, she will behave according to her most recent profile. The child's profile will remain the same until a connection to the cloud can be re-established. Once this connection is re-established, the interactions that were recorded while offline will be uploaded and will train the deep learning AI, and this will then be used to update the child's profile.

100 **Other considerations**

Margaret is aware that the increasing personalization of these services will require the collection of a significant amount of personal data from children. Sonia can see the potential commercial opportunities that sharing the data collected by her company could provide. In contrast, Nia is acutely aware that adequate security measures will be needed to protect the individual profiles
105 of the children – on both the servers and in the dolls themselves – because much of this data would be highly sensitive.

Margaret is keen for any of the data collected by *MAGS* to be used ethically, and she is also concerned that many companies lack openness about how they share their customer's data. Margaret feels that she is entering into a relationship with a customer when they buy an Alicia
110 doll, and that she should therefore act in that customer's best interests.

When Margaret raised these concerns at the first meeting, Mark explained the need for standard data formats and protocols to ensure the correct storage and transmission of the data between the cloud and Alicia. He also reminded her that some countries have privacy laws that give users the right to access and inspect any data stored about them. When he started
115 to talk about converting data into standard format and secure transmission protocols, Margaret realised that this would need to be looked at in more detail once the ideas for Alicia were more concrete.

Margaret is confident that Alicia will prove to be a success, and Sonia can see that there are other potential uses for AI that would benefit a variety of users. For example, AI could be used
120 in an assistive or adaptive capacity to help an elderly user, or someone with a particular learning need, where it would supply the appropriate response to the situations they encounter.

Challenges faced

After the first meeting, each member of the team conducted further research. A second meeting between Margaret, Nia, Sonia and Mark was held to plan a way forward. Yasmin Bruce, a child
125 psychologist, was also invited to the meeting. In this meeting a number of challenges were identified:

Technical challenges

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- Mark wants to ensure that the AI software is compatible with future developments and standards, and can also be easily adapted for use with other products from *MAGS* and other companies.
- Mark is concerned about the December 2019 deadline and whether there is adequate time to develop and test effective deep learning algorithms. To expedite the process, he is considering whether to hire experts from other companies, to buy AI software from other companies, or even whether to buy the companies themselves.

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- Yasmin wants to ensure that Alicia learns to develop an appropriate relationship with the child. Mark wants to monitor the different ways in which the product could adapt itself. He believes it will be necessary to put limits on its learned behaviour. He questions how far Alicia should be able to evolve from the generic behavioural profile. He needs to think about how to handle behaviour from Alicia that may be considered to be beyond the "norm", or is

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aggressive or inappropriate.
- Mark is aware of the need to develop a more sophisticated Human–Computer Interaction (HCI) for Alicia that goes beyond the initial market. With greater global customization, this would mean accommodating different cultural norms, as well as a range of languages, dialects and colloquial words or phrases.

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- Mark is concerned about the security of the data being transferred between Alicia and the cloud, and has asked his team to investigate encryption techniques. He has also asked his team to investigate appropriate levels of access for the children and their parents.
- Yasmin knows that adapting the doll's shape and face to make it more human-like to enhance its role as a companion would need to be considered. Robotic research has shown

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that there is an issue with the degree of humanization that humans can cope with. This is referred to as the "uncanny valley".

Ethical challenges

- Data collected from the child's interactions with Alicia is stored in a profile so that Alicia can be personalized to the individual needs of the child. Margaret wants to ensure the privacy of

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the child, and has asked Nia to investigate the degree to which data privacy and protection principles would apply to data that is collected as a result of the child's interactions with Alicia.
- Sonia wants to share the data with third parties for educational purposes and advertising campaigns, whereas Margaret wants to ethically manage the data associated with the

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children's profiles and assure parents that their child's data profile will not be misused.
- In the medium term there will be the potential to add messages and games from third parties into Alicia's responses. However these third parties may request additional personal data from *MAGS* so that they can personalize the information they provide.
- Nia suggests that the parents of some children are likely to be concerned that collecting data

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from the interactions between their child and Alicia is not appropriate at all, and should not be shared under any circumstances.

Social challenges

- Sonia is concerned that Alicia will not be as intuitive to the child's needs in the first few weeks after purchase, and may not respond in the way that the child would want. Until the AI has

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learned about the child's preferences there is a chance that the child will not interact well with Alicia and the doll will be discarded.

- Yasmin is concerned that the child's behaviour may change as a result of its interactions with Alicia. Over time, the child could become over-reliant on Alicia, and in more extreme cases Alicia could take the place of the child's existing [human] friends. She is concerned

175   that some children may become so involved with Alicia that they lose their ability to think independently and critically. In effect, they may lose their autonomy.
- Yasmin is also concerned that languages or dialects with relatively small numbers of speakers will not be included.

Other challenges

180 - People are often fearful of AI and there are many myths and preconceptions. Extreme views predict a technological singularity. Sonia wants to find a way to convince potential customers that these myths and preconceptions are unfounded.
- Margaret wants to ensure that products such as Alicia are used in conjunction with a human, rather than in place of a human. For example, the doll should not to be used to babysit a

185   child, or supervise an elderly or disabled person, without an appropriate person nearby.
- Nia is concerned that there may be issues linked to accountability if an accident occurs while a child is playing with Alicia, especially if the child is following instructions or recommendations given by Alicia. Nia believes that being able to determine accountability is critical. Future AI applications may be developed for use in situations where the AI software

190   could become the decision-maker for the user, for example an elderly person with dementia.

At the close of the meeting, Margaret reflects that many of the challenges can be reduced to the fundamental question about the relationship between humans and machines. She is mindful of this problem, and is thinking about how limitations can be built into the products that *MAGS* develops. Mark reminds the team that Ray Kurzweil has hypothesized that a

195 technological singularity will be reached in the mid-21st century. Margaret is concerned that the continued development of AI software could be a contributing factor to this, and that intelligent machines could unwittingly be involved in the next stage of human sociocultural evolution. These concepts have also been considered by Alan Turing and Isaac Asimov, and also appear in science fiction writings and films. Companies such as *MAGS* need to be aware of these

200 concerns when developing and designing AI-based products.

Key terms associated with *A Doll Called Alicia*

Assistive technology
Accountability
Autonomy
Consumer-grade artificial intelligence
Data privacy and protection principles
Digital profile
Emotional artificial intelligence
Human–Computer Interaction (HCI)
Natural language processing
Pattern recognition
Protocols
Standard data formats
Technological singularity
Uncanny valley

It is not necessary to investigate the technical aspects of artificial intelligence (AI) beyond the depth outlined in the Case Study.

Any individuals named in this case study are fictitious and any similarities with actual entities are purely coincidental.