

No part of this product may be reproduced in any form or by any electronic or mechanical means, including information storage and retrieval systems, without written permission from the IB.

Additionally, the license tied with this product prohibits commercial use of any selected files or extracts from this product. Use by third parties, including but not limited to publishers, private teachers, tutoring or study services, preparatory schools, vendors operating curriculum mapping services or teacher resource digital platforms and app developers, is not permitted and is subject to the IB's prior written consent via a license. More information on how to request a license can be obtained from <http://www.ibo.org/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Aucune partie de ce produit ne peut être reproduite sous quelque forme ni par quelque moyen que ce soit, électronique ou mécanique, y compris des systèmes de stockage et de récupération d'informations, sans l'autorisation écrite de l'IB.

De plus, la licence associée à ce produit interdit toute utilisation commerciale de tout fichier ou extrait sélectionné dans ce produit. L'utilisation par des tiers, y compris, sans toutefois s'y limiter, des éditeurs, des professeurs particuliers, des services de tutorat ou d'aide aux études, des établissements de préparation à l'enseignement supérieur, des fournisseurs de services de planification des programmes d'études, des gestionnaires de plateformes pédagogiques en ligne, et des développeurs d'applications, n'est pas autorisée et est soumise au consentement écrit préalable de l'IB par l'intermédiaire d'une licence. Pour plus d'informations sur la procédure à suivre pour demander une licence, rendez-vous à l'adresse <http://www.ibo.org/fr/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

No se podrá reproducir ninguna parte de este producto de ninguna forma ni por ningún medio electrónico o mecánico, incluidos los sistemas de almacenamiento y recuperación de información, sin que medie la autorización escrita del IB.

Además, la licencia vinculada a este producto prohíbe el uso con fines comerciales de todo archivo o fragmento seleccionado de este producto. El uso por parte de terceros —lo que incluye, a título enunciativo, editoriales, profesores particulares, servicios de apoyo académico o ayuda para el estudio, colegios preparatorios, desarrolladores de aplicaciones y entidades que presten servicios de planificación curricular u ofrezcan recursos para docentes mediante plataformas digitales— no está permitido y estará sujeto al otorgamiento previo de una licencia escrita por parte del IB. En este enlace encontrará más información sobre cómo solicitar una licencia: <http://www.ibo.org/es/contact-the-ib/media-inquiries/for-publishers/guidance-for-third-party-publishers-and-providers/how-to-apply-for-a-license>.

Information technology in a global society
Higher level
Paper 1

Friday 10 May 2019 (afternoon)

2 hours 15 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Section A: answer two questions.
- Section B: answer one question.
- Each question is worth **[20 marks]**.
- The maximum mark for this examination paper is **[60 marks]**.

Section A

Answer **two** questions. Each question is worth [20 marks].

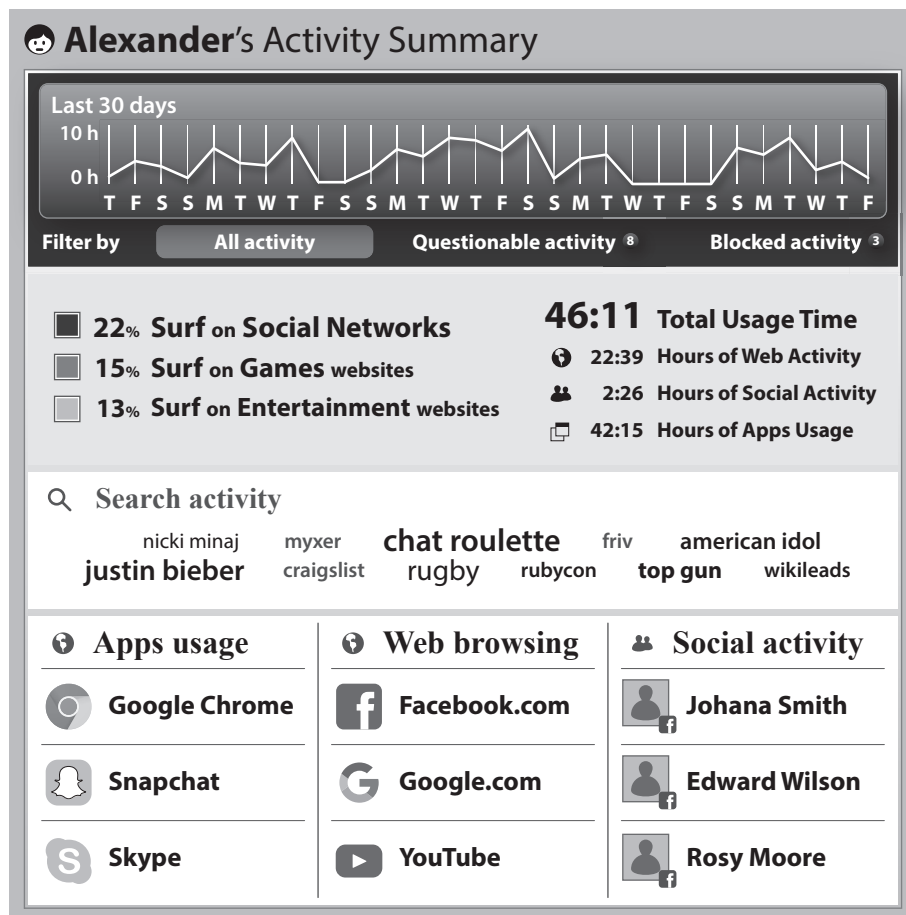
1. Parents “cyber-spying” on their children

The *New York Times* reports that an increasing number of parents use technology to protect their children and keep track of their online activities.

Many companies are developing cell/mobile phone apps* to sell to parents who want to keep an eye on their child’s online activities. Some apps operate as a simple global positioning system (GPS) tracking device, but others are much more advanced. For example:

- Qustodio restricts internet browsing and monitors for signs of cyber-bullying by detecting keywords in social media.
- TeenSafe lets parents see all the texts, web history and apps on the child’s phone, tablet or computer. With one of its options, the parents can receive copies of all the messages that the child sends and receives. Parents can also receive weekly activity reports, similar to the one in **Figure 1**.

Figure 1: Example of a weekly report that can be sent to parents



[Source: with kind permission from Qustodio]

(This question continues on the following page)

(Question 1 continued)

Some of the apps are invisible to the children, so they do not always know they are being monitored by their parents. Some child psychologists believe that this approach to parenting is wrong. They argue that parents should develop trust with their children, rather than using spyware and engaging in online surveillance.

* apps: an app (application software) is typically a small, specialized program downloaded onto mobile devices; apps can also run on the internet, on a computer, or on a cell/mobile phone or other electronic device

- (a) (i) Identify **two** features of spyware. [2]
- (ii) Identify the steps taken by a GPS device to determine its location. [4]
- (b) The developers of Qustodio decided to use automated keyword detection to monitor for signs of cyber-bullying.

Analyse this decision. [6]
- (c) To what extent is it acceptable for parents to use apps such as Qustodio and TeenSafe to monitor their child's online activities? [8]

2. Braille keyboards

According to the World Health Organization, over 250 million people worldwide are blind or visually impaired. Many of them use a tactile writing system called Braille, which they read with their hands by touching patterns of raised dots with their fingertips.

Several companies have recently developed Braille keyboards, such as the one shown in **Figure 2**. Braille keyboards use different combinations of the nine main keys to form characters.

Figure 2: A Braille keyboard



[Source: with the permission of HumanWare]

Braille keyboards are usually very expensive. They can cost twenty or thirty times more than standard keyboards. They are always protected by patents and cannot be cheaply reproduced.

Umair Osman, a young teacher in Pakistan, has invented a system that uses a flexible plastic overlay¹ to imitate the layout of a Braille keyboard.

Umair has also developed software that converts the combinations of keys pressed on the overlay to the corresponding ASCII² character. The overlay, together with the software, enables visually impaired students to convert a standard keyboard into a Braille keyboard.

Umair has decided to release his software as open source software and is considering using crowdfunding³ for future projects.

¹ overlay: a flexible plastic cover that is placed over the keyboard to allow combinations of keys to be pressed by the user

² ASCII: American Standard Code for Information Interchange

³ crowdfunding: funding projects from donations made by a large number of people via the internet

(This question continues on the following page)

(Question 2 continued)

- (a) (i) Identify **two** features of American Standard Code for Information Interchange (ASCII). [2]

- (ii) Describe **two** methods that Umair could have used to gather information from visually impaired people during the development of his system. [4]

- (b) Umair has decided to release his Braille software as open source software, rather than proprietary software.

Explain why Umair took this decision. [6]

- (c) Umair has two options:

- Option 1: he could continue to develop his software and Braille keyboard by using crowdfunding.
- Option 2: he could sell the intellectual property rights to *AssistivIT*, a large company that develops software.

Evaluate these **two** options. [8]

3. Hurricane warning systems

In 2017, Hurricane Irma was a catastrophic disaster. Unfortunately the computer models did not accurately predict its track (course) in time to warn residents in the areas affected. Accurately predicting the track of a hurricane is critical for protecting life and property.

The potential tracks that Hurricane Irma could have taken are shown in **Figure 3**.

Figure 3: Potential tracks of Hurricane Irma



The European computer model, run by the European Centre for Medium-Range Weather Forecasts, performed far better than the American model, known as the Global Forecast System. However a new model created by the electronics company *Panasonic*, called PWS, performed best.

The American and European models depend on data gathered from weather balloons. *Panasonic*, on the other hand, creates systems that collect real-time weather data from over 3500 aircraft every day.

The PWS model resulted in accurate simulations of the track of the hurricane four to seven days in advance.

(This question continues on the following page)

(Question 3 continued)

- (a) (i) Identify **two** file types that could be used for the image in **Figure 3**, which shows the potential tracks of Hurricane Irma. [2]
- (ii) Outline the difference between data and information. [2]
- (iii) Outline why visualization is used to present data. [2]
- (b) (i) Distinguish between a model and a simulation. [2]
- (ii) Different weather variables, such as wind speed and temperature, need to be collected in order to predict the track of a hurricane. Wind speed data is sampled more frequently than temperature data in a hurricane.
- Explain **one** reason why wind speed data would be sampled more frequently than temperature data in a hurricane. [2]
- (iii) Explain why the data collected about Hurricane Irma was not encrypted prior to being transmitted. [2]
- (c) *Panasonic* does not make its PWS model available to governments, as the company says that doing so would compromise its commercial interests.
- Discuss whether governments should be able to make private companies such as *Panasonic* share their data. [8]

Section B

Answer **one** question. Each question is worth [20 marks].

4. Automated journalism software

Some of the news articles that you read are written by automated journalism software. This software uses algorithms and natural language generators to turn facts and trends into news stories.

At present, these stories are restricted to topics based on facts and trends that can be represented and stored as data. These stories always have a very clear structure and must be published very quickly in order to be relevant to the reader.

The *Washington Post*, for example, updated their reports about the 2016 Summer Olympics in Rio de Janeiro using automated journalism software. The *Washington Post* also used this software to cover the elections taking place in all 50 states of the United States in 2016. This meant the newspaper could produce articles that were available to the large number of different audiences much more quickly.

The manager of the *Washington Post* argues that using automated journalism software frees human journalists for more important work. Other people disagree and think that all news stories should be written by humans.

Narrative Science, a company that produces automated journalism software, predicts that by 2026 up to 90 % of news articles could be generated by algorithms.

- (a) (i) Identify **two** characteristics of an algorithm. [2]
- (ii) Identify **two** types of logic that would be used in a machine learning algorithm. [2]
- (iii) Outline why human testers are required during the testing phase of the automated journalism software. [2]
- (b) Developers of automated journalism software need to understand how human journalists work. Two methods of gathering this information from journalists are:
- Interviews
 - Literature searches of existing work
- Analyse these **two** methods of gathering information about how human journalists work. [6]
- (c) To what extent should newspapers rely on automated journalism software to create stories? [8]

5. Sentencing criminals using artificial intelligence (AI)

In 10 states in the United States, artificial intelligence (AI) software is used for sentencing criminals. Once criminals are found guilty, judges need to determine the lengths of their prison sentences. One factor used by judges is the likelihood of the criminal re-offending*.

The AI software uses machine learning to determine how likely it is that a criminal will re-offend. This result is presented as a percentage; for example, the criminal has a 90 % chance of re-offending. Research has indicated that AI software is often, but not always, more reliable than human judges in predicting who is likely to re-offend.

There is general support for identifying people who are unlikely to re-offend, as they do not need to be sent to prisons that are already overcrowded.

Recently, Eric Loomis was sentenced by the state of Wisconsin using proprietary AI software. Eric had to answer over 100 questions to provide the AI software with enough information for it to decide the length of his sentence. When Eric was given a six-year sentence he appealed and wanted to see the algorithms that led to this sentence. Eric lost the appeal.

On the other hand, the European Union (EU) has passed a law that allows citizens to challenge decisions made by algorithms in the criminal justice system.

* re-offending: committing another crime in the future

- (a) (i) Identify **two** characteristics of artificial intelligence (AI) systems. [2]
- (ii) The developers of the AI software created a data flow diagram as part of the development process.

Identify **two** features of a data flow diagram. [2]
- (iii) The developers of the AI software carried out an economic feasibility study.

Identify **two** other feasibility studies that should have been carried out at this time. [2]
- (b) The developers of the AI software decided to use machine learning instead of an expert system.

Explain why this decision was taken. [6]
- (c) To what extent should the decisions of judges be based on algorithms rather than their knowledge and experience? [8]

6. Robots in restaurants

Bruce Vellison is very interested in the latest developments in technology, so he has purchased a robot called Sally (version 1.0) for use in his 5000 fast food restaurants worldwide.

Sally can cook the burgers, toast the buns and add tomatoes, onions and pickles before assembling the hamburger.

Sally has a user interface that lets customers choose what they want in their hamburger. Sally can also clean the cookery utensils so there will be no food contamination, and can use a scraper to clean the grill.

Bruce Velison is already thinking about the second version of Sally (version 2.0) that has more functionality and uses machine learning.

- (a) (i) Sally uses pattern recognition to tell the difference between the burgers and the buns.

Identify **two** characteristics of pattern recognition. [2]

- (ii) Identify **two** characteristics of machine learning. [2]

- (iii) Prototypes will be created during the development of Sally 2.0.

Identify **two** reasons why a prototype would be used. [2]

- (b) The developers of Sally 2.0 can choose to use a Pert chart or a Gantt chart to guide the project.

Analyse these **two** options. [6]

- (c) The initial version of Sally follows a fixed set of procedures, and can only make hamburgers. Bruce Velison is already thinking about the second version of Sally (version 2.0). He would like Sally 2.0 to make a variety of foods. He would also like to use machine learning to create these foods and cloud computing to connect all 5000 Sallys with each other.

Evaluate Bruce's decision to improve Sally. [8]
