A2. CITIZENS INTERACTING WITH AI SYSTEMS

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Today, for citizens to engage confidently, critically and safely with new and emerging technologies, including systems driven by artificial intelligence (AI), they need to acquire a basic understanding of such tools and technologies (DEAP2).

Greater awareness will also lead to improved sensibility towards potential issues related to data protection and privacy, ethics, children's rights and bias – including accessibility, gender bias and disabilities. The DigComp 2.2 update addresses the topic of citizens interacting with AI systems rather than focusing on the knowledge about Artificial Intelligence per se (see Box 6).

The co-creation process of the 2.2 update resulted in a list of more than 80 examples of knowledge, skills and attitudes related to citizens interacting with AI systems (see more about the process in **FIG.9**). 35 are included in Dimension 4 so that each DigComp competence area has a number of examples that illustrate various aspects to pay attention to when citizens interact with AI systems. The selection was guided by the feedback collected through public validation.

Additionally, a separate appendix on this new topic was created. It covers all 73 examples which have been revised according to comments received through the public validation. In this appendix, the examples are thematically grouped so as to facilitate the reading. After each example, the corresponding number to the competence is given. This can help curriculum developers and trainers to get inspired when updating their content regarding new and emerging technologies. The list of examples below should not be considered as a ready curriculum to teach about AI as such. Whereas these examples cover competences outlined in the DigComp conceptual reference model, they leave out some themes and topics that might be considered rudimentary when providing a curriculum outline or a training syllabus about AI and emerging technologies (e.g. what is AI, history of AI, different types of AI).

A. What do AI systems do and what do they not do?
B. How do AI systems work?
C. When interacting with AI systems
D. The challenges and ethics of AI
E. Attitudes regarding human agency and control

A **little red dot** identifies the examples **included in DigComp2.2**

BOX 6. Requirements for citizens interacting with AI systems

As part of the update process focusing on citizens interacting with AI systems, the requirements gathering captured the following:

KNOWLEDGE

- To be aware of what AI systems do and what they do not do
- To understand the benefits, limitations and challenges of AI systems

SKILLS

- To use, interact and give feedback to AI systems as an end-user
- To configure, supervise and adapt AI systems (e.g. overwrite, tweak)

ATTITUDES

- Human agency and control
- Critical yet open attitude
- Ethical considerations of usage

A. WHAT DO AI SYSTEMS DO AND WHAT DO THEY NOT DO?

To engage confidently, critically and safely with AI systems, examples include that a citizen...

AI 01. ● Knows how to identify areas where AI can bring benefits to various aspects of everyday life. For example, in healthcare, AI might contribute to early diagnosis, while in agriculture, it might be used to detect pest infestations. (**2.3**)

AI 02. Able to identify some examples of AI systems: product recommenders (e.g. on online shopping sites), voice recognition (e.g. by virtual assistants), image recognition (e.g. for detecting tumours in x-rays) and facial recognition (e.g. in surveillance systems). (**5.2**)

AI 03. ● Aware that search engines, social media and content platforms often use AI algorithms to generate responses that are adapted to the individual user (e.g. users continue to see similar results or content). This is often referred to as "personalisation". (**1.1**)

AI 04. ● Aware that AI systems collect and process multiple types of user data (e.g. personal data, behavioural data and contextual data) to create user profiles which are then used, for example, to predict what the user might want to see or do next (e.g. offer advertisements, recommendations, services). (**2.6**)

AI 05. ● Aware that AI systems can be used to automatically create digital content (e.g. texts, news, essays, tweets, music, images) using existing digital content as its source. Such content may be difficult to distinguish from human creations. (**3.1**)

AI 06. Aware that in the news media and journalism, for example, AI can be used to author and produce news stories, and also distribute stories based on users' online behaviour. (**3.1**)

AI 07. Aware that AI systems can help the user to edit and process digital content (e.g. some photo editing software uses AI to automatically age a face, while some text applications use AI to suggest words, sentences and paragraphs). (**3.2**).

AI 08. Aware that some AI systems aim to provide human-like interaction with machines (e.g. conversational agents such as customer service chatbots). (**2.1**)

AI 09. Aware that some AI systems can detect users' moods, sentiments and emotions automatically from one's online content and context (e.g. content posted on social media), but this application is not always accurate and can be controversial. (**2.5**)

AI 10. Aware that some AI systems have been designed to support teaching and training humans (e.g. to carry out tasks and assignments in education, at work or doing sports). (**5.4**).

AI 11. Aware that digital tools (including AI-driven ones) can contribute to energy efficiency (e.g. through monitoring the need for heating at home and optimising its management). (**4.3**)

AI 12. Aware that AI is involved in many other technologies (e.g. the Internet of Things (IoT), blockchain, virtual reality). (**5.2**)

AI 13. Aware that many AI systems require a combination of AI techniques to function in real-world scenarios (e.g. a virtual agent might use natural language processing to process instructions and reasoning in uncertainty to make recommendations). (**5.2**)

AI 14. Aware that AI is not involved in all digital technologies (e.g. in GPS systems, AI is not used to determine the location, but it can be used to calculate a route). (**5.2**)

B. HOW DO AI SYSTEMS WORK?

AI 15. Aware that search results, social media activity streams and content recommendations are often ranked using AI algorithms (software rules followed by computers) and models (simplified representations of the real world). (**1.1**)

AI 16. Aware that AI systems use statistics and algorithms to process (analyse) data and generate outcomes (e.g. predict what video the user might like to watch). (**1.3**)

AI 17. ● Aware that sensors used in many digital technologies and applications

(e.g. facial tracking cameras, virtual assistants, wearable technologies, mobile phones, smart devices) automatically generate large amounts of data, including personal data, that can be used to train an AI system. (**1.3**)

AI 18. Aware that AI systems can use personal tracking identifiers related to one's digital identity to combine multiple sources of data (e.g. mobile devices, wearable technology, IoT devices, digital environments). For example, by drawing on mobile phone positioning data and a user profile, a display could offer adaptable advertisement to a person standing in front of it. (**2.6**)

What is AI?

Aware that "AI refers to machine-based systems that can, given a set of human-defined objectives, make predictions, recommendations, or decisions that influence real or virtual environments. AI systems interact with us and act on our environment, either directly or indirectly. Often, they appear to operate autonomously, and can adapt their behaviour by learning about the context." (UNICEF, 2021)

AI 19. ● Aware that AI is a product of human intelligence and decision-making (i.e. humans choose, clean and encode the data, they design the algorithms, train the models, and curate and apply human values to the outputs) and therefore does not exist independently of humans. (**5.1**)

AI 20. Aware that what is usually meant by AI today is Machine Learning, which is only one type of AI. What distinguishes Machine Learning from other types of AI (e.g. rule-based AI and Bayesian networks) is that it requires huge amounts of data. (**5.1**)

AI 21. Aware that some AI algorithms and models are created by human engineers, while other AI algorithms and models are automatically created by AI systems (e.g. huge amounts of data are used to 'train' the AI). (**3.4**)

AI 22. Aware that, while we often think of AI in human or physical terms, such as humanoid robots, most AI is software and so is unseen by users. (**5.4**)

AI 23. ● Aware that AI is a constantly-evolving field, whose development and impact is still very unclear. (**5.4**)

AI 24. Aware that there are many myths and exaggerated claims about AI, and that it is important to dig beneath the headlines to achieve a better understanding. (**5.4**)

AI 25. ● Knows that AI per se is neither good nor bad. What determines whether the outcomes of an AI system are positive or negative for society are how the AI system is designed and used, by whom and for what purposes. (**2.3**)

AI 26. Aware that what AI systems can do easily (e.g. identify patterns in huge amounts of data), humans are not able to do; while many things that humans can do easily (e.g. understand, decide what to do, and apply human values), AI systems are not able to do. (**5.2**)

AI 27. Recognises that AI tools designed to create images, writing and music depend on humans (e.g. to set the original parameters and select the outcomes), while humans can use AI tools to enhance their creativity. (**5.3**)

AI 28. Aware that while most AI systems process data centrally (or 'in the cloud'), some distribute the processing across several devices ('distributed AI'), while others process the data on the device (e.g. a mobile phone) itself ('edge AI'). (**1.3**)

C. WHEN INTERACTING WITH AI SYSTEMS

Looking for information

AI 29. ● Knows how to formulate search queries to achieve the desired output when interacting with conversational agents or smart speakers (e.g. Siri, Alexa, Cortana, Google Assistant), e.g. recognising that, for the system to be able to respond as required, the query must be unambiguous and spoken clearly so that the system can respond. (**1.1**)

AI 30. ● Able to recognise that some AI algorithms may reinforce existing views in digital environments by creating "echo chambers" or "filter bubbles" (e.g. if a social media stream favours a particular political ideology, additional recommendations can reinforce that ideology without exposing it to opposing arguments). (**1.2**)

AI 31. ● Weighs the benefits and disadvantages of using AI-driven search engines (e.g. while they might help users find the desired information, they may

compromise privacy and personal data, or subject the user to commercial interests). (**1.1**)

Using AI systems and Apps

AI 32. ● Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not). (**2.1**)

AI 33. ● Able to interact and give feedback to the AI system (e.g. by giving user ratings, likes, tags to online content) to influence what it next recommends (e.g. to get more recommendations on similar movies that the user previously liked. (**2.1**)

AI 34. Knows that sometimes not reacting to the content that an AI system proposes (e.g. on an activity stream) can also be taken as a signal by the system (e.g. an indication that the user is not interested in that particular content). (**2.1**)

AI 35. ● Knows how to modify user configurations (e.g. in apps, software, digital platforms) to enable, prevent or moderate the AI system tracking, collecting or analysing data (e.g. not allowing the mobile phone to track the user's location). (**2.6**)

AI 36. ● Knows how and when to use machine translation solutions (e.g. Google Translate, DeepL) and simultaneous interpretation apps (e.g. iTranslate) to get a rough understanding of a document or conversation. However, also knows that when the content requires an accurate translation (e.g. in healthcare, commerce or diplomacy), a more precise translation may be needed. (**5.2**)

AI 37. ● Aware that AI-driven speech-based technology enables the use of spoken commands that can enhance the accessibility of digital tools and devices (e.g. for those with mobility or visual limitations, limited cognition, language or learning difficulties), however, languages spoken by smaller populations are often not available, or perform worse, due to commercial prioritisation. (**5.2**)

AI 38. ● Knows how to incorporate AI edited/manipulated digital content in one's own work (e.g. incorporate AI generated melodies in one's own musical composition). This use of AI can be controversial as it raises questions about the role of AI in artworks, and for example, who should be credited. (**3.2**)

Focusing on privacy and personal data

AI 39. ● Knows that the processing of personal data is subject to local regulations such as the EU's General Data Protection Regulation (GDPR) (e.g. . voice interactions with a virtual assistant are personal data in terms of the GDPR and can expose users to certain data protection, privacy and security risks. (**4.2**)

AI 40. ● Weighs the benefits and risks of using biometric identification techniques (e.g. fingerprint, face images) as they can affect safety in unintended ways. If biometric information is leaked or hacked, it becomes compromised and can lead to identity fraud. (**4.1**)

AI 41. Aware that AI systems that rely on users' personal data (e.g. voice assistants, chatbots) might collect and process that data more than is necessary. This would be considered 'disproportionate' and so would violate the principle of proportionality specified by GDPR. (**4.2**)

AI 42. Weighs the benefits and risks before activating a virtual assistant (e.g. Siri, Alexa, Cortana, Google assistant) or AI-driven Internet of Things (IoT) devices as they may expose personal daily routines and private conversations. (**2.6**)

AI 43. ● Weighs the benefits and risks before allowing third parties to process personal data (e.g. recognises that a voice assistant on a smartphone, that is used to give commands to a robot vacuum cleaner, could give third parties - companies, governments, cybercriminals - access to the data). (**4.2**)

AI 44. ● Identifies both the positive and negative implications of the use of all data (collection, encoding and processing), but especially personal data, by AI-driven digital technologies such as apps and online services. (**2.6**)

AI 45. ● Aware that everything that one shares publicly online (e.g. images, videos, sounds) can be used to train AI systems. For example, commercial software companies who develop AI facial recognition systems can use personal images shared online (e.g. family photographs) to train and improve the software's capability to automatically recognise those persons in other images, which might not be desirable (e.g. might be a breach of privacy). (**2.2**)

AI 46. Aware that an AI system can link different pieces of apparently anonymous information together, which can lead to de-anonymisation (i.e. the identification of a particular person). (**2.6**)

AI 47. Can help mitigate the risks of personal data breaches by expressing concerns to relevant authorities relating to the usage of AI systems that collect data, especially if there is a suspicion that there is a violation of the GDPR or when the company does not make the information available. (**4.2**)

D. THE CHALLENGES AND ETHICS OF AI

Challenges

AI 48. ● Aware that AI algorithms might not be configured to provide only the information that the user wants; they might also embody a commercial or political message (e.g. to encourage users to stay on the site, to watch or buy something particular, to share specific opinions). This can also have negative consequences (e.g. reproducing stereotypes, sharing misinformation). (**1.2**)

AI 49. ● Aware that the data, on which AI depends, may include biases. If so, these biases can become automated and worsened by the use of AI. For example, search results about occupation may include stereotypes about male or female jobs (e.g. male bus drivers, female sales persons). (**1.2**)

AI 50. ● Aware that AI algorithms work in ways that are usually not visible or easily understood by users. This is often referred to as "black box" decision-making as it may be impossible to trace back how and why an algorithm makes specific suggestions or predictions. (**1.1**)

AI 51. ● Knows that the term "deep-fakes" refers to AI-generated images, videos or audio recordings of events or persons that did not really happen (e.g. speeches by politicians, celebrity faces on pornographic imagery). They may be impossible to distinguish from the real thing. (**1.2**)

AI 52. Aware that so-called "personalised" results (e.g. from search engines, social media, content platforms) are based on patterns and averages of interactions of millions of users. In other words, the AI system might predict group behaviour but not the behaviour of any one person, therefore the term personalised might be misleading. (**1.2**)

AI 53. Aware that the EU is striving to ensure that AI systems are trustworthy. However, not all AI systems are trustworthy and not all AI systems developed in the world are regulated by the EU law (**4.1**).

AI 54. Aware that the question of ownership of personal data in AI systems can be controversial (e.g. the data created by people using social media or students using AI systems in classrooms). The business models of many AI commercial organisations depend on them being able to collate and analyse that data. Others have argued that personal data belongs instead to the person who created it (like any other copyrighted materials such as texts, images or music). (**3.3**)

AI 55. Aware that AI systems are typically developed in English-speaking contexts which means that they might work less accurately in non-English contexts. For example, AI-based automatic translation systems work better with often used languages (e.g. English to Spanish) than less used ones (e.g. Slovenian to Finnish). (**2.5**)

AI 56. Aware that AI systems are typically developed by those from narrow demographic backgrounds (e.g. white males from higher-socio economic groups in higher-income countries) which can mean that the systems they develop are less sensitive to the needs of women, people from different ethnic minority groups, lower socio-economic groups, people who require digital accessibility (e.g. with disabilities, functional limitations), or citizens from lower-income countries. (**2.5**)

Ethics

AI 57. ● Considers the ethical consequences of AI systems throughout their life-cycle: they include both the environmental impact (environmental consequences of the production of digital devices and services) and societal impact (e.g. platformisation of work and algorithmic management that may repress workers' privacy or rights; the use of low-cost labour for labelling images to train AI systems). (**4.4**)

AI 58. ● Readiness to contemplate ethical questions related to AI systems (e.g. in which contexts, such as sentencing criminals, should AI recommendations not be used without human intervention?) (**2.3**)

AI 59. ● Aware that certain activities (e.g. training AI and producing cryptocurrencies like Bitcoin) are resource intensive processes in terms of data and computing power. Therefore, energy consumption can be high which can also have a high environmental impact. (**4.4**)

AI 60. Aware that AI-based technologies can be used to replace some human functions (e.g. customer service), which might lead to some job losses or reallocations, but that new jobs might be created to address new needs. (**2.4**)

AI 61. ● Considers ethics (including but not limited to human agency and oversight, transparency, non-discrimination, accessibility, and biases and fairness) as one of the core pillars when developing or deploying AI systems. (**3.4**)

E. ATTITUDES REGARDING HUMAN AGENCY AND CONTROL

AI 62. ● Open to AI systems supporting humans to make informed decisions in accordance with their goals (e.g. users actively deciding whether to act upon a recommendation or not). (**2.1**)

AI 63. ● Recognises that while the application of AI systems in many domains is usually uncontroversial (e.g. AI that helps avert climate change), AI that directly interacts with humans and takes decisions about their life can often be controversial (e.g. CV-sorting software for recruitment procedures, scoring of exams that may determine access to education). (**2.3**)

AI 64. ● Knows that all EU citizens have the right to not be subject to fully automated decision-making (e.g. if an automatic system refuses a credit application, the customer has the right to ask for the decision to be reviewed by a person). See here (**2.3**)

AI 65. Weighs the benefits of adopting the use of AI systems to improve the quality of human interaction in communication (e.g. use AI-generated replies to emails might risk dehumanising interactions). (**2.4**)

AI 66. Willing to collaborate with AI projects for social good in order to create value for others (e.g. by sharing data so long as appropriate and robust controls are in place). (**2.2**)

AI 67. Open to contribute to the improvement of AI systems by reporting errors, risks, biases or misconceptions in data or outputs (e.g. image recognition software being trained only on images of people belonging to certain groups). (**1.3**)

AI 68. ● Open to engage in collaborative processes to co-design and co-create new products and services based on AI systems to support and enhance citizens' participation in society. (**5.3**)

AI 69. Willing to take part in citizen-led collective actions (e.g. through civic participation channels, opinion campaigns, voting, activism and advocacy) to initiate changes in AI services and products (e.g. business models, developments). (**5.3**)

AI 70. Aware that sometimes the best way to control an AI system (e.g. to protect oneself and others), is to not interact with it or to turn it off. (**5.1**)

AI 71. Interested in experimenting with various types of AI systems depending on one's own personal needs (e.g. virtual assistant, image analysis software, speech and face recognition systems, autonomous cars, "embodied" AI such as robots). (**5.2**)

AI 72. ● Has a disposition to keep learning, to educate oneself and stay informed about AI (e.g to understand how AI algorithms work; to understand how automatic decision-making can be biased; to distinguish between realistic and unrealistic AI; and to understand the difference between Artificial Narrow Intelligence, i.e. today's AI capable of narrow tasks such as game playing, and Artificial General Intelligence, i.e. AI that surpasses human intelligence, which still remains science fiction). (**5.4**)

AI 73. Open and curious towards today's emerging technologies and applications (e.g. reads reviews about Virtual Reality, gaming, AI) and intentionally discusses about their use with other people. (**5.4**)