STATISTICS

Recording Artificial Intelligence in National Accounts

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16 NOVEMBER 2021
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Artificial Intelligence (AI)

- What is AI?
- Proposed statistical definition
- Some Accounting and Presentational Guidance

What is AI? - Applications of AI

- Voice-controlled virtual assistants
  - Convert soundwaves to text, then determine action
    - Retrieve answers, make purchases, play music, deliver messages, etc.
  - Can be installed on speaker, display, headphones, watches, eyeglasses, etc.

- Autonomous vehicles
  - Gather real-time information about environment from sensors
  - Feed information into software that maps the route, adjusts to avoid obstacles, follows traffic laws, and triggers vehicle actions

- Decision-support / decision-making for businesses
  - Agriculture – which crops to grow, when to plant, pesticide usage
  - Health care – analyze diagnostic images
  - Finance – make lending decisions

Motivation: AI in National Accounts

- One important feature of AI is its ability to substitute labor as a factor of production.
- Over the last decade there has been a trend for capital to replace labor – but this has mainly been limited to tasks that were rule-based, requiring human dexterity, strength, or coordination.
- AI has the potential to replace high reasoning / decision making tasks traditionally undertaken by labor – making it an analytically important element for SNA/BPM users.
- Currently AI is not mentioned in:
  - SNA 2008
  - BPM6
  - ISIC Rev.4
  - CPC 2.1

Towards a Definition - How IOs and NSOs define AI

OECD	"An AI system is a **machine-based system** that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. It does so by using machine and/or human-based inputs to: i) **perceive** real and/or virtual environments; ii) abstract such perceptions into models through analysis in an **automated manner** (e.g. with machine learning, or manually); and iii) use model inference to formulate options for information or action. AI systems are designed to operate with varying levels of **autonomy**." (OECD, 2019a)

Towards a Definition - How IOs and NSOs define AI

Canada	Artificial Intelligence (AI) refers to **systems** that display intelligent behavior by **analyzing** their environment and taking actions – with some degree autonomy – to achieve specific goals. AI-based systems can be **purely software-based** or **embedded** in a device.
France	Artificial intelligence includes all the technologies aiming at computerization of **cognitive tasks** traditionally performed by humans: **voice recognition**, biometrics, image recognition, decision support, etc.
Japan	AI (Artificial Intelligence) can be defined as something that can perform, **learn, infer, recognize, judge**, etc. through data analysis.
Korea	Artificial intelligence **technologies** and services are machine-generated intelligence (artificial intelligence) ….Refers to a technology that embodies abilities, **reasoning skills**, **perception skills**, and natural language comprehension skills……Example) AI assistant service that provides necessary information while talking by voice (S Voice and Bixby of Samsung, Q-Voice of LG, Apple's Siri, Google's Now, Microsoft's Cortana, Amazon's Alexa and Echo, SK Telecom's AI Speaker)

Towards a Definition – Common Characteristics of AI

- Common features:
  - “System” or “Technology”
  - Ingests and evaluates data (“analyzes environment”)
  - Functions with some autonomy in executing cognitive tasks, solving problems, or making predictions
  - Can be embedded on devices / machinery and equipment or standalone software.
  - Important link to data (training data, real-time database access)
  - Development in-house as “own-account” AI
  - Licensing systems developed by “publishers”
  - Customizing licensed systems, possibly with the assistance of IT consultants / systems integration service providers
  - Purchasing hardware that includes embedded systems

Towards a Definition – Is AI a Machine or Software

- While an argument could be made that an autonomous vehicle is AI it seems that a more appropriate view is that it is a car that includes an AI system.
- If we define AI to include both machine and software we would be saying the primary purpose of an autonomous vehicle is to reason and make decision rather than move people and goods from point “A” to point “B”.
- For conceptual, pragmatic and analytical reasons, it may be best to restrict the definition of AI to “software”.

What is AI? – Proposed Definition

AI is… a computer program operating a system capable of recognition and reasoning consistent with human recognition and reasoning.

- Definition recognizes AI as a computer program, but highlights the aspects that differentiate it from traditional software.
- Definition includes the key attributes of recognition (visual, audio) and reasoning (provides a credible response consistent with a human response).
- Key assumption is that firms should be able to distinguish software along these lines (software that includes reasoning and recognition capabilities vs software that does not).

Incorporating the Definition of AI into the SNA/BPM

- To incorporate this AI definition into the SNA/BPM, updates will be required to both the definition of IIP and Computer Software and Databases.

- Definition of IPPs in 2008 SNA 10.98 can be broadened to highlight the unique nature of AI (proposed new text in bold):
  - "The result of research, development, investigation or innovation leading to knowledge **or the creation of intelligent systems** that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection".

- IIP product "Computer Software and Databases" can be similarly broadened to "Computer Software, Databases **and Artificial Intelligence Systems"** with the following definition:
  - "Computer software consists of computer programs, program descriptions and supporting materials for both systems and applications software. Databases consist of files of data organized in such a way as to permit resource-effective access and use of the data. **Artificial intelligence systems are computer programs operating a system capable of recognition and reasoning consistent with human recognition and reasoning."**

Accounting Guidance – Valuing "Own-Account" AI

- (SNA 10.111) - "Software developed in-house is valued at its estimated basic price, or at its costs of production if it is not possible to estimate the basic price."

- Question to consider: should data be included in costs of production for AI?
  - Training data for new AI
    - Used to develop AI's ability to recognize patterns and make inferences
    - Seems appropriate to include costs associated with "producing" the training data into the cost of own-account AI.

  - Continuous data streams for existing AI
    - Provides real-time information to help AI make contextually appropriate decisions
    - Seems more appropriately considered an intermediate input in operation of AI
    - If AI continues gaining intelligence, is production of AI continuous and indefinite?

Accounting Guidance – Licensed AI

- AI systems can be embedded in vehicles, machinery, consumer electronics, etc.
- Once embedded the AI system is key quality feature of hardware, which is classified according to its primary use
- Embedded AI may in some cases require separate subscription to keep it updated and operational, in which case this service can be reported separately as licensing of IPP
- Recommendation is to record Licensed AI consistent with the way the SNA treats licensed software – “License recorded as fixed asset if expected to be used for more than 1 year, as with software”

Accounting Guidance – Unique Quality Issues

- Many AI systems adapt and refine their methods based on new data and an evaluation of its own previous performance
- As a result, the value of an AI system may appreciate rather than depreciate over time
- Volume measures should reflect these quality improvements
- Challenge for prices compilers – need creative solutions to value capabilities of AI systems and how they change over time for quality adjustment

Accounting / Presentational Guidance – Classifications

- New CPC products for AI systems important for identifying production
- Need for new ISIC activity is less clear, as AI systems development does not appear to be primarily produced by firms that specialize in this activity
  - Much of AI is currently developed on own-account, by computer systems design / IT consultants, and by publishers of licensed software
- Updates of the International Standard Classification of Occupations may be beneficial in identifying changes in labor force that may be caused by AI

Summary of Recommendations for SNA/BPM Update

1. Update the definition of IPPs to “The result of research, development, investigation or innovation leading to knowledge **or the creation of intelligent systems** that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection”.

2. Define AI as “A computer program operating a system capable of recognition and reasoning consistent with human recognition and reasoning.”

3. Include the cost of producing training data sets in the value of own-account AI.

4. Exclude the value of the cost of databases providing continuous services to AI systems from the value of AI.

5. Update the CPC to include specific AI products.

6. Consider the need to establish separate ISIC classes for AI producing units.