Anatomy of an AI system

An anatomical case study of the Amazon echo as a artificial intelligence system made of human labor

Harelbeke

Product of labor (Subject-object)
Labour power (Subject)
Means of production (Object)
Waste

Marx's dialectic of subject and object in economy

Fractal chains of production and exploitation

Income distribution

Occupations

US Dollars / Approximate average salary per month in USD

- 16,000 Chief Executives (US)
- 15,000
- 14,000
- 13,000
- 12,000
- 11,000
- 10,000
- 9,000
- 8,000
- 7,000
- 6,000
- 5,000
- 4,000
- 3,000
- 2,000
- 1,000
- 900
- 800
- 700
- 600
- 500
- 400
- 300
- 200
- 100
- 0

Chief Executives (US)
Hair Clinical Engineer (US)
Sales Managers (US)
Senior Data Scientist (US)
Management Occupations (US)
Computer Hardware Engineers (US)
Machine Learning Engineer (US)
Software Developers, Systems Software (US)
Optometrists (US)
Software Developers, Applications (US)
Computer Network Architects (US)
Mining and Geological Engineers (US)
Component Design Engineer at Intel (US)
Data Scientist (US)
Transportation, Storage, and Distribution Managers (US)
Information Security Analysts (US)
Air Transportation Workers (US)
Computer Systems Analysts (US)
Iron Workers (US)
Industrial Machinery Mechanics (US)
Network and Computer Systems Administrators (US)
Forger Welder (US, Tulsa, OK)
Mechanical Engineer (US)
AT&T Labs Technician (US)
Cargo Vessel Crew (US)
Web Developers (US)
Underground miner (Canada)
Underground Miner (US)
Landfill workers (US)
Underground Miner (US)
Iron Manufacturing Technician (US)
Amazon Data Center Technician (US)
Rail Transportation Workers (US)
Electrical Engineer (US)
Mining Machine Operators (US)
Cargo vessel 3rd Engineer (US)
Hazardous Materials Removal Workers (US)
Construction Manufacturer (US)
Garbage collector (US)
Cross-Rated Workers and Trade Drivers (US)
Bank Tellers and Bank Loaders (US)
Semiconductor Processors (US)
Amazon Delivery Driver (US)
Hair Dresser Technician (US)
Assembly Line Worker (US)
Amazon Warehouse Worker (US)
Foxconn Assembly line Worker (China)
Software developer at Huawei (Shenzhen)
Software developer at Google (US)
Senior Software Engineer at SoftServe (Ukraine)
Mining Engineer (US, Alaska)
Mining Engineer (US, Alaska)
Cargo vessel Reefermen (US)
Cargo vessel Able Seaman (US)
Repair Worker (China)
PA Contact-tracing(tracers for Typhoon (Philippines)
Call center agents (Philippines)
Cargo vessel Cook (US)
Cargo vessel Oiler (US)
Software developer at Google (India)
Software developer at Google (US)
Unpaid Intern Labor (US)

Distributors

Product
Owner
Distributor
Product
Tools

Assembly line

Assemblers

Issues

Low paid labour
Illegal working hours
Unfair compensation for unscheduled overtime
Health and Safety issues
Lack of Freedom of Association
Migrant workers rights
Working conditions
Increased health risk workers
Workers health care programs

Hazards

Working

Injurious working conditions
Repetitive work
Injurious chemical exposure
Exposure to lead and other substances
Ergonomic hazards from awkward postures and practices
Illegal exposure to toxic chemicals (benzene, n-hexane)
Injuries from fire, explosion, electrocution, stroke, and scald, and pit stress

Product
Owner
Assembly-line workers
Components
Tools

Component manufacturers

Issues

Toxic waste
Health hazards

Hazards

Working

Use of toxic materials such as arsenic, phosphorus, and gallium causes birth defects, miscarriages and birth defects

Inhalation of dust and respiratory organs

Neurotoxins

Low-frequency electromagnetic magnetic and electromagnetic fields

Dangerous hazards, heat injuries, repetitive work, shift work, and pit stress

Environmental

Use of hazardous chemicals including cadmium, arsenic, lead, mercury and gallium, and metals, silicon

Air pollution

Groundwater pollution

Toxic waste

Product
Owner
Labour
Component
Resource
Waste
Tools

Smelters & Refiners

Issues

Acidic and Radioactive waste
Health and environmental hazards

Hazards

Working

Long-term radiation
Exposure to toxic chemicals
Contact with corrosive substances
Injuries from burns, falls, slips and trips
Injuries lifting heavy loads and working in awkward positions
Injuries from being struck by or caught between moving objects
Injuries from burns, falls, slips and trips
Injuries from cuts, scrapes, or entrapment by or between objects
Injuries from exposure to hot objects or substances
Injuries from elevated risks to machinery and equipment

Environmental

Large proportion of the harmful waste products never enter disposal

Nothing may ever leach elements after refining one ton of rare earth elements, leaving behind 2,000 kilograms of hydrofluoric acid, 9 kilograms of sulfuric acid, 75 kilograms of radioactive waste residue are produced

Product
Owner
Smelters
Metal
Ore
Waste
Tools

Mines

Issues

Hard labour
Forced labour
Child labour
Low paid labour
Conflict minerals
Environmental and working hazards

Hazards

Working

Accidents
Exposure to toxic chemicals
Silica exposure
Diesel particulate matter
Noise
Health risks
Dust
Toxic
Heavy metals
Noxious fumes
Toxic gas
Heavy metals
Heavy tools

Environmental

Erosion
Formation of sinkholes
Loss of biodiversity
Hazardous substances leaching
Contamination of soil
Contamination of groundwater
Contamination of ground and surface water
Release of chemicals, heavy metals, and mercury
Affecting surrounding vegetation
Affecting surrounding population
Deforestation

Product
Owner
Trader
Ore
Miners
Resource
Waste
Mining tools

Privatization and exploitation of common resource (Earth)

Elements

Rare Earth elements / Other used elements

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	

Rare Earth Elements (REE) exploitation

Since 1980, mining companies have produced four times the amount of mass, if not all, ores compared to the amount they produced from the beginning of time until 1980.

Amazon storage systems

Transportation

Issues

Air and water pollution
Toxic waste
Health hazards

Transportation
Sailors / Drivers
Owner
Cargo ships
Trucks
Trains
Cargo containers
Waste

Hazards

Working

Cargo theft
Long working hours
Injuries from being struck by or caught between objects
Injuries from being struck by or caught between moving objects
Fire

Environmental

Air pollution (combustion of diesel and gasoline, greenhouse gases)
Noise pollution
Water pollution (discharge of oil and other hydrocarbons, heavy metals and nuclear facilities, ballast water containing invasive species, and other chemical and biological contaminants)
Land pollution (waste and other chemical contaminants, Collisions with marine mammals)

Human operator

Issues

Privacy
Digital security
Unpaid immaterial labour

Unpaid immaterial labour
Object of analysis and targeting
Unpaid trainer of AIs
Free care and maintenance
Creating new content for training datasets

Mostly immaterial Labour
Knowledge and Experience
Voice command
Reception of results

Domestic infrastructure

Amazon **Echo Dot**

Issues

Right to repair
Digital Redlining
Diagnostic tools
Planned obsolescence
Proprietary software
Privacy
Digital Security

WiFi Router

Amazon Echo Dot
Home Wifi Routers
Home border

Internet infrastructure

Internet Service Provider (ISP)

Internet Exchange Points (IXP)

Submarine Cable Infrastructure

Network engineers
Network technicians
Setup
Maintenance
Management
Devices
Tools
Cables
Buildings
Sheds

Issues

Privacy
Surveillance
Data Retention
Censorship
Network Neutrality
Energy Consumption
Digital Governance
Shadow

300 Submarine cable systems
900.000 km Total length

Submarine cable
Optical fiber
Optical submarine cable repeater

Routers
Cables
Repeaters
Internet Router
Internet Switch

Internet Platforms & Services

Internet Infrastructure

Servers and Infrastructure

Content Platforms & Services

(eg. Bing, Wikipedia, Weather.com ...)

Owners and investors
Management and administration
Web developers
Programmers
Designers (Web, UI, UX ...)
Network administrators
Content producers (users, editors, journalists)
PR & Marketing
Free Labour (user labour, volunteers ...)

Devices
Tools
Offices

Time
Knowledge
Experience

Corporate border

Amazon Inc. Infrastructure

AWS

Corporate border
Servers
Energy Consumption
Water Consumption

Amazon Data Center

Network engineers
Network technicians
Management
Security
Setup
Maintenance
Management
Devices
Tools
Cables
Buildings
Time
Knowledge
Experience

AVS

Alexa Voice Service

Alexa Voice Service performs speech to text and text to speech, natural language processing, NLP (and other functions)

AVS: Speech to Text
AVS: Text to Speech

Issues

AI black box
Bias in language models
Unverified and unaudited

Skills
Setup

Skills
Setup

ASK
Alexa Skill Kit

Amazon's suite of various APIs, tools, documentation, and code samples for making of 3rd party Alexa Skills

AVS: Intent
Text to Action

Public
Closed

AI Training

Issues

AI Black Box
Bias
Energy Consumption

x80 Accelerators
80 640 Gigabytes

GPU
Processors
Energy Consumption
Water Consumption

Data Preparation and Labeling

User voice recordings ⓘ Privacy

Network engineers
Network technicians
Management
Security
Setup
Maintenance
Management
Resource

Training datasets
~5000

Training datasets

Unremunerated labour
Immaterial labour (eg. user labour)
Unpaid crowdsourcing (eg. ReCaptcha)

Underpaid or underfaid labour
Students, Volunteers, Interns (eg. TED talks translation volunteers)
Crowdworkers (eg. Amazon Mechanical Turk workers)
Outsourced services in developing countries

Semi-Human Labour
Science and engineering professionals (eg. research scientist)
Information and communications technology professionals (eg. developers)

Non-Human Labour
Algorithms or other machine learning systems

Training datasets

Methods
Technology (Software, hardware, infrastructure ...)

Facilities (Offices, homes, edu.institutions ...)

Databanks

GPU
Processors
Corporate border

Abandoned devices

Households
Waste
Companies
Public Bodies

Collecting

Informal sector
Formal sector

Informal waste collection

Waste Bins
Waste collectors
Waste
Street Collectors
E-Waste

Formal Collection

Formal collection and transportation

Auctions

Informal dismantling

Issues

Toxic waste
Health hazards

Hazards

Working Hazards

The massive exposures found in the e-waste recycle contained qualities of lead, cadmium, vanadium and beryllium, which are known to be toxic and cause health hazards and can cause cardiovascular disease or cancer. Workers who dismantle electronic equipment come in contact with these but in larger forms via damage the equipment and breaking it into pieces. Workers who burn wires to recover copper are exposed to carcinogenic and toxic fumes. Workers who work in the e-waste recycle are also exposed to carcinogenic and toxic processing chemicals. One tonne of e-waste processed can release hazardous waste equal to 2,000

Informal dismantlers
Waste
Metals
PVC
Plastic
Components
E Waste Traders

Formal Recycling Enterprises

E-waste separation

Labour

Shipping

Issues

Air and water pollution
Toxic waste
Health hazards

Cargo ships
Trucks
Trains
Cargo containers
Waste
E-Waste
Sailors / Drivers

Recovering

2nd Hand Resellers

Dismantlers
Remanufacturers
Components traders
Device separators
Manual recycling shops
Leaching facilities
Elec. material traders

2nd Hand Product
Component

Issues

Toxic waste
Health hazards

Hazards

Working

Use of toxic materials such as vanadium, cadmium, and beryllium causes health hazards, which can cause cardiovascular disease or cancer. Workers who dismantle electronic equipment come in contact with these but in larger forms via damage the equipment and breaking it into pieces. Workers who burn wires to recover copper are exposed to carcinogenic and toxic fumes. Workers who work in the e-waste recycle are also exposed to carcinogenic and toxic processing chemicals. One tonne of e-waste processed can release hazardous waste equal to 2,000

Environmental

Use of hazardous chemicals including cadmium, arsenic, lead, mercury and gallium, and metals, silicon

Air pollution

Groundwater pollution

Toxic waste

Toxic gas

Plastic Recycling
Toxic Hazardous Facilities
Labour
Plastic
PC
PE
PET
Toxic Hazardous Facilities
Smelters
Smelters and Refiners
E-Waste
Metal
Metals

Issues

Acidic and Radioactive waste
Health and environmental hazards

Hazards

Working

Long-term radiation
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Injuries from exposure to hot objects or substances
Injuries from elevated risks to machinery and equipment

Environmental

Long-term leaches products never enter disposal

Disposing

Toxic or Hazardous Facilities
Landfill or Incineration

Informal Workers
Waste pickers

Reuse
2nd Hand Product
Component
Metals
Plastic
PVC

Geological process

Deep Time

Earth

Quantification of nature

From Nature to Databanks

Living
Animals
Humans
Plants

Quantification of human body, actions and behaviour

Data exploitation

Data as means of control
Data as commodity
Data in Science and Culture
Databanks
Quantification of nature
Labour
Quantified nature - data
Labour
Resource
Nature
Quantification tools

Quantification of human-made products

Vlaiter Joke and Ruben Crawford (2018)