Online Appendix

The Employment Impact of Emerging Digital Technologies

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Tables OA.1 and OA.2 present the structured queries discussed in the appendix that retrieve the patent sample.

Table OA.1: The Structured Patent Queries in Derwent Innovation Index Database (1/2)

1. **Process and Machine Control in Production.**
MAN=(T06* NOT P36*) NOT DC=(X26 OR X27 OR W07) OR MAN=(T01-J07 OR T01-J07A* OR T01-J07B OR T01-J07B1 NOT P36*) NOT DC=(X26 OR X27 OR W07)
2. **Process and Workflow Control in Services.**
IP=(G06Q*) OR MAN=(T01-n01a* OR T01-N01B3* OR T01-N01D3A OR T01-n01e* OR T01-J05A* OR T01-J06A* OR S05-D06A*)
3. **Additive Manufacturing.**
MAN=(T01-J07B3* OR X25-A08*) OR IP=(B33Y*)

Technology Constraints.
Networking
MAN=(W01-A* OR T01-N* OR W05-D06E* OR W05-D06F* OR W05-D07* OR T06-A11* NOT W05-D07A* NOT W05-D07C*) OR IP=(H04L* OR H04W*) OR TS=(MWSN OR WSN OR (SENSOR NEAR/1 (CLUSTER$ OR NETWORK$ OR NODE$)) OR (NETWORK NEAR/3 (TRANSDUCER$ OR PROBE$)) OR (DETECTOR$ NEAR/0 NETWORK$) OR (METER NEAR/1 NETWORK$)) OR IP=(H04B-001/00 OR H04B-001/02 OR H04B-001/03 OR H04B-001/034 OR H04B-001/036 OR H04B-001/04 OR H04B-001/06 OR H04B-001/08 OR H04B-001/10 OR H04B-001/12 OR H04B-001/14 OR H04B-001/16 OR H04B-001/18 OR H04B-001/20 OR H04B-001/22 OR H04B-001/24 OR H04B-001/26 OR H04B-001/28 OR H04B-001/30 OR H04B-001/38 OR H04B-001/3805 OR H04B-001/3816 OR H04B-001/3818 OR H04B-001/3822 OR H04B-001/3827 OR H04B-001/3877 OR H04B-001/3883 OR H04B-001/3888 OR H04B-001/40 OR H04B-001/401 OR H04B-001/403 OR H04B-001/405 OR H04B-001/408 OR H04B-001/44 OR H04B-001/46 OR H04B-001/48 OR H04B-001/50 OR H04B-001/52 OR H04B-001/525 OR H04B-001/54 OR H04B-001/56 OR H04B-001/58 OR H04B-001/59 OR H04B-001/60 OR H04B-001/62 OR H04B-001/64 OR H04B-001/66 OR H04B-001/68 OR H04B-001/72 OR H04B-001/74 OR H04B-001/76 OR H04B-001/59 OR G01S-013/74 OR G01S-013/75 OR G01S-013/76 OR G01S-013/78 OR G01S-013/79 OR G01S-013/82 OR G01S-013/84 OR G01V-015*) OR TS=(D2D OR IOT OR M2M OR M2MI OR MTC OR MTM OR INTER-VEHIC* OR DEVICE-2-DEVICE OR DEVICE-TO-DEVICE OR MACHINE-TO-MACHINE OR MACHINE-2-MACHINE OR MACHINE-TYPE-COMMUNICATION$ OR PEER-TO-PEER OR P2P OR (VEHICLE-TO- NEAR/0 (ANYTHING OR SERVER OR SOMETHING)) OR (INTER NEAR/0 (VEHICLE OR CAR)) OR (INTERNET NEAR/1 (THINGS OR EVERYTHING)) OR (WEB NEAR/1 THING$) OR (UBIQUITOUS NEAR/0 COMPUT*) OR (AMBIENT NEAR/1 INTELLIGENCE) OR (INTER-VEHIC* NEAR/0 COMMUNIC*))
Data Acquisition
TS=(MWSN OR WSN OR (SENSOR NEAR/1 (CLUSTER$ OR NETWORK$ OR NODE$)) OR (NETWORK NEAR/3 (TRANSDUCER$ OR PROBE$)) OR (DETECTOR$ NEAR/0 NETWORK$) OR (METER NEAR/1 NETWORK$)) OR IP=(G01S-013/74 OR G01S-013/75 OR G01S-013/76 OR G01S-013/78 OR G01S-013/79 OR G01S-013/82 OR G01S-013/84 OR G06T-011* OR G06T-013* OR G01V-015*)
Data Management
IP=(H04L-009* OR H04W-012*)

Figure OA.1 presents the correlation between the 1-digit exposure scores with all patents and those while excluding the European patents.

Tables OA.3 to OA.16 presents the top three most-cited patents by emerging digital technologies.

Table OA.2: The Structured Patent Queries in Derwent Innovation Index Database (2/2)

AI and Intelligent Systems

MAN=(T01-J16* OR T06-A05* OR T06-A07*) OR IP=(G06K-009/00 OR G06K-009/03 OR G06K-009/18 OR G06K-009/46 OR G06K-009/48 OR G06K-009/50 OR G06K-009/52 OR G06K-009/54 OR G06K-009/56 OR G06K-009/58 OR G06K-009/60 OR G06K-009/62 OR G06K-009/64 OR G06K-009/66 OR G06K-009/68 OR G06K-009/70 OR G06K-009/72 OR G06K-009/74 OR G06K-009/76 OR G06K-009/78 OR G06K-009/80 OR G06K-009/82 OR G06T-007/30 OR G06T-007/32 OR G06T-007/33 OR G06T-007/35 OR G06T-007/37 OR G06T-007/38 OR G06T-007/40 OR G06T-007/41 OR G06T-007/42 OR G06T-007/44 OR G06T-007/45 OR G06T-007/46 OR G06T-007/48 OR G06T-007/49 OR G06T-007/50 OR G06T-007/507 OR G06T-007/514 OR G06T-007/521 OR G06T-007/529 OR G06T-007/536 OR G06T-007/543 OR G06T-007/55 OR G06T-007/557 OR G06T-007/564 OR G06T-007/571 OR G06T-007/579 OR G06T-007/586 OR G06T-007/593 OR G06T-007/60 OR G06T-007/62 OR G06T-007/64 OR G06T-007/66 OR G06T-007/68 OR G08G* OR G06N-003/00 OR G06N-003/02 OR G06N-003/04 OR G06N-003/06 OR G06N-003/063 OR G06N-003/067 OR G06N-003/08 OR G06N-003/10 OR G06N-003/12 OR G10L-025/63 OR G10L-025/66 OR G06N5* OR G10L15* OR G10L17*) OR TS=(((ARTIFIC* OR COMPUTATION*) NEAR/1 INTELLIGEN*) OR (NEURAL NEAR/1 NETWORK*) OR (BAYES* NEAR/1 NETWORK$) OR (CHATBOT$) OR (DATA NEAR/1 MINING) OR (DECISION NEAR/1 MODEL*) OR (DEEP NEAR/1 LEARNING*) OR (GENETIC NEAR/1 ALGORITHM$) OR ((INDUCTIVE NEAR/1 LOGIC) NEAR/0 PROGRAM*) OR (MACHINE NEAR/1 LEARNING) OR ((NATURAL NEAR/1 LANGUAGE) NEAR/1 (GENERATION OR PROCESSING)) OR (REINFORCEMENT NEAR/1 LEARNING) OR ((SUPERVISED OR UNSUPERVISED) NEAR/1 (LEARNING OR TRAINING)) OR (SWARM NEAR/1 INTELLIGEN*) OR ((SEMI-SUPERVISED OR SEMISUPERVISED) NEAR/1 (LEARN-ING OR TRAINING)) OR CONNECTIONIS* OR (EXPERT NEAR/1 SYSTEM$) OR (FUZZY NEAR/1 LOGIC) OR (TRANSFER NEAR/1 LEARNING) OR (LEARNING NEAR/2 ALGORITHM$) OR (LEARNING NEAR/1 MODEL*) OR (SUPPORT VECTOR MACHINE$) OR (RANDOM FOREST$) OR (DECISION TREE$) OR (GRADIENT TREE BOOSTING) OR (XGBOOST) OR AD-ABOOST OR RANKBOOST OR (LOGISTIC REGRESSION) OR (STOCHASTIC GRADIENT DESCENT) OR (MULTILAYER PER-CEPTRON$) OR (LATENT SEMANTIC ANALYSIS) OR (LATENT DIRICHLET ALLOCATION) OR (MULTIAGENT SYSTEM$) OR (HIDDEN MARKOV MODEL$)) OR TS=((ARTIFI* NEAR/1 INTELLI*) OR (AUTO* NEAR/1 LEARNING*) OR BAYESIAN OR (DATA NEAR/1 MINING) OR (DEEP NEAR/1 LEARNING) OR (MACHINE NEAR/1 LEARNING) OR (ARTIFICIAL* NEAR/1 LOGIC) OR (INTELLIG* NEAR/1 NEURONAL*), (NEURAL* NEAR/1 REASON*) OR (FUZZY NEAR/2 NETWORK*) OR (DATA NEAR/1 MINING) OR (ARTIFICIAL NEAR/2 INTELLIGENCE) OR (INDUCTIVE NEAR/2 LOGIC) OR (DEEP NEAR/1 LEARN-ING) OR (GENETIC NEAR/1 ALGORITHM*) OR (SUPPORT VECTOR MACHINE$) OR (NEURONAL NEAR/1 NETWORK$) OR (FUZZY NEAR/1 LOGIC)) OR IP=(G06F-015/18 OR G10L-013/027 OR G06N-020* OR G06F-017/00 OR G06F-017/10 OR G06F-017/11 OR G06F-017/12 OR G06F-017/13 OR G06F-017/14 OR G06F-017/15 OR G06F-017/16 OR G06F-017/17 OR G06F-017/18)

User Interfaces

MAN=(T01-J10C4A OR T01-J40 OR T01-J40C OR T04-F02B7) OR TS=((AUGM* NEAR/1 REALITY) OR (DATA NEAR/0 EYE-GLASS$) OR (DATA NEAR/0 SPECTACLE$) OR (GOOGLE NEAR/0 GLASS$) OR (HEAD NEAR/0 MOUNT* NEAR/0 DIS-PLAY$) OR (HEAD$UP NEAR/0 DISPLAY$) OR HMD OR HUD OR (HEAD NEAR/0 DISPLAY$) OR (WEARABLE NEAR/1 DIS-PLAY$) OR (ENVIRONMENT$ NEAR/3 VIRTUAL) OR (DISPLAY NEAR/2 HELMET) OR (MIXED NEAR/1 REALITY) OR (VIR-TUAL NEAR/1 REALITY) OR (ENHANCED NEAR/1 REALITY) OR (AUGMENTED NEAR/1 ENVIRONMENT$) OR (MEDIATED NEAR/1 REALITY) OR (MIXED NEAR/1 ENVIRONMENT) OR (VIRTUAL NEAR/1 WORLD)) OR IP=(G06K-011* OR G06T-011* OR G06T-013*)
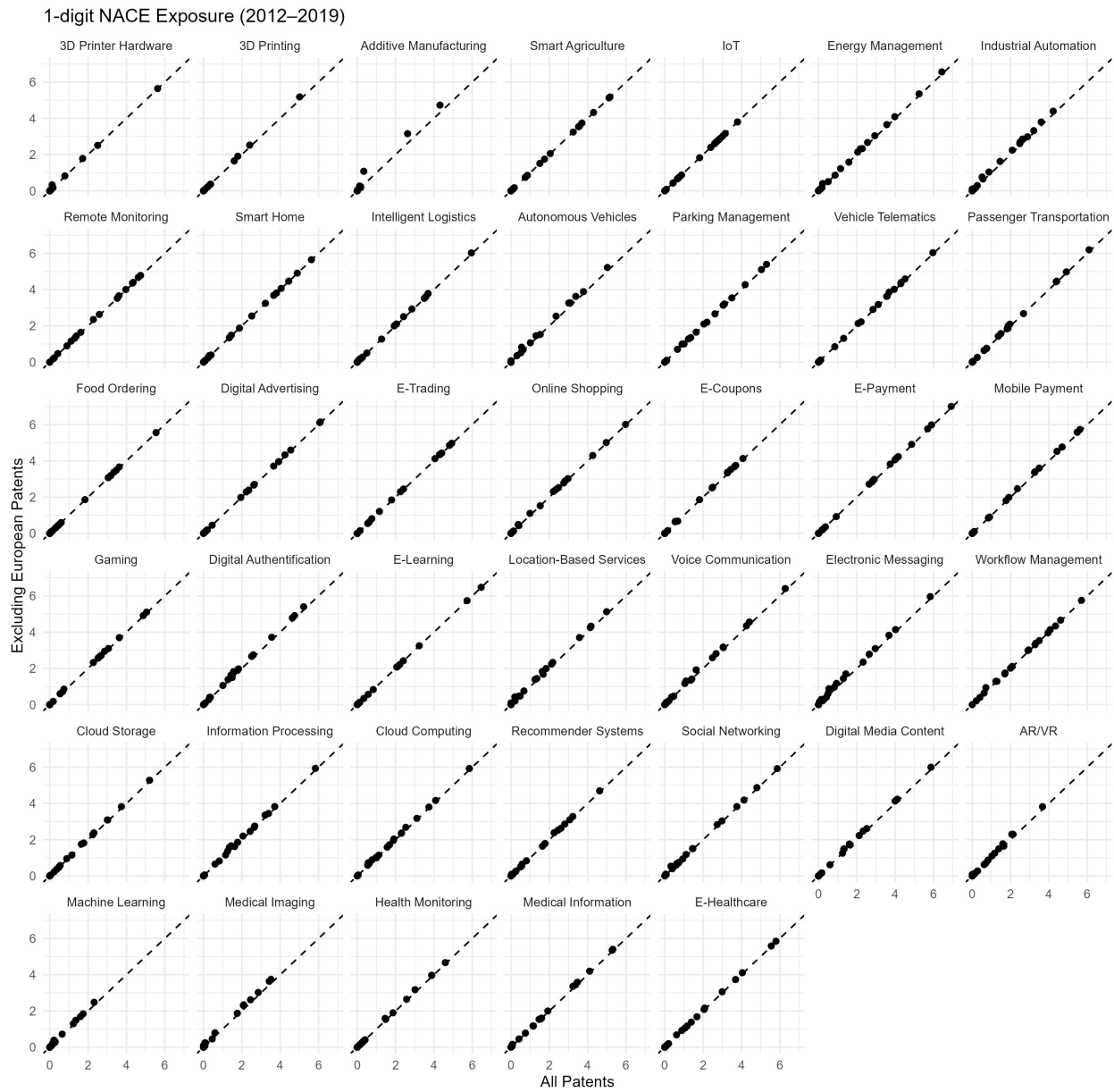
Computing

MAN=(T01-M06C OR T01-M06Q) OR TS= (IAAS OR PAAS OR SAAS OR ((SOFTWARE OR PLATFORM OR INFRASTRUCTURE) NEAR/2 SERVICE$) OR (SERVER$ NEAR/1 CLUSTER) OR (CLOUD NEAR/1 (COMPUT* OR DATA OR DISTRIBUT* OR GRID* OR POINT OR SERVER OR SERVICE$ OR STOR*)) OR (COMPUT* NEAR/1 GRID$) OR (DATA NEAR/0 CENTER$) OR (SERVER NEAR/0 FARM$)) OR IP=(G06E* OR G06J* OR G06N*)

Figure OA.2 depicts a positive relationship between the change in the employment-to-population ratio from 2012 to 2019 and the regional exposure to emerging digital technologies, after excluding regions with exceptionally low exposure levels—specifically, those with an exposure index below -2 standard deviations (i.e. below 0.929), which typically includes rural areas in Romania, Turkey, and overseas French territories.

Figures OA.3, OA.4, and OA.5 display the most exposed tasks to IoT, Industrial Automation, and Machine Learning by 1-digit ISCO-08 group.

Figure OA.1: 1-digit Industry Exposure With and Without European Patents (2012–2019)

1-digit NACE Exposure (2012–2019)

Note: European Patents account for 7.12% of the patent sample.

Notes: Each panel depicts the correlation between the 1-digit NACE exposure scores over the period 2012–2019 for each emerging digital technology with (x-axis) and without (y-axis) European patents. European patents are identified as those filed in the European Patent Office (EPO).

Table OA.3: Most cited patents by technology (1/14)

Patent ID	Patent title	Year	Cited
[01] 3D Printer Hardware			
201736370E	Three-dimensional object printer, has actuator for moving outlet into alignment with two channels in set of channels at different times to supply extrusion material from extrusion material supply to channels in set of channels	2017	54
2017363641	Multi-nozzle extrusion printhead for use in three-dimensional object printer, has electromechanical actuator for moving unit to position to enable flow of extrusion material through corresponding fluid outlet in fluid outlets	2017	53
201641448Q	Three-dimensional printer, has set of status pin connections for transferring data comprising identity of each cartridge, properties of associated build material dispenser, and properties of build material	2016	44
[02] 3D Printing			
201757292P	Method for generating three-dimensional object, involves accessing alteration of characteristic of three-dimensional printing based on measurement during three-dimensional printing and generating three-dimensional object	2017	216
201742766M	Method for printing three-dimensional object involves using energy beam to transform at least portion of exposed surface to transformed material, in which transformed material is portion of three-dimensional object	2017	137
201800449Q	Apparatus for printing e.g. three-dimensional objects in three-dimensional printer system, has load-lock for defining volume, and energy source for generating energy beam that irradiates to facilitate printing of three-dimensional object	2018	115
[03] Additive Manufacturing			
201730027V	Method for forming three-dimensional object, involves altering three-dimensional model of requested three-dimensional object to form altered model, and transforming portion of material bed with energy beam according to altered model	2017	85
201723486N	Formation of three-dimensional object, such as medical devices e.g. stents, involves providing carrier and optically transparent component defining a build region in between and irradiating build region with light through the component	2017	80
201835956B	Forming three-dimensional object for e.g. medical devices involves filling build region of transparent component with polymerizable liquid comprising polymerizable component, upconverting particles and photoinitiator and irradiating region	2018	79

Notes: This table presents the three most cited patents by technology.

Table OA.4: Most cited patents by technology (2/14)

Patent ID	Patent title	Year	Cited
[04] Smart Agriculture & Water Management			
2015385330	User display graphical configuration system for use in plant monitoring system for monitoring e.g. chemical process, has editor for presenting interface, and configuration form application using information to create graphical element usage	2015	41
201616464K	Computer-implemented method for managing agricultural activities, involves determining multiple field condition data based on subset of input data and providing multiple field condition data to user device	2016	41
2013H90027	System for controlling direct-drinking water equipment, has remote monitoring platform module to receive data obtained by monitoring control module so as to remotely monitor operation status of direct-drinking water device	2013	39
[05] Internet of Things (IoT)			
2017509033	ZigBee and cloud computing based intelligent household control system, has zigBee three-level tree wireless sensing network provided with network framework for shortening communication distance and reducing electromagnetic pollution	2017	89
2020669092	IoT system configured for monitoring and creating a digital twin of an industrial setting, comprises multiple sensors that capture sensor data and transmit the sensor data via a self-configuring sensor kit network	2020	54
2016224608	Internet-of-things based method for controlling and monitoring group of internet-of-things devices or mash-up service through computer, involves providing messaging service participated in internet-of-things devices through group chat room	2016	52
[06] Predictive Energy Management and Distribution			
2013V51221	System for electric power grid element and network registration and management of grid elements, has active grid element that is constructed within housing, and update message transforms function by updating attribute of grid element	2013	243
2013F50499	Method for interactively and graphically displaying e.g. energy consumption of Heating, Ventilation and Air conditioning system to user, in home, involves gathering information relating to system usage using thermostat	2013	173
201570114J	System for analyzing building energy consumption information, has real-time energy efficiency plan providing device providing energy efficiency improvement plan for building in real-time based on energy consumption analysis result	2015	138

Notes: This table presents the three most cited patents by technology.

Table OA.5: Most cited patents by technology (3/14)

Patent ID	Patent title	Year	Cited
[07] Industrial Automation & Robot Control			
2014R39999	System for operating process plant e.g. chemical process plant, has one user interface (UI) device that is operated, so that status information indicating one multiple routines on one UI device is passed to another UI device	2014	190
2012M05358	Control system for controlling operation of pallet truck in e.g. shipping dock, has input device responding to operational data by producing commands that are transmitted for remotely controlling operation of industrial vehicle	2012	154
2018A3032C	Method for performing device operations management in schedule of tasks involving devices, involves unlocking machine for use by operator by using computer at scheduled time by sending unlock message to machine at updated start time	2018	132
[08] Remote Monitoring & Control Systems			
2017783476	Data collection system for industrial environment, comprises platform that is provided with a computing environment, where computing environment of the platform compares the relative phases of the first and second sensor signals	2017	523
201913893E	Data collection system for use in industrial production environment, has analysis response circuit which is structured to adjust sensor scaling value or sensor sampling frequency value, in response to sensor performance value	2019	309
2013N11698	Method of operating heating, ventilation or air conditioning (HVAC) monitoring system installed in e.g. residential building, involves analyzing stored data to selectively identify problems and predict faults of HVAC system	2013	189
[09] Smart Home & Intelligent Household Control			
2014T60296	Method for controlling home automation system by vehicle control system, involves monitoring status of person in home and determining whether status of person is changed or not, by microprocessor executable home automation system	2014	257
201532495K	Method for controlling smart-home environment of smart devices in e.g. resource-consuming physical systems, involves automatically adjusting functionality of one of smart devices using computing system based on analyzing	2015	230
2013K37085	Intelligent control method for intelligent home system and household appliance, involves controlling gateway by intelligent control unit to control and enable household appliances for executing operations according to habit order table	2013	195

Notes: This table presents the three most cited patents by technology.

Table OA.6: Most cited patents by technology (4/14)

Patent ID	Patent title	Year	Cited
[10] Intelligent Logistics			
201542986L	Shelving system for package-delivery vehicle e.g. delivery truck, has central processing unit that is configured to identify package-location information, in response to vehicle-location information	2015	280
2013Q07655	Method for delivering items stored in e.g. bin of pickup location to customers for electronic-commerce and mail-order companies, involves providing instructions at location to place item into storage compartments of identified location	2013	222
201537957C	Computerized electronic locker system for parcel delivery and pick-up, has computer and software with internet connection, which are configured to transmit parcel related data and notifications to parcel recipient	2015	148
[11] Autonomous Vehicles & UAVs			
2013J15200	Vehicle control method of vehicle system, involves automatically determining person within vehicle, automatically identifying person, determining if setting to be stored for person, and storing setting	2013	1101
201749377L	Navigation system for host vehicle, has processing device determining actual navigational action having modification of desired navigational action, and causing adjustment of navigational actuator in response to actual navigational action	2017	259
201648714V	Autonomous guidance system for operating a vehicle in an autonomous mode, comprises a controller to determine an object-location of object on a map of area based on a vehicle-location of vehicle on map, image signal, and reflection signal	2016	231
[12] Parking & Vehicle Space Management			
2012E53618	Computer-implemented system for managing motor vehicle e.g. car parking reservations, has availability module to indicate availability of parking space through nearest parking availability indicator	2012	200
2014P33734	Parking meter for monitoring and managing vehicle parking, has processor which detects vehicle presence in parking space, captures identification (ID) of vehicle, times initial grace period, and receives payment for parking time period	2014	152
2012J60343	Auto-valet parking (AVP) server device for AVP system, has parking map management unit that receives information about final slot selected by user from among customized parking slots, and provides route to final slot	2012	134

Notes: This table presents the three most cited patents by technology.

Table OA.7: Most cited patents by technology (5/14)

Patent ID	Patent title	Year	Cited
[13] Vehicle Telematics & Electric Vehicle Management			
2012D36559	Risk management system for monitoring and facilitating review of data collected from vehicle, has server processes selected vehicle data and generates rating factor based on selected vehicle data stored in database	2012	342
2013K60165	Apparatus for detecting usage of mobile phone during driving of car, has detection system including processor and set of sensors that are operative to be used by processor, where detection system is operated to communicate to remote server	2013	236
2012K82179	System for monitoring vehicle data that is used to determine e.g. level of risk, in operating vehicle e.g. automobile, has wireless transceiver to encrypt and encode relationship data and vehicle data and transmit encoded data	2012	208
[14] Passenger Transportation			
2012C13650	Method for coordinating transportation service e.g. taxi service, involves determining suitable transportation vehicle for trip, and delaying the dispatching if request for trip specifies delayed pick-up	2012	266
2015381635	Method for automobile sharing server, involves crediting financial account of owner with payment of renter in threshold radial distance from driverless vehicle when predicted at non-transitory location for available period of time	2015	200
2014M09285	Method for operating dispatch server used in system for facilitating short-term automobile rentals, involves dispatching private vehicle of set of private vehicles in geo-spatial vicinity of geo-spatial location	2014	189
[15] Food Ordering & Vending Systems			
2014E23249	Method for tracking of delivery of menu item from restaurant to dwelling of customer, involves sending displacement notification to customer interface including indication of geographical position of available delivery vehicle	2014	77
2013F52957	Method for offering and managing reservations for restaurant on e.g. smartphone, involves receiving approval from user to have reservation to be transferred to another user, and arranging incentive to be provided to user	2013	76
2015641449	System for presenting smart recurrent orders for purchasing e.g. baby wipe by consumer, has analysis module executed by processor for determining adjustment to order schedule, and order module facilitating adjustment to schedule for item	2015	70

Notes: This table presents the three most cited patents by technology.

Table OA.8: Most cited patents by technology (6/14)

Patent ID	Patent title	Year	Cited
[16] Digital Advertising			
2013B87254	Method for targeting television advertisement based on profile linked to online device, involves selecting television advertisement to be directed to set-top box based on profile information pertaining to user or online activity	2013	382
201522675P	Method for targeting advertising content, involves determining individual sets of advertising content from individual sets of advertising content, and transmitting individual sets of advertising content to fictitious user name	2015	329
2013T30678	Method for delivering marketing information to customers, involves receiving sighting message and transmitting message to computing device including identified marketing information relevant to wireless identity transmitter	2013	244
[17] Electronic Trading and Auctions			
2014M20580	Data processing system e.g. desktop computer for managing electronic offer, has logic module that automatically suggest offer to offer provider based on subset of historical transaction records and subset of offer data	2014	252
201619462W	Computer-implemented method for trading assets using decentralized escrow service, involves receiving notification from central processing server of trade order match module using order matching module	2016	114
2013M28862	Exchange data processing system for e.g. trading valuation of consumer-directed trading financial products, has trading software for executing on computer for trading financial product of system using monetary value and transparency index	2013	109
[18] Online Shopping Platforms			
2014A42720	Method for purchasing product or service in e.g. social network, involves electronically providing mobile and internet posting of location based-customized, promotion or offer comprising website for products or services to user	2014	373
2013M09177	Method for processing e.g. point-of-sale transaction for purchase of grocery item in supermarket, involves processing transaction based on data regarding information regarding transaction and physical location of electronic device	2013	320
2014T48720	System for fulfilling sale request for item in e.g. internet based online store, has processing element that determines whether item is suitable for use in fulfilling request based on fulfillment confidence score	2014	255

Notes: This table presents the three most cited patents by technology.

Table OA.9: Most cited patents by technology (7/14)

Patent ID	Patent title	Year	Cited
[19] E-Coupons & Promotion Management			
2013E25218	Information storage and display device for managing and redeeming bar-coded coupons displayed from light emitting display surfaces of information display devices, comprise computing platform for running computer applications	2013	373
2013E12801	Method for generating wireless and internet posted-location based customized promotion and offer e.g. coupon for product and service, involves assigning unique identifier to user of client mobile device that receives request from user	2013	327
2014V55925	Device e.g. smart-phone for displaying digital images of bar-coded store coupon for coupon redemption operation, has computing platform that is configured to convert barcode symbol to pulse code modulation formatted barcode symbol	2014	263
[20] Electronic Payments & Financial Transactions			
201604016J	Method for sending funds or credits relating to good or service to e.g. location of participating entity, involves delivering electronic communication to electronic address, where communication comprises data pertaining to instruction	2016	694
2013X40687	Bill payment apparatus for e.g. facilitating transactions relating to effectuating payments of bills to consumers, has processor to expire temporary postponement payment account if balance value reaches zero, by deleting account	2013	334
2014E57471	Cloud-based virtual wallet secure transaction processor-implemented method for processing electronic purchase transaction in e.g. online shopping, involves providing transaction bounding token to transaction security server	2014	295
[21] Mobile Payments			
2012D97057	Mobile payment account activation system has account activation unit that automatically authenticates user associated with inactive mobile payment account by transmitting validation data to portable electronic device	2012	324
2015135153	Method for processing transaction in e.g. portable electronic device, involves processing transaction based on data regarding information regarding transaction and physical location when obtaining information regarding time of day	2015	311
2012J91915	Mobile device e.g. mobile phone, for authorizing payment for transaction in e.g. restaurants by e.g. point of sale terminal, has processor using communication device to transmit predetermined payment information and authorize payment	2012	298

Notes: This table presents the three most cited patents by technology.

Table OA.10: Most cited patents by technology (8/14)

Patent ID	Patent title	Year	Cited
[22] Gaming & Wagering Systems			
2013B47685	Game networking system for combining games based on levels of interactivity of e.g. gambling games has integrating module that provides player with option to participate in secondary game while having idle time with respect to primary game	2013	183
2013M91402	Method for performing casino game using personal digital assistant, involves allowing cellular telephone to access gaming services based on location of cellular telephone being in approved location by computing device	2013	107
2016106891	Wireless communication system for lottery ticket selling with a single platform, has computer system with a workflow server, and workflow module with sets of workflow instructions for processing different types of lottery game packets	2016	106
[23] Digital Authentication			
2014R64759	Apparatus for performing advanced authentication techniques for banking applications, has authentication logic attesting to model and/or integrity of component to another components prior to allowing components to form authenticator	2014	647
2014B84307	Proxy wallet transaction authentication method for finding, storing and applying discounts in transaction, involves receiving transaction authentication request associated with proxy payment identifier and authenticating transaction	2014	358
2012R18811	System for acquiring digital credential data to perform securing authorization of card present financial transaction with card issuing bank in financial transaction industry, has communication device receiving repository response with data	2012	311
[24] E-Learning			
2014K73633	Learning management system for managing multiple e.g. tablet computers simultaneously in smart classroom, has server system for interpreting and handling communications between controllable devices and controller device	2014	181
201519486C	Interactive learning platform, has teaching resource management module connected with online classroom management module that is connected with collecting unit, and data package storing and uploading process performed	2015	101
2013V12318	System for interactive class support and education management using e.g. portable terminal, has specific device that performs correction guidance for assignment and test and stores teacher-correction-guided content in server	2013	98

Notes: This table presents the three most cited patents by technology.

Table OA.11: Most cited patents by technology (9/14)

Patent ID	Patent title	Year	Cited
[25] Location-Based Services & Tracking			
2015159503	Method for distributing micro-location-based notification to computing device, involves resolving unique identifier that is collected from wireless beacon by computing device, into identity of wireless beacon using rule	2015	162
2013E12714	Method for identifying e.g. airport visited by user of e.g. pager, involves receiving indicated named location from device corresponding to business location visited by user of device, and transmitting reference number to device	2013	150
201563193M	Method for power management of mobile clients using location-based services in social networking environment, by sending location history to location server of online social network based on current status of mobile-client system	2015	149
[26] Voice Communication			
2013L87369	Personal safety notification system i.e. mobile alert system, for alerting e.g. students, during emergency situation, has server providing alert/event details to mobile device in active sub-network in response to occurrence of alert/event	2013	336
2014E49356	Communication device e.g. cell phone has mixed array that is provided with different types of array units and provided to occupy area coinciding with in plan view as viewed perpendicular to major surface, and entire major surface	2014	205
2014G07765	Wireless communication device e.g. smart phone, for use in communication system, has processor for establishing connection between device and end-point device and applying control to traffic, and memory coupled to processor	2014	195
[27] Electronic Messaging			
2016569813	Messaging system used for instructing staff with enterprise related matters, has distributed network gateway server that validates client device with message management policy before authorizing transmission of impermanent text message	2016	221
2013C74472	Method for e.g. integrating conversation view with voice over-internet protocol calls and communication, involves selecting contact from list of contacts, and displaying graphical user interface including interaction events	2013	188
2013B03892	On-line system for providing group interaction e.g. group chats, around common online content in computing device, has user devices accessing and loading content via computer network in response to receiving reference to content	2013	184

Notes: This table presents the three most cited patents by technology.

Table OA.12: Most cited patents by technology (10/14)

Patent ID	Patent title	Year	Cited
[28] Workflow Management			
2016535312	System for providing enhanced security for enterprise computing environment has modules which provide services to computing environment and interfaces, which provide access to collected data and services	2016	391
2016112028	Inventory management system for managing tasks in facilities, has computer system for generating connectivity improvement information and providing connectivity improvement information to one of access points or mobile drive unit	2016	174
2014R46796	Computer implemented method for interacting with records from user interface, involves receiving second information associated with first record or second record from publisher, and updating database system based on second information	2014	143
[29] Cloud Storage & Data Security			
2013M79136	Method for enabling provision of keys between users to enable data security, involves providing specific key encrypted with specific further key to predetermined user in manner independent of data	2013	208
2014P51999	Method for executing application program in public cloud network without moving private dataset of application program from data storage, involves executing application program with data processor to access data blocks of private dataset	2014	138
2014W31419	Method for providing cloud storage service in communication system in hybrid cloud computing environment, involves deploying cloud storage gateway in cloud, where gateway facilitates secure migration of data associated with virtual machine	2014	136
[30] Information Processing			
201865517X	Readable and rewriteable card blank for use with hand-held electronic device, has personal electronic data sets that are read into card to form factor collectively for electronic transacting or fulfillment of electronic identification query	2018	81
2014Q18150	System for processing data in connection with insurance information submissions to generate insurance policy, has storage devices for storing data relating to accessing of entity data where insurance form is outputted for display on device	2014	45
2019427506	Method for processing information of terminal device, involves obtaining first information, where first information is processed by terminal device, and transmitting operation instruction to computing device to obtain second information	2019	43

Notes: This table presents the three most cited patents by technology.

Patent ID	Patent title	Year	Cited
[31] Cloud Computing			
2014D78354	Multi-tenant cloud computing system, has cloud controllers for managing cloud infrastructures utilizing virtual resources to operate other resources that provide access to physical resource pool through controllers	2014	297
2014A40902	Computer-implemented method for implementing hybrid-cloud computing network infrastructure, involves installing user application in provisioned computing resource in accordance with application blueprint	2014	221
201516824J	Method for providing cloud service brokering service by computer-implemented cloud service brokering system, involves allocating selected cloud computing resource for use by customer by computer-implemented cloud service brokering system	2015	187
[32] Recommender Systems			
201541187F	Method for generating client-side structured search queries involves generating structured queries by matching unstructured text query to accessed nodes and grammar templates having non-terminal tokens by mobile client system	2015	131
2012P90150	Computer-implemented method for searching e.g. application object of website, involves ordering objects of combined result set, and providing portion of combined result set to client device in response to query	2012	119
201764769V	System for providing personalized content recommendation, has memory that executable by processors generates user interface in which individual cards of group of cards are corresponds to individual containers in group of containers	2017	108
[33] Social Networking & Media Platforms			
2015197305	Method for presenting real-time interface for sending invitation for adding users to contacts and groups or social networks, involves enabling requestor users and users of wireless networks for participating with activities of each other	2015	240
2013L99116	Method for detecting social graph elements for queries to perform search for e.g. text, within e.g. internet, involves identifying nodes including score greater than node-threshold score and generating query including references to nodes	2013	195
2013H44326	Method for generating structured queries based on social-graph information, involves identifying identified edges corresponding to grams, and generating structured queries with references to identified nodes and identified edges	2013	192

Notes: This table presents the three most cited patents by technology.

Table OA.14: Most cited patents by technology (12/14)

Patent ID	Patent title	Year	Cited
[34] Digital Media Content			
201673838R	Non-transitory computer-readable storage medium for proactively identifying and surfacing relevant content on electronic device, comprises multiple executable instructions that are executed for executing an application on electronic device	2016	332
201726949F	Playback device e.g. mobile device for accessing content using decentralized blockchain right ledger, has ledger modification application to decrypt content from digital media work using decrypted content key and play back decrypted content	2017	239
201547609G	System for sharing digital user content through distinct network-accessible sharing platforms, has external content exposure tracker that is configured for tracking integration of external content with user content for distinct users	2015	228
[35] Augmented and Virtual Reality (AR/VR)			
201553908H	Wall-mounted interactive sensing and audio-visual node device for networked e.g. living space, has faceplate mounted to wall such that outer surface of faceplate is placed away from wall, where wall power input is connected to power line	2015	115
2015364438	Method for controlling operation of display screens of vehicle, involves processing instructions to automatically move item of graphical content rendered in display screen to being rendered in dashboard display screen	2015	88
2014T69316	Multimedia data aesthetic and synchronous display method for graphical user interfaces of smart TV set of social network user, involves displaying arranged content of video channel by graphical user interface according to display design	2014	67
[36] Machine Learning & Neural Networks			
202050356J	Method for image recognition in image or video recognition platform, involves obtaining match for image of search engine for images based on contradiction, uncertainty analysis and datas, and outputting match for image of engine for images	2020	94
201937401H	Method for generating augmented training dataset for training convolutional neural network model to recognize target object, involves training convolutional neural network model to recognize target object based on training dataset	2019	49
201923013S	Method for training neural network, involves obtaining trained neural network, and continuing input of first training input image and second training input image to repeat training process when loss value does not satisfy preset condition	2019	48

Notes: This table presents the three most cited patents by technology.

Table OA.15: Most cited patents by technology (13/14)

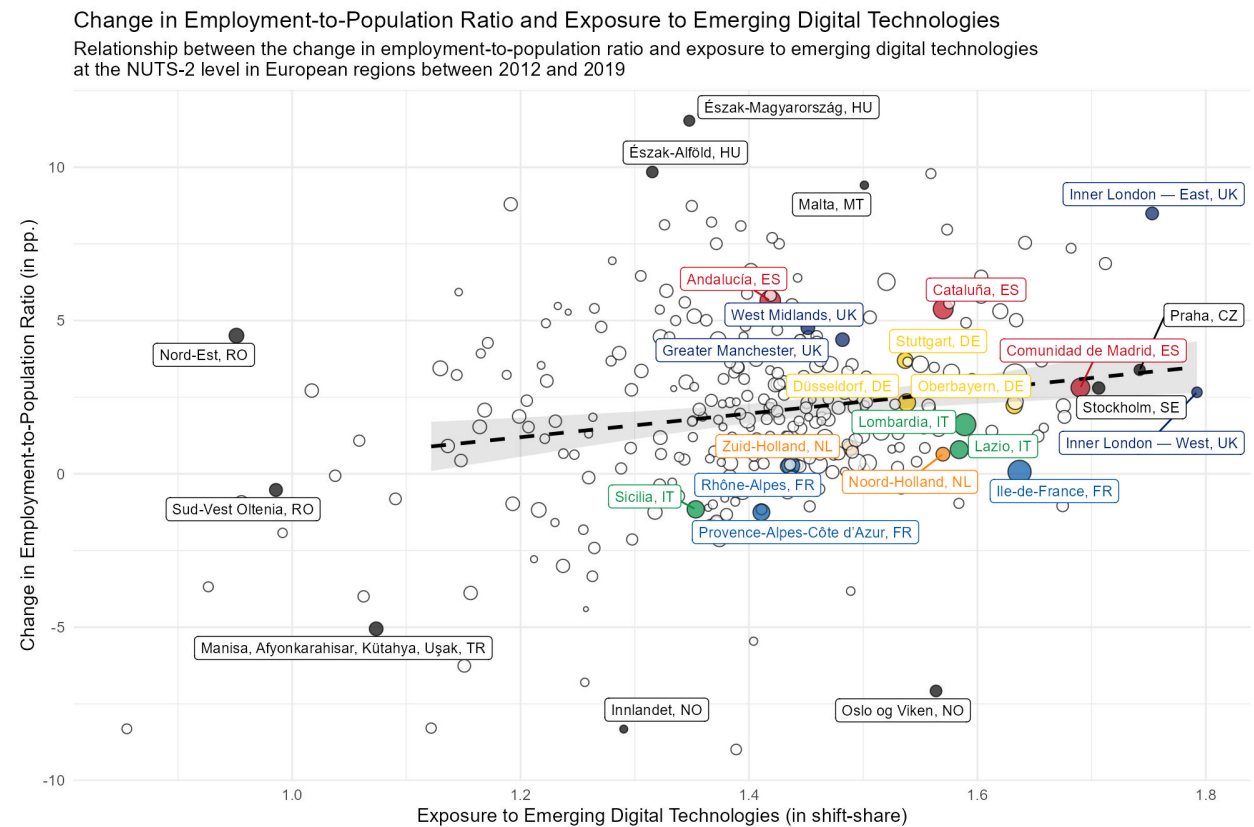| Patent ID	Patent title	Year	Cited
[37] Medical Imaging & Image Processing			
2014V59740	System for displaying three-dimensional point cloud image of biopsy needle and ultrasonic image of patient's anatomy on movable display, has processor repositioning image of patient's anatomy on display screen in real-time	2014	177
2019567486	Surgical image acquisition system for use in operating theater of hospital, has computing system for determining depth location of structure within tissue sample and calculating visualization data regarding structure and depth location	2019	174
2017165997	Computer-implemented method of providing ensuring medical device position and functionality, involves confirming position of medical device within patient using imaging device	2017	91
[38] Health Monitoring			
2013V85481	System for electronic patient care in hospital, has medical device that operatively receives and communicates measured physiological parameter from medical sensor, and server receives and stores measured physiological parameter	2013	407
201549924Y	Electronic device for use in network environment, has main body for obtaining bio-information of user by using communication module of bio-signal detection sensor, and processor for providing service of bio-information	2015	333
2013G61970	Wearable device e.g. radio, to provide physical or physiological characteristics associated with e.g. speed data, has instructions displaying metric of one mode in response to determining that time-out period has expired	2013	268
[39] Medical Information			
201832322L	System for facilitating synthetic interaction between patient, and computer-implemented program, has processor for identifying and executing action including instructing interactive device to present subsequent script to user	2018	227
2019575586	Method for collecting data within healthcare facility i.e. hospital, involves determining trends associated with surgical procedures performed in facility by computer system according to perioperative data and procedural context data	2019	226
2013U13719	Method for processing medical documentation about patient in healthcare industry, involves receiving structured data set including information relating to medical facts, from medical documentation system	2013	179

Notes: This table presents the three most cited patents by technology.

Table OA.16: Most cited patents by technology (14/14)

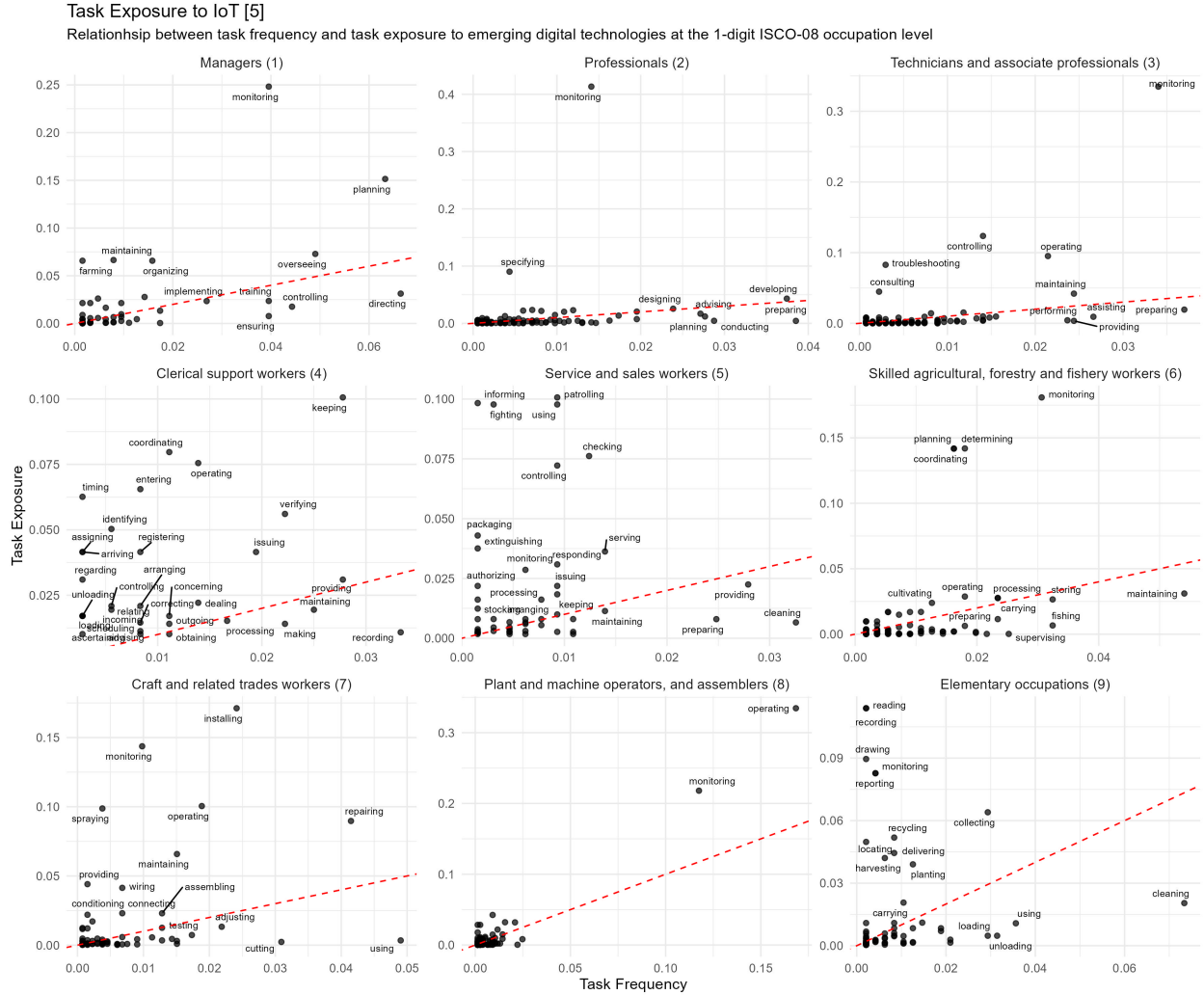| Patent ID	Patent title	Year	Cited
[40] E-Healthcare			
201521223E	Method for using mobile information gateway for home healthcare for treating patient by e.g. nurse, involves retrieving information using captured information, and presenting retrieved information using human interface module	2015	255
2013C62758	Medical image exchange system for exchanging medical image data in medical institution, has medical image transmission system, which is provided with terminal in hospital, relay server, medical image display terminal and information system	2013	252
2013F70757	System for providing automatic messaging to patient on behalf of e.g. doctors from hospital regarding health instructions to continuously monitor patient, has processor selecting agents to send instruction promoting healthy client behavior	2013	242

Notes: This table presents the three most cited patents by technology.

Figure OA.2: Change in Employment-to-Population Ratio and Exposure to Emerging Digital Technologies (excluding regions below -2 standard deviations)
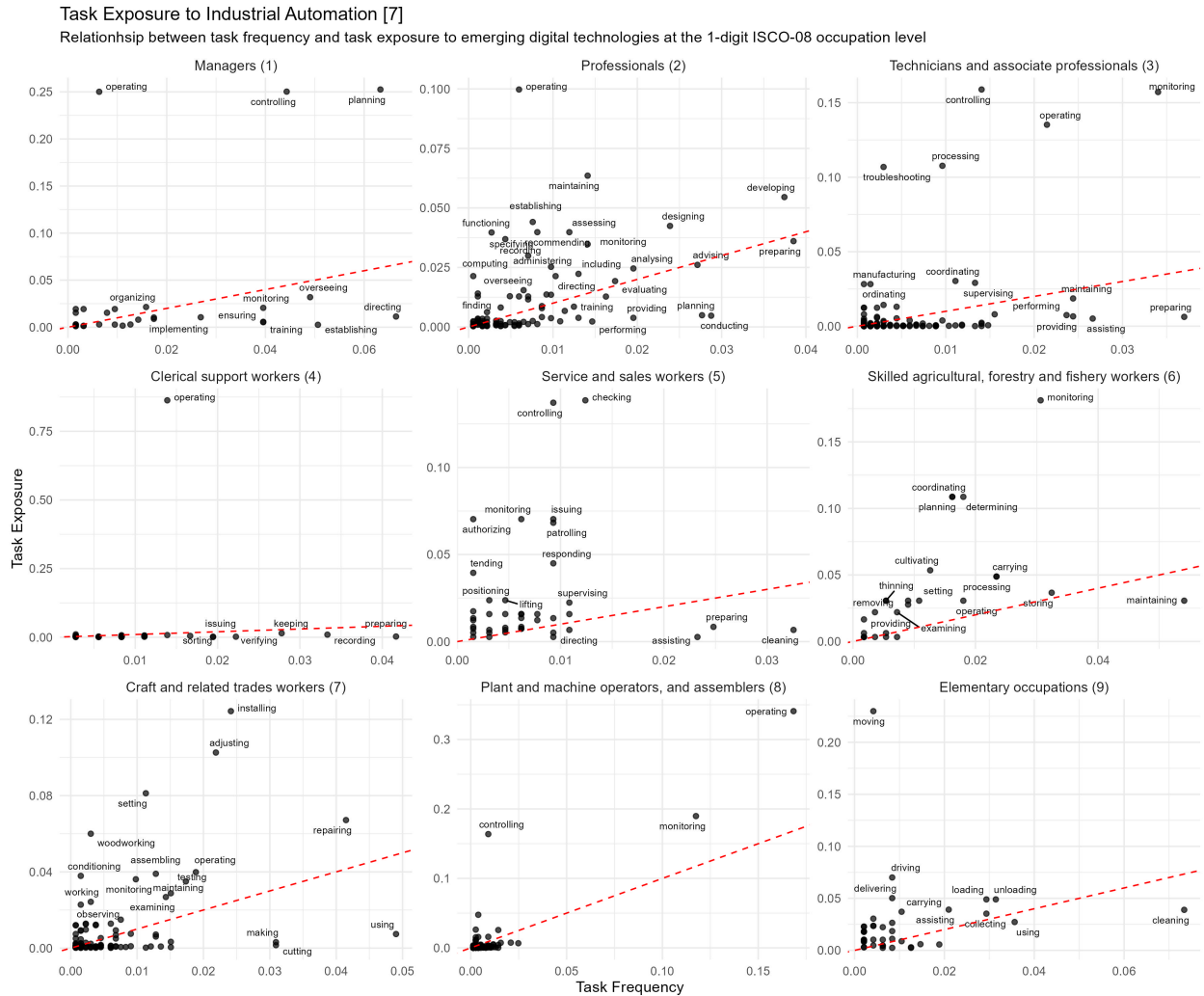

Change in Employment-to-Population Ratio and Exposure to Emerging Digital Technologies
Relationship between the change in employment-to-population ratio and exposure to emerging digital technologies at the NUTS-2 level in European regions between 2012 and 2019

Notes: This figure shows the relationship between the change in the employment-to-population ratio and the exposure to emerging technologies in European NUTS-2 regions between 2012 and 2019. Each point represents a region, with select regions labeled for emphasis. The size of the point is proportional to the population in 2010. The horizontal axis measures the exposure to emerging technologies calculated by the shift-share method, while the vertical axis represents the change in the employment-to-population ratio. The solid line indicates a positive correlation between increased regional exposure to emerging technologies and employment growth. Regressions lines are weighted by population in 2010. Data points are color-coded by country. Outliers are highlighted and labeled for clarity.

Figure OA.3: Most Exposed Tasks by 1-digit ISCO-08 Occupations Groups to IoT

Task Exposure to IoT [5]

Relationhsip between task frequency and task exposure to emerging digital technologies at the 1-digit ISCO-08 occupation level
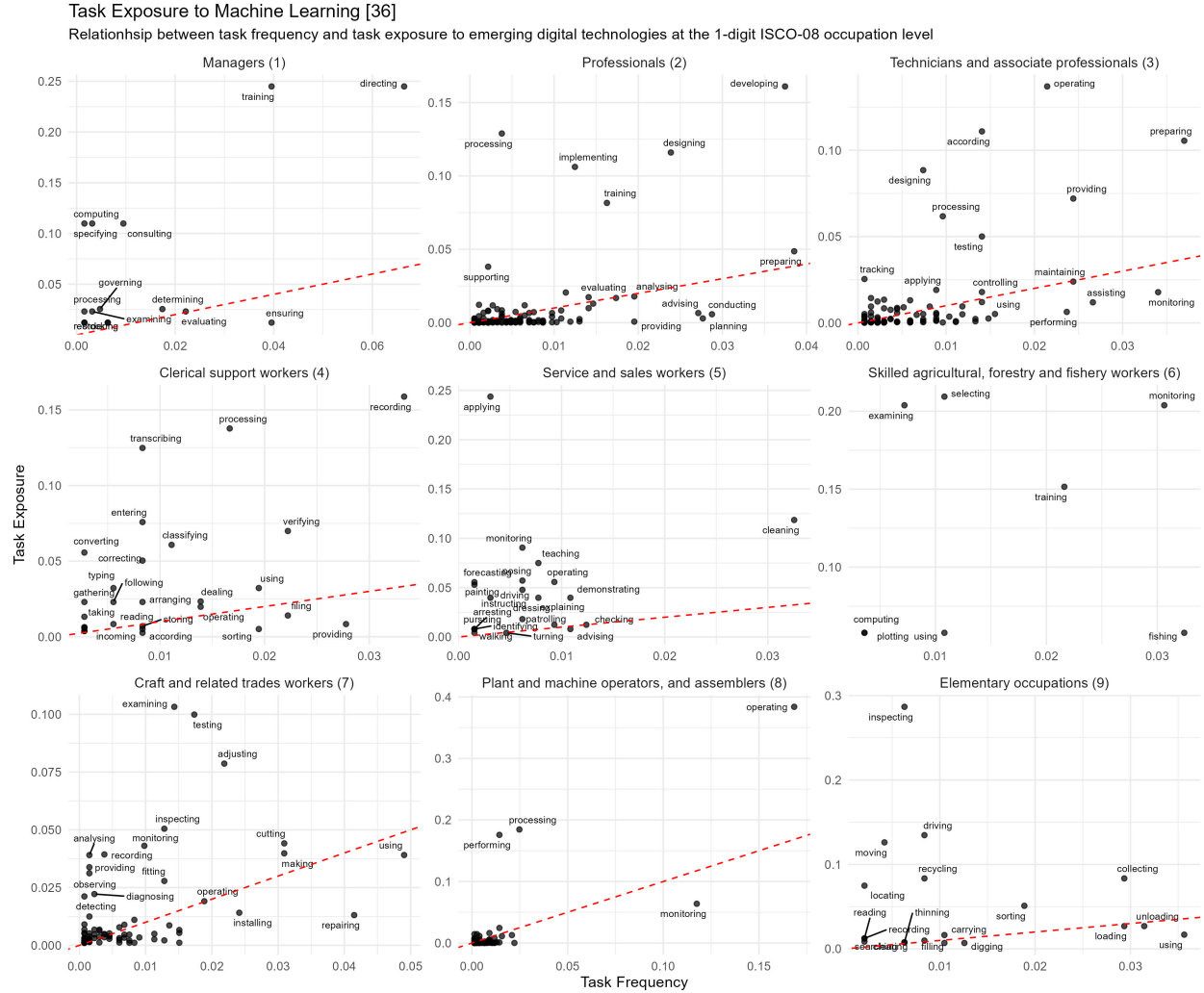

Notes: This figure displays the top exposed tasks, summarized with their gerunds. The horizontal axis is the term's baseline frequency (i.e., ISCO-08 classification). The vertical axis is the term's target frequency. The probabilities in the target corpus are weighted by the cosine similarity between the task and the technology. The diagonal line indicates equality between the baseline and target frequencies.

Figure OA.4: Most Exposed Tasks by 1-digit ISCO-08 Occupations Groups to Industrial Automation

Task Exposure to Industrial Automation [7]

Relationhsip between task frequency and task exposure to emerging digital technologies at the 1-digit ISCO-08 occupation level

Notes: This figure displays the top exposed tasks, summarized with their gerunds. The horizontal axis is the term's baseline frequency (i.e., ISCO-08 classification). The vertical axis is the term's target frequency. The probabilities in the target corpus are weighted by the cosine similarity between the task and the technology. The diagonal line indicates equality between the baseline and target frequencies.

Figure OA.5: Most Exposed Tasks by 1-digit ISCO-08 Occupations Groups to Machine Learning

Task Exposure to Machine Learning [36]

Relationhsip between task frequency and task exposure to emerging digital technologies at the 1-digit ISCO-08 occupation level

Notes: This figure displays the top exposed tasks, summarized with their gerunds. The horizontal axis is the term's baseline frequency (i.e., ISCO-08 classification). The vertical axis is the term's target frequency. The probabilities in the target corpus are weighted by the cosine similarity between the task and the technology. The diagonal line indicates equality between the baseline and target frequencies.