

The future of employment

How susceptible are jobs to computerisation?

Frey, Osborne 2013, University of Oxford

10th April 2015

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Nearly half of US jobs could be at risk of computerization, Oxford Martin School study shows

Transport, logistics, and office roles most likely to come under threat

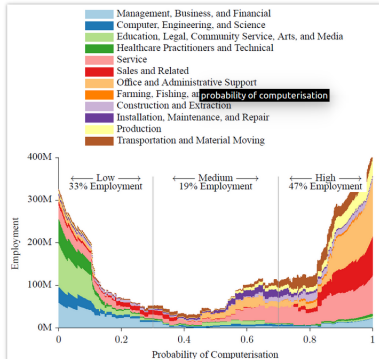
September 19, 2013

Nearly half of U.S. jobs could be susceptible to computerization over the next two decades, a [study](#) from the [Oxford Martin Programme on the Impacts of Future Technology](#) suggests.

The study, a collaboration between Dr. Carl Benedikt Frey (Oxford Martin School) and Dr. Michael A. Osborne (Department of Engineering Science, University of Oxford), found that jobs in transportation, logistics, and office/administrative support are at "high risk" of automation.

More surprisingly, occupations within the service industry are also highly susceptible, despite recent job growth in this sector, they say.

"We identified several key bottlenecks currently preventing occupations being



The probability of computerization (0 = none; 1 = certain) for the U.S. Bureau of Labor



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Aviva Hope Rutkin
September 12, 2013

Report Suggests Nearly Half
of U.S. Jobs Are Vulnerable
to Computerization

Oxford researchers say that 45 percent of America's occupations will be automated within the next 20 years.

Rapid advances in technology have long represented [a serious potential threat to many jobs](#) ordinarily performed by people.

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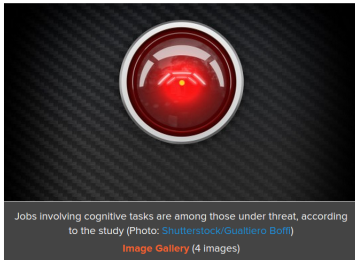
www.gizmag.com/half-of-us-jobs-computerized/29142/

COMPUTERS

47% of US jobs under threat from computerization according to Oxford study

By Lakshmi Sandhana
September 24, 2013

17 Comments
4 Pictures



Almost 47 percent of US jobs could be computerized within one or two decades according to a recent study that attempts to gauge the growing impact of computers on the job market. It isn't only manual labor jobs that could be affected: The study reveals a trend of computers taking over many cognitive tasks thanks to the availability of big data. It suggests two waves

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About A 50/50 Chance A Computer Threatens To Steal Your Job: Paper

The Huffington Post | By Maxwell Strachan   

Posted: 09/14/2013 1:29 pm EDT | Updated: 09/14/2013 2:11 pm EDT

75

49

0

525

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online.

There's a fairly good chance a computer could one day be doing your job instead of you, according to a recent paper out of Oxford College.

The working paper, put out in August and complete with the fun title, "[The Future of Employment: How Susceptible are Jobs to Computerisation?](#)", comes from the Oxford Martin Programme on the Impacts of Future Technology and is not available

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10 Jobs That Won't Be Taken By Robots, Yet

5 of 11

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6. Most Health Care

If you're a doctor, nurse, or physical therapist--working in a healthcare job that requires a lot of direct interaction with patients--there's probably no need to be looking over your shoulder for a machine version of yourself, says Ford. All the same, he cautions, "there are certainly a lot of areas where automation is developing--like hospital delivery and pharmacy robots. The Japanese are even working on automating some nursing and elder-care functions." In fact, he

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10 Jobs That Won't Be Taken By Robots, Yet

1 of 11

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10. Politics

Predictions about our robot overlords aside, we will probably never have a robot in the White House. "I think a lot of government jobs may someday be threatened, but probably not those of politicians," says Ford. A robotic president would require human-like artificial intelligence of a kind that experts may never be able to develop, he points out. And even if they could, the people who kiss babies, give speeches, and make laws for a living will probably retain their

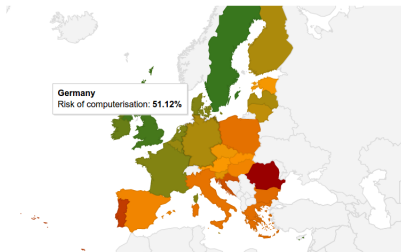
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www.bruegel.org/hc/blog/detail/article/1394-the-computerisation-of-european-jobs/

computerisation risk equivalent to the proportion of total employment likely to be challenged significantly by technological advances in the next decade or two across the entirety of EU-28.

It is worth mentioning a significant limitation of the original paper which the authors acknowledge – as individual tasks are made obsolete by technology, this frees up time for workers to perform other tasks and particular job definitions will shift accordingly. It is hard to predict how the jobs of 2014 will look in a decade or two and consequently it should be remembered that the estimates consider how many jobs as *currently defined* could be replaced by computers over this horizon.

The results are mapped below.



Source: Bruegel calculations based on Frey & Osborne (2013), ILO, EU Labour Force Survey

Background

- ▶ Keynes's 1933 prediction of widespread technological unemployment – “due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour”
- ▶ Current trend: labour market polarisation “Lousy and Lovely Jobs”, Goos, Manning, 2007

Non routine tasks

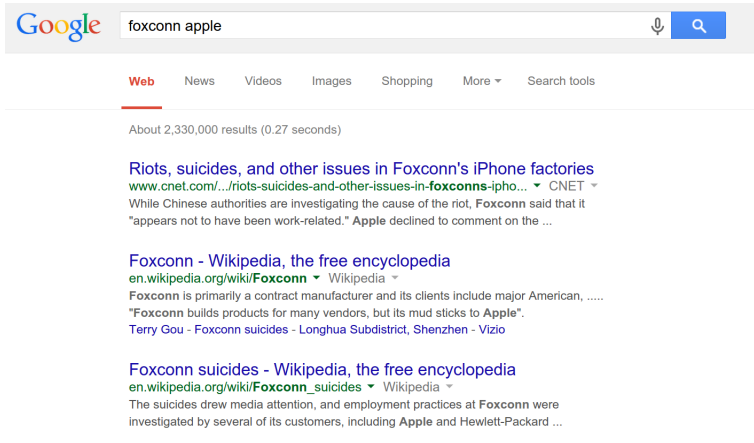
- ▶ “Why people still matter”, Levy, Murnane, 2004 – “But executing a left turn against oncoming traffic involves so many factors that it is hard to imagine discovering the set of rules that can replicate the driver’s behaviour”
- ▶ Six years later: Google’s autonomous car works
- ▶ Computerisation no longer confined to routine manufacturing tasks
- ▶ Which engineering tasks need to be solved for an occupation to be automated?

Cognitive non-routine tasks

- ▶ Big Data allows to **quantify** previously ill-posed tasks
- ▶ United nations documents for Google translate
- ▶ Memorial Sloan-Kettering Cancer used IBM's Watson to provide diagnosis based on 600k reports of 1.5m trials
- ▶ Symatec's Clearwell: Automatic graphical visualisation/sorting of documents
- ▶ CCTV
- ▶ Software engineering

Manual non-routine tasks

- ▶ Service robots for wind turbines
- ▶ Autonomous vehicles (agriculture, transport)
- ▶ Foxconn employs 1.2m workers, investigates “smart” robots



The image shows a Google search interface. The search bar contains the text "foxconn apple". Below the search bar, there are navigation tabs for "Web", "News", "Videos", "Images", "Shopping", "More", and "Search tools". The "Web" tab is selected and underlined. Below the tabs, it says "About 2,330,000 results (0.27 seconds)". There are three search results listed:

- Riots, suicides, and other issues in Foxconn's iPhone factories**
www.cnet.com/.../riots-suicides-and-other-issues-in-foxconn-iphone... CNET
While Chinese authorities are investigating the cause of the riot, Foxconn said that it "appears not to have been work-related." Apple declined to comment on the ...
- Foxconn - Wikipedia, the free encyclopedia**
en.wikipedia.org/wiki/Foxconn Wikipedia
Foxconn is primarily a contract manufacturer and its clients include major American,
"Foxconn builds products for many vendors, but its mud sticks to Apple".
Terry Gou - Foxconn suicides - Longhua Subdistrict, Shenzhen - Vizio
- Foxconn suicides - Wikipedia, the free encyclopedia**
en.wikipedia.org/wiki/Foxconn_suicides Wikipedia
The suicides drew media attention, and employment practices at Foxconn were investigated by several of its customers, including Apple and Hewlett-Packard ...

Task model / Bottleneck variables

- ▶ Perception and manipulation tasks
 - ▶ Finger dexterity
 - ▶ Manual dexterity
 - ▶ Cramped work space, awkward position
- ▶ Creative intelligent tasks
 - ▶ Originality
 - ▶ Fine arts
- ▶ Social intelligence tasks
 - ▶ Social perceptiveness
 - ▶ Negotiation
 - ▶ Persuasion
 - ▶ Assisting and caring for others

Data: covariates

O*NET

- ▶ Online service developed by US Department of Labor
- ▶ After some preprocessing/cleaning, 702 entries
- ▶ Both numbers and open-end description
- ▶ 9 real variables (seem to be $x \in [0, 100]^9$)

Task model / Bottleneck variables

Example, manual dexterity

- ▶ low: “Screw a light bulb into a light socket”
- ▶ medium: “Pack oranges in crates as quickly as possible”
- ▶ high: “Perform open-heart surgery with surgical instruments”

Data: labels

- ▶ Hand label 70 Occupations via a ML workshop survey
- ▶ Question: “Can the tasks of this job be sufficiently specified, conditional on the availability of big data, to be performed by state of the art computer-controlled equipment?”
- ▶ Only use high confident ones
- ▶ “By hand-labelling occupations, we work around the issues that O*NET data was not specifically gathered to ... measure automatability.”
- ▶ “The fact that we label only (most confident) 70/702, ... further reduces the risk of subjective bias.”

GP classification

- ▶ Covariates $x_i \in \mathbb{R}^9$, labels $y_i \in \{0, 1\}$
- ▶ 70 training, 702 testing pairs
- ▶ Model

$$p(y, f|X) = p(y|f)p(f|X)$$

where

$$p(f|X) = \mathcal{N}(f|\mathbf{0}, K) \quad p(y = 1|f) = \frac{1}{1 + \exp(-f)}$$

and $K_{ij} = k(x_i, x_j)$.

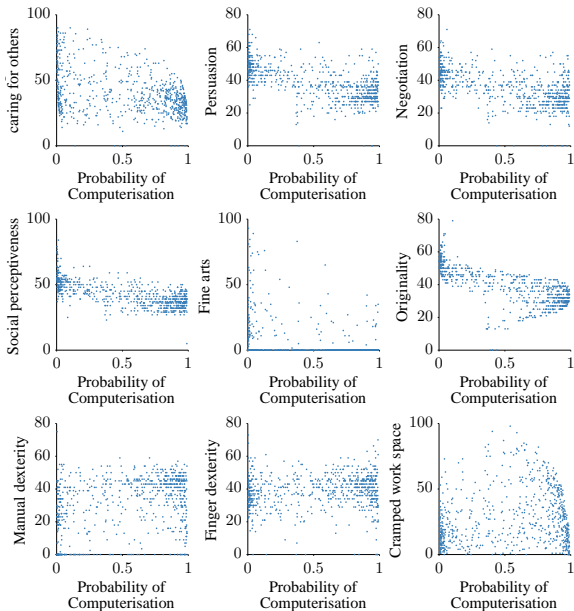
- ▶ Inference, learning:
 - ▶ Compute predictive posterior $p(y^*)$ using EP
 - ▶ 3 kernels: exp. quadratic, rational quadratic, linear
 - ▶ No details on hyper-parameters, no code published

X-validation

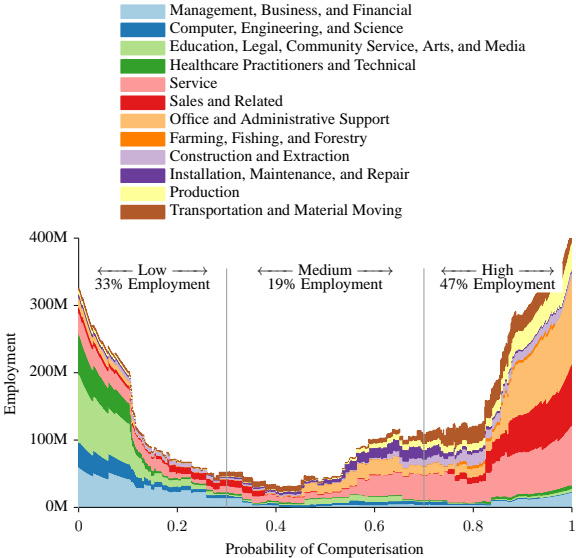
TABLE II. Performance of various classifiers; best performances in bold.

classifier model	AUC	log-likelihood
exponentiated quadratic	0.894	− 163.3
rational quadratic	0.893	−163.7
linear (logit regression)	0.827	−205.0

Prediction slices



Employment and computerisation



Interpretation

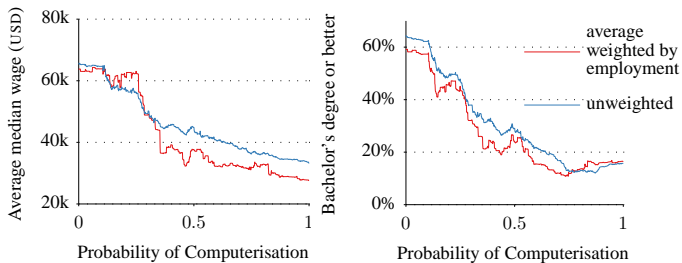
- ▶ “According to our estimate, 47% of ... employment is potentially automatable ... perhaps in a decade or two”
- ▶ “It shall be noted that the probability axis can be seen as a rough timeline”
- ▶ Two waves of computerisation, technological plateau

Interpretation

Assisting and caring for others	48±20	41±17	34±10
Persuasion	48±7.1	35±9.8	32±7.8
Negotiation	44±7.6	33±9.3	30±8.9
Social perceptiveness	51±7.9	41±7.4	37±5.5
Fine arts	12±20	3.5±12	1.3±5.5
Originality	51±6.5	35±12	32±5.6
Manual dexterity	22±18	34±15	36±14
Finger dexterity	36±10	39±10	40±10
Cramped work space	19±15	37±26	31±20

- ▶ Plateau mostly manual tasks (dexterity, ...)
- ▶ Second wave mostly creative and social intelligence.
- ▶ Quite well in-line with technological trends

Wages and computerisation



Hitlist

Computerisable				
Rank	Probability	Label	SOC code	Occupation
1.	0.0028		29-1125	Recreational Therapists
2.	0.003		49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers
3.	0.003		11-9161	Emergency Management Directors
4.	0.0031		21-1023	Mental Health and Substance Abuse Social Workers
5.	0.0033		29-1181	Audiologists
6.	0.0035		29-1122	Occupational Therapists
7.	0.0035		29-2091	Orthotists and Prosthetists
8.	0.0035		21-1022	Healthcare Social Workers
9.	0.0036		29-1022	Oral and Maxillofacial Surgeons
10.	0.0036		33-1021	First-Line Supervisors of Fire Fighting and Prevention Workers
11.	0.0039		29-1031	Dietitians and Nutritionists
12.	0.0039		11-9081	Lodging Managers
13.	0.004		27-2032	Choreographers
14.	0.0041		41-9031	Sales Engineers

Hitlist

275.	0.41		51-2041	Structural Metal Fabricators and Fitters
276.	0.41	1	23-1012	Judicial Law Clerks
277.	0.41		49-2094	Electrical and Electronics Repairers, Commercial and Industrial I ment
278.	0.42		19-4093	Forest and Conservation Technicians
279.	0.42		53-1021	First-Line Supervisors of Helpers, Laborers, and Material M Hand
280.	0.43		39-3093	Locker Room, Coatroom, and Dressing Room Attendants
281.	0.43		19-2099	Physical Scientists, All Other
282.	0.43	0	19-3011	Economists
283.	0.44		19-3093	Historians
284.	0.45		51-9082	Medical Appliance Technicians
285.	0.46		43-4031	Court, Municipal, and License Clerks
286.	0.47		13-1141	Compensation, Benefits, and Job Analysis Specialists
287.	0.47		31-1013	Psychiatric Aides
288.	0.47		29-2012	Medical and Clinical Laboratory Technicians
289.	0.48		33-2021	Fire Inspectors and Investigators
290.	0.48		17-3021	Aerospace Engineering and Operations Technicians
291.	0.48		27-1026	Merchandise Displayers and Window Trimmers
292.	0.48		47-5031	Explosives Workers, Ordnance Handling Experts, and Blasters
293.	0.48		15-1131	Computer Programmers

Hitlist

687.	0.98		43-4151	Order Clerks
688.	0.98		43-4011	Brokerage Clerks
689.	0.98		43-9041	Insurance Claims and Policy Processing Clerks
690.	0.98		51-2093	Timing Device Assemblers and Adjusters
691.	0.99	1	43-9021	Data Entry Keyers
692.	0.99		25-4031	Library Technicians
693.	0.99		43-4141	New Accounts Clerks
694.	0.99		51-9151	Photographic Process Workers and Processing Machine Operato
695.	0.99		13-2082	Tax Preparers
696.	0.99		43-5011	Cargo and Freight Agents
697.	0.99		49-9064	Watch Repairers
698.	0.99	1	13-2053	Insurance Underwriters
699.	0.99		15-2091	Mathematical Technicians
700.	0.99		51-6051	Sewers, Hand
701.	0.99		23-2093	Title Examiners, Abstractors, and Searchers
702.	0.99		41-9041	Telemarketers

Limitations

- ▶ Potential substitution, no estimate on how many jobs **will** be automated
- ▶ Wage level changes
- ▶ Regulatory politics

“Thou aimest high, Master Lee. Consider thou what the invention could do to my poor subjects. It would assuredly bring to them ruin by depriving them of employment, thus making them beggars.”

Statistics?

- ▶ Covariates not sampled iid (only most confident)
- ▶ Polarisation sampling artifact?
- ▶ Time?
- ▶ $N_{\text{train}} = 70$ in \mathbb{R}^9

Conclusion

Barry cannot be replaced

Thank you

