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Technology at work:
The future of employment

Michael A Osborne @maosbot

Why would we want a machine to learn and act rather than a human?

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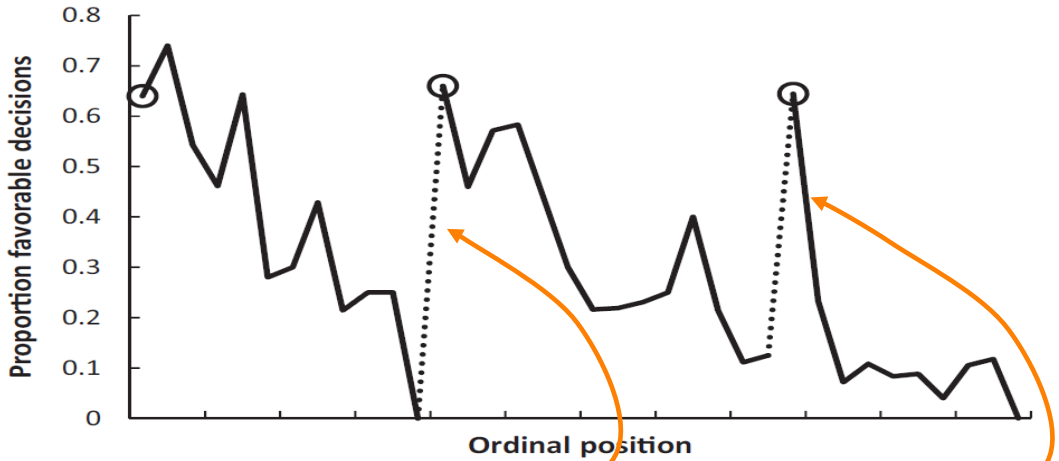

Judges are significantly more lenient after a food break (Danziger et al 2011).

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Please list what it would it take for an algorithm to automate your job.

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Please try to convince your partner that their job is automatable.

Retail and sales jobs will be increasingly affected by automation.

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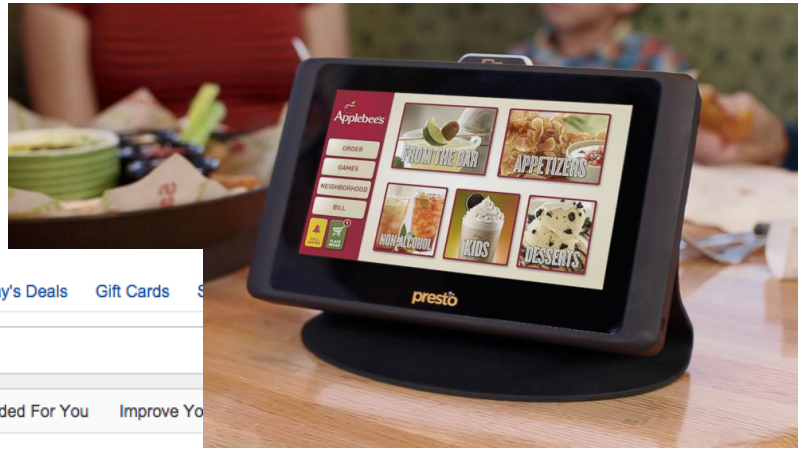

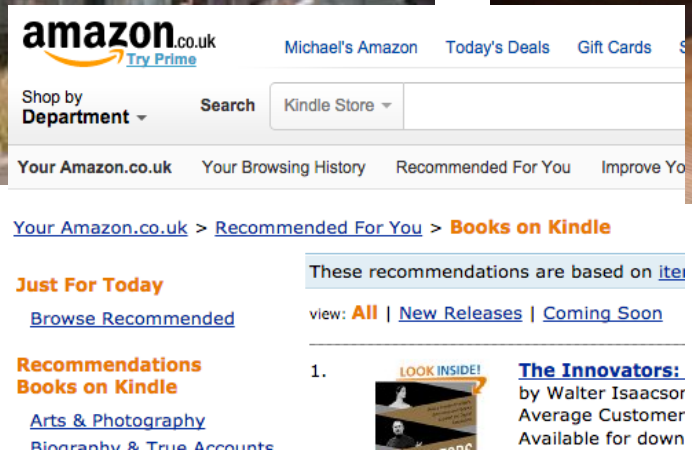

Big data analysis is automating paralegal, contract law and patent law tasks.

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“a lot of people who used to be allocated to conduct document review are no longer able to be billed out” [NYTimes, 2011].

Robotic process automation is automating clerical work.

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Data to Intelligence

blueprism®

Accounting and auditing are also being automated by smart software.

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KashFlow
Accounting Software

pwc | Halo for Journals

Overview | What Halo can do | How Halo wo

INTUIT
TurboTax

Many logistics tasks are now being automated with the use of machine learning and mobile robotics technologies.

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Vehicles will be recording their environment constantly, generating big data with consequences for insurance, law enforcement, mining and meteor detection.

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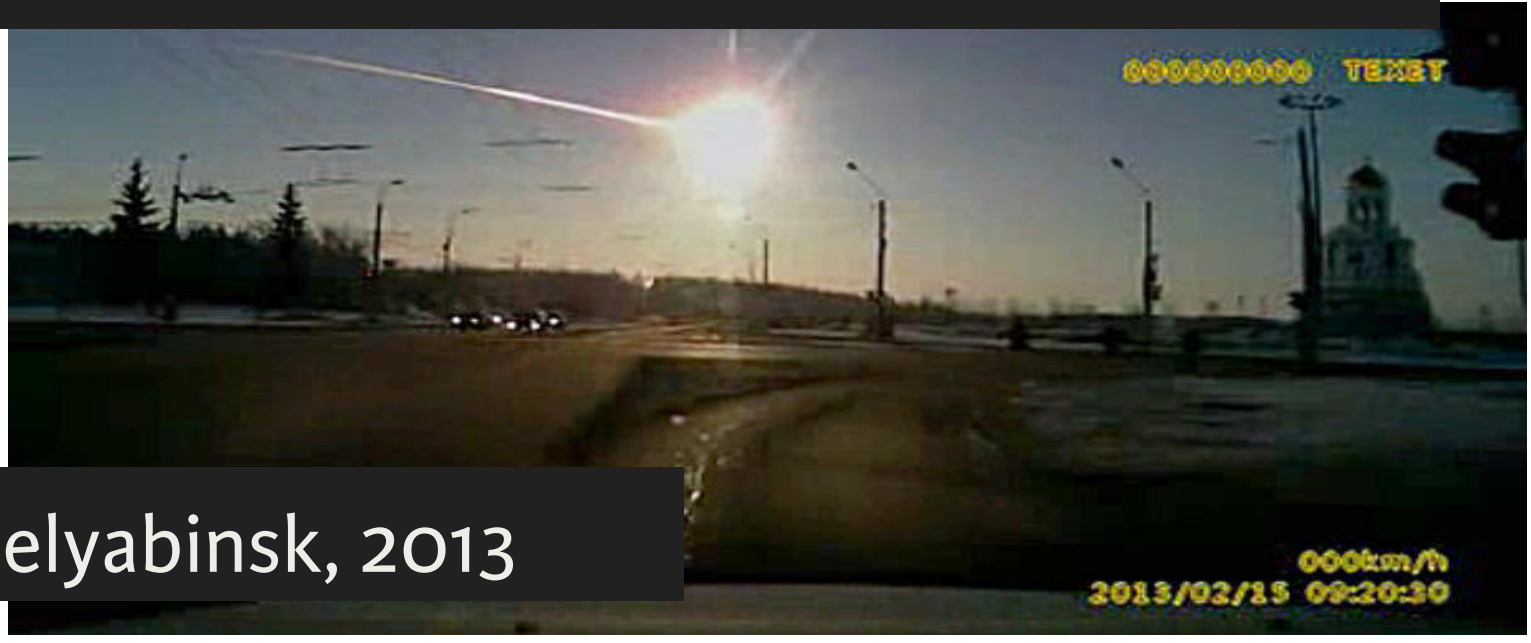

Chelyabinsk, 2013

So, if machines can drive, serve customers, and look through data, for what are humans still good? We suggest:

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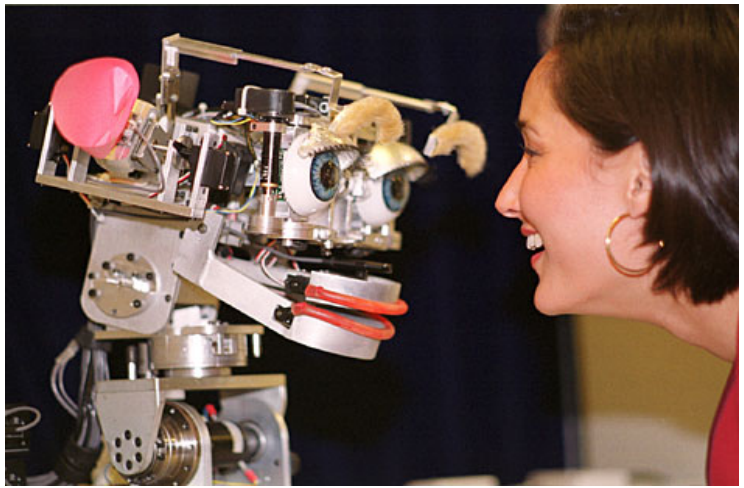
creativity



and social intelligence.

Autonomous manipulation is also hard.

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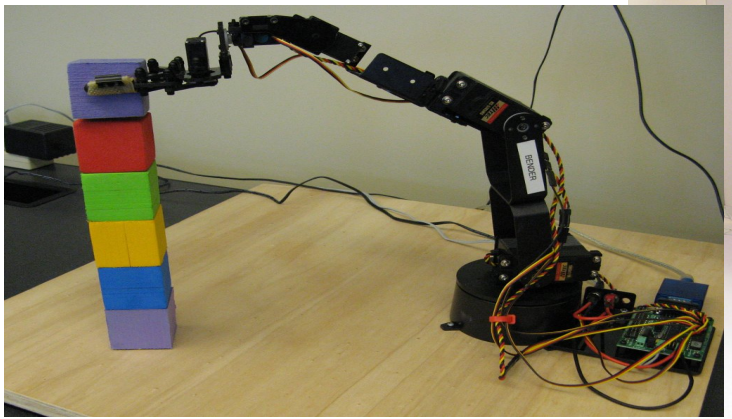

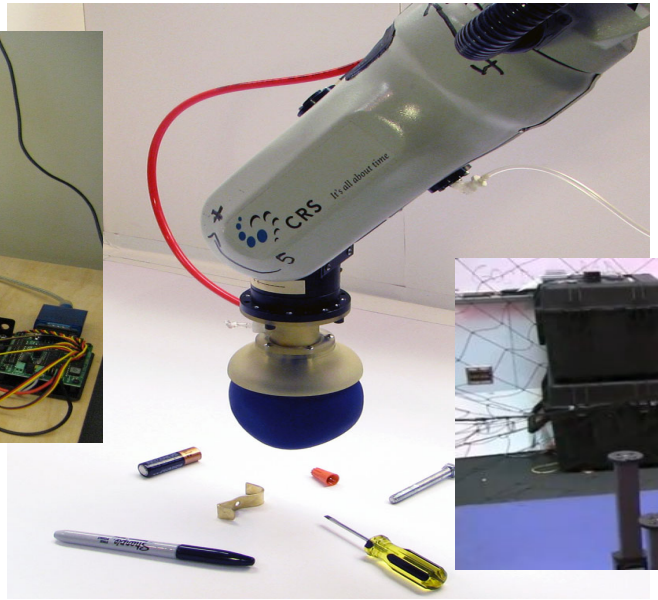

Precisely, manipulation in unstructured environments is difficult to automate.

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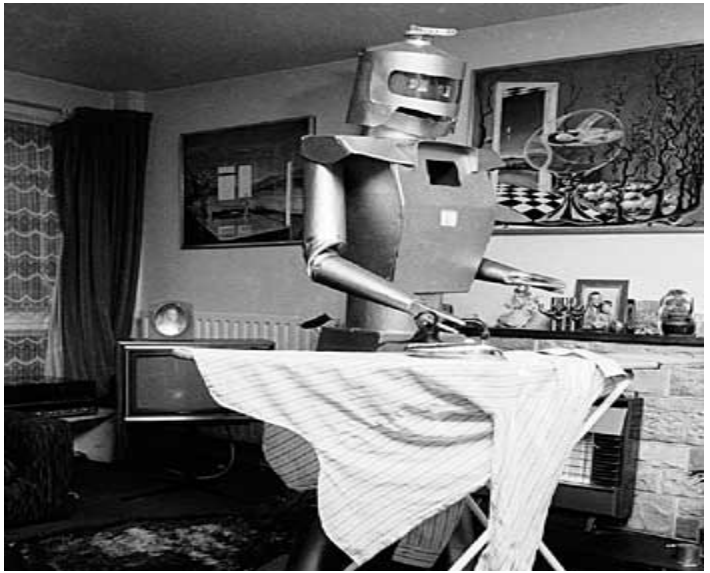
amazon.com



Will an algorithm steal your job? Perhaps an algorithm can tell us! We used a Gaussian process to classify the automatability of occupations using data from the US.

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Job Title	Persuasion	Originality	Social Perceptiveness	Fine Arts
Administrative Services Managers	46	41	52	0
Tax Examiners and Collectors and Revenue Agents	45	39	43	0
Accountants and Auditors	45.5	41	44.5	0
Budget Analysts	37	41	41	0
Loan Officers	45	30	43	0
Tax Preparers	37	34	37	0

What is the probability of automatability for US insurance underwriters?

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1. Between 0.00 and 0.25.
2. Between 0.25 and 0.50.
3. Between 0.50 and 0.75.
4. Between 0.75 and 1.00.

What is our probability of automatability for US insurance underwriters?

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1. Between 0.00 and 0.25.
2. Between 0.25 and 0.50.
3. Between 0.50 and 0.75.
4. Between 0.75 and 1.00: the probability is 0.99!

Insurance Underwriters (13-2053.00)

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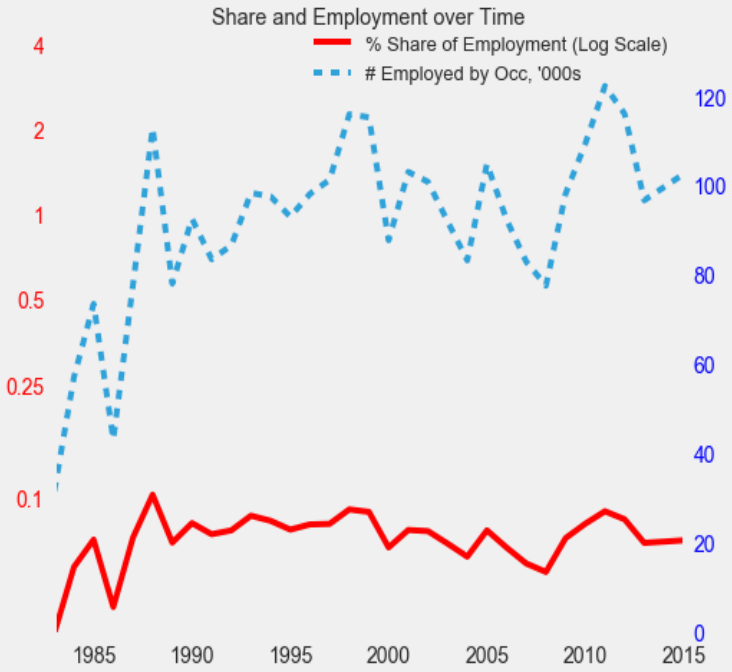
EMPLOYMENT SHARES



What is the probability of automatability for US mechanical engineers?

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1. Between 0.00 and 0.25.
2. Between 0.25 and 0.50.
3. Between 0.50 and 0.75.
4. Between 0.75 and 1.00.

What is our probability of automatability for US mechanical engineers?

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1. Between 0.00 and 0.25: the probability is 0.01.
2. Between 0.25 and 0.50.
3. Between 0.50 and 0.75.
4. Between 0.75 and 1.00.

Mechanical Engineers (17-2141.00)

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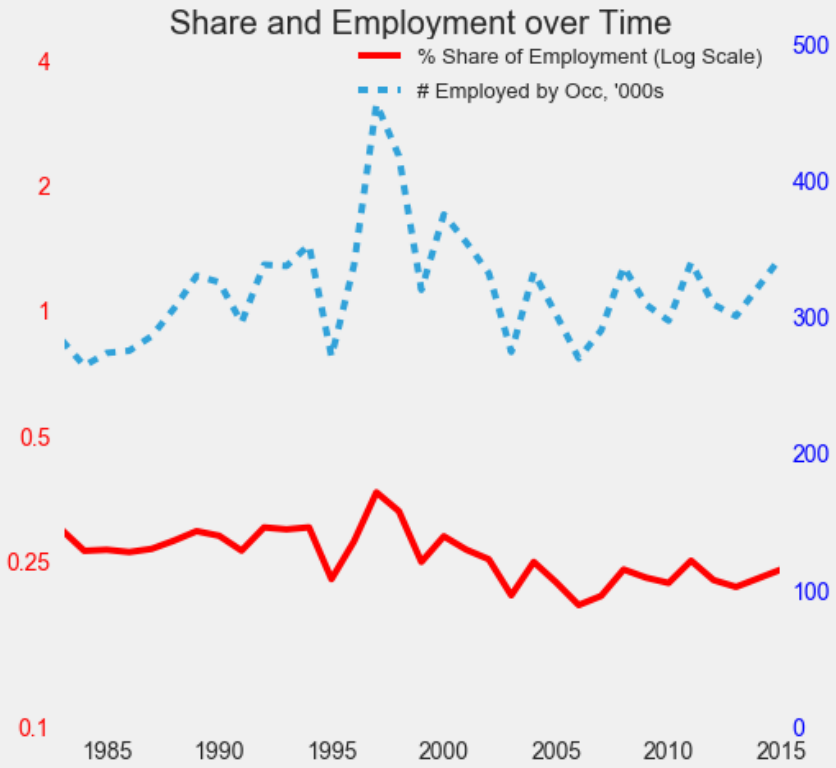
EMPLOYMENT SHARES



Occupation	Label	Probability
Data Entry Keyers	1	0.99
Tax Preparers		0.99
Umpires and Referees		0.98
Paralegals and Legal Assistants	1	0.94
Waiters and waitresses	0	0.94
Slaughterers		0.60
Economists	0	0.43
Financial Analysts		0.23
Lawyers	0	0.03
Choreographers		0.00

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We predict that high-skilled jobs are relatively resistant to computerisation.

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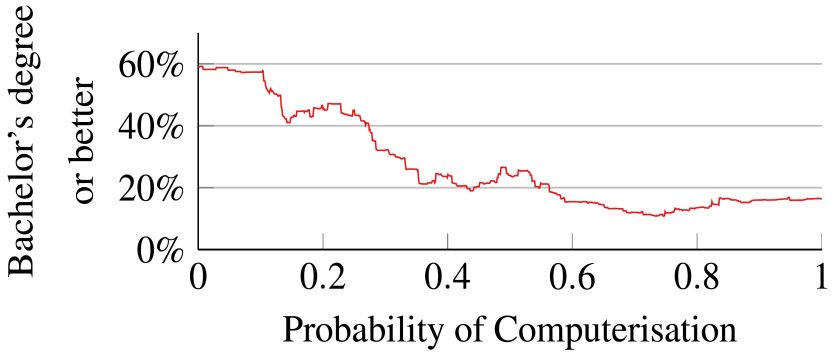

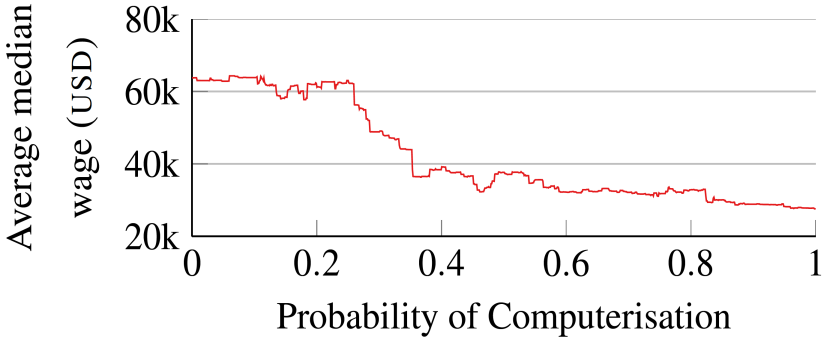

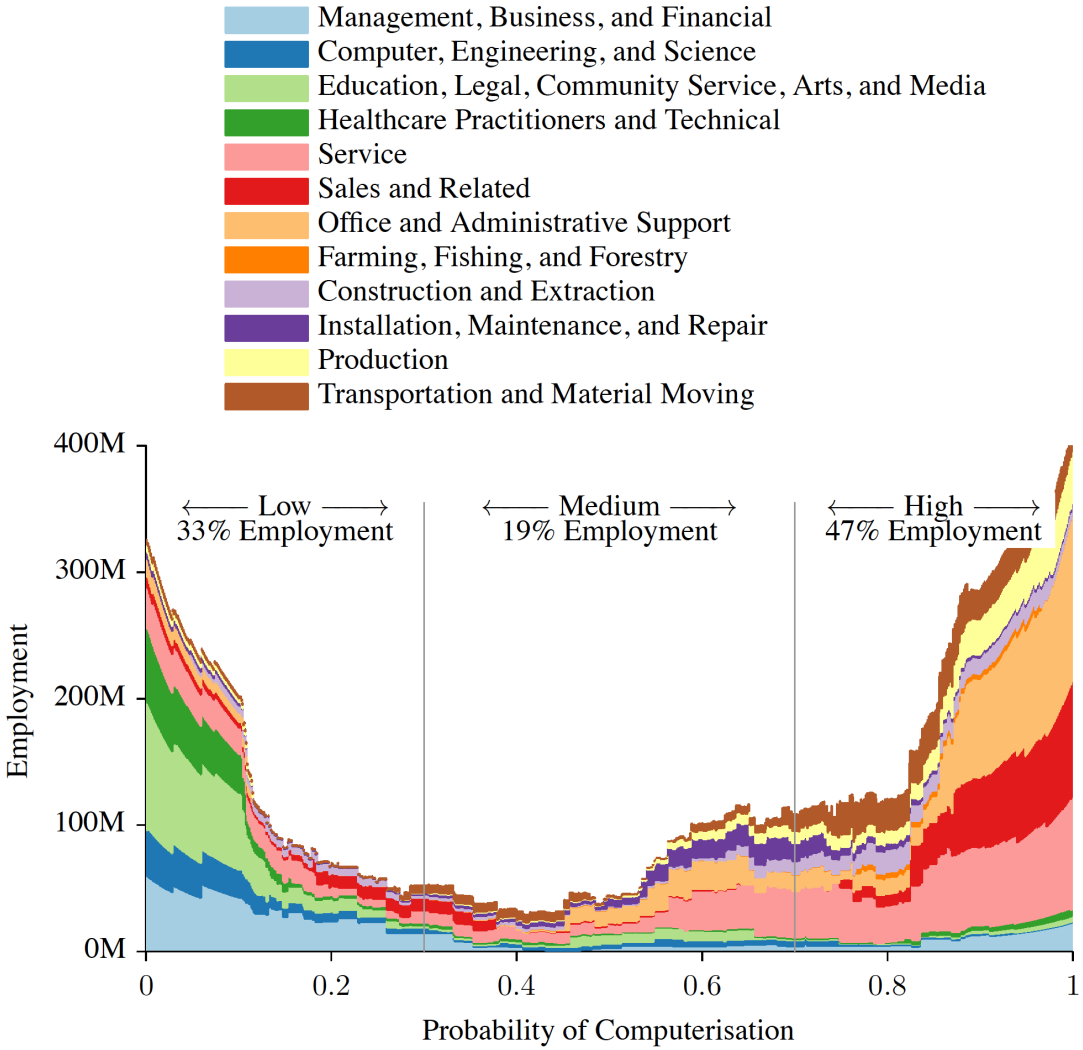

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USA

Which country has the greatest fraction of jobs at high risk of automation?

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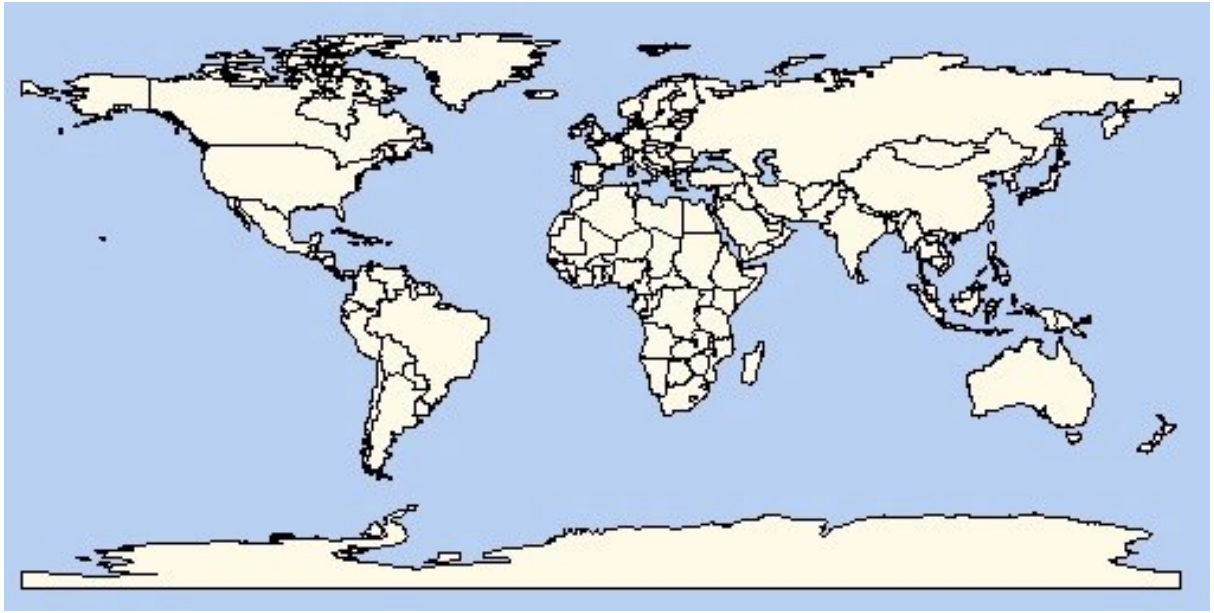
1. Albania
2. Bangladesh
3. Ethiopia
4. Uzbekistan



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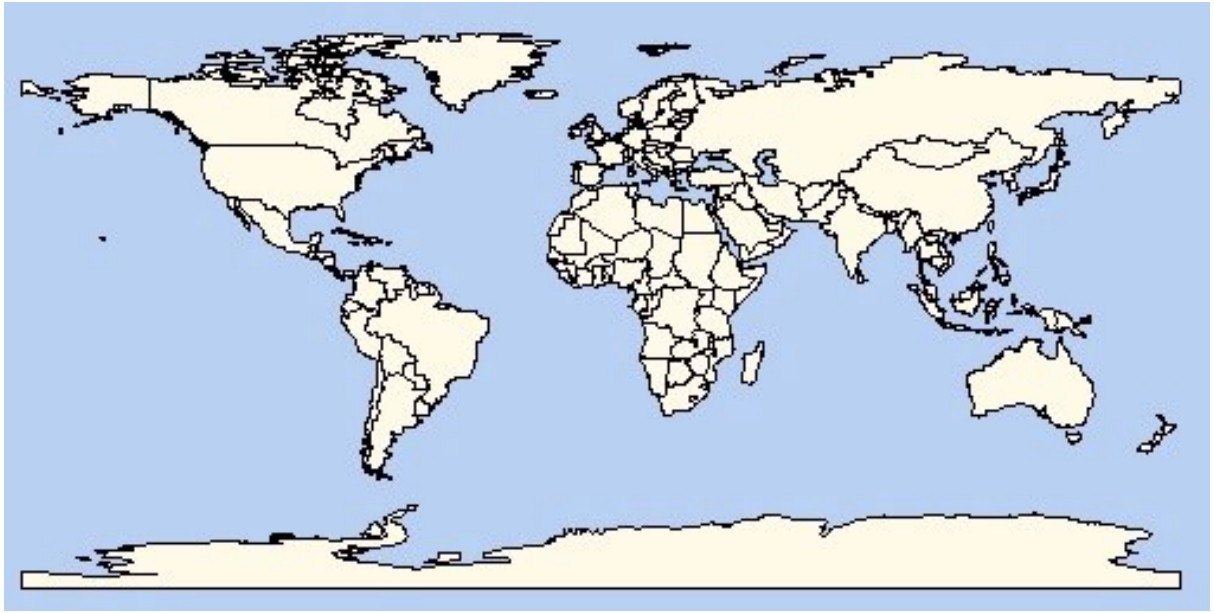
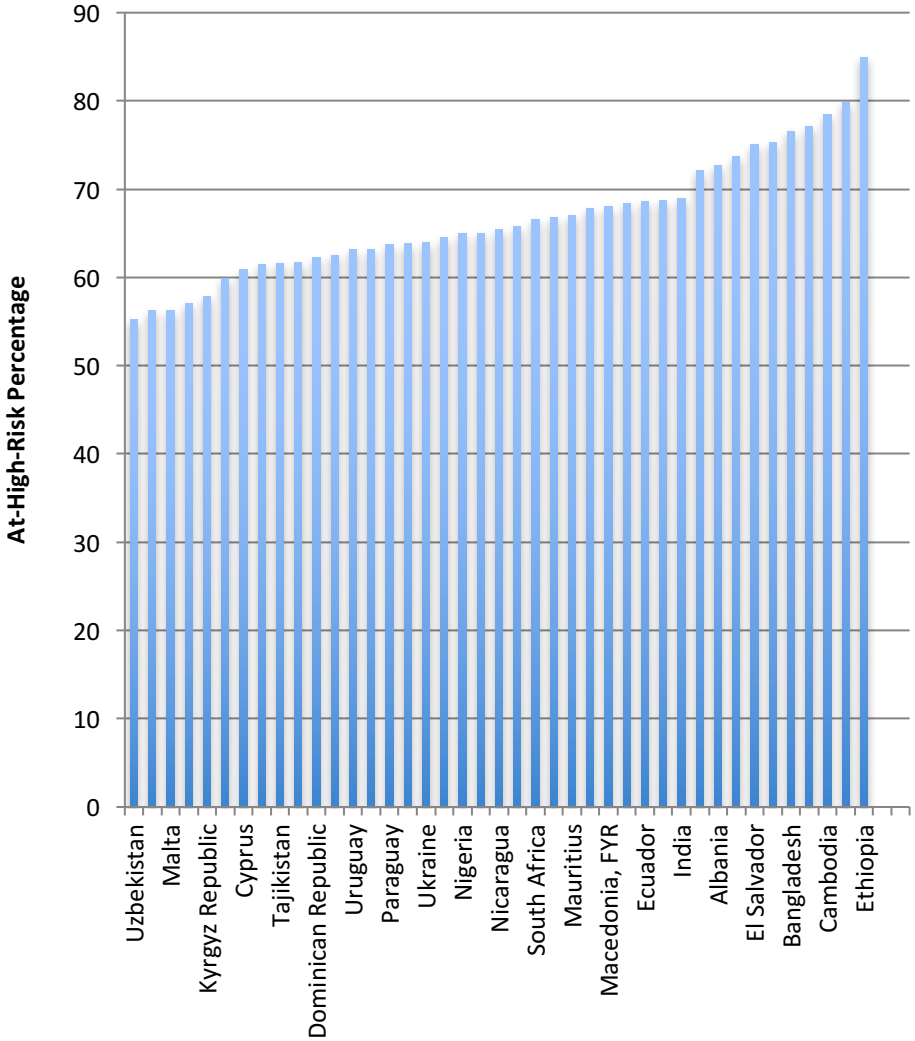
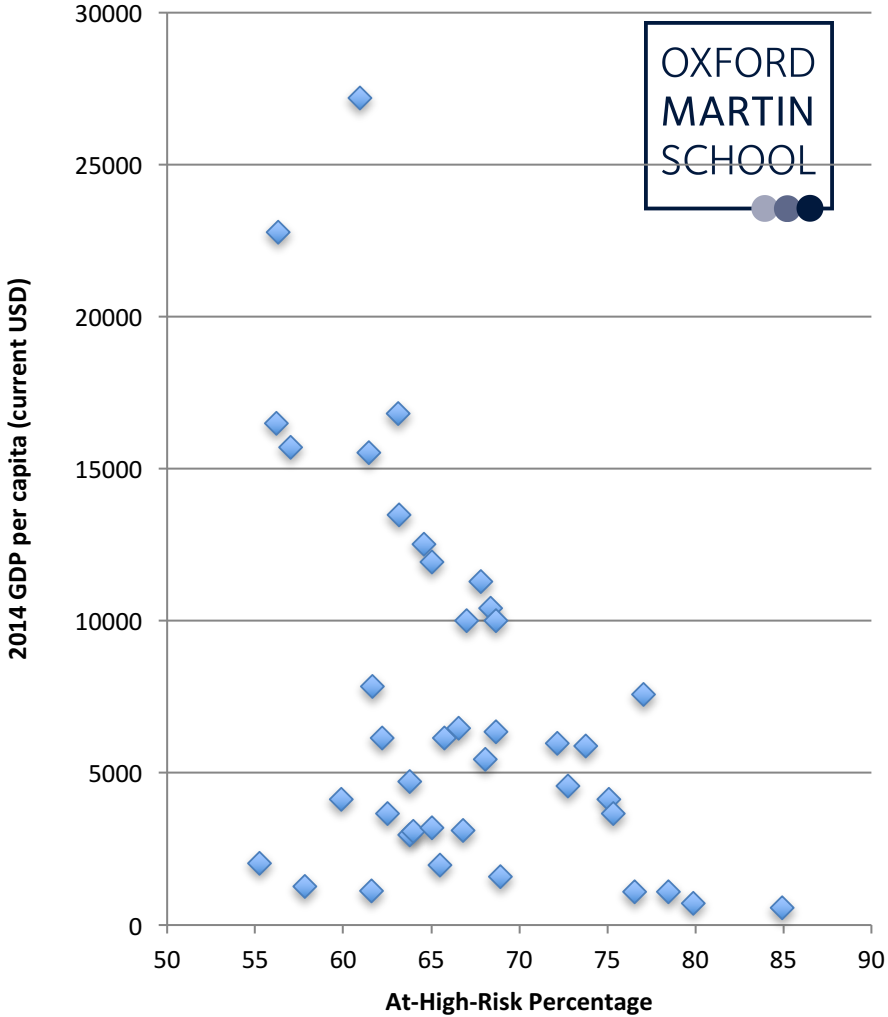



At-High-Risk Percentage
90
80
70
60
50
40
30
20
10
0
Uzbekistan
Malta
Kyrgyz Republic
Cyprus
Tajikistan
Dominican Republic
Uruguay
Paraguay
Ukraine
Nigeria
Nicaragua
South Africa
Mauritius
Macedonia, FYR
Ecuador
India
Albania
El Salvador
Bangladesh
Cambodia
Ethiopia


2014 GDP per capita (current USD)
30000
25000
20000
15000
10000
5000
0
50
55
60
65
70
75
80
85
90
At-High-Risk Percentage
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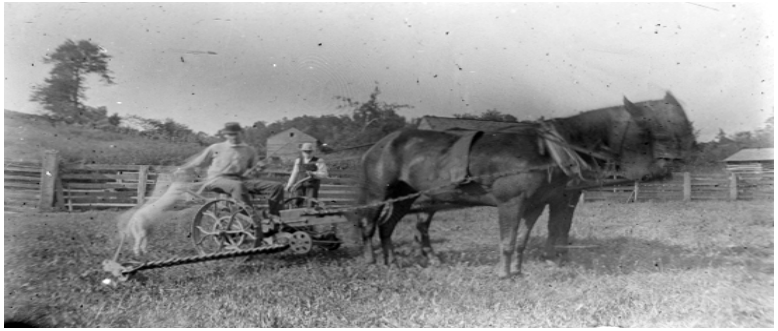

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In 1900, 40% of US workers were farmers; in 1999, the figure was 2%.

In 1900, unemployment was 5%; in 1999, it was 4.2%.

Will new technologies threaten the historical pattern of employment resisting technological change?

UK, 2000-2015

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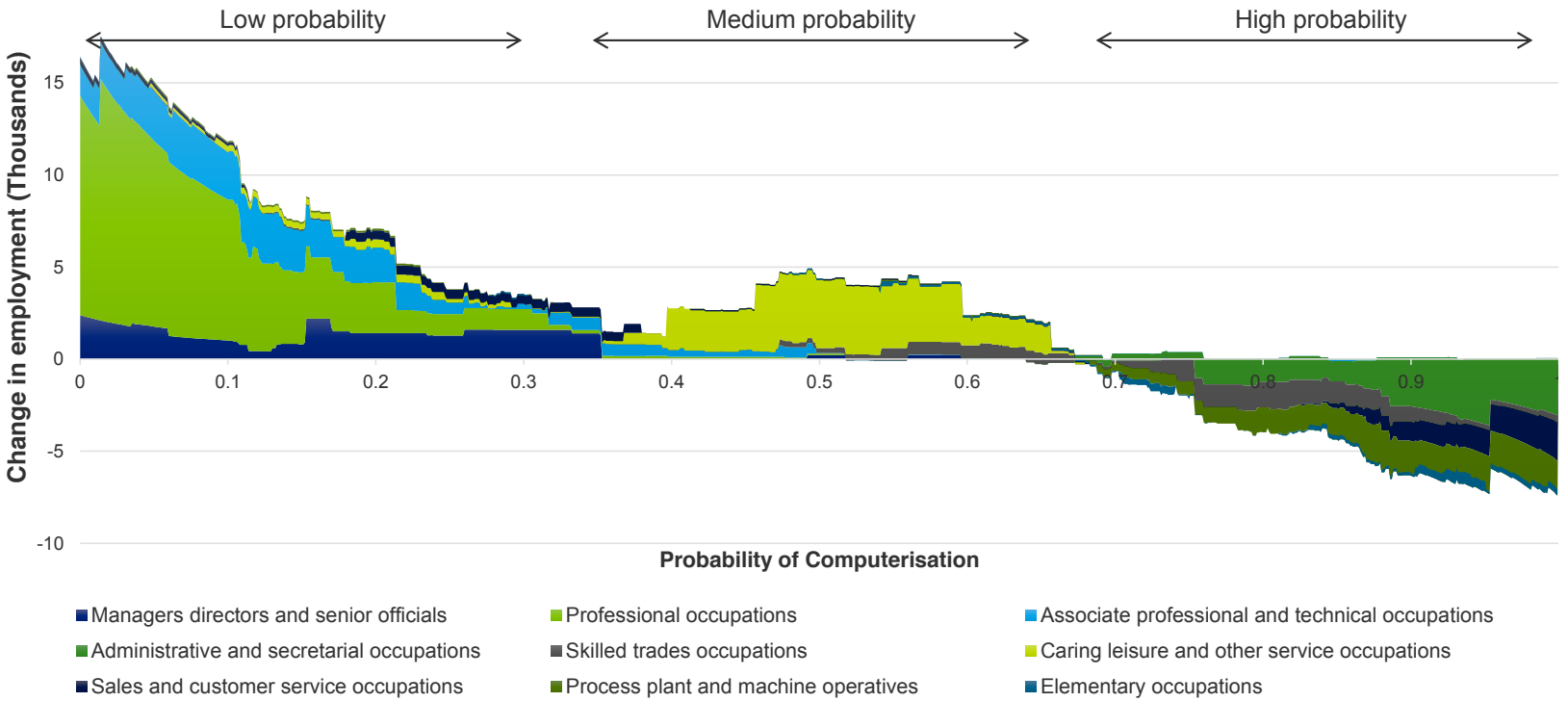

Source: Deloitte LLP

New occupations are being created.

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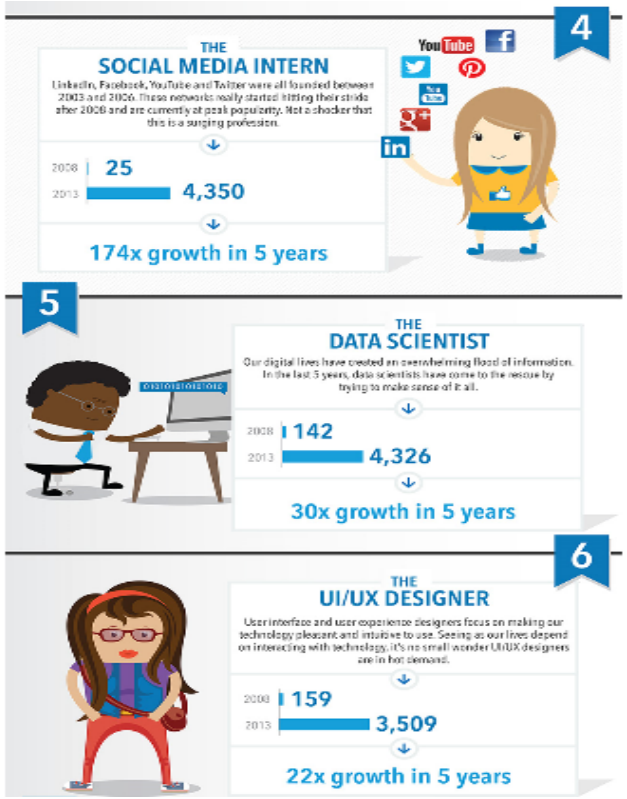

Source: LinkedIn

New occupations are being created.

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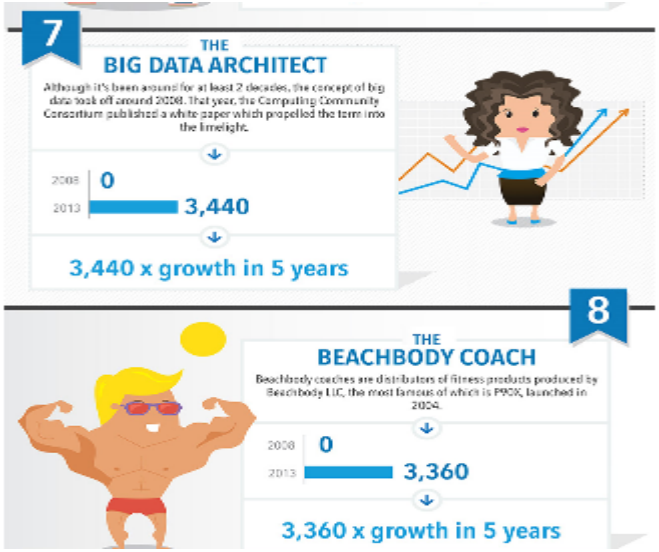

Source: LinkedIn

New industries have emerged, but they're not employing many.

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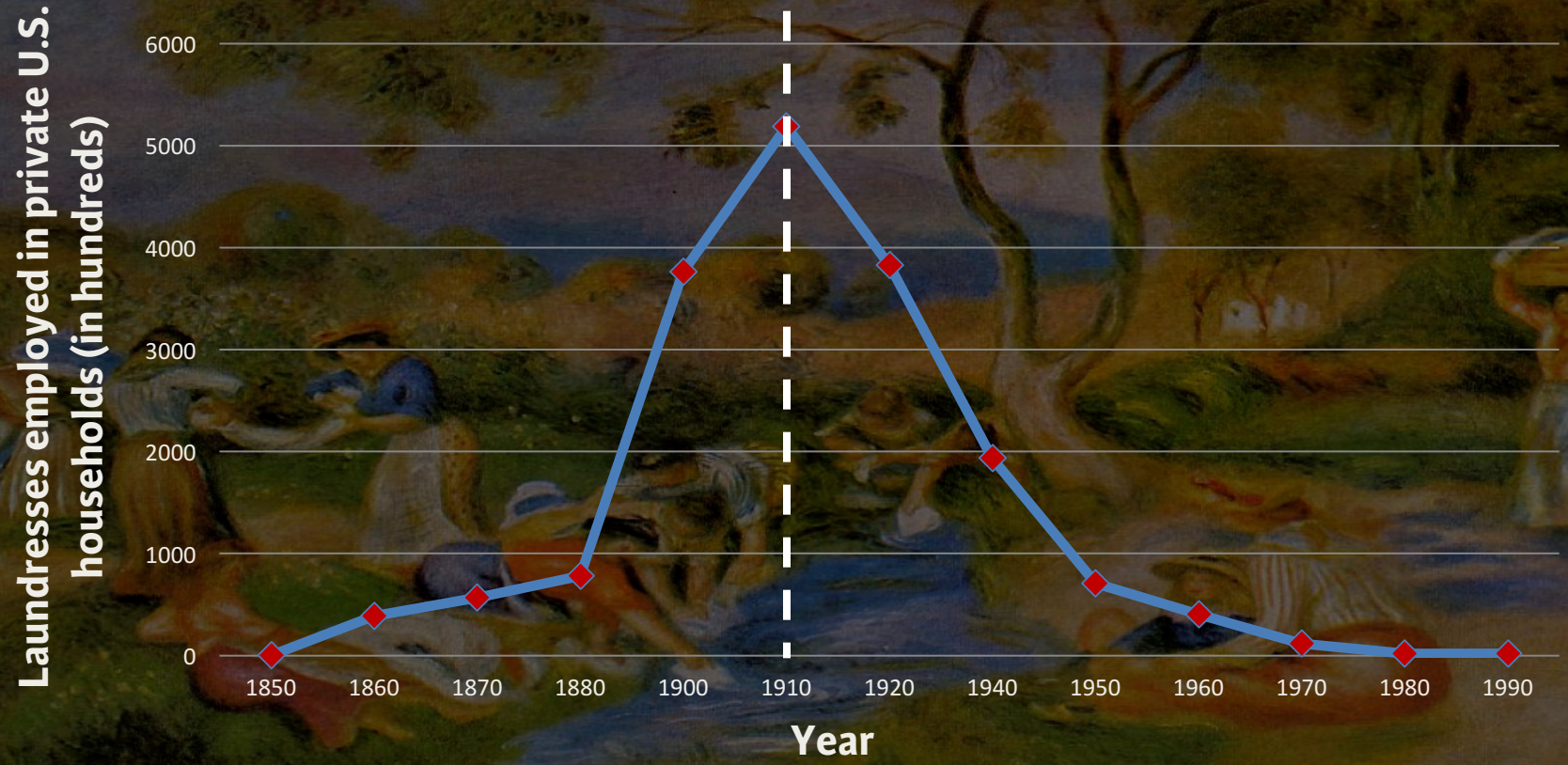
Decade	Fraction of the US workforce employed in new industries
1980s	8.2%
1990s	4.4%
2000s	**0.5%**

Sources: Lin (2011); Berger & Frey (2014)

In 1910 A.J Fischer was granted a patent for the first electric-powered washing machine



Source: Sobek, Matthew , "Detailed occupations – all persons: 1850–1990 in Historical Statistics of the United States, Earliest Times to the Present: Millennial Edition.

Household income has stagnated in the US.

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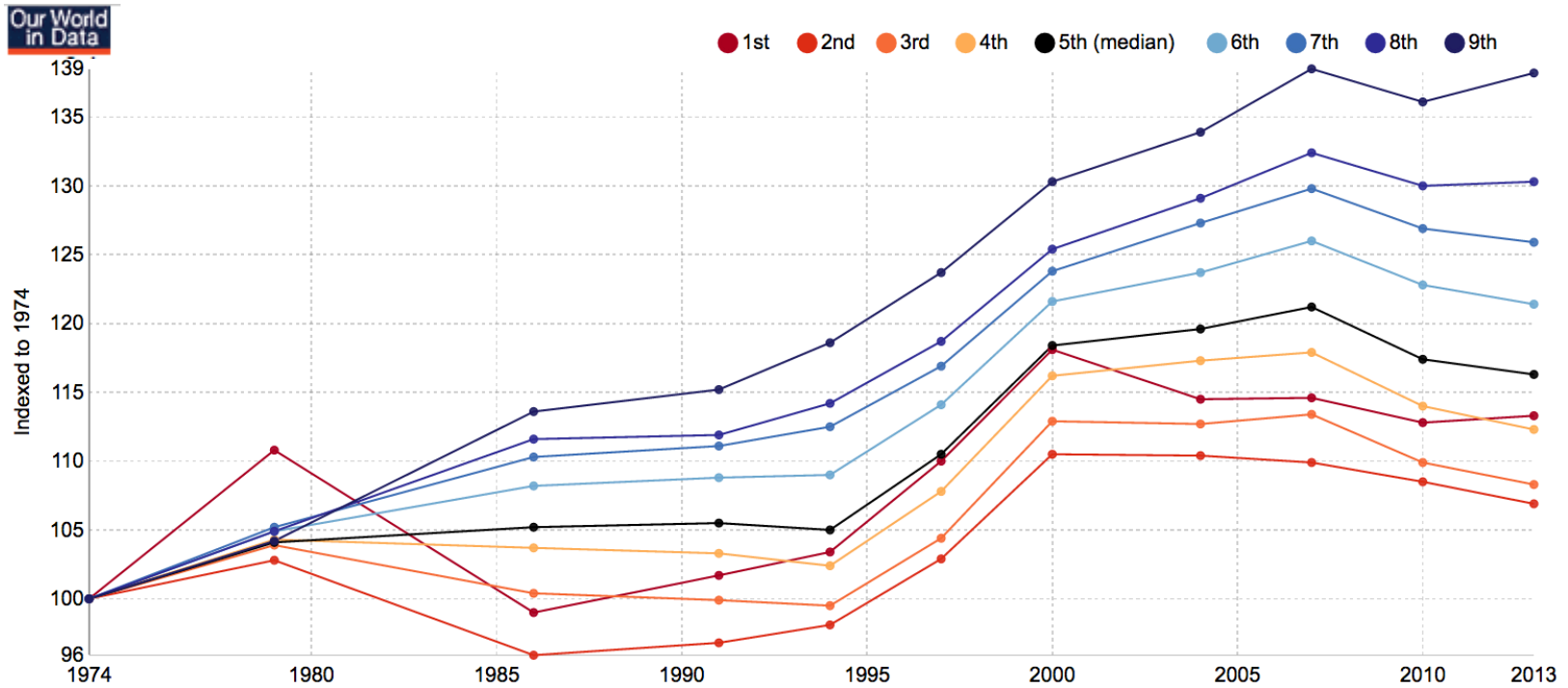

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Data Source: Based on data from the Luxembourg Income Study.

It was some time until the English industrial revolution benefited most workers.

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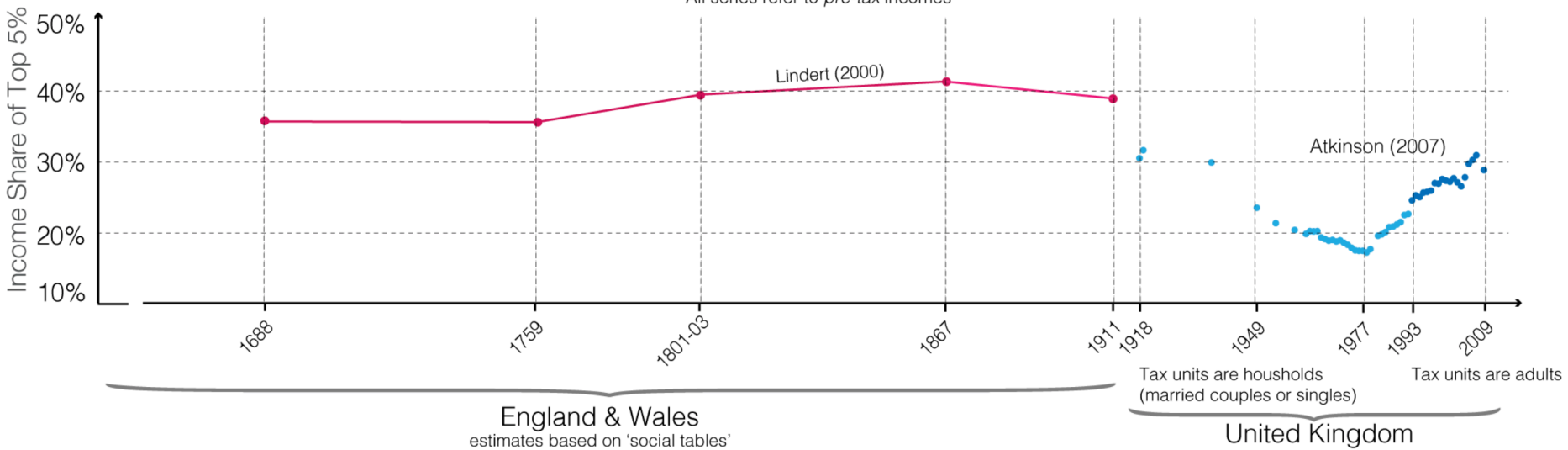
Our World in Data

Income inequality in the UK over 700 years (1290-2010)

Share of total income going to the top 5% of income earners

All series refer to *pre-tax* incomes



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Data sources: Lindert (2000), Atkinson (2007), Milanovic, Lindert and Williamson (2008), and ONS (2011)

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If we choose to try to automate the ith occupation, our expected utility is

$$\mathbb{E}\big(U(i)\big) = p_i \, N_i \, W_i,$$

where p_i is the probability of automation, N_i is employment, and W_i is wage.

Jobs can possess only two of three features.

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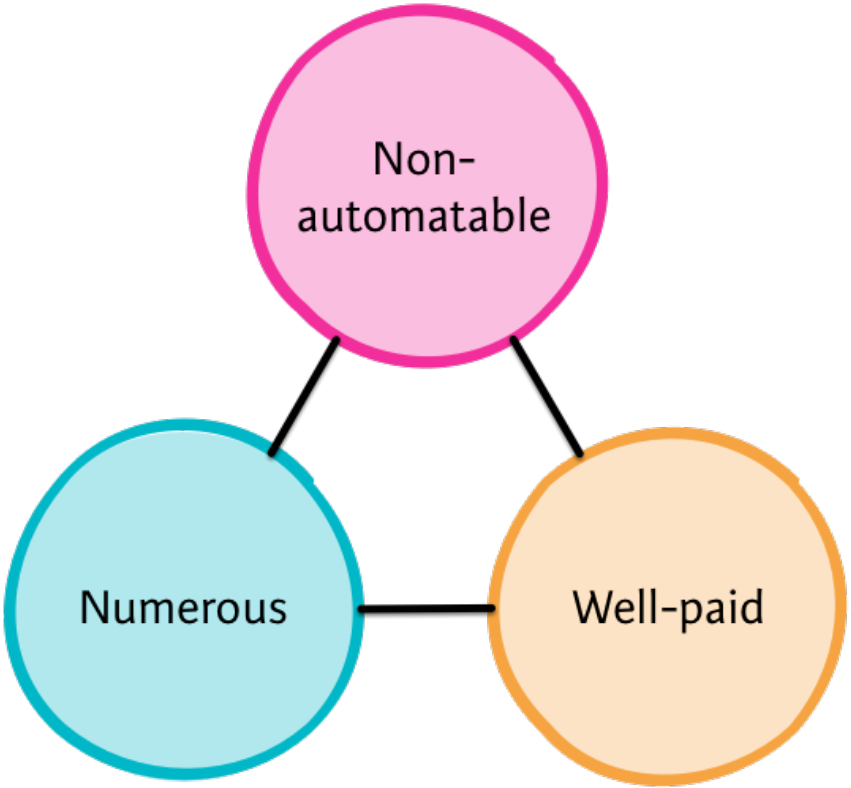

Source: Avent, R. (2016) “The Wealth of Humans”.

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