Technology at work: The future of employment

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

Judges are significantly more lenient after a food break (Danziger et al 2011).
Please list what it would take for an algorithm to automate your job.
Please try to convince your partner that their job is automatable.
Retail and sales jobs will be increasingly affected by automation.
Big data analysis is automating **paralegal**, contract law and patent law tasks.

“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.
Accounting and auditing are also being automated by smart software.
Many logistics tasks are now being automated with the use of machine learning and mobile robotics technologies.
Vehicles will be recording their environment constantly, generating big data with consequences for insurance, law enforcement, mining and meteor detection.
So, if machines can drive, serve customers, and look through data, for what are humans still good? We suggest:

creativity

and social intelligence.
Autonomous manipulation is also hard.
Precisely, manipulation in unstructured environments is difficult to automate.
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.

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Persuasion</th>
<th>Originality</th>
<th>Social Perceptiveness</th>
<th>Fine Arts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administrative Services Managers</td>
<td>46</td>
<td>41</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td>Tax Examiners and Collectors and Revenue</td>
<td>45</td>
<td>39</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Agents</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accountants and Auditors</td>
<td>45.5</td>
<td>41</td>
<td>44.5</td>
<td>0</td>
</tr>
<tr>
<td>Budget Analysts</td>
<td>37</td>
<td>41</td>
<td>41</td>
<td>0</td>
</tr>
<tr>
<td>Loan Officers</td>
<td>45</td>
<td>30</td>
<td>43</td>
<td>0</td>
</tr>
<tr>
<td>Tax Preparers</td>
<td>37</td>
<td>34</td>
<td>37</td>
<td>0</td>
</tr>
</tbody>
</table>
What is the probability of automatability for US insurance underwriters?

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?

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)

EMPLOYMENT SHARES

Share and Employment over Time
- % Share of Employment (Log Scale)
- # Employed by Occ, '000s

What is the probability of automatability for US mechanical engineers?

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?

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.
<table>
<thead>
<tr>
<th>Occupation</th>
<th>Label</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry Keyers</td>
<td>1</td>
<td>0.99</td>
</tr>
<tr>
<td>Tax Preparers</td>
<td></td>
<td>0.99</td>
</tr>
<tr>
<td>Umpires and Referees</td>
<td></td>
<td>0.98</td>
</tr>
<tr>
<td>Paralegals and Legal Assistants</td>
<td>1</td>
<td>0.94</td>
</tr>
<tr>
<td>Waiters and waitresses</td>
<td>0</td>
<td>0.94</td>
</tr>
<tr>
<td>Slaughterers</td>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td>Economists</td>
<td>0</td>
<td>0.43</td>
</tr>
<tr>
<td>Financial Analysts</td>
<td></td>
<td>0.23</td>
</tr>
<tr>
<td>Lawyers</td>
<td>0</td>
<td>0.03</td>
</tr>
<tr>
<td>Choreographers</td>
<td></td>
<td>0.00</td>
</tr>
</tbody>
</table>
We predict that high-skilled jobs are relatively resistant to computerisation.
Which country has the greatest fraction of jobs at high risk of automation?

1. Albania
2. Bangladesh
3. Ethiopia
4. Uzbekistan
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At-High-Risk Percentage

2014 GDP per capita (current USD)

At-High-Risk Percentage
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?
In the last 15 years, occupations classified by Osborne and Frey in 2014 as having the lowest probability of computerisation have created approximately 3.5m jobs while higher probability occupations have lost over 800k jobs.

The area under all curves equals the total change in employment between 2001 and 2015.

Source: Deloitte LLP
New occupations are being created.

**1. The iOS Developer**
Apple announced the iPhone in 2007, and 3rd party developer support for iOS took off in 2008 with the release of iOS 2 and the App Store.

- 2008: 89
- 2013: 12,634
- 142x growth in 5 years

**2. The Android Developer**
Google's Android platform was also announced in 2007, with the release of the first Android-powered handset in 2008.

- 2008: 53
- 2013: 10,554
- 199x growth in 5 years

**3. The Zumba Instructor**
Zumba started in the early 2000s and quickly gained traction in 2007 as fitness centers started popping up all over the US.

- 2009: 16
- 2013: 6,331
- 396x growth in 5 years

**4. The Social Media Intern**
LinkedIn, Facebook, YouTube, and Twitter were all founded between 2003 and 2006. These companies rapidly started hiring their interns.

- 2008: 25
- 2013: 4,350
- 174x growth in 5 years

**5. The Data Scientist**
0-0: Digital lines have created a mountain of information. In the last 5 years, data scientists have come to the rescue by trying to make sense of it all.

- 2008: 142
- 2013: 4,326
- 30x growth in 5 years

**6. The UI/UX Designer**
User interfaces and use simply become more complex, making our understanding of user interfaces and user experience design critical.

- 2008: 159
- 2013: 3,509
- 22x growth in 5 years

Source: LinkedIn
New occupations are being created.
New industries have emerged, but they’re not employing many.

<table>
<thead>
<tr>
<th>Decade</th>
<th>Fraction of the US workforce employed in new industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980s</td>
<td>8.2%</td>
</tr>
<tr>
<td>1990s</td>
<td>4.4%</td>
</tr>
<tr>
<td>2000s</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Sources: Lin (2011); Berger & Frey (2014)
Laundresses employed in private U.S. households (in hundreds)

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

Household income has stagnated in the US.
It was some time until the English industrial revolution benefited most workers.
If we choose to try to automate the $i$th occupation, our expected utility is

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

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.
