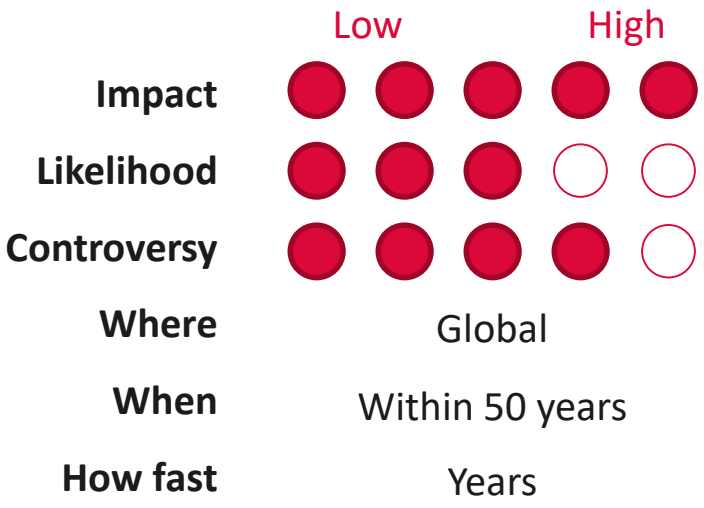
Automating science with advanced AI could lead to explosive economic growth by 2070

Replicable, self-improving ‘AI scientists’ may enable very fast technological progress that leads to far higher GDP growth and greatly improved living standards

Richard Moulange

PhD candidate | Improving AI in cancer medicine

MRC Biostatistics Unit



Global economic growth has stopped rising: For most of the last 2,000 years, increases in the rate of world economic growth and global living standards were driven by increases in population. More people can come up with more ideas and invent more technology, which improved economic output. This output allowed society to feed more people, leading to more ideas and creating a virtuous cycle of idea-generation – this is known as the ‘ideas-based’ model in economics. This cycle ended in the 20th century with the ‘demographic transition’ – when people stopped having as many children.

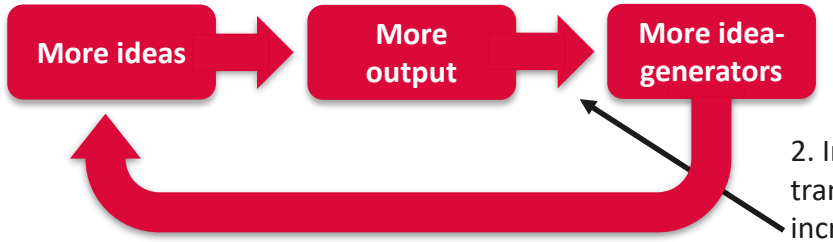
‘AI scientists’ could increase GDP growth again: We already have early signs of artificial intelligence (AI) science capability. AI can perform many specific tasks associated with scientific advancement as capably as a human, such as writing essays, programming code and solving problems in mathematics and biology. Given more powerful, general AI systems, we could run millions of copies of ‘AI scientists’ very cheaply, discovering new technologies more quickly. Crucially, these advances could be used to build more and better scientific AI systems, restoring the virtuous cycle of idea-generation. AI has consistently advanced faster than aggregate expert prediction; current best forecasts suggest a ~60% probability that automatic AI science will be possible by 2070.

A new Industrial Revolution: Annual GDP growth grew tenfold from 0.3% to 3% between 1400 and 1900 but then remained about constant for 120 years. AI scientists could enable another tenfold increase to growth rates of ~30% this century. Like the Industrial Revolution, this would massively increase living standards worldwide. We could possibly see a large reorganisation of the labour market and a significant drop in working hours, but this is very uncertain.

Summary

Detail

I: BACKGROUND



The 'ideas-based' cycle of GDP growth

1. For most of history, humans were the idea-generators that drove the 'ideas-based' model,[1,2] leading GDP growth to **increase tenfold** from 0.3% a year in 1400 to 3% annually in 1900.[3]

2. In the 20th century, the 'demographic transition' **broke the link** connecting increasing resources to population growth – ever since, yearly GDP growth has remained constant at around 3%.[4,5]

3. An AI system that automates scientific discovery may be able to act as **new idea-generators**, which increase in number as the economy grows – this would restart the cycle and enable the GDP growth rate to increase again, perhaps tenfold to ~30%/year.[6,7]

II: CURRENT TRENDS

Recent 'AI scientist' breakthroughs in a wide range of fields + **AI has advanced much faster than predicted** → **Automated 'AI scientists' are a very plausible technology**

- Beating most professional coders in competitions[8,9]
- Predicting protein-folding shape[10]
- Making new mathematics breakthroughs[11,12]
- Writing university-level essays[13]

The best forecasts in 2019 suggested successful AI protein-folding was ~15% likely by 2020[14] → It was solved in 2020

Forecasters expected the best AI systems would achieve 12% on a university maths test by 2021[12] → The top scorer got 51%

III: LIKELIHOOD

Many types of forecasting:	**Chance of 'AI scientist' by 2070**
Biological (comparing AI models to human brains)[6]	70%
Historical/economic analysis[7]	38%
Aggregating expert opinion[15]	65%

Quite wide range of estimates and long timescales imply medium–high uncertainty

IV: IMPLICATIONS

1. **Scientific discovery becomes much faster**
2. **Economic growth increases to record-high levels**
3. **Large increase in living standards**:
   - Reduced poverty globally
   - Countries who automate science first (e.g. UK with its strong AI industry) would have huge advantages
4. **Significant labour market reorganisation:**
   - 'AI scientists' replace millions of high-skilled workers
   - People have much more free time

The Industrial Revolution led extreme poverty to drop from ~90% in 1820 to ~10% now[16]

UK had ~1.7 times the GDP per capita of France and Germany in 1750 thanks to faster industrialisation[17]

Average working hours fell from 53h/week to 32h/week between 1870 and 2017[18]

V: SPEED OF CHANGE

Inhibitors	**Accelerators**
A few key tasks could be un-automatable, bottlenecking growth	Countries increase AI investment in an 'AI arms race'
Significant population loss from unsafe military AI	A partially-automatic AI science system speeds up creation of a full 'AI scientist'

References: [1]Romer, 1990; [2]Jones, 1995; [3]Roodman, 2020; [4]Kirk, 1996; [5]Galor & Weil, 2000; [6]Cotra, 2020; [7]Davidson, 2021; [8]Chen et al., 2021; [9]Li et al., 2022; [10]Jumper et al., 2021; [11]Davies et al., 2021; [12]Steinhardt, 2022; [13]Sharples, 2022; [14]Sergio, 2022; [15]Grace et al., 2018; [16]Roser & Ortiz-Ospina, 2013; [17]Roser, 2013; [18]Giattino et al., 2020