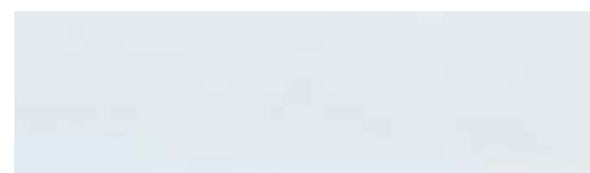
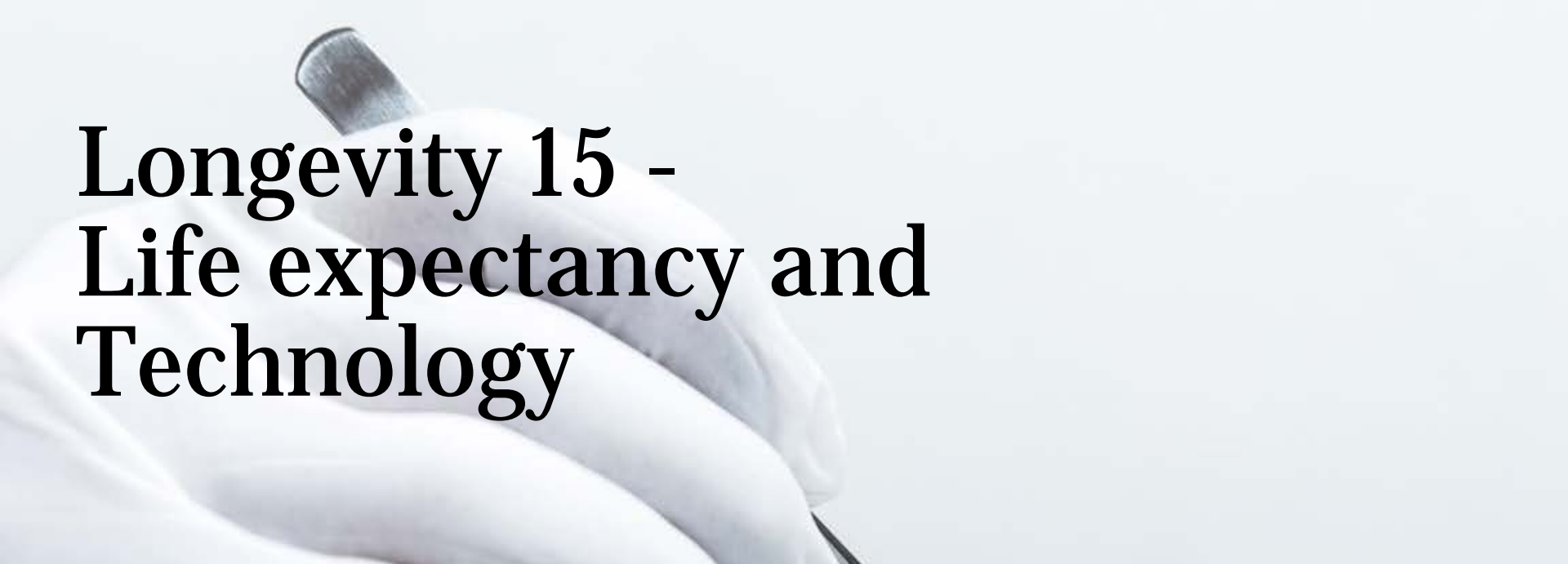


# Longevity 15 - Life expectancy and Technology



# Homer Simpson famously toasted:

## To Alcohol...

The cause of...  
and solution to...  
all of life's problems



# But, what about if

# Technology is...

The cause of...  
and solution to...  
life expectancy modelling's  
problems

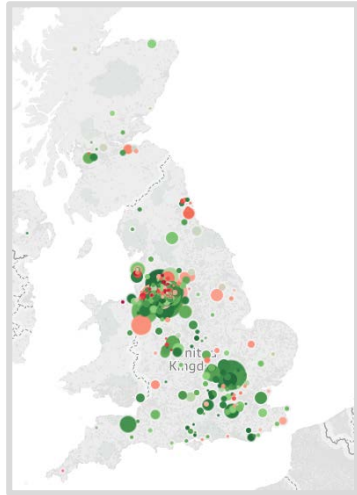


# Act 1

The need to look forward - not backwards:  
How technology may change life expectancy in the future

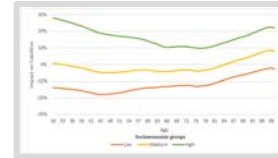


# What might Disrupt life expectancy improvements?

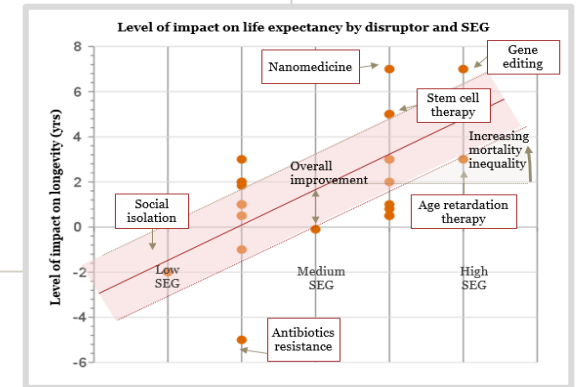


Source of uncertainty	Magnitude	
	Uncertain	Reasonably certain
Likelihood	<p><b>Gene editing</b> Underestimating of the benefits</p> <p>GH/IGF1 axis age retardation therapy Telomere extension</p> <p><b>Nanomedicine</b> Fast access to care</p> <p><b>Antibiotic resistance</b> Negative mortality effect of widely used drug</p>	<p>Reduction in air pollution in major cities Obesity epidemic</p> <p>Smoking cessation Improved treatment of the vaccination</p> <p>Automation Social isolation</p>
Reasonably certain	<p>Antibiotics reduce the number of deaths Wagepay</p> <p>Technology improves access to care</p> <p>Personalized medicine</p> <p>3D Printing replacement organs</p>	<p>Use of vaccine adjuvants</p> <p><b>Real time medical risk technology</b></p> <p>Immunotherapy</p> <p><b>Stem cell therapy</b> Artificial intelligence in medical intervention</p>

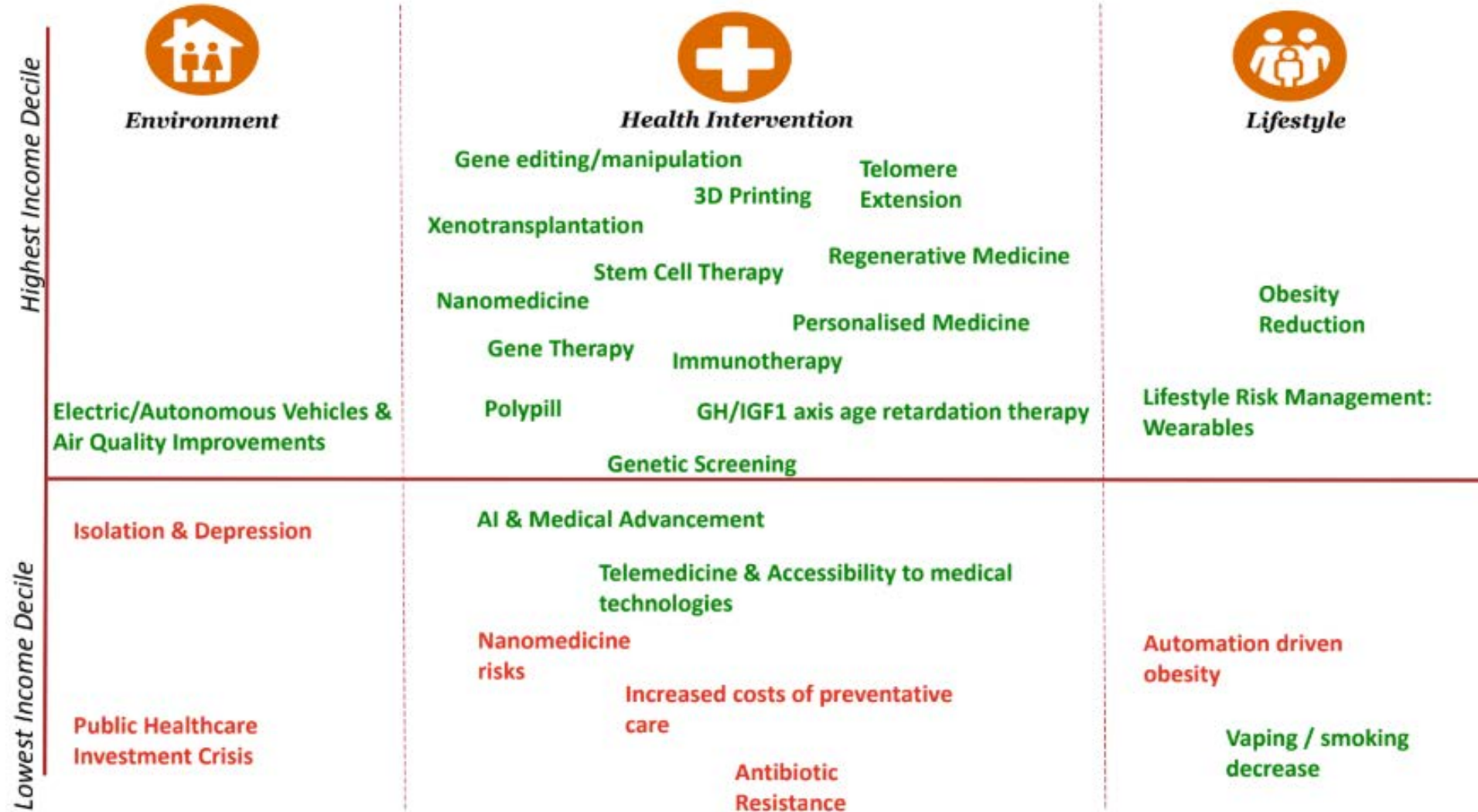
## 5. Population level impact



Disruptor	Description	Estimated qualitative impact on life expectancy	Timeline of potential impact	Notes
Gene editing tools	Insertion, deletion, modification or replacement of DNA in the genome of a living organism.	Slight increase	→	
Understand how microbial communities impact human health	Microbial communities are groups of microorganisms that share a common living space.	Slight increase	→	
Reduction in accidental deaths from adoption of autonomous vehicles	A reduction in motor-related deaths due to from the adoption of autonomous vehicles reducing driver error.	Slight increase	→	
Increased isolation and absence of social interactions	The negative impact from increased social isolation where virtual online interactions increase as technology develops.	Slight decrease	→	
Lack of access to health care	A lack of access due to lower funding for social, health and long term care and a shortfall in investment staff after Brexit.	Slight decrease	→	
Obesity epidemic	Positive impact which could arise from lifestyle changes e.g. improved diet and increased exercise.	Slight increase	→	
Nanomedicine	The use of materials which are used in the nanoscale range, targeting the application and effectiveness of drugs.	Slight increase	→	
Antibiotic resistance	Increased antibiotic resistance due to over or unnecessary use.	Slight decrease	→	
Negative mortality effect of widely used drug	Reduced effectiveness of a drug following virus mutation due to antibiotic usage	Slight decrease	→	



# What might Disrupt life expectancy improvements?



# What did we conclude?

- Analysis for a large UK Pension Plan showed that the impact of these Disruptors ***could increase liabilities by up to 40%...***
- ... even after allowing for the diminishing marginal impact on life extension from each technology
- However, there is ***material uncertainty*** around both the likelihood and impact of a number of the Disruptive technologies
- And, by definition, this analysis excludes ‘unknown unknowns’ (both positive and negative)
- ***Our conclusion: Never before has the possible range of life expectancy outcomes been so great and so uncertain***

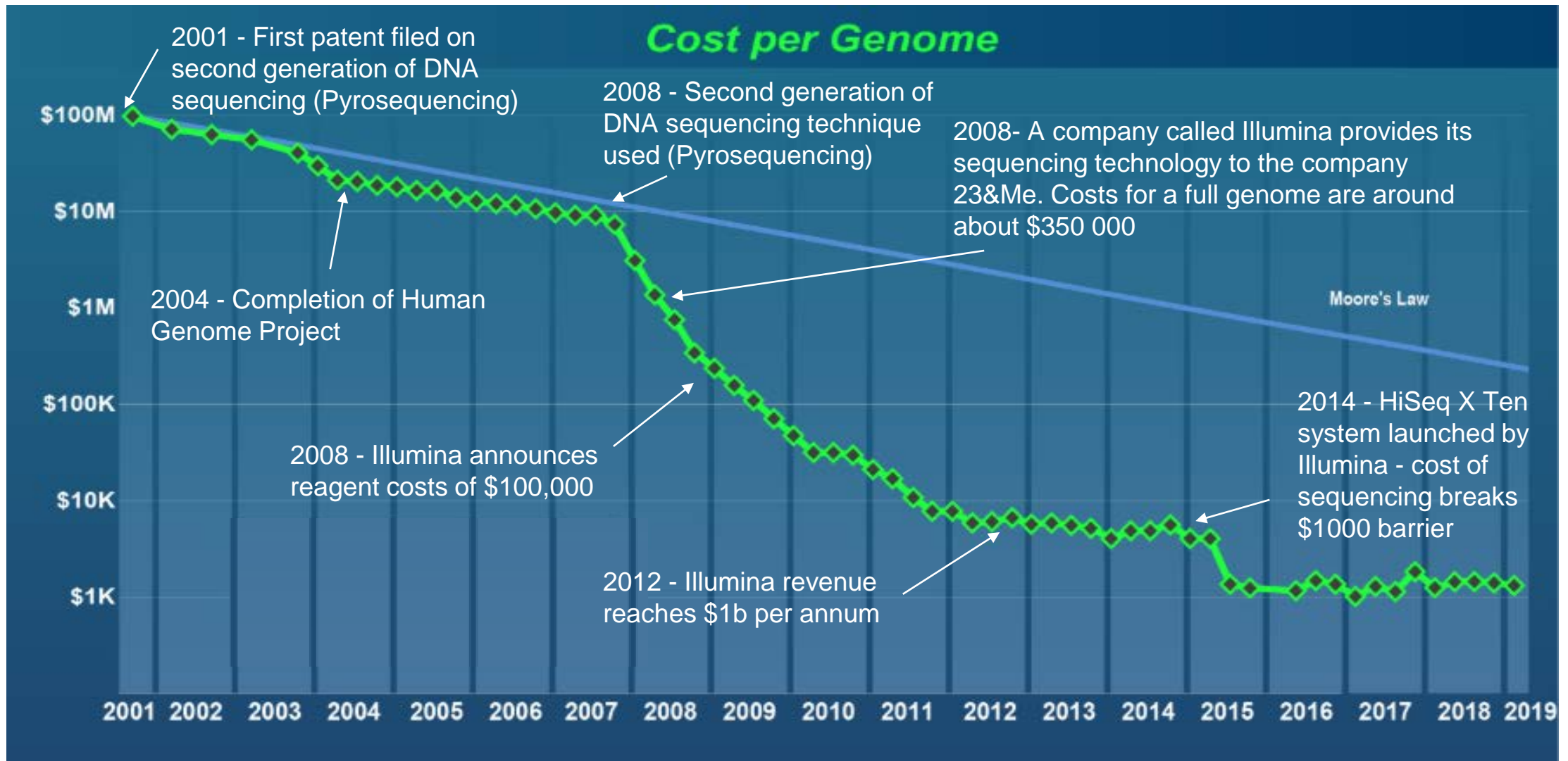
# Act 2

How technology can help us better predict longevity changes

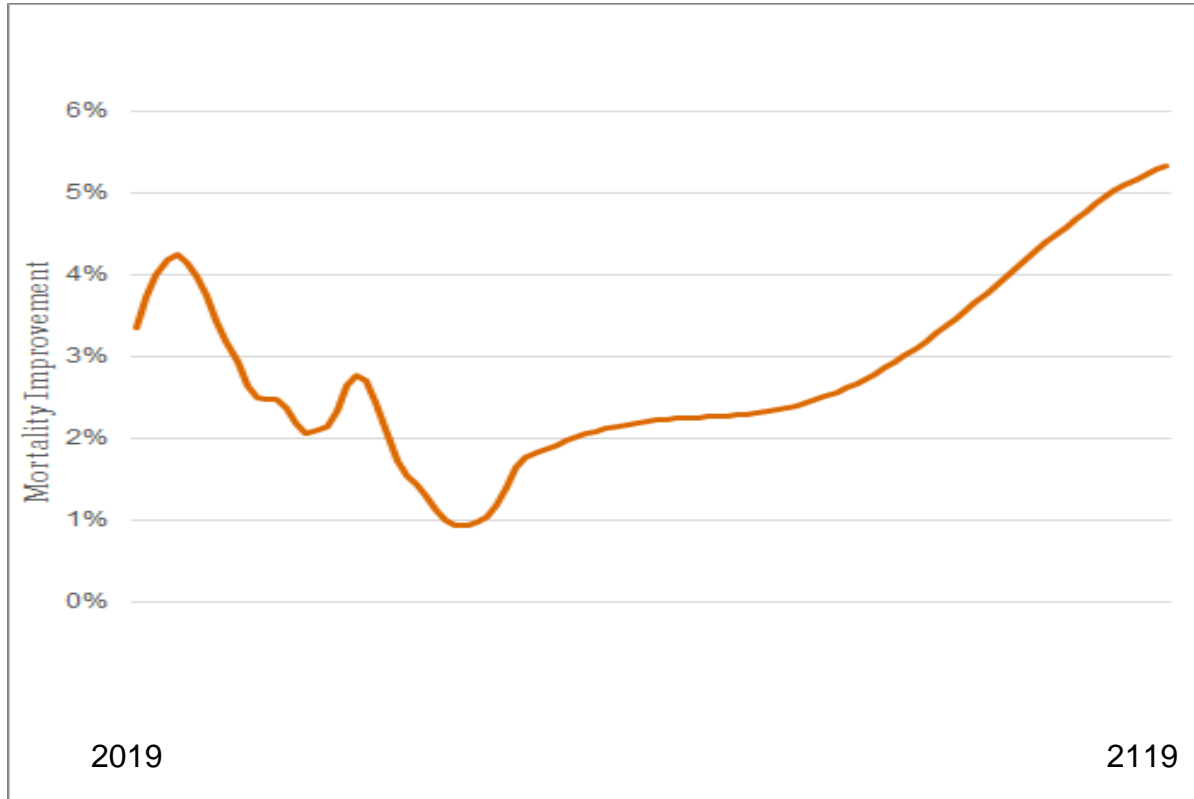




# Timeline of development of genome sequencing



# When will the Disruptors impact?



Of the **24** Disruptors identified:

- **12** are expected to be with us in the next 5 years
- **6** in 5 to 10 years
- **3** in 10 to 20 years
- **3** in 20 years+

Of the **12** that may emerge in the next 5 years, **4** have the potential to have a moderate to material positive (greater than 1 year life extension) impact on life expectancy:

- Management of lifestyle using real time technology, including wearables
- Smoking cessation
- 3D printing of replacement organs
- Technology enabled access to care

And **1** that may have a material negative impact:

- Increased isolation and reduced access to care

# Which questions are we trying to answer with different data sources?

Is there technology / a trend available which could have an impact on life expectancy?

- Patent Data
- Drug approvals/stage trials
- Trials undertaken (volunteers)
- Drug funding
- Regulation
- Medical journal output
- Share price
- Medical job applications


Is there public interest and appetite in these new technologies?

- Web usage
- Social Media activity
- Google Searches
- Broader online activity
- NHS access
- NHS usage (including web, tech-enabled formats)
- Wealth Distribution

Is public interest translating into action?

- Medicine sales
- Doctor visits
- Smoking prevalence
- Suicide prevention
- Young (male) driver awareness/safety e.g. take up of advanced driving test

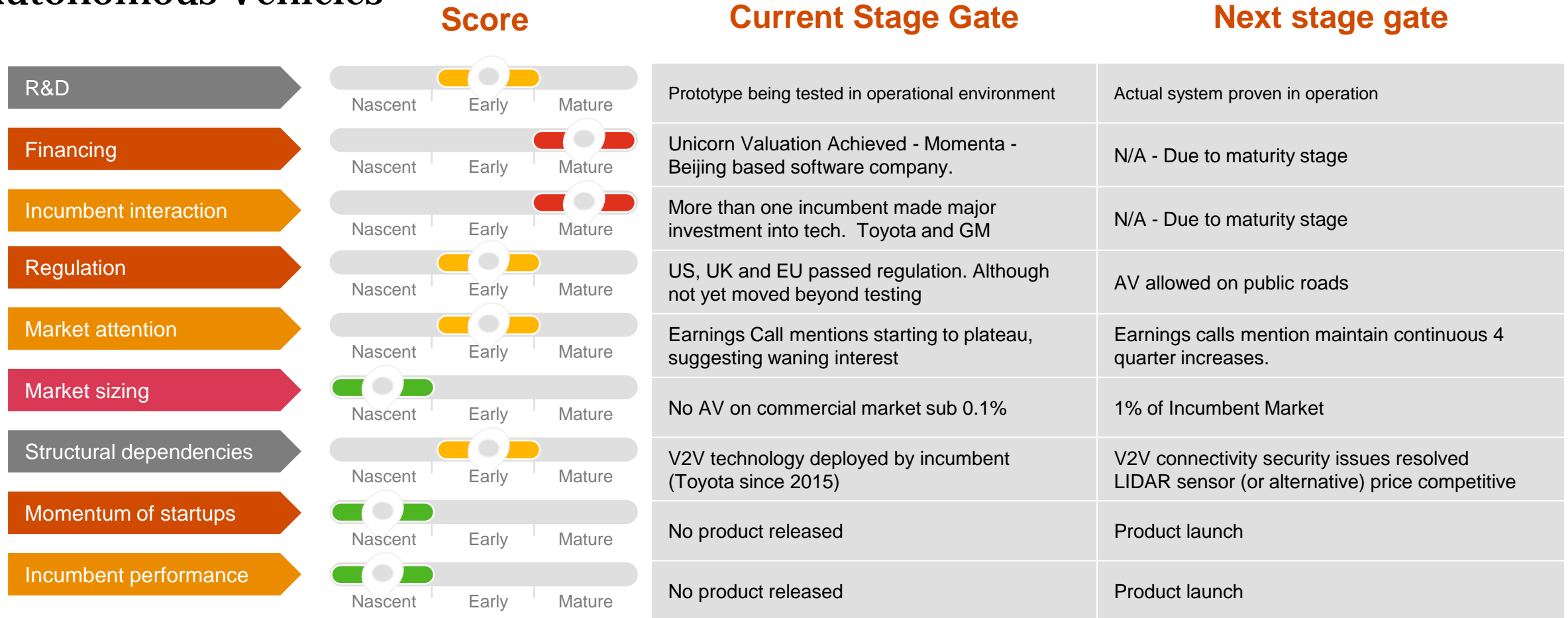
# Building a Weak Signal Monitoring framework



Weak Signal Stage Gates	R&D	Published Papers	Prototype Working	Deployed commercial product in sector
	Financing	VC / Self Finance	Series B +	IPO / Unicorn Valuation
	Incumbent interaction	Small Startups only within space	Invest in Commercially Viable Concept	Deployed Commercially viable concept
	Regulation	No Interaction	Debated in Commons	FCA Handbook
	Market attention	Little or no mentions on earnings calls	Month on month increase in mentions over 6 month period	Spike in mentions over last year, over [x] standard deviations
	Market sizing	0.1% of Incumbent	1% of Incumbent	5% of Incumbent
	Structural dependencies	Significant tech dependencies unsolved	Solo tech dependency	None
	Momentum of startups	User Adoption Rate	User Adoption Rate	User Adoption Rate
	Incumbent performance	No Customer movement	Marginal Customer Movement	Loss of Core Customer

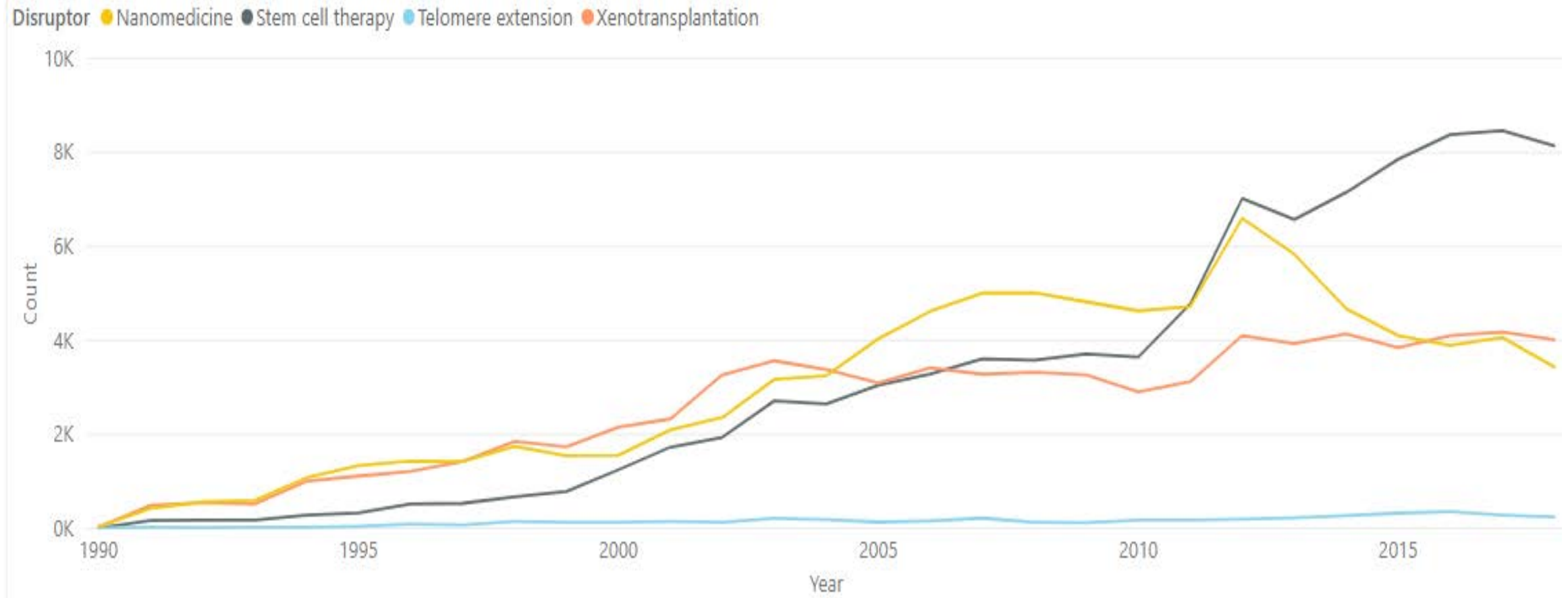
# Example Weak Signal Monitoring framework

## Autonomous Vehicles



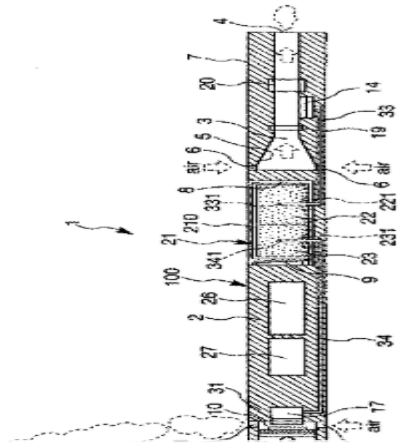
# What is the availability of patent data

Volume of patents over time in life extending therapies

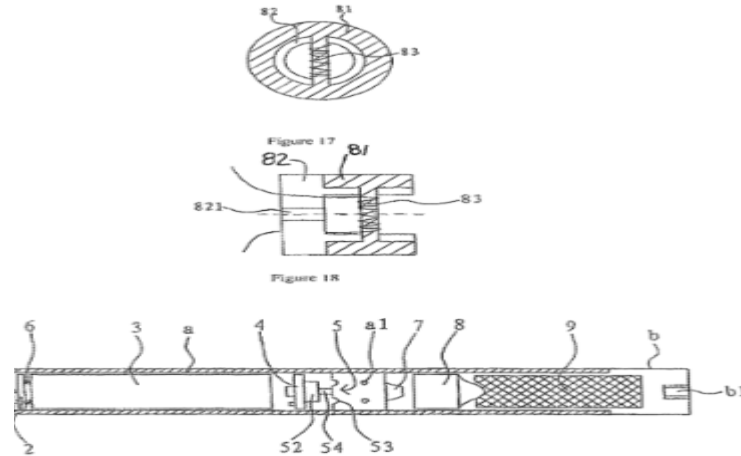


# Combining Patent data and Internet activity

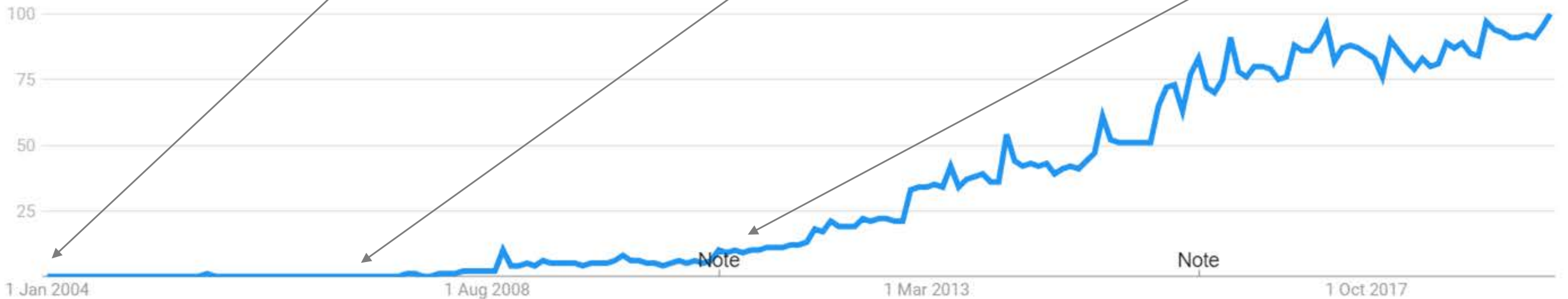
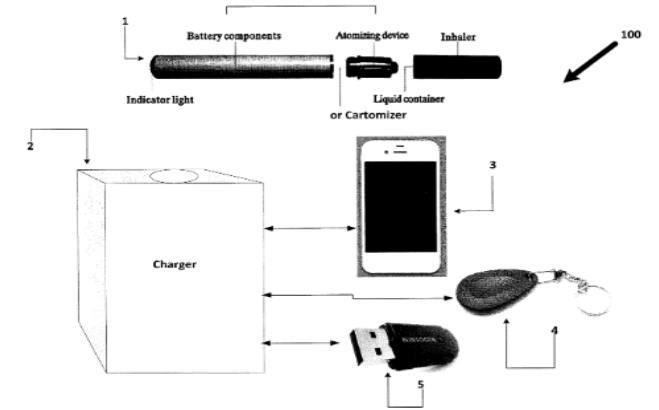
Patent application filed in 2003



Patent application filed in 2006



Patent application filed in 2012



# What is the public interest in life extending behaviour?

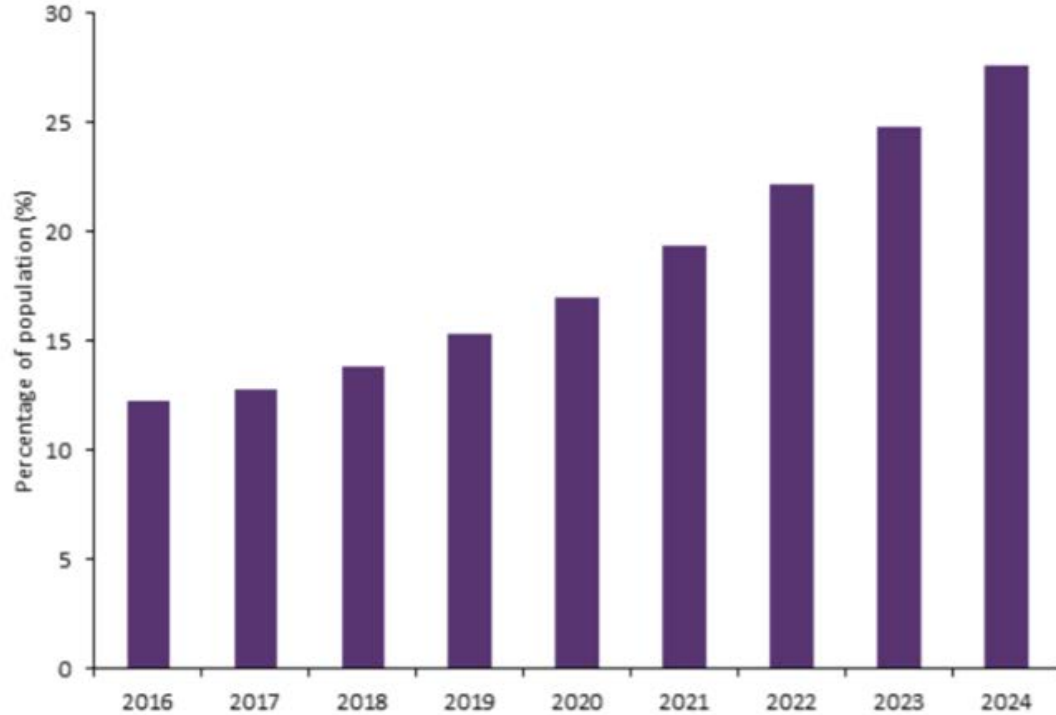
Internet activity in over 50s home work-out, running & yoga videos





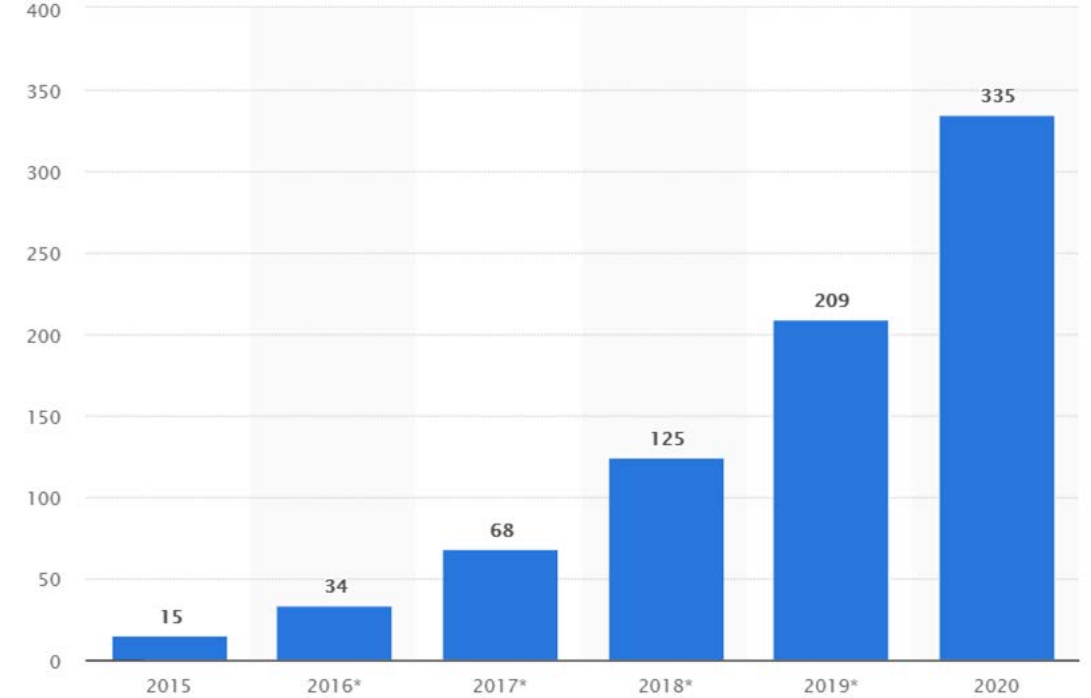
# Wearables and associated data

The % of the population set to own wearables is increasing rapidly



Source: GlobalData

Volume of data generated by wearables (Petabytes per month)



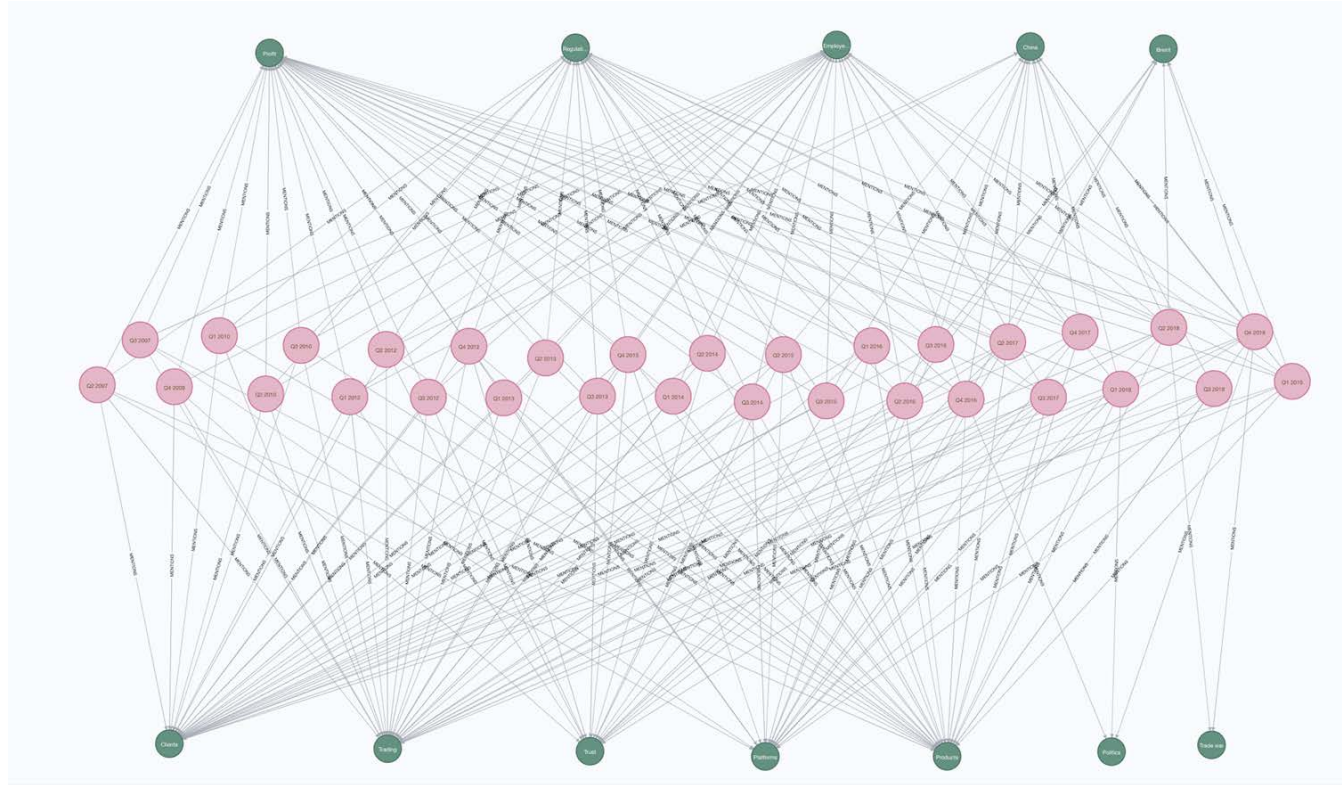
Source: Statista

1 petabyte = 1000 terabytes. In 2018 there were 125 petabytes, which equals 125,000 terabytes per month. For context Wikipedia is roughly 50GB of text.

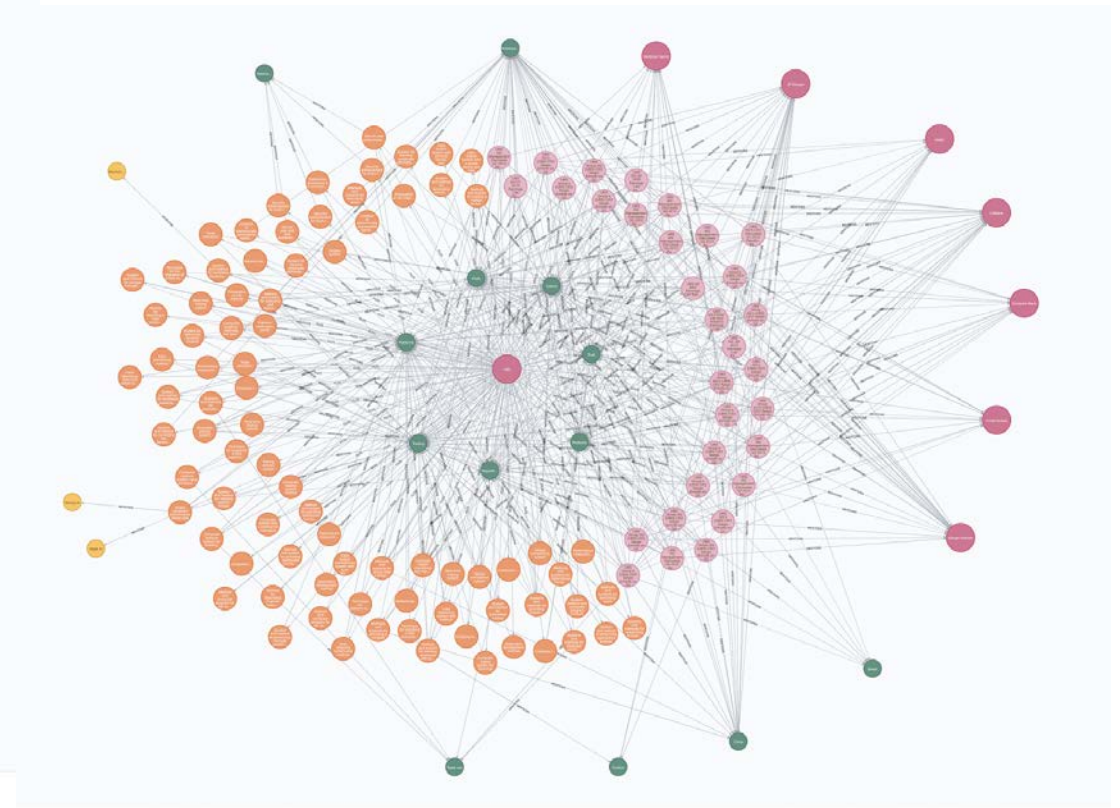
This means there are roughly 2.5 million Wikipedia's worth of data being generated monthly by wearables.

# How can we use technology to analyse vast quantities of data

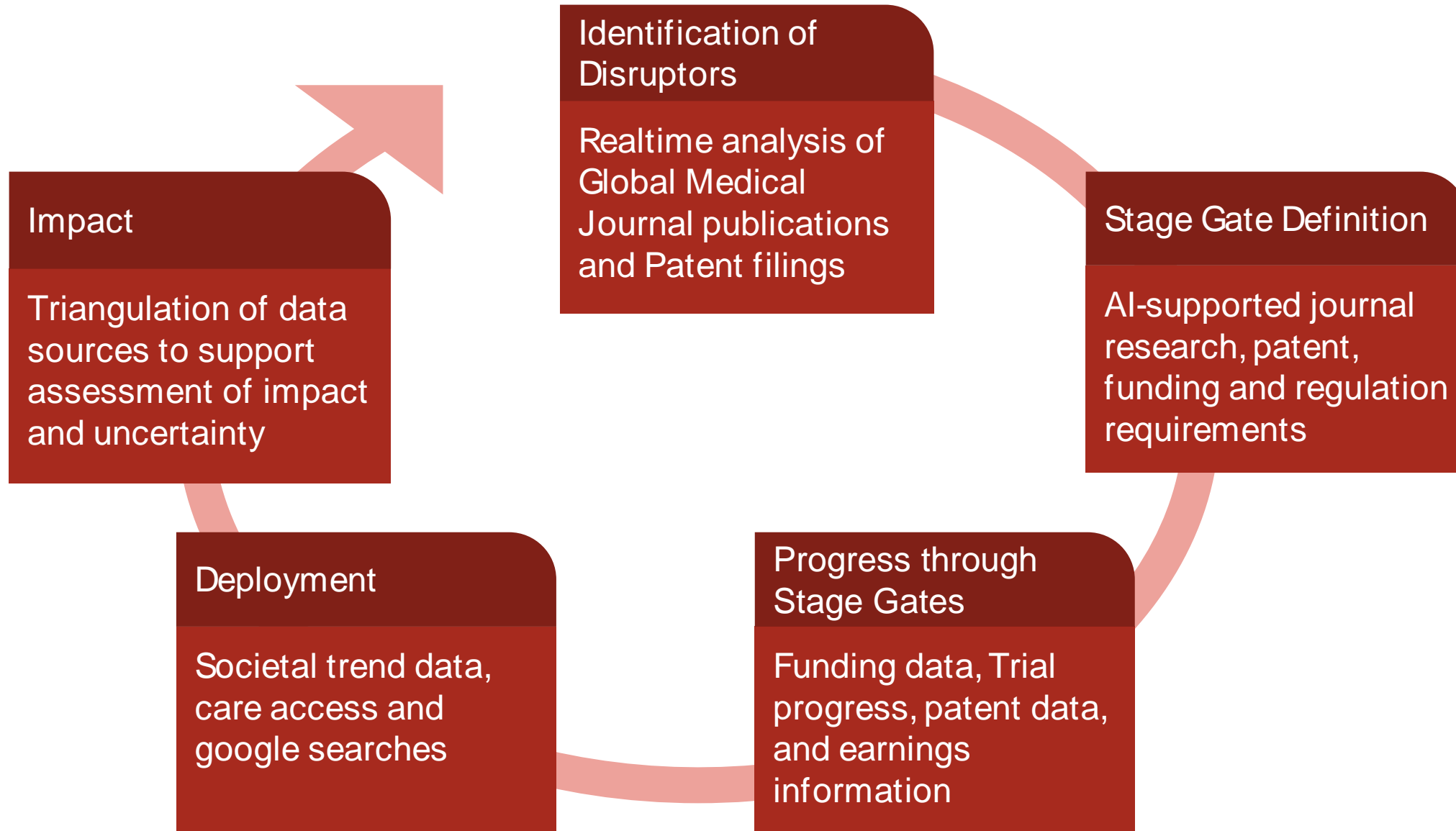
AI techniques are making new levels of topic modelling, pattern identification and prediction possible



g 43 nodes, 226 relationships.



# What may be possible?



# Act 3

The PwC Life Expectancy Volatility Index



# PwC Life Expectancy Volatility Index

