Economic Perspectives on the Digital Transformation

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Who is This Guy?

- Microsoft Chief Economic Policy Strategist and Chief Economist WWPS
- PhD 1990, U. Rochester
- Co-Designer, Generalized Second Price Auction used to rank search ad results for Goto.com now used by Bing and Google
- Author, 40+ articles
- Former Chief Economist of FCC
- Former Chair Economics Dept. USC
- Taught at Caltech, Columbia, USC
- Expert Testimony: US FTC, FCC, EU, CCB

What is a Chief

Digital Transformation: Cheap sensors + connectivity + cheap data storage + machine intelligence

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Universal Ambient

Vignettes- all in use today

- Sensors in fields direct irrigation, pesticides
- X-Ray, MRI analyzed by machines
  - MSR melanoma app beats best experts in diagnostics
- Chat-bot answers X-Box user's problem
- Driving behavior, alertness monitored by OBD2
  - My Insurance rates determined by my behavior not population average
- Delve introduces 2 managers to discuss specific topic
- Police dispatched to warehouse by video monitoring software

Not since the early 1900s have we seen this level of technological innovation.

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Technological Acceleration

1. Mobility (devices, data, intelligence)
2. IoT (ubiquitous comms, cheap chips)
3. Cloud (VLS computing)
4. Machine intelligence
5. Big data
6. Mobile payment systems
7. Personalization
8. Voice control, conversational
9. Virtual reality
10. Silicon photonics
11. Software writing software
12. 3-D printing
13. Wearables & quantified self

15. Online markets
16. Lightweight, low altitude satellites
17. Drones
18. Native advertising
19. Driverless vehicles
20. Robotics, industrial automation
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22. Near-instant product delivery
23. Freelance employment model
24. Assetless company
25. Nano-machines
26. Genomics
27. Economical solar, wind, tidal

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global business
leaders survey

23%

are confident their
organizations have the
knowledge and skills
to succeed in the digital
aspects of their business.

45%

said they personally had
the technology knowledge
they need to succeed in
their jobs.

What is Coming?

- New markets
  - Uber is just the beginning
- New organizations
  - Delve is just the beginning
- New contracting
  - Intelligent measurement
- New jobs

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Why market design?

Market failures

- Thin markets
- Information and measurement problems
- Externalities (e.g. traffic congestion)
- Public Goods and Cost Allocation

How?

- Treat the market as a game
- Design the game to induce desired outcomes
- Information is a critical resource

Market Design Desiderata

Economic Theory

Efficiency – cant make anyone better off without hurting others

Incentive Compatibility – no one can "game the system"

Balance – Revenues from participants cover all costs

Voluntary Participation- All are better off in the market than leaving

One shot design

Real World

Pareto Improve on current situation- All win

Monotonicity – Bigger players benefit more

Near Balance – OK if we make a profit

Voluntary Participation- This is key, a must in real world!

Market Design for Platforms

Efficiency – **need to bring both sides of the market together**

   Uber: Riders (Mobility Demands) and Drivers (Mobility Suppliers)

Incentive Compatibility – **no one can "game the system"**

   Uber: Innovation Surge pricing and advanced price discrimination

Voluntary Participation- All are better off joining the platform

This is the tough one for platforms – The "Cold Start" problem

   Uber: Easy to identify benefit to riders through the App. Hard bit need to get drivers to sign up. Two key innovations: No background check for drivers! Non

New Markets

- Power – smart grids with dynamic markets
- Mobility as a Service
- Spectrum/connectivity dynamic spectrum allocation
- Real time, on demand, imaging
- Movement of things in the physical world
- Employment
  - Virtual companies
  - Education
  - Professional services
 - Simple tasks (dog-walking)
  - Shopping

AI MSR Economics and Finance 1

- Deep CRM and Finance internal sales forecasting:
  - Replace expert guesses with deep neural nets
  - Mine not just sales data but other internal sources
  - Apply sentiment analysis to CRM field reports from sales team
  - More accurate and faster forecasting
 - Using the "Whole Enterprise Brain."

AIR Economics and Finance 2

- Bing Predicts improving Treasury performance
  - Mine the billions of Bing queries – apply sentiment analysis e.g. "New BMW 760" is positive "unemployment insurance" is negative
  - Combine with Twitter feed and traditional Economic variables
  - Can predict macro variables better than consensus expert estimates (next slide)
  - Can use this as basis for trading or hedging strategy
  - Nowcasting: Continuous use of data
  - Data sharing platform – Partner with us join your data with our data to generate new value – we share the increase in value as partners
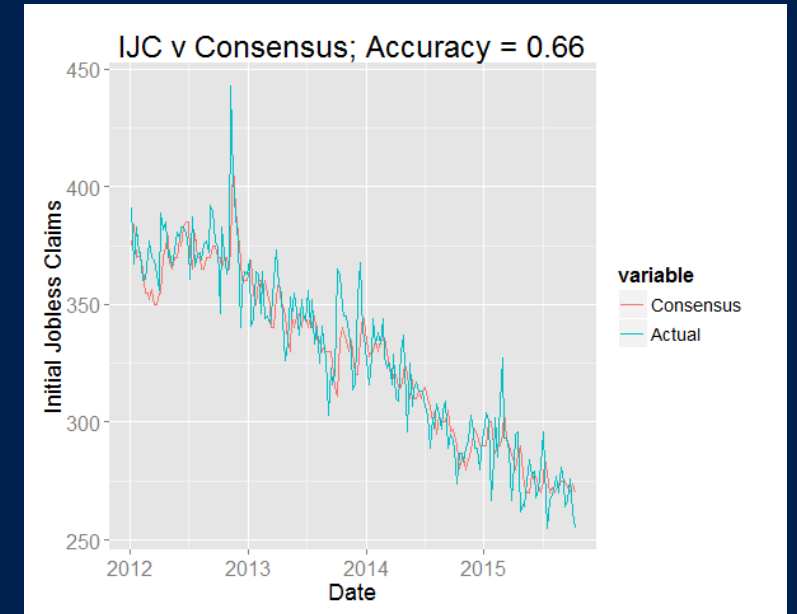
Predicting Initial Jobless Claims
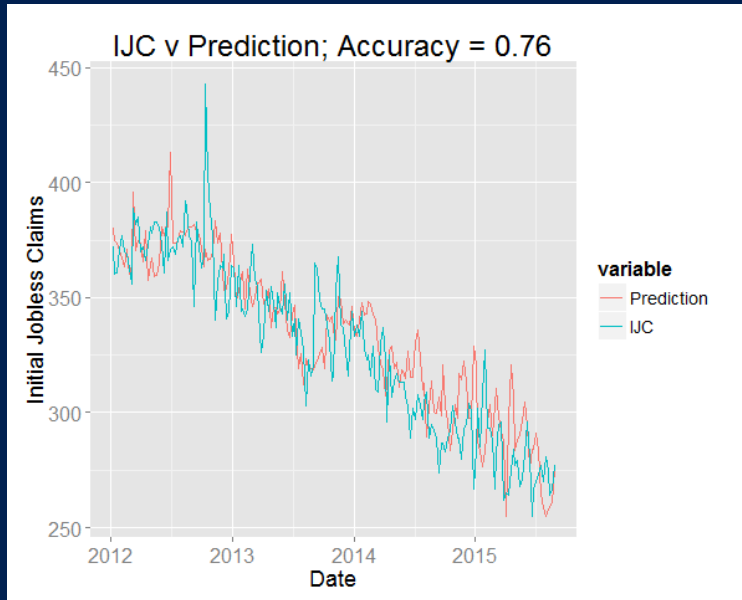
1 week
ahead
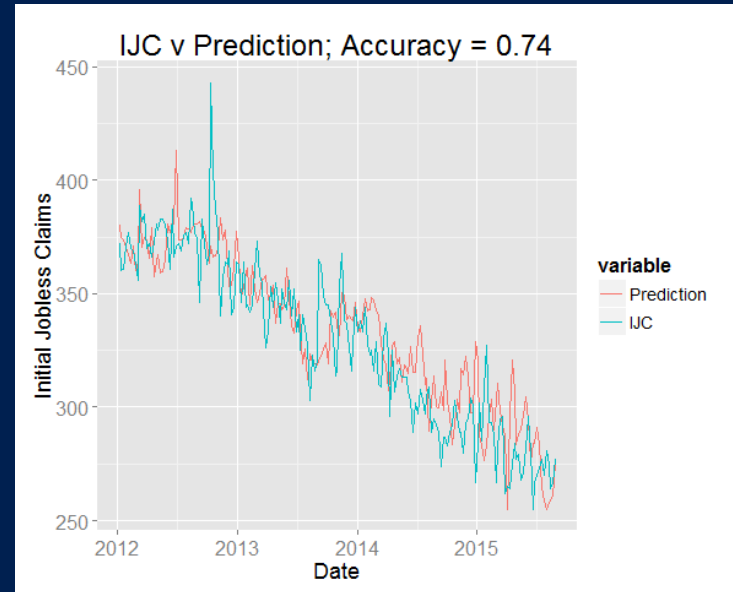
1 month
ahead

< 1 day
ahead

Models based on public social media data have higher directional accuracy than consensus, with far greater lead time.

AI MSR Economics and Finance 3

- Causality meets AI:
  - Most AI and machine learning optimized for prediction
  - Will make errors if the world changes do to a policy or strategy change-
  - Can be catastrophic if follow naïve AI prediction for policy evaluation
  - Need to understand causality to recommend policy changes
- ALICE : **Automated Learning and Intelligence for Causation and Economics**
  - Use Economic models to constrian AI
  - Solution when experimental methods (e.g. A/B Testing) are not practical
  - Economic AI: Recipes for stacking together ML tasks to reliably address causal questions

Econometrics

Hand picked models
that exploit natural
experiments to mimic
A/B tests

Machine Learning

Automated model
selection, embrace high
dimensional data, focus
on prediction

The intersection is brand new

Harness the predictive power
of ML to do causal inference

What does this mean?

- Machine Learning is good at selecting from many features to predict something.
- Econometrics is good at carefully measuring effects that we care about.

- Solution: Split demand estimation into
  - Pure prediction steps where machine learning algorithms can be used to optimally control for high-dimensional confounds.
  - Measurement steps where elasticities are estimated in an unbiased way on left over variation.

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The End of the Workplace

Gartner Says

By 2018,	~~Robot overlords~~ Smart machines will distribute 10% of human work.
	four out of 10 high performers will distribute their work across a team of "virtual doppelgangers" to boost their personal productivity.
By 2020,	as much as 65% of knowledge worker career paths will be disrupted by smart machines.
	non-routine work will account for more than 65% of U.S. jobs.

Rapid Restructuring and Change Management
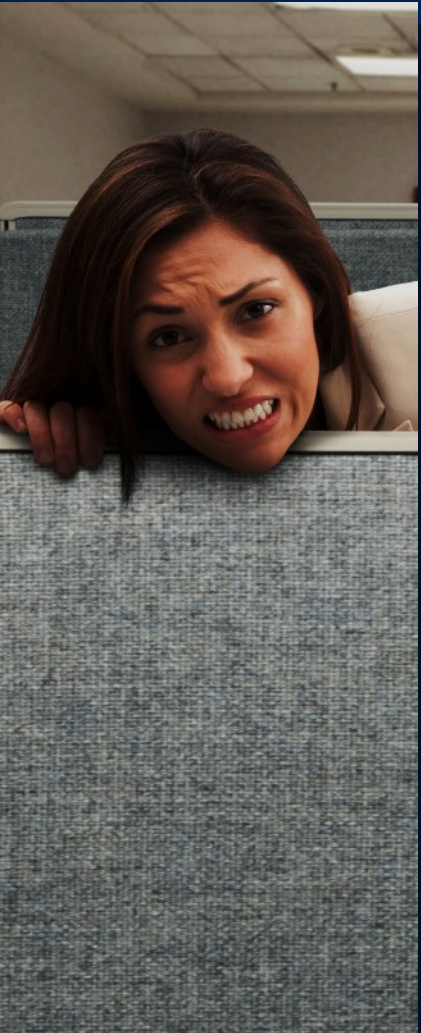
Change business practices much more quickly

Automate employee, resource assignments

Create new, virtual teams or virtual companies

Rapidly prototype new products

Launch web-based channel and scale as needed

Corporate Culture

- Culture Definition:
  - Absent managerial direction or strong incentives, how to behave?
  - We copy other employees
- Culture optimized for problem being solved
  - Dell, Walmart, Southwest must be cheap
  - Time Warner AOL merger – culture clash
  - Mature companies versus growth companies

Digital transformation changes mission, changing culture

- Data, learning critical
- Just-in-time knowledge distribution
- Using cognitive services
- Fast iteration
- Changing employee roles

Plan for culture change, use AI to monitor

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New Contracting Methodologies

- New signals and measurement
  - Insurance rates depend on driving behavior
- AI
  - Predict salesperson success, determine compensation
- Auctions and bidding
  - e.g. crowd-sourced logo
- Price discrimination
  - Based on time of day, day of week
  - Geography
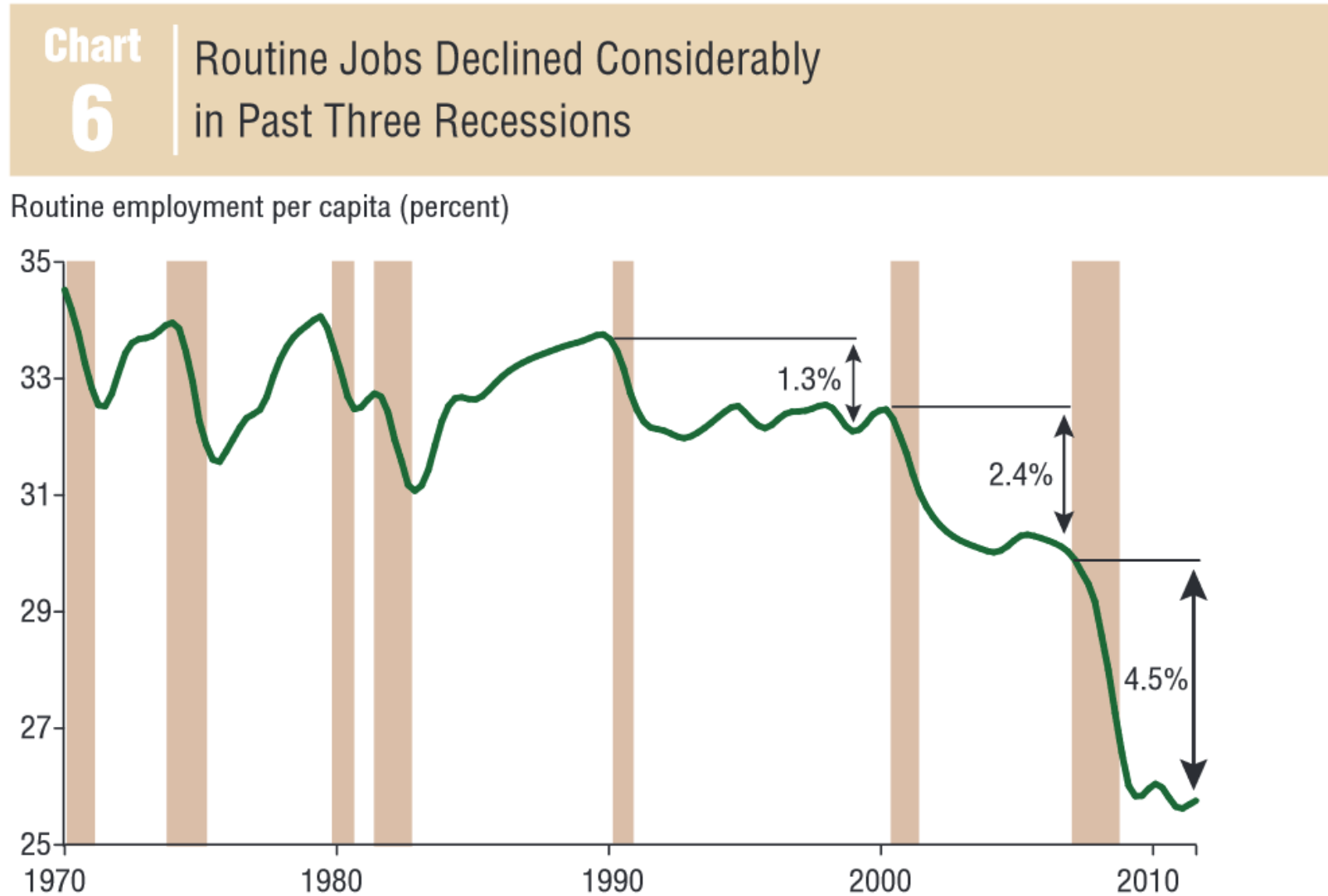 - Other purchases
  - AI-based models

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Changing Employment to Non-Routine

In the past jobs were lost recessions but came bac the recovery.
Since 1990 in each recess routine jobs were destroy
They do not come back.
The trend has been incre

Chart 6 | Routine Jobs Declined Considerably in Past Three Recessions

Routine employment per capita (percent)

1.3%

2.4%

4.5%

NOTE: Shaded bars indicate National Bureau of Economic Research dated recessions.

SOURCE: Adapted with permission from "The Trend Is the Cycle: Job Polarization and Jobless Recoveries," by Nir Jaimovich and Henry E. Siu, National Bureau of Economic Research, NBER Working Paper no. 18334, August 2012.

http://www.dallasfed.org/assets/documents/research/eclett/2014/el1405.pdf

Complements and Substitutes

- A complement makes something more valuable
  - Xbox and controller
- One person with a bulldozer does the work of hundreds with shovels
- Initially reduces employment of diggers
- Drives up wages: *requires greater skill*
- Cost of earth-moving falls
  - More earthmoving
  - Employment may go up or down

North Korea's Masikryong Ski Resort Is Kept Open by Work Gangs

NBC News

by BILL NEELY
1/27/2017

Backbreaking Work Keeps N. Korea Ski Resort Open

NBC NEWS

There are thousands of workers just like this

Click to expand

00:14   00:59

MASIKRYONG, North Korea — On the bumpy road to North Korea's top ski resort, work gangs hack and shovel the fresh snowfall to clear the route for busloads of their fortunate fellow citizens.

Complements and **Substitutes**, Continued
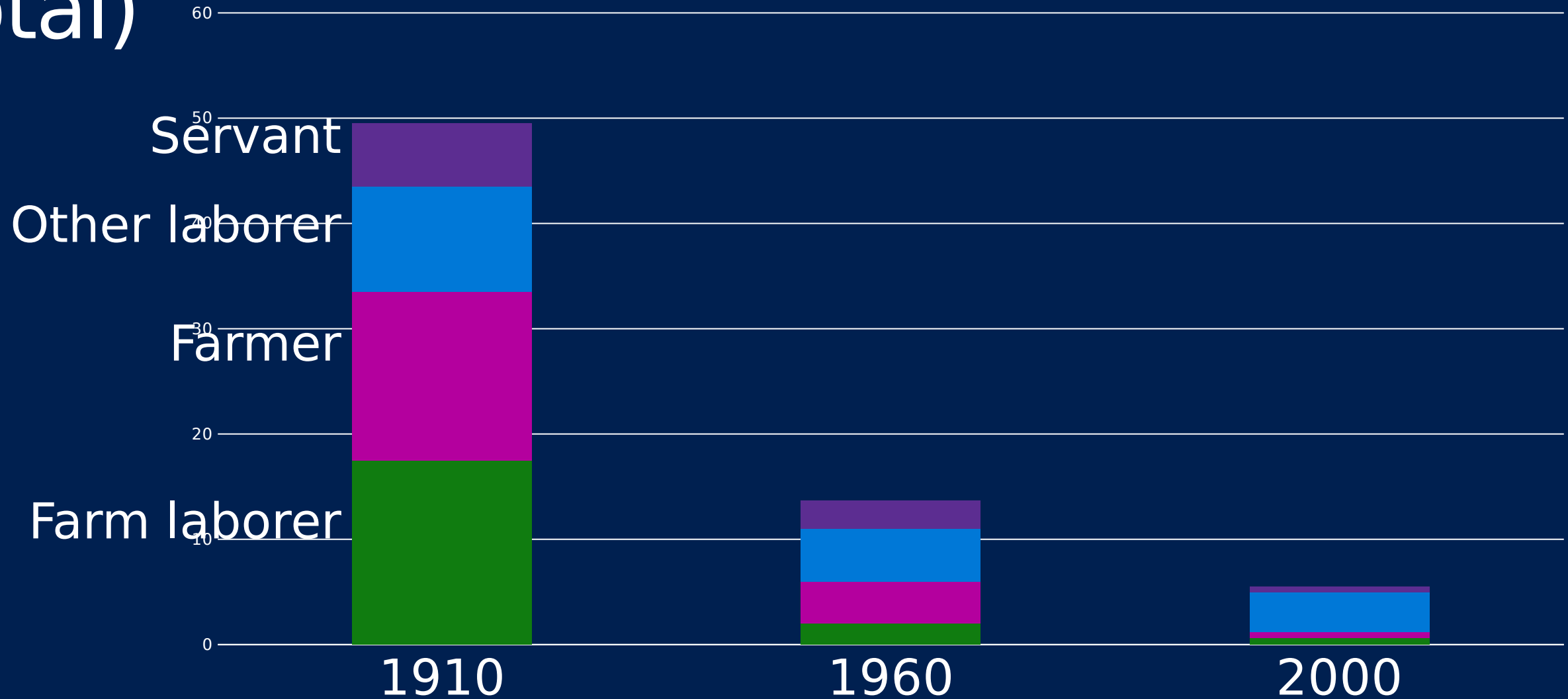
Cotton Gin

- Adding machine in fast food restaurant
  - Substitutes for math skills
  - Reduces skill level
  - Wages fall, employment rises
- Word processing
  - Reduced secretarial wages
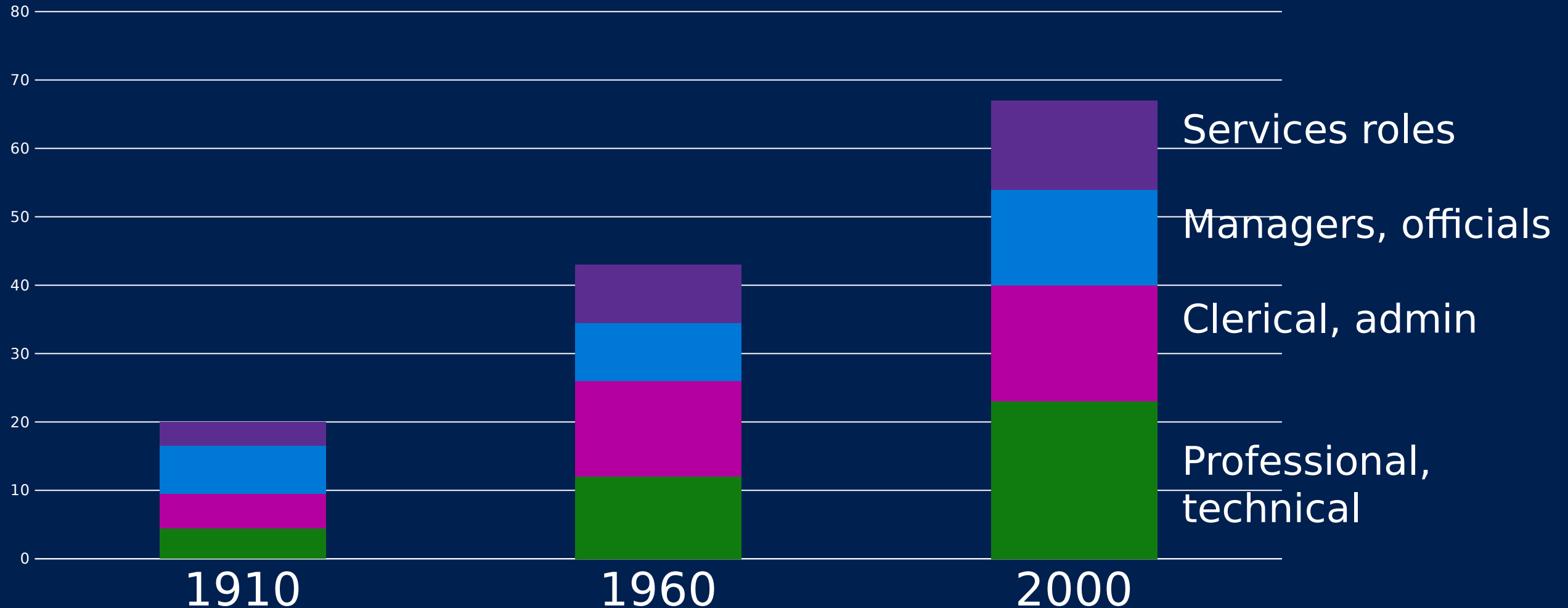
Effects on Wages

- 1750-1900: "Deskilling"
  - Machines + low skilled workers substituted for skilled artisans
  - Pin factory, Cotton gin
  - Wages flat or fall, increasing inequality
- 1875-1980: Machines complement skills
  - Bulldozer, assembly line, services
  - Middle-class wages rise, decreasing inequality
- 1980-2017: Machines substitute for skills
  - Wages flat for bottom 60%
  - Widening skill gap, "college premium", increasing inequality
  - Increasing "underemployment"
- 2017-2100: Is AI a substitute or complement?

Jobs disappearing in 20th century (% of total)

Servant
Other laborer
Farmer
Farm laborer

60
50
40
30
20
10
0

1910
1960
2000

New jobs 20th century (% of total)

Services roles

Managers, officials

Clerical, admin

Professional, technical

80
70
60
50
40
30
20
10
0

1910

1960

2000

Job Losses 2000-15

000's	2000	2015	Δ%
Production	12400	9073	-27
Office and admin	22936	21846	-5
Management	7783	6936	-11
Construction			

New jobs 2000-15

000's	2000	2015	Δ%
Food preparation, serving	9955	12577	26
Biz, financial operations	4610	7032	53
Health practitioners	6041	8021	33
Personal care	2701	4307	59
Education, training, library	7451	8542	15
Computing and maths	2933	4005	37
Sales	13507	14462	7

Another Perspective

- 100 years ago, 33% of us grew food. Now 2%
- 40 years ago 22% made 'things'. Now 8%.
- Automation increasingly takes service jobs
- But … purchases of rich spread to middle class
  - Predicts future jobs

What do the top 5% buy

- Fancy construction
- Craft & designer items
- Fine dining
- Entertainment – sports, theatre, tourism
- Personal trainers, massage, b

Jobs, Continued

- New technologies create new job roles
  - But this has been shrinking over time, below 1%
- Jobs come where humans are better
  - Communications
  - Creativity
  - Care (especially where empathy ne
  - Service

Substitute or Complement?

- Complements – increase wages
  - Delve, DeepCRM, Hololens, Office
  - Design tools, 3-D printers,
- Substitutes – decrease wages/increase inequality
  - Turbo-Tax
  - Medical diagnostics
  - Driverless shuttle bus

Technologies: Substitutes and Complements

1. Mobility (devices, data, intelligence)
2. IoT (ubiquitous comms, cheap chips)
3. Cloud (VLS computing)
4. Machine intelligence
5. Big data
6. Mobile payment systems
7. Personalization
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What are the growth industries for this century?

- The tasks that make us human
  - Communications and persuasion
  - Creativity and invention
  - Care and Empathy

- How to thrive?
  - Treat AI and automation as a to
  - Expect to learn new tools
- New Social Contract?
  - Digital Inclusion
  - Self worth/identity
  - Artisan economy

Microsoft