

Complexity



What do we mean when we talk about complexity?

- Can crowds help you write something?

Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)



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- Can crowds create things from whole cloth?

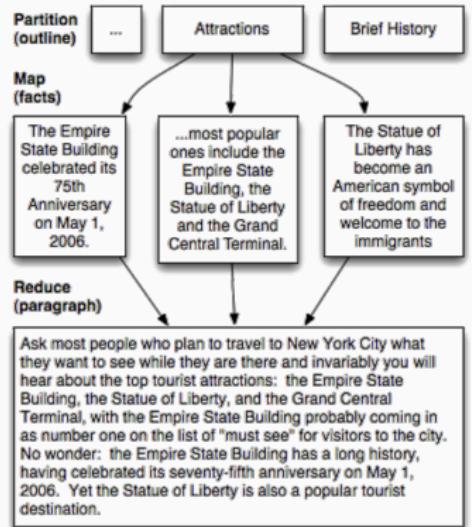
Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)



What Does Crowdsourcing Say?

- Build complexity into the process
 - Apply CS methods to people

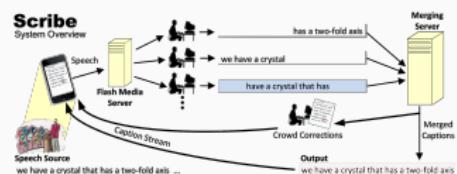
Kittur et al. (2011)





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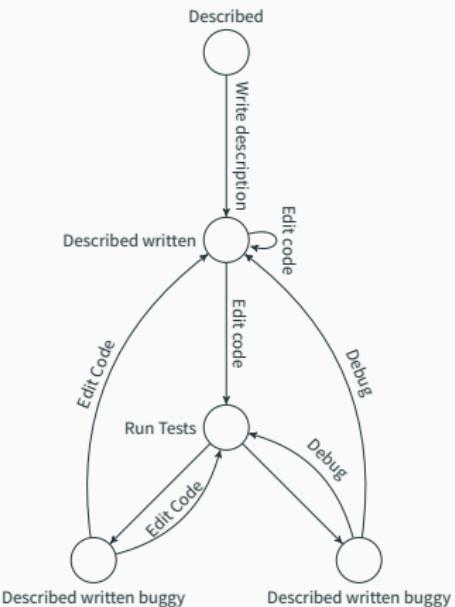
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What Does Crowdsourcing Say?

- Build complexity into the process
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Kittur et al. (2011)
 - Humans as computational units
Lasecki, Kushalnagar, and Bigham (2014)
 - Crowdsourcing workflows as function state machines
LaToza et al. (2014)





What Does Piecework Say?

George Airy (astronomer) used a very similar approach

Grier (2013)



- Employed computers
- 13–20 years old
- no particularly strong background in mathematics
- A basic understanding of logarithms, algebra, etc...

George Airy



Airy built complexity into the process, assigning *human computers* to calculate & verify the *right ascension* and *declination* of stars.

No. of Swings.	Approximate Time (Astronomical Reckoning).	Number of Signals.	Mean of Times by SHELTON.	Mean of Times by EARNSHAW.	Interval by SHELTON.	Interval by EARNSHAW.	Rate $\frac{\text{EARNSHAW}}{\text{SHELTON}}$	Logarithm of $\frac{\text{EARNSHAW}}{\text{SHELTON}}$	Corrected Logarithm of $\frac{\text{EARNSHAW}}{\text{SHELTON}}$
	Oct. h		h m s	h m s	h m s	h m s			
1....	1. 23	22	3 19 36.505	21 23 28.764	4 0 23.100	4 0 38.722	1.0010831	0.00047012	
2....	2. 3	21	7 19 59.605	1 24 7.486	3 58 21.652	3 58 37.400	1.0011011	0.00047793	
3....	2. 7	21	11 18 21.257	5 22 44.886	4 45 27.829	4 45 46.421	1.0010855	0.00047117	0.00047387
4....	2. 11	29	16 3 49.086	10 8 31.307	4 17 6.532	4 17 23.234	1.0010827	0.00046995	
5....	2. 16	17	20 20 55.618	14 25 54.541	3 13 21.898	3 13 34.795	1.0011116	0.00048249	
6....	2. 19	25	23 34 17.516	17 39 29.336	3 49 42.503	3 49 57.654	1.0010994	0.00047720	0.00047990
7....	2. 23	31	3 24 0.019	21 29 26.990	3 55 2.071	3 55 17.433	1.0010893	0.00047282	
8....	3. 3	21	7 19 2.090	1 24 44.423	4 2 41.510	4 2 57.445	1.0010944	0.00047503	
9....	3. 7	25	11 21 43.600	5 27 41.868	4 31 5.786	4 31 23.591	1.0010947	0.00047516	0.00046316
10....	3. 11	22	15 52 49.386	9 59 5.459	3 27 49.747	3 28 3.324	1.0010888	0.00047260	
11....	3. 15	24	19 20 39.133	13 27 8.783	3 59 47.292	4 0 3.188	1.0011049	0.00047959	
12....	3. 19	24	23 20 26.425	17 27 11.971	4 3 30.416	4 3 46.020	1.0010686	0.00046384	0.00047104



Farms



- Formalization of piecework:
payment for results
Chadwick ([1865](#))
- Dynamic piece rates



Marginal Complexity

Textiles

- Distributed workers



- Assuming common skills



Marginal Complexity

- Strict management
- Formalizing work methods

Matchstick Girls



Marginal Complexity



Farms



Textiles



Matchstick Girls





Trains

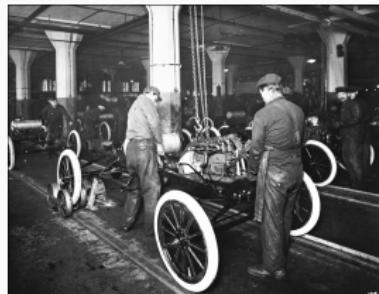


- “Efficiency experts” measured how long it would take to do various jobs
Cunningham ([1911](#))
- These measurements would be used to assign values for each specific task
Jewell ([1921](#))



Automobiles

- Consolidating and training workers
(Fordism)
Schoenberger ([1988](#))
and Tolliday and Zeitlin
([1986](#))



- Measuring and evaluating workers by very carefully defined instructions
(Taylorism)
Taylor ([1911](#))

Planes, Trains, and Automobiles



Planes

- Men drafted during World War II
- Factories turned to a new workforce who had neither conventional training nor experience
- **Specialized training and assignment**



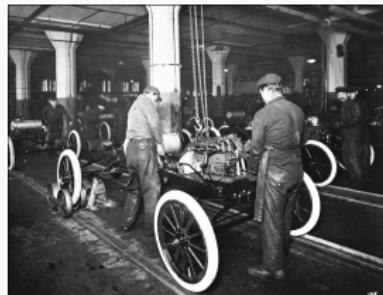
Planes, Trains, and Automobiles



Trains



Automobiles



Planes





Comparisons

- Limited array of tasks versus arbitrarily complex work
 - *Building* planes versus *fixing* trains
- Has technology changed this?
 - Technology makes *some* complex tasks relatively trivial
 - Measuring workers is easier than ever



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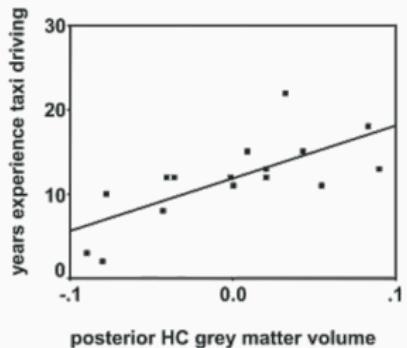
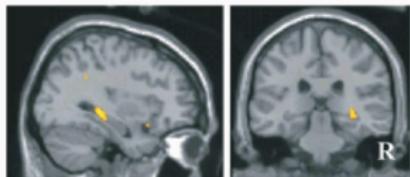




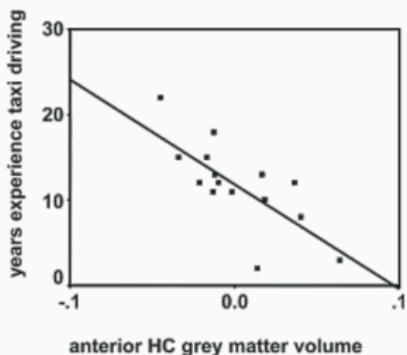
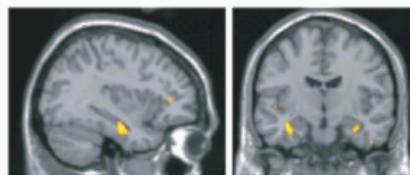
Complexity



A



B





Complexity





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notes

- I'm thinking of pointing to UpWork's screen recording tool as a way to measure workers
- also maybe google analytics and other ways of tracking web-based workers

Implications



- We make stronger assumptions about workers' abilities thanks to technology
- Evaluation remains difficult, but we're trying to find stopgap solutions through decomposition
- We're still not solving the problems of inherently subjectively judged work

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