

Future of Computing and What Do We Do Assignment Project Exam Help When We Get There? <https://powcoder.com>

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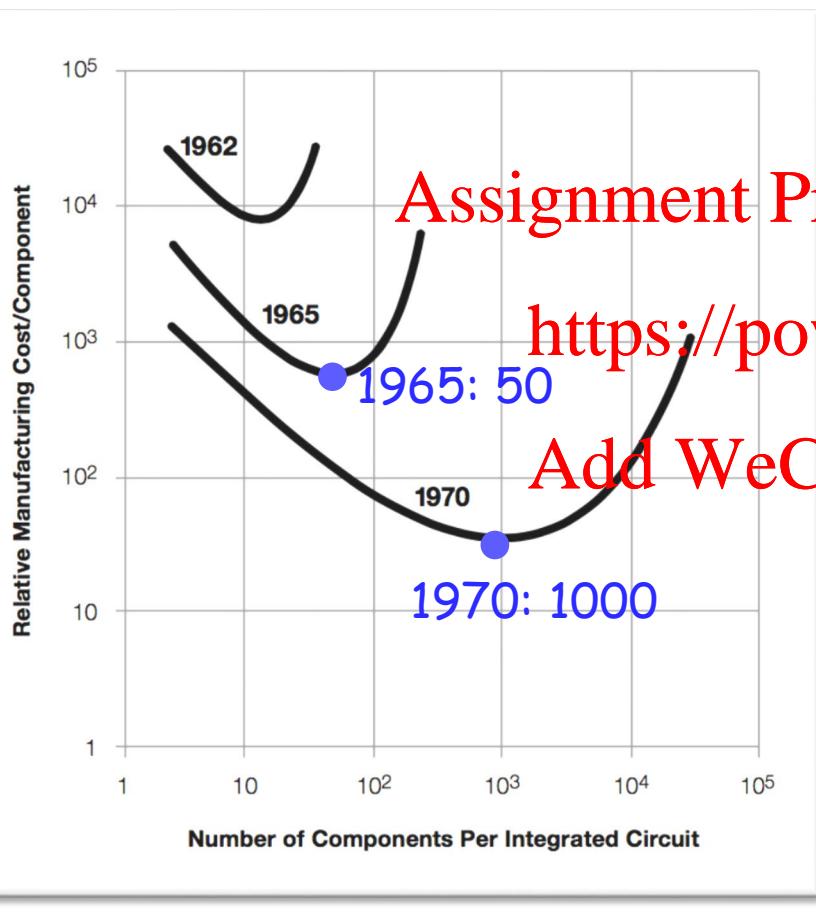
April 30, 2020

Today

- Beyond Moore's Law
- Technology & Labor
- What is Money?
Assignment Project Exam Help
- 213 Final
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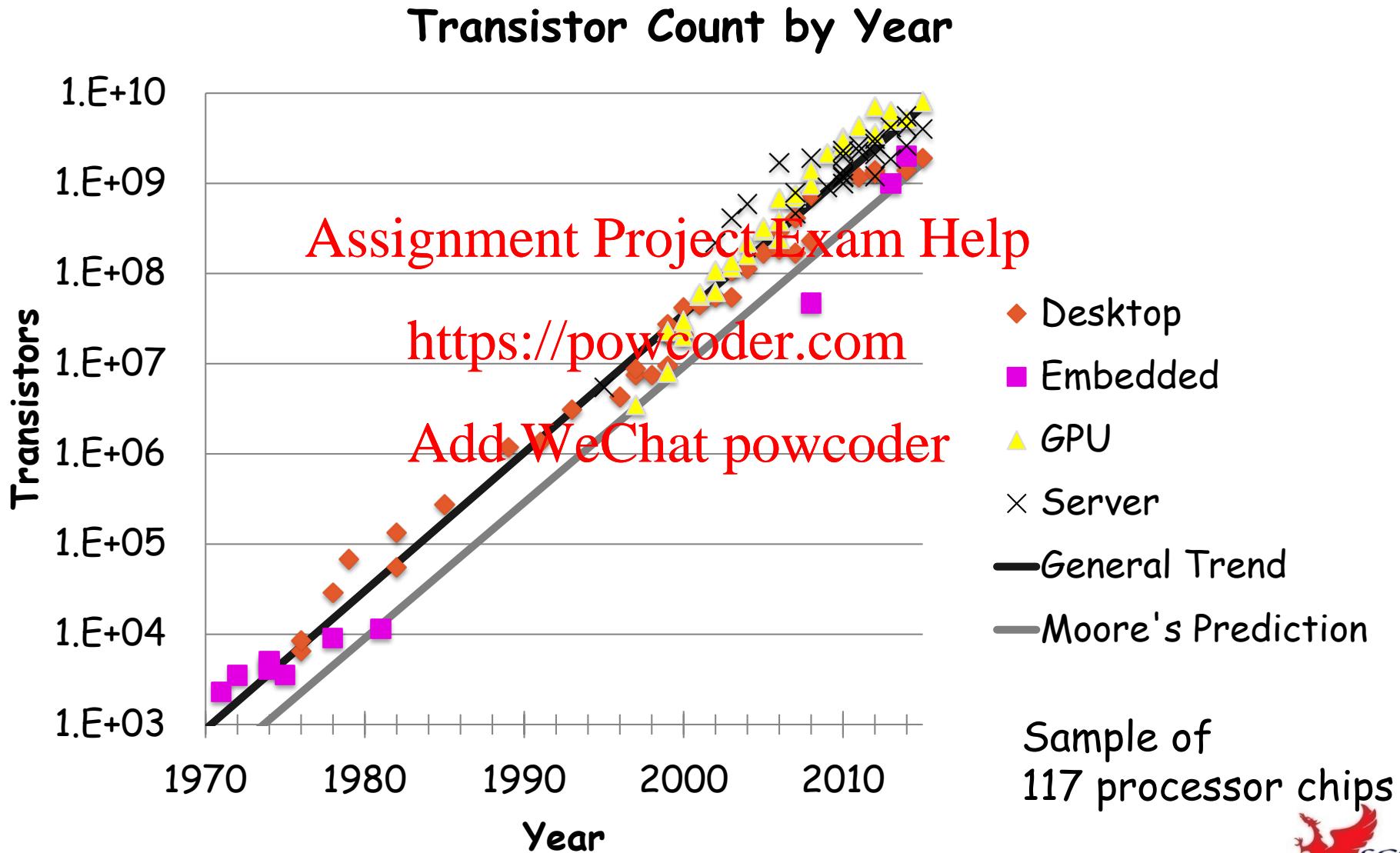
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Moore's Law Origins

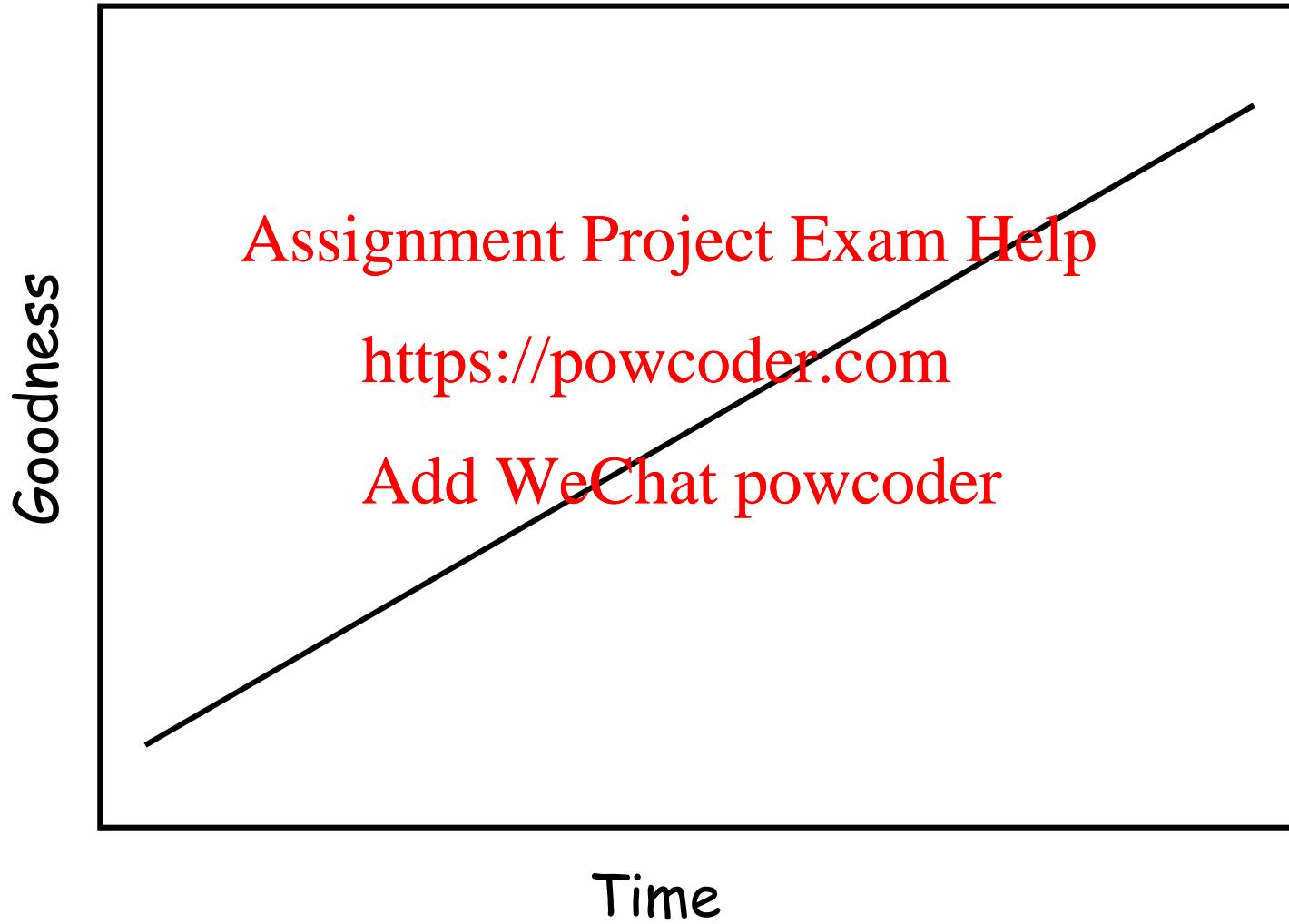


- Moore's Thesis
 - Minimize price per device
 - Optimum number of devices / chip increasing 2x / year
- 2x / 2 years
- "Moore's Prediction"

Moore's Law: 50 Years



Moore's Law



Moore's Law

Goodness

Time

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Moore's Law

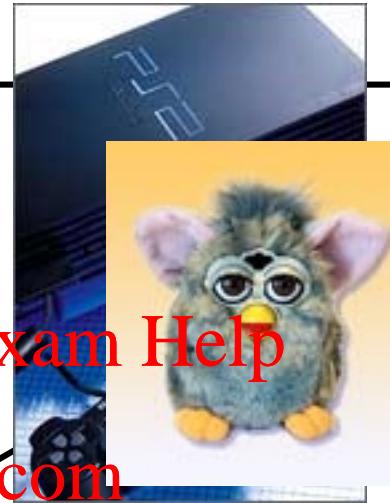
Goodness

Time

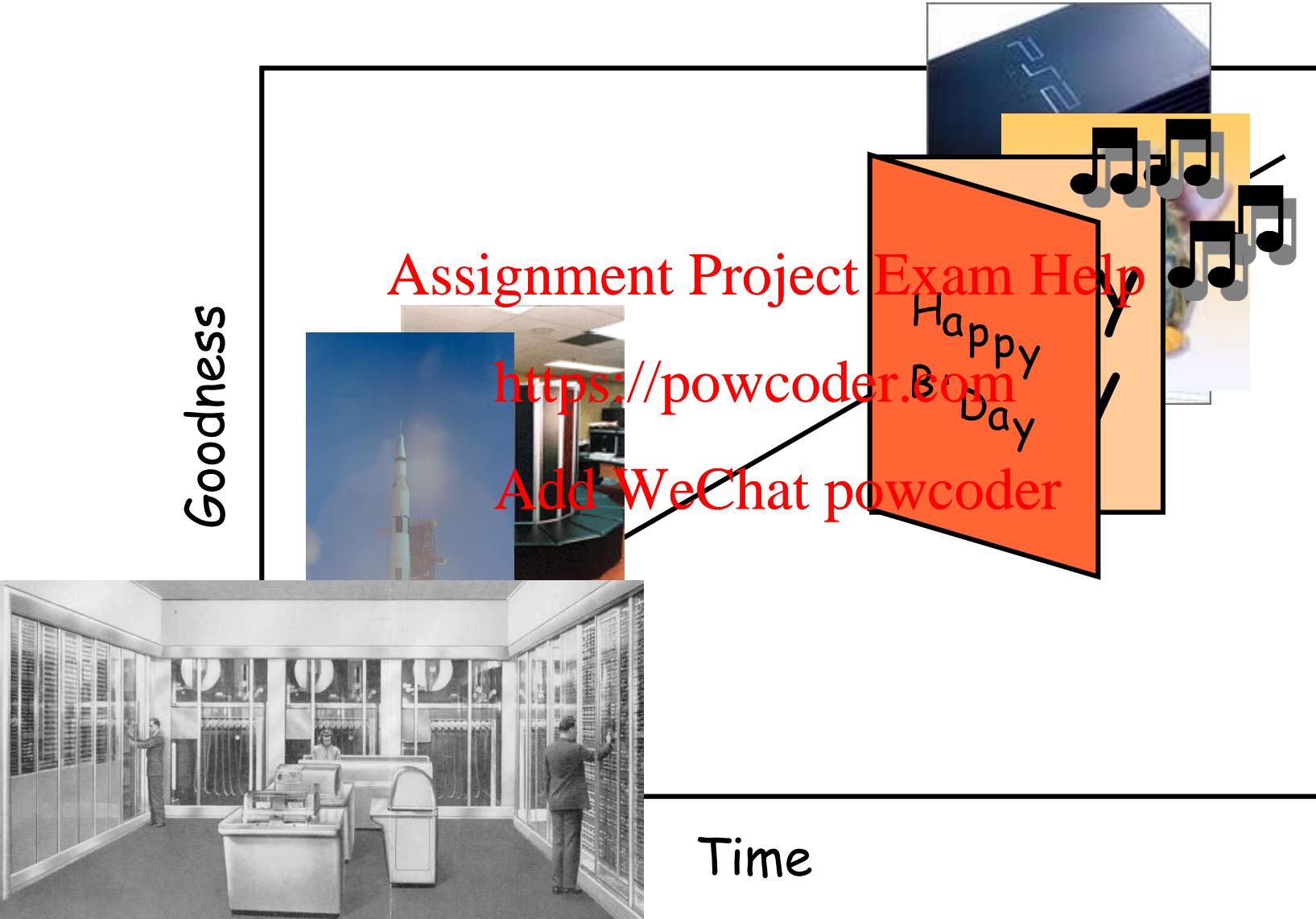
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Moore's Law



Eniac → PS/4

- How much would enough Eniac's weigh to equal 2.8Kg of PS/4 computing?

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Eniac → PS/4

- How much would Eniac weigh to equal 2.8Kg of computing?



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Alternatively, more than all the buildings in Pittsburgh!

Eniac → PS/4

- From 1946 to 2014

	Eniac	PS/4	Improvement
Ops/sec	5×10^3	2×10^{10}	10^6
Cost	Assignment Project Exam Help https://powcoder.com		
Power	An improvement of Add WeChat powcoder 10^{24} ops/sec-\$-Kg-m ³ -W		
Volume			
Weight	2.7×10^5 Kg	2.8 Kg	10^5

Understanding Exponentials

- Key to future forecasting
- Very Very hard for humans to do

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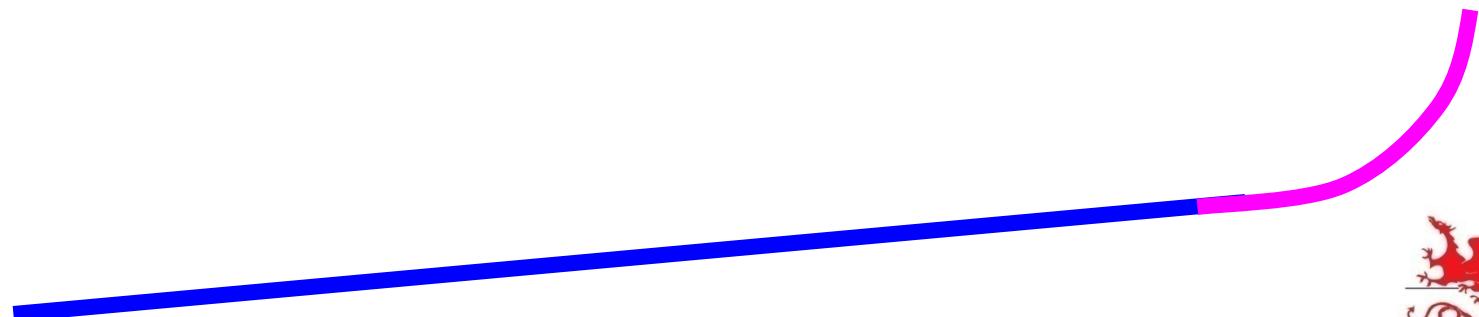
Understanding Exponentials

- Key to future forecasting
- Very Very hard for humans to do
- Example: Kasparov Vs Deep Blue
 - 1989: Kasparov destroys deep blue
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Understanding Exponentials

- Key to future forecasting
- Very Very hard for humans to do
- Example: Kasparov Vs Deep Blue
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 - 1989: Kasparov destroys deep blue
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 - 1996: Deep Blue wins one game
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Understanding Exponentials

- Key to future forecasting
- Very Very hard for humans to do
- Example: Kasparov Vs Deep Blue
 - 1989: Kasparov destroys deep blue
<https://powcoder.com>
 - 1996: Deep Blue wins one game
 - 1997: Deep Blue wins tournament

Understanding Exponentials

- Key to future forecasting
- Very Very hard for humans to do
- Example: Kasparov Vs Deep Blue
Assignment Project Exam Help
 - 1989: Kasparov destroys deep blue
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 - 1996: Deep Blue wins one game
 - 1997: Deep Blue wins tournament
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- Particularly hard in the beginning

What Moore's Law Has Meant



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- 1976 Cray 1
 - 250 M Ops/second
 - ~170,000 chips
 - 0.5B transistors
 - 5,000 kg, 115 KW
 - \$9M
 - 80 manufactured

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- 2017 iPhone
 - > 10 B Ops/second
 - 16 chips
 - 4.3B transistors
 - 174 g, < 1W
 - \$999
 - ~3 million
- + Camera
+ GPS
+ Microphone
+ Wireless
+ graphics
+ + + + + +



What Moore's Law Has Meant

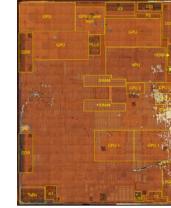
- 1965 Consumer Product
- 2017 Consumer Product



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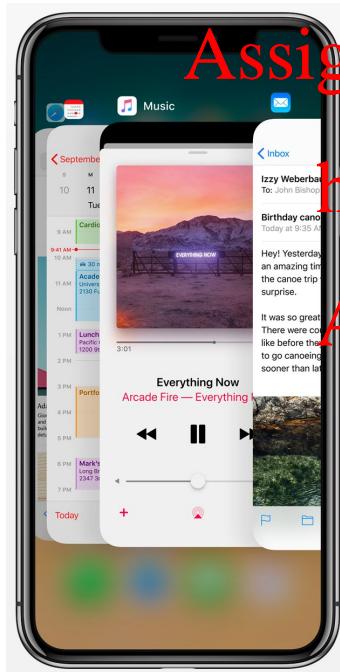
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Apple A11 Processor
4.3B transistors

What Moore's Law Could Mean

- 2017 Consumer Product
- 2065 Consumer Product



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- Portable
- Low power
- Will drive markets & innovation

Using All Those Transistors

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Insatiable Demand for Computing

- Programmable matter?
- Simulating life
- Augmented Reality
[Assignment](#) [Project](#) [Exam](#) [Help](#)
- Many many many more
<https://powcoder.com>

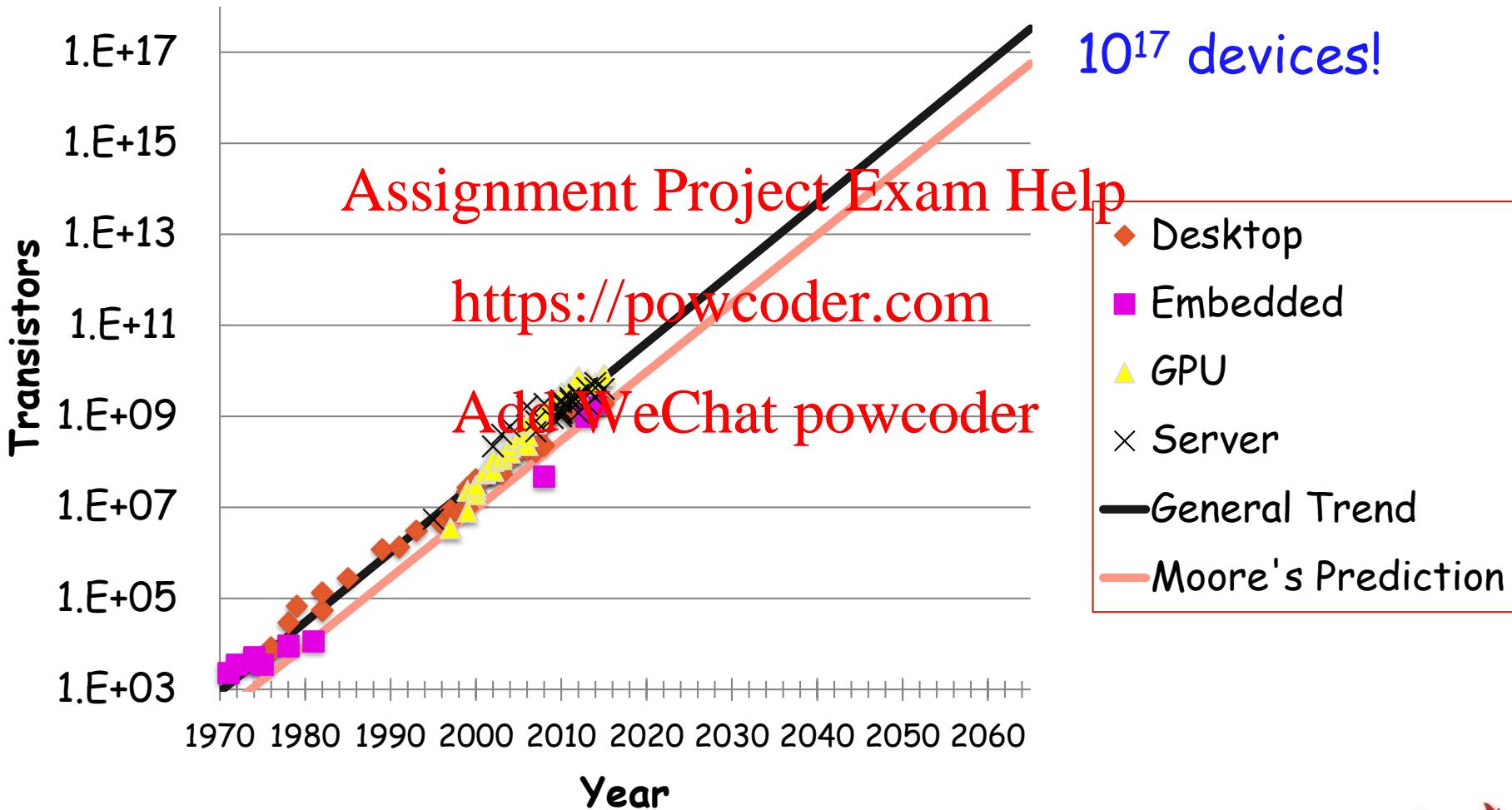
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Requirements for Future Technology

- Must be suitable for portable, low-power operation
 - Consumer products
 - Internet of Things components
 - Not cryogenic
- Must be inexpensive to manufacture
 - Comparable to current semiconductor technology
 - $O(1)$ cost to make a chip
- Need not be based on transistors
 - Memristors, carbon nanotubes, DNA transcription, ...
 - Possibly new models of computation
 - But, still want lots of devices in an integrated system

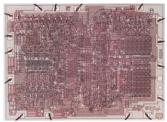
Moore's Law: 100 Years

Device Count by Year



Chips Have Gotten Bigger

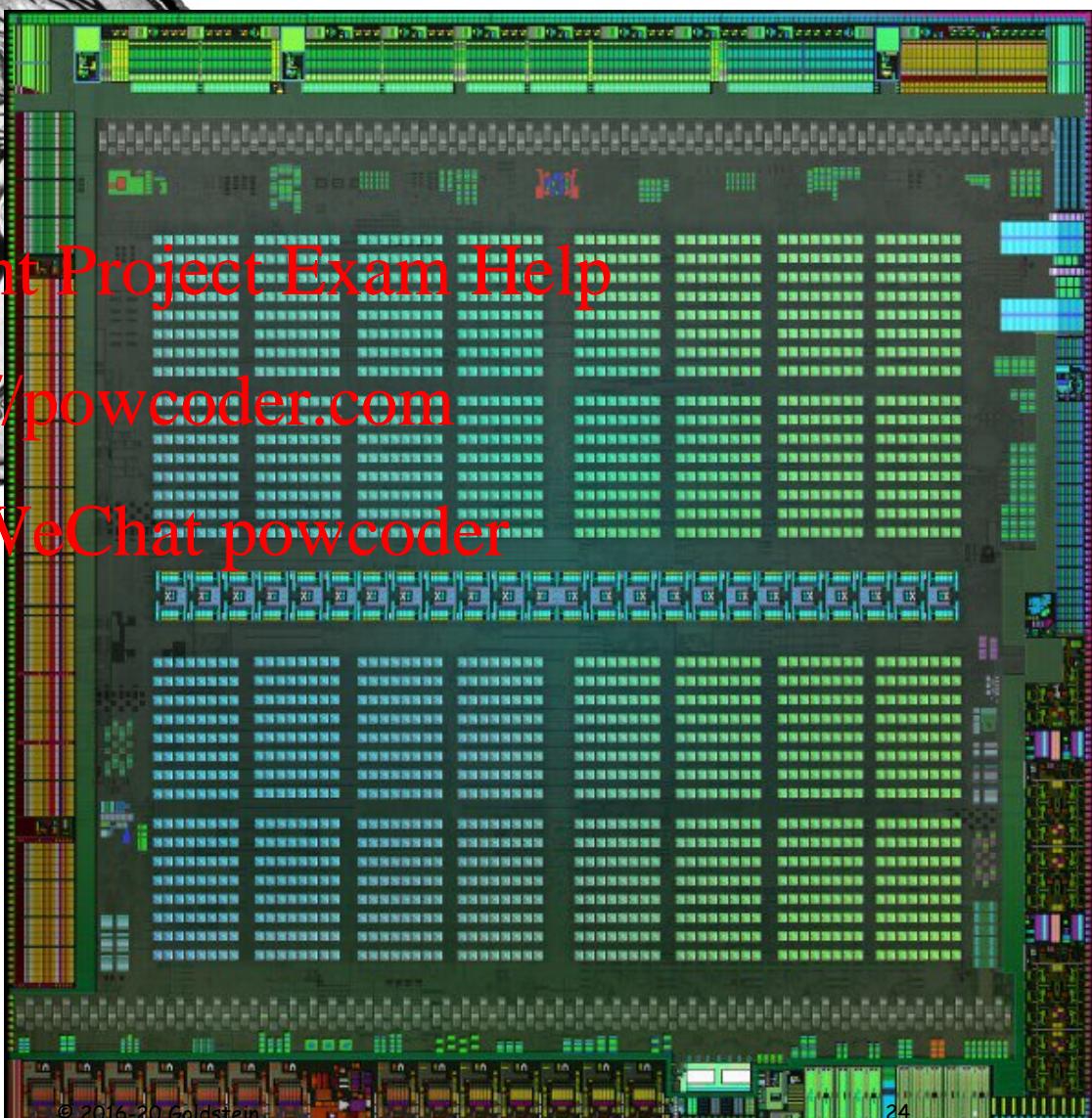
Intel 4004
1971
2,300 transistors
12 mm²



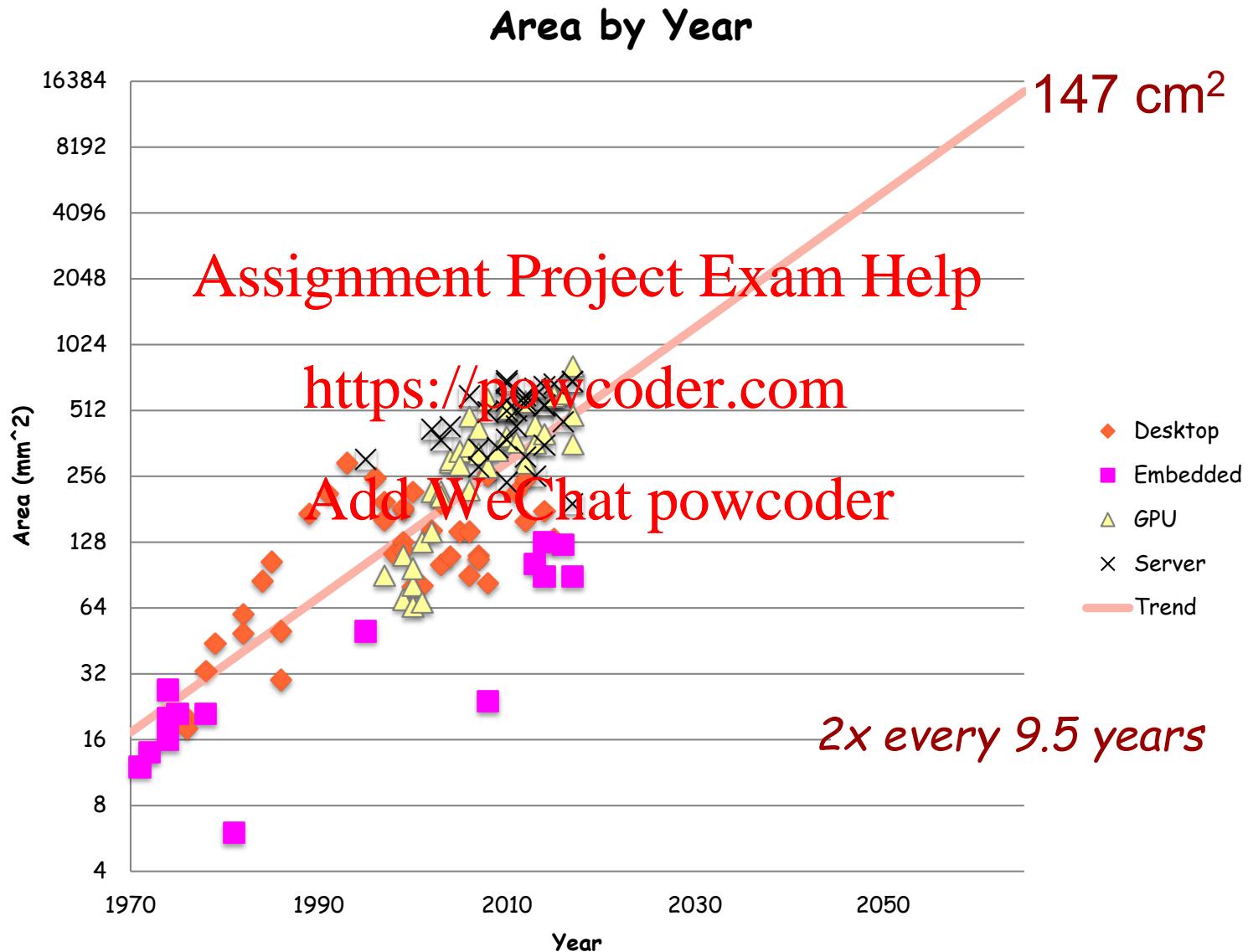
Apple A11
2017
4.3 B transistors
89 mm²



NVIDIA GV100 Volta
2017
21.1 B transistors
815 mm²

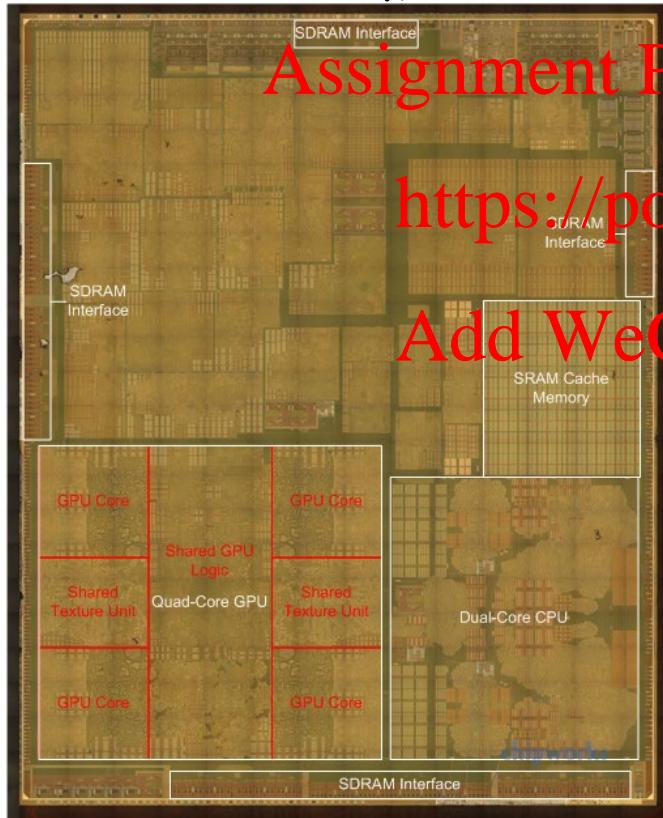


Chip Size Extrapolation



Extrapolation: The iPhone XXX

Apple A59
2065
 10^{17} transistors
 147 cm^2



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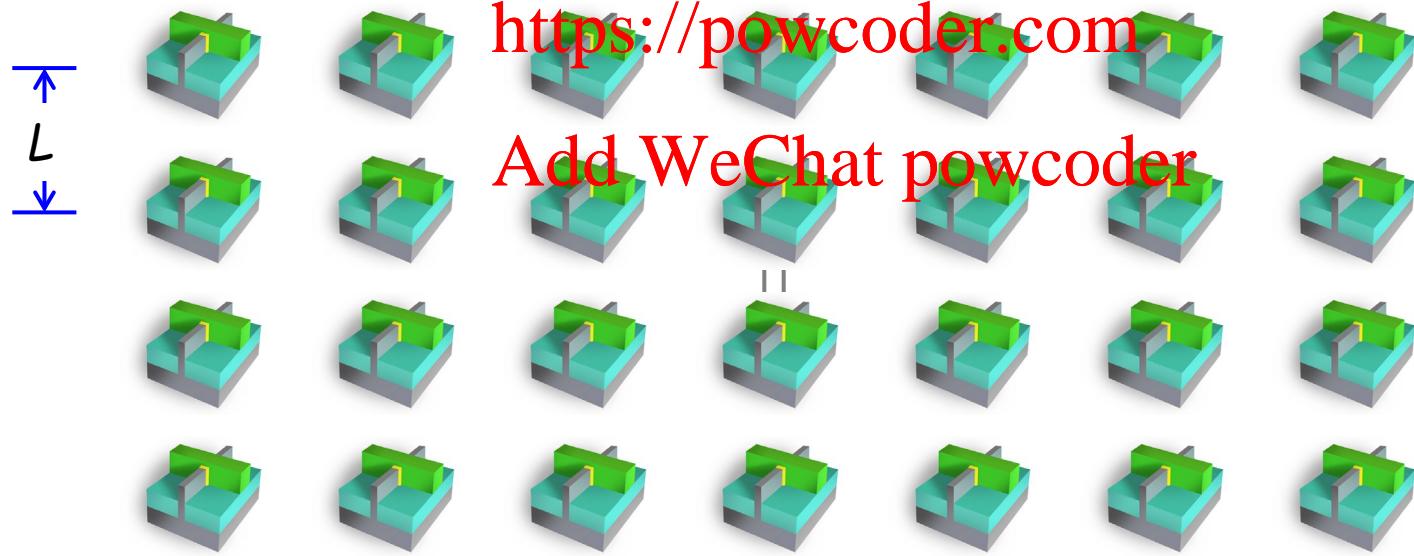
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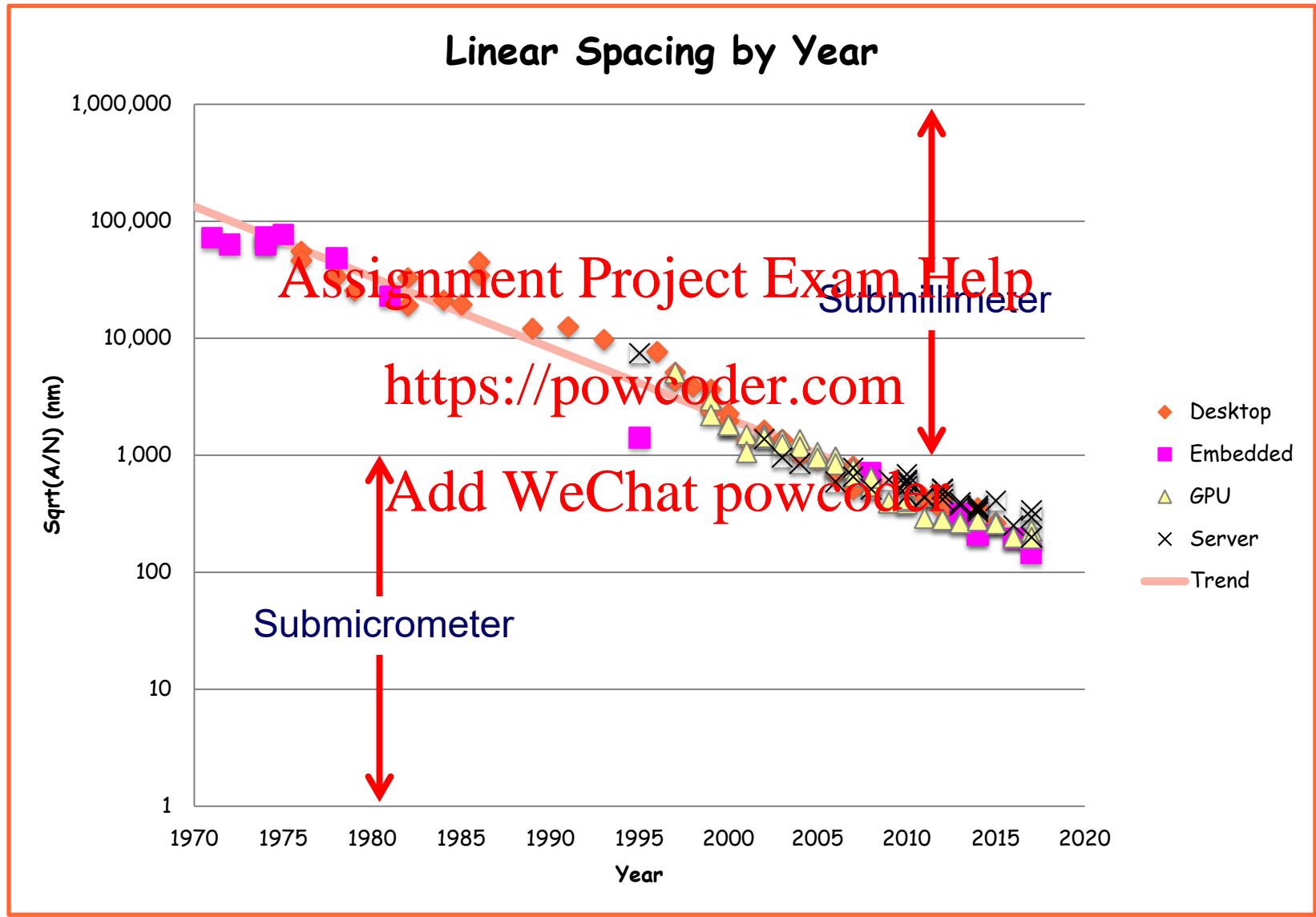


Transistors Have Gotten Smaller

- Area A
- N devices
- Linear ~~Assignment~~ Project Exam Help



Linear Scaling Trend



Submillimeter Dimensions

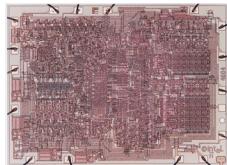
10^{-3} 1 millimeter (mm)

500 μm : Length of amoeba



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10^{-4}



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50 μm : Average size of cell in human body

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10^{-5}

10 μm : Thickness of sheet of plastic food wrap

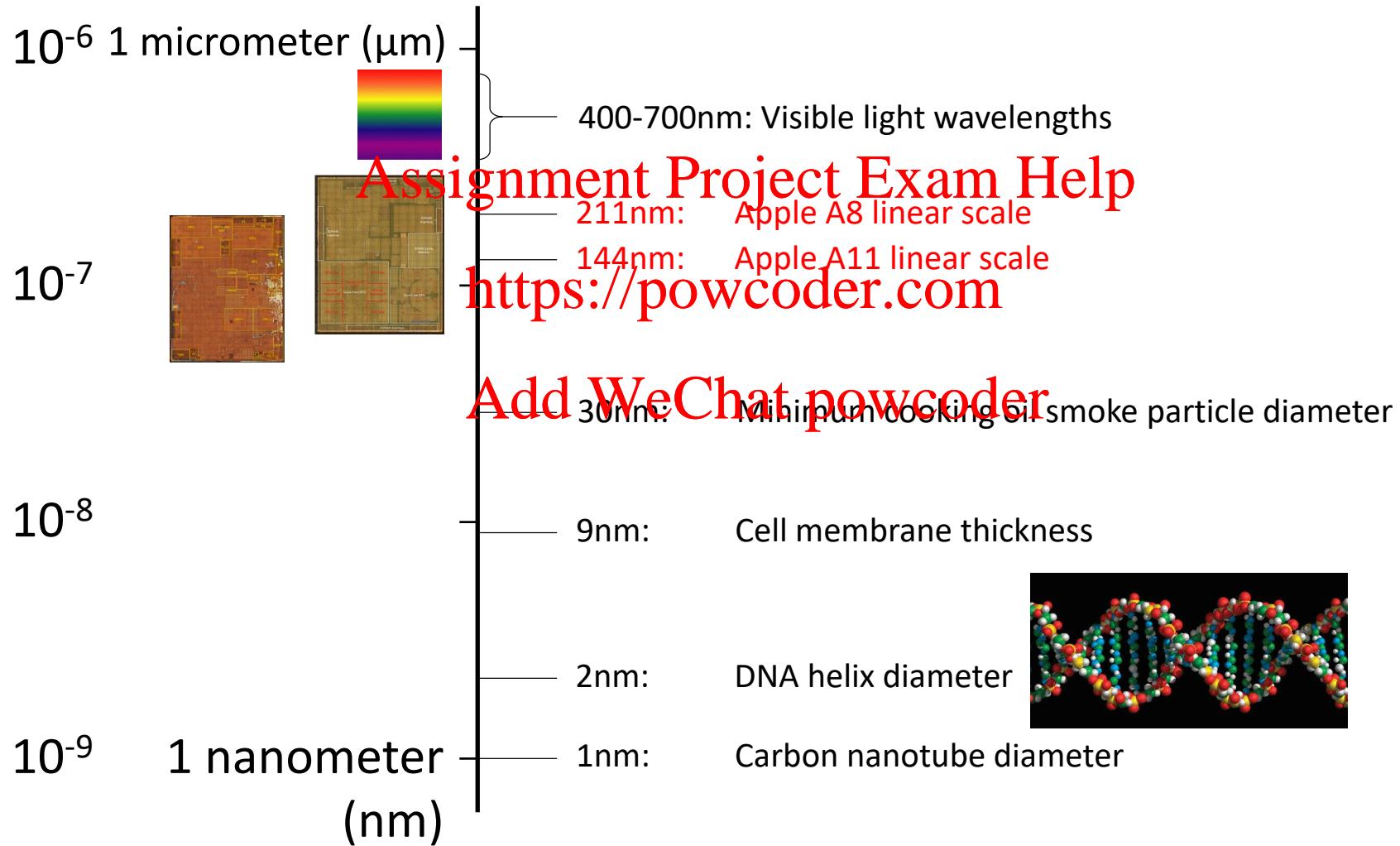
5 μm : Spider silk thickness

2 μm : E coli bacterium length

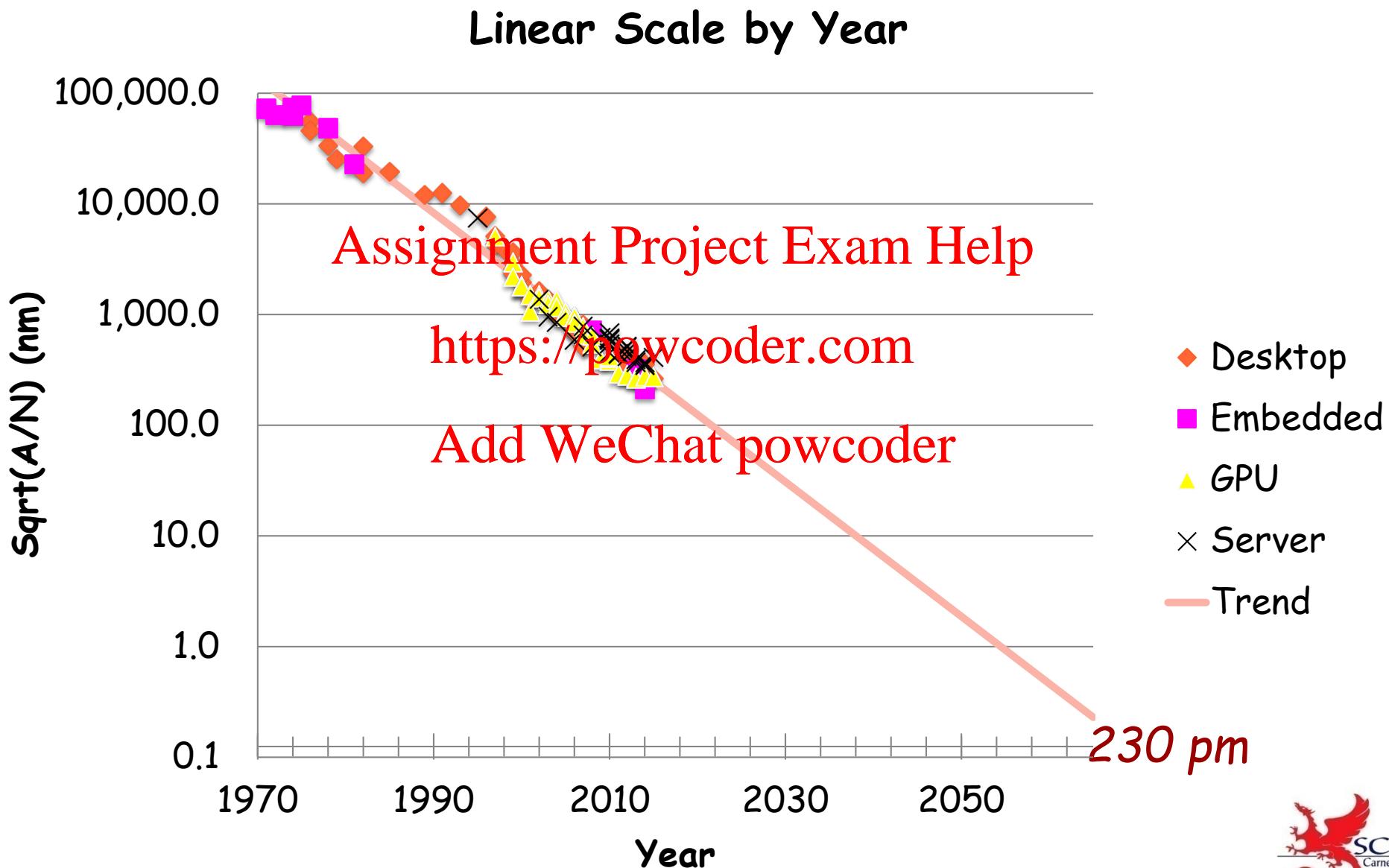


10^{-6} 1 micrometer (μm)

Submicrometer Dimensions



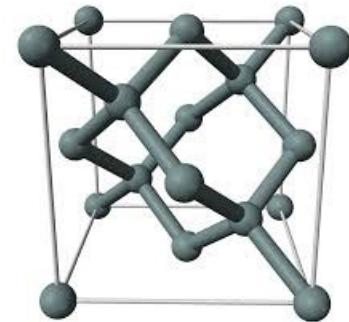
Linear Scaling Extrapolation



Subnanometer Dimensions

10^{-9} 1 nanometer
(nm)

1nm: Carbon nanotube diameter
543pm: Silicon crystal lattice spacing

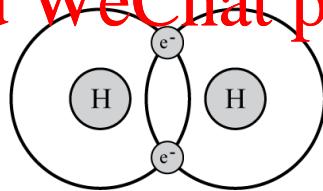


10^{-10}

74pm: Spacing between atoms in hydrogen molecule

53pm: Electron-proton spacing in hydrogen (Bohr radius)

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10^{-11}

2.4pm: Electron wavelength (Compton wavelength)

10^{-12} 1 picometer
(pm)

Pause for a second

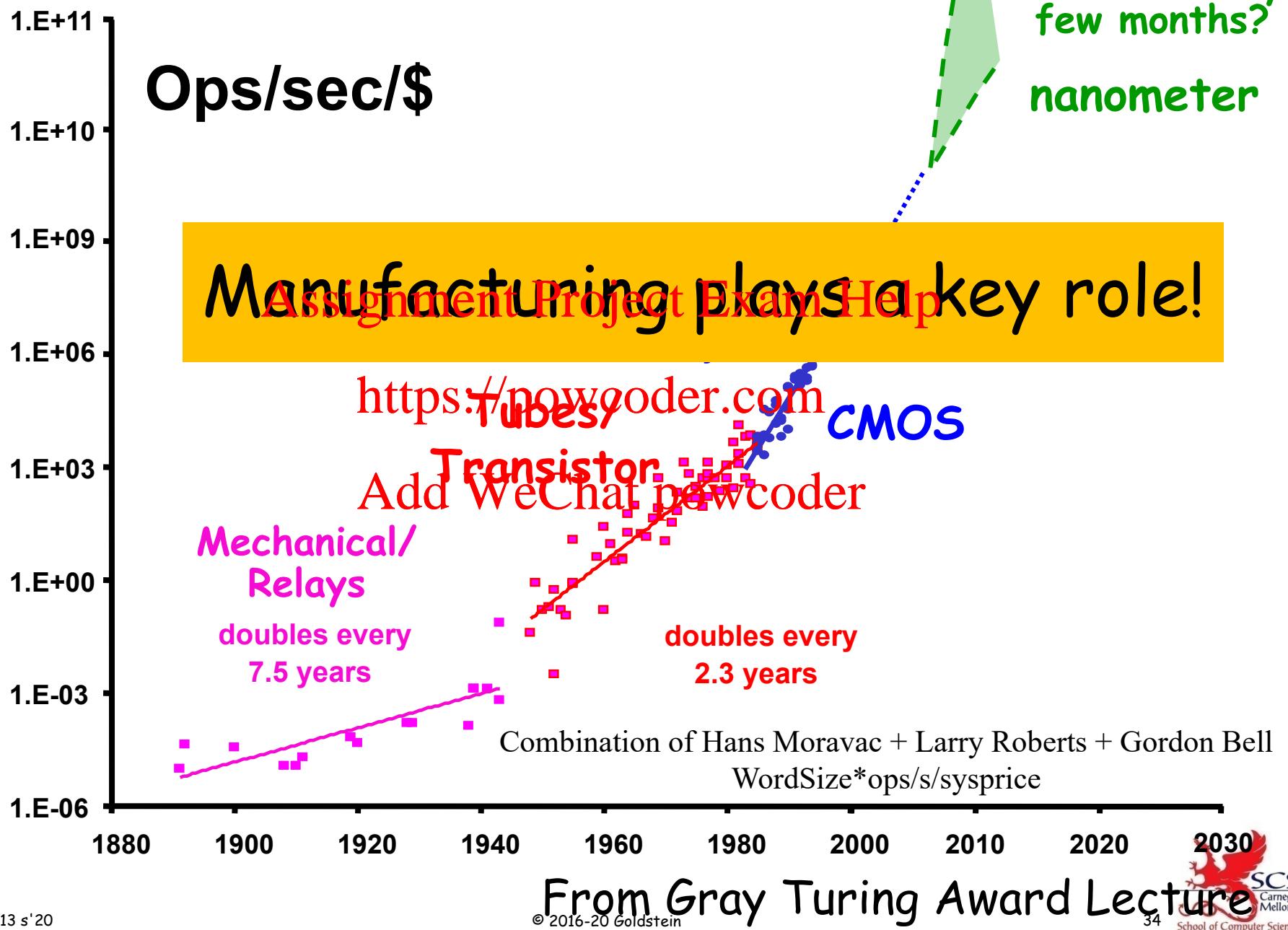
- 50 more years of Moore's law?
 - Probably not in Si, but ...
- Probably need new architectures, etc.
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- But, so far,
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Necessity is the mother of invention

What Comes Next?



What This Means for You

- As Computer users and Scientists?
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- As People?
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Great Reality

- More Heterogeneity



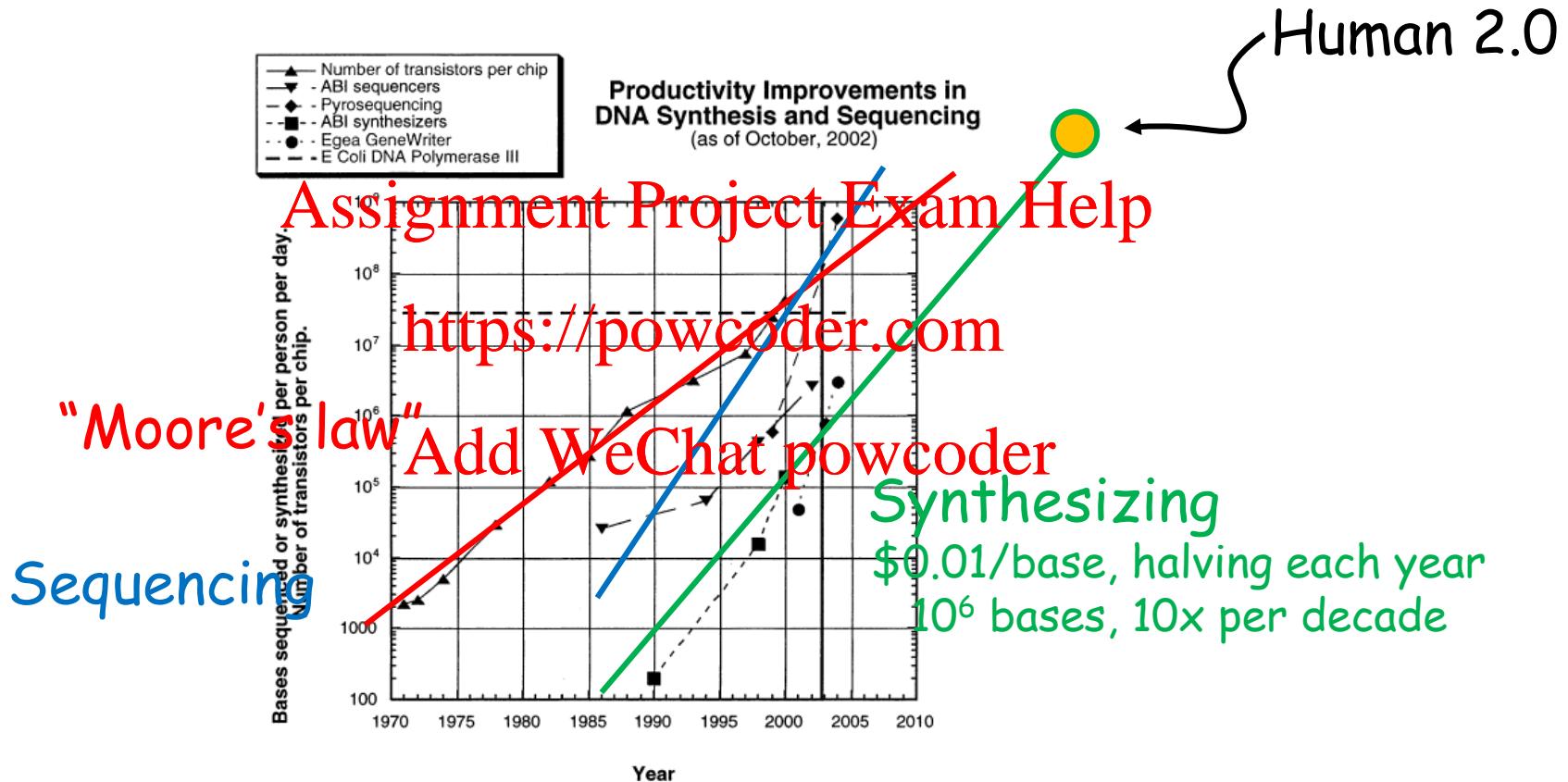
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- Centers of Racks of Systems of Boards of Chips of
 - Cores
 - GPUs
 - FPGAs
- Lots of Concurrency

Exponentials

- Moore's Law
- Biology
- Big Data/AI
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- Manufacturing
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 - Computing
 - Synthetic Biology
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 - Additive Manufacturing
- Robotics
- Energy

Exponentials Abound



Big Data can look like AI



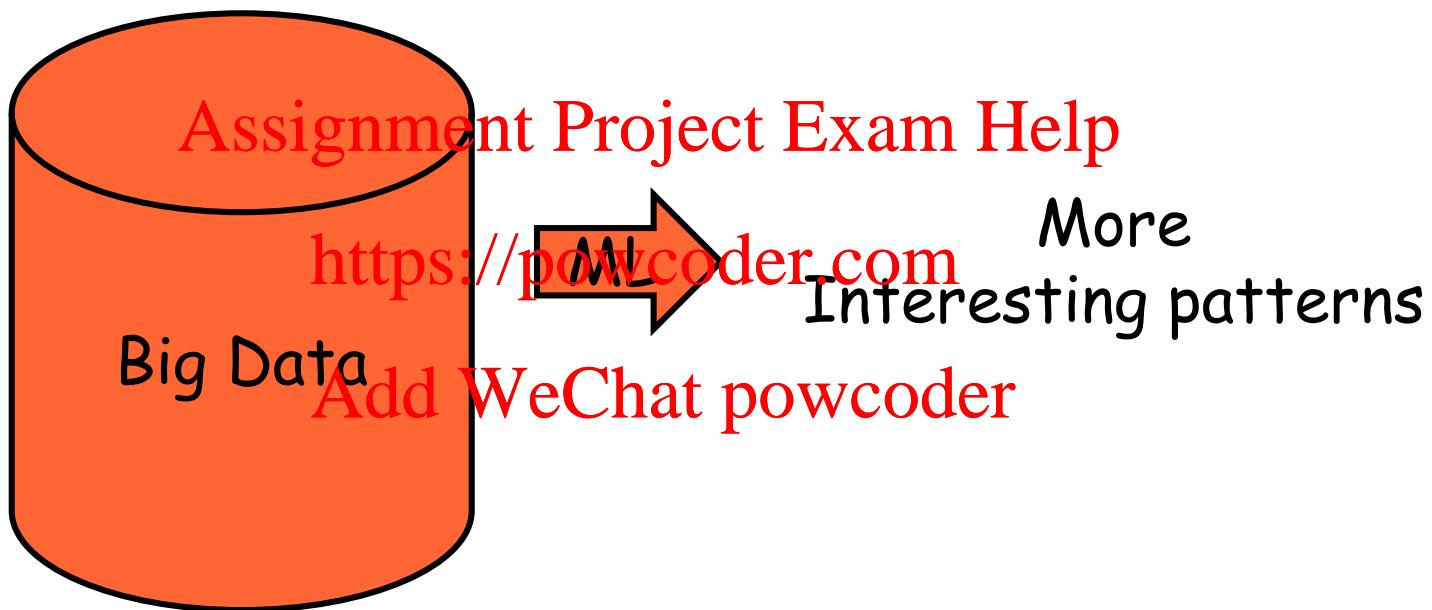
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Big Data

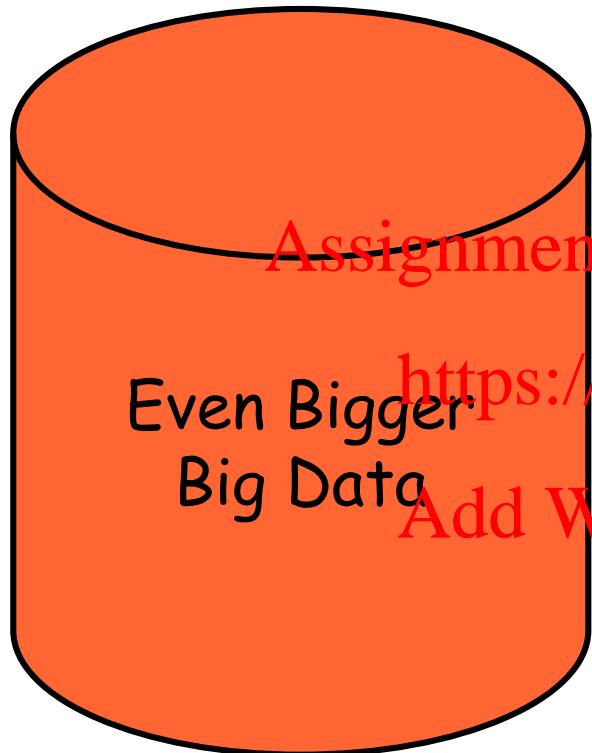
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<https://powcoder.com> Interesting patterns

Big Data can look like AI



Big Data can look like AI



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Even Bigger
Big Data

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Patterns that look like
Creativity/Intelligence

What is your prediction?

AI-ish?

From Forbes.com:

Despite an expected dip in profit, analysts are generally optimistic about Fluor as it prepares to reports its first quarter earnings on Thursday, May 1, 2014. The consensus earnings per share estimate is 96 cents per share.

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<https://powcoder.com>

1.E+05

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"WISCONSIN appears to be in the driver's seat en route to a win, as it leads 51-10 after the third quarter. Wisconsin added to its lead when Russell Wilson found Jacob Pedersen for an eight-yard touchdown to make the score 44-3"

1987

2011

Exponentials

- Moore's Law
- Biology
- Big Data/AI
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- Manufacturing
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 - Computing
 - Synthetic Biology
 - Additive Manufacturing
- Robotics
- Energy

The World is Changing

- Technology Trends

- Nanotechnology Clean ubiquitous Cheap Energy
- Synthesis More Knowledge available to more people
- Computers Assignment Project Exam Help Safer & Faster travel
- Robotics <https://powcoder.com> A level playing field

- Some Implications

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Customized anything

- What Should We Do?

Better Health

Dematerialization of Value

Utopia?

- Technology Trends

- Nanotechnology Clean ubiquitous Cheap Energy
- Synthesis More Knowledge available to more people
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Customized anything

- What Should We Do?

Better Health

Dematerialization of Value



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Killer Robots? Really?

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It's a Lot More Complicated.

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Today

- Beyond Moore's Law
- Technology & Labor
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Technology & Jobs

- Replace Workers



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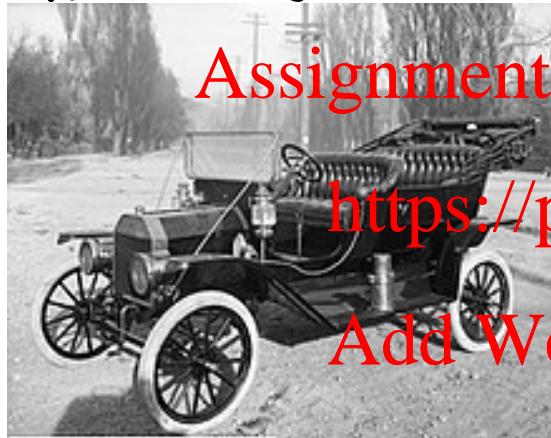
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Technology & Jobs

- Replace Workers
- Eliminate Jobs



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Technology & Jobs

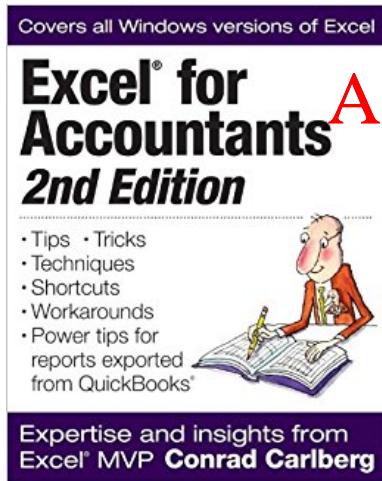
- Replace Workers

- Eliminate Jobs

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- Enhance Workers

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Technology & Jobs

- Replace Workers

- Eliminate Jobs

- Enhance Workers

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- Create New Jobs

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Some Questions

- Is this time different?
- Why no significant job loss?
- Why is rate of GDP growth decreasing?
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- What is net effect?
<https://powcoder.com>
- If there is an effect, When?
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Some Questions

- Is this time different?
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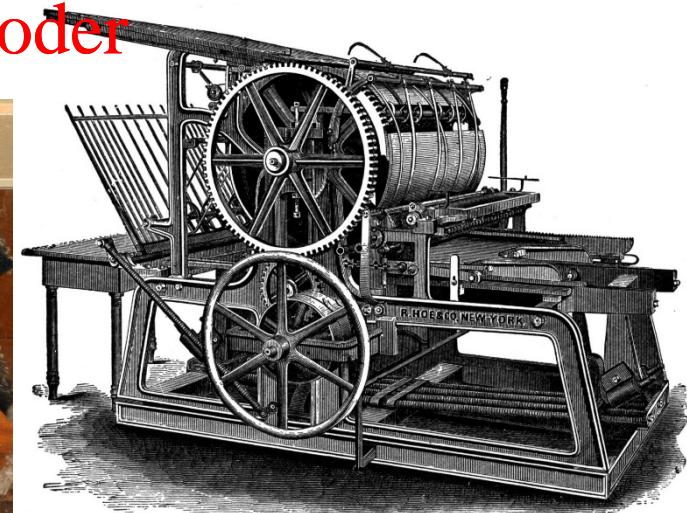
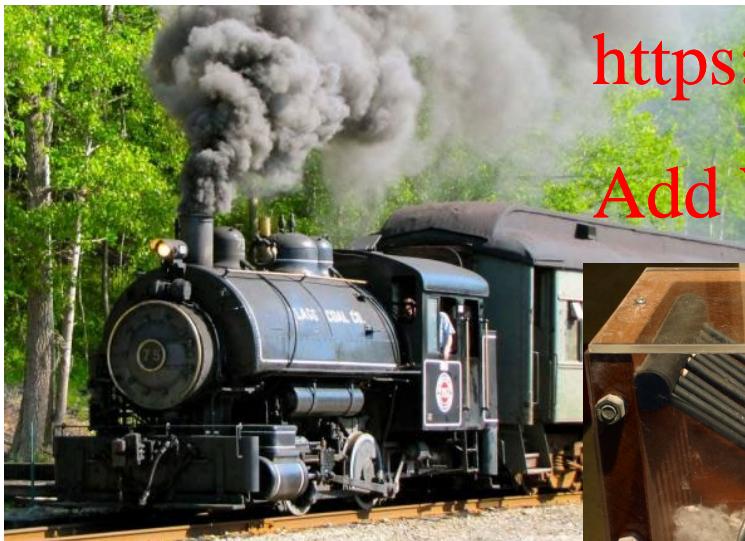
Technology Revolutions

- TR1: (aka First Industrial Revolution) 1760-1830
 - Coal powered steam engine
 - Cotton Gin
 - Steam-powered printing presses

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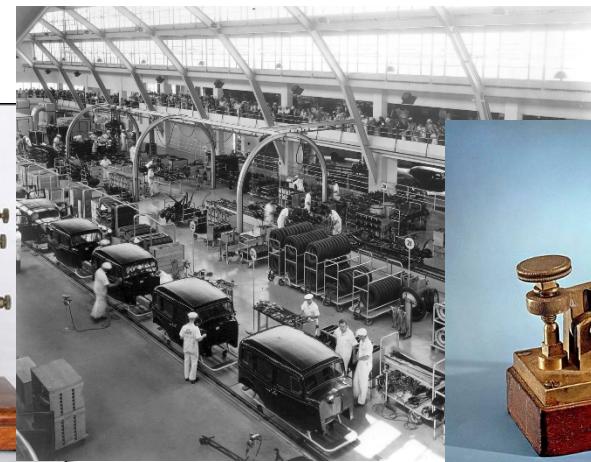
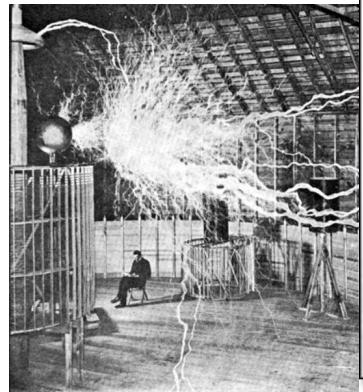
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Technology Revolutions

- TR1: (aka First Industrial Revolution) 1760-1830
 - Coal powered steam engine
 - Cotton Gin
 - Steam-powered printing presses
- TR2: (aka Second IR) 1860-1910
 - Electricity/Internal Combustion Engine
 - Assembly Aids WeChat [powcoder](https://powcoder.com)
 - Telegraph/Telephone



Technology Revolutions

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 - Coal powered steam engine
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 - Steam-powered printing presses
- TR2: (aka Second IR) 1860-1910
 - Electricity/Internal Combustion Engine
 - Assembly Aids WeChat powcoder
 - Telegraph/Telephone
- Third Technology Revolution 1965-?
 - Renewables
 - Manufacturing without assembly
 - Computation



Just Like TR1 and TR2

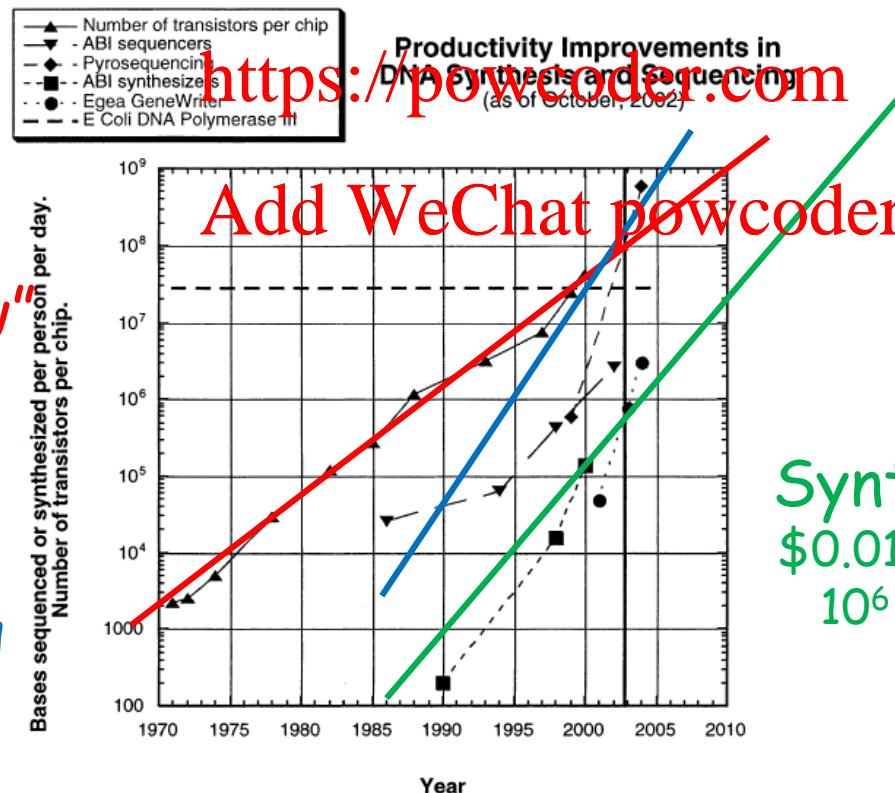
TR3 will:

- Improve productivity
- Increase wealth (on average)
- Cause massive disruption

But, TR3 is different

- Continued exponential improvement
(E.g., Computation, Networking, Renewable energy,
Synthetic biology, ML&BD, Robotics, ...)

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Synthesizing
\$0.01/base, halving each year
10⁶ bases, 10x per decade

But, TR3 is different

- Continued exponential improvement
(E.g., Computation, Networking, Renewable energy,
Synthetic biology, ML&BD, Robotics, ...)

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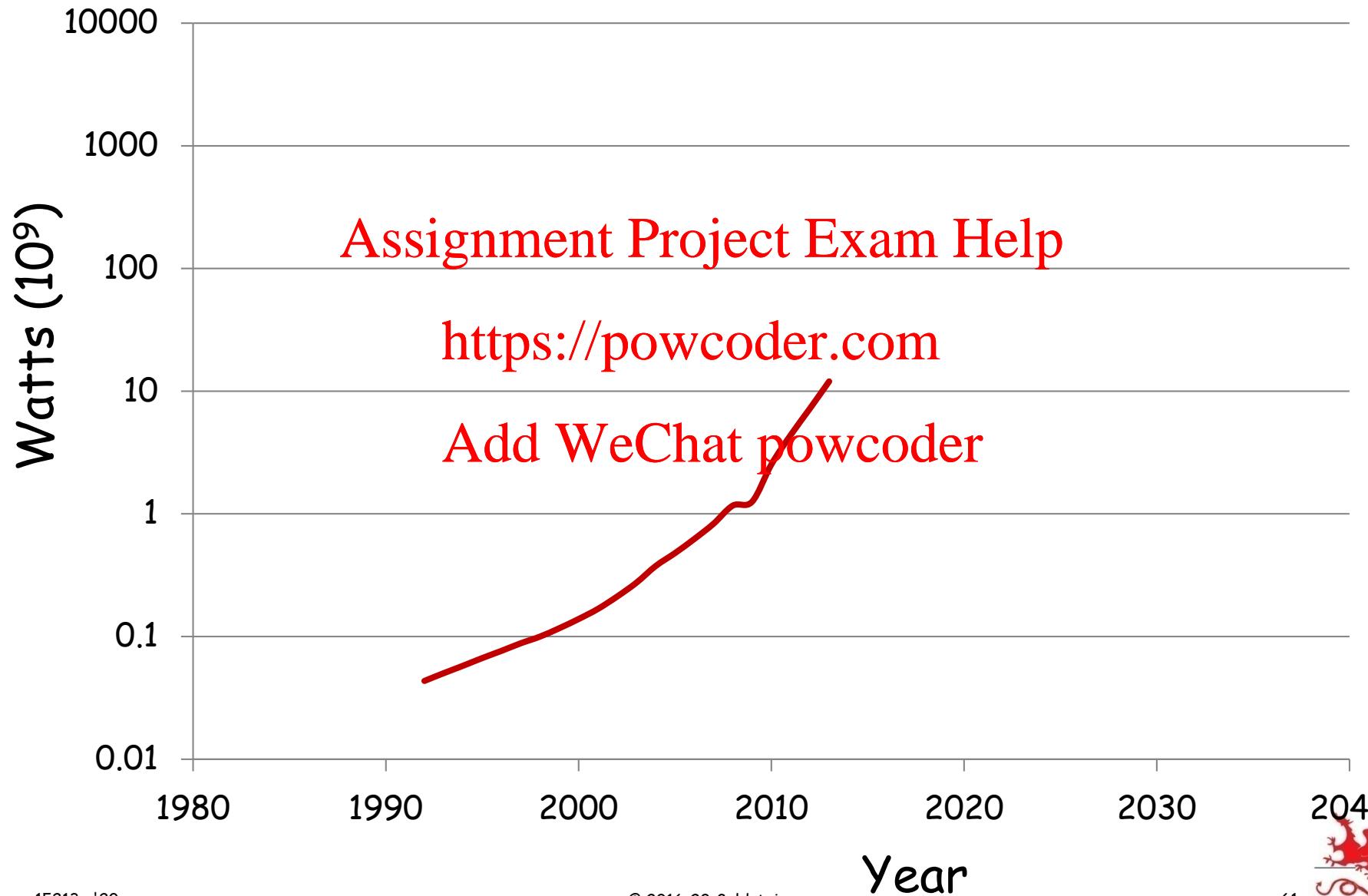
Don't get confused.
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It is not just about computation.

Assembly-Free Manufacturing!

Number of Components per Integrated Circuit

Solar Power in US



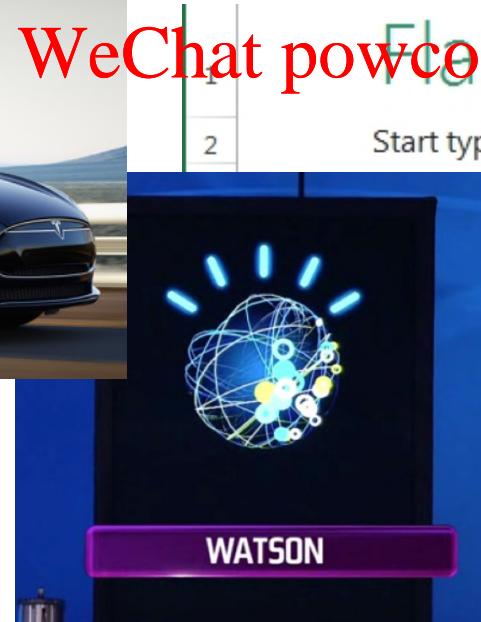
But, TR3 is different

- Continued exponential improvement
(E.g., Computation, Networking, Renewable energy, Synthetic biology, ML&BD, Robotics, ...)
- Technology is able to do "Uniquely human" cognitive and physical tasks.
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Start typing and let Excel finish your work for you



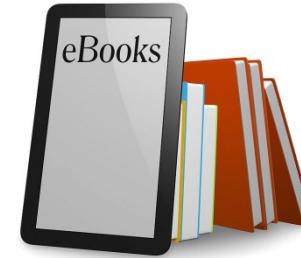
First Name	Last Name
Nancy	
Andrew	
Jan	
Mariya	
Steven	
Michael	
Robert	
Laura	
Anne	
reeHafer@fourthcoffee.com	
.Cencini@northwindtraders.com	
as@litwareinc.com	
Sergienko@graphicdesigninstitute.com	
Thorpe@northwindtraders.com	
.Neipper@northwindtraders.com	
Zare@northwindtraders.com	
iussani@adventure-works.com	
Anne.HL@northwindtraders.com	

But, TR3 is different

- Continued exponential improvement
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- Technology is able to do "Uniquely human" cognitive and physical tasks.
<https://powcoder.com>
- Labor component of the marginal cost of production → 0!

But, TR3 is different

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- Technology is able to do "Uniquely human" cognitive and physical tasks.
<https://powcoder.com>
- Labor component of the marginal cost of production → 0!
(E.g., how much labor to produce and deliver the next copy of an eBook?)



But, TR3 is different

- Continued exponential improvement
(E.g., Computation, Networking, Renewable energy, Synthetic biology, ML&BD, Robotics, ...)
- Technology is able to do "Uniquely human" cognitive and physical tasks.
<https://powcoder.com>
- Labor component of the marginal cost of production → 0!
(E.g., how much labor to produce and deliver the next copy of an eBook?)
- Unlike TR1 and TR2, TR3 will create massive technological unemployment

Not Much Work Now for Horses



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TR2: Forever ended the horse as a factor of production.

Not Much Work Now for Horses



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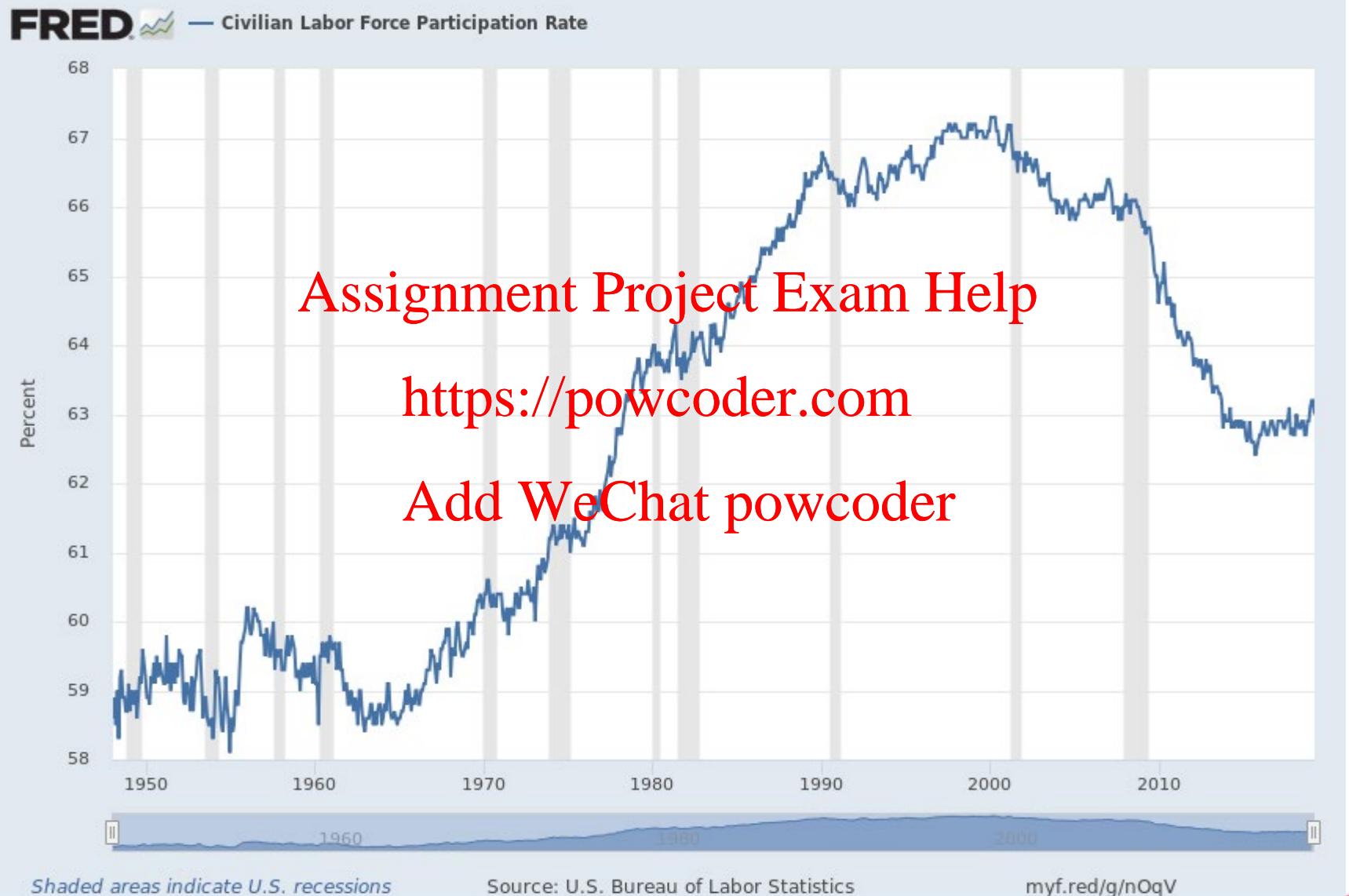
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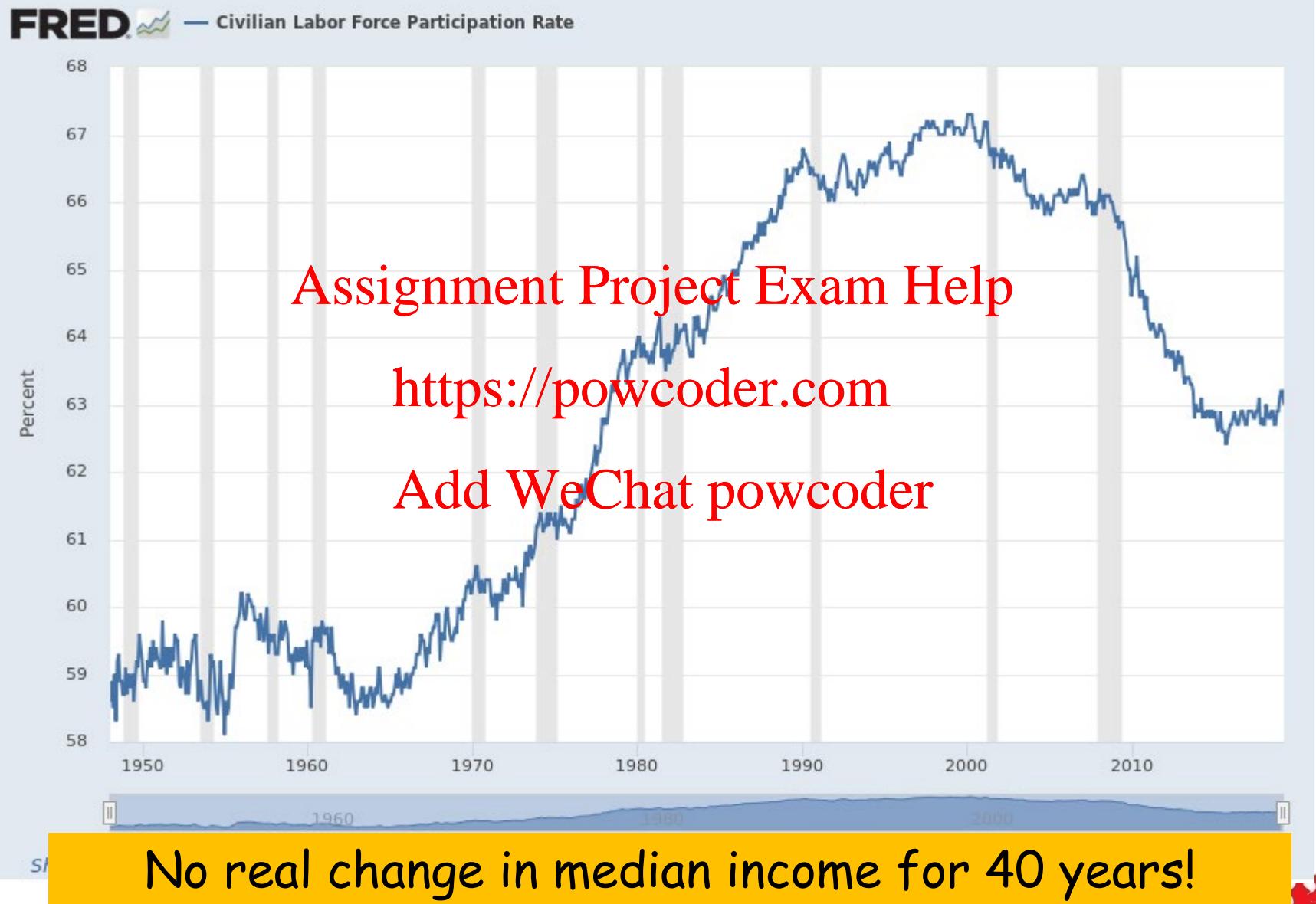


With respect to human labor:
Is TR3 the last Technology Revolution?

Wait a Second!



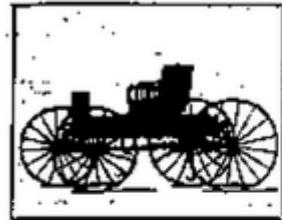
Losses yes, Exponential no



Wait a Second!

- Where are the exponential job losses?
- What about new jobs?

Another Cut in Prices
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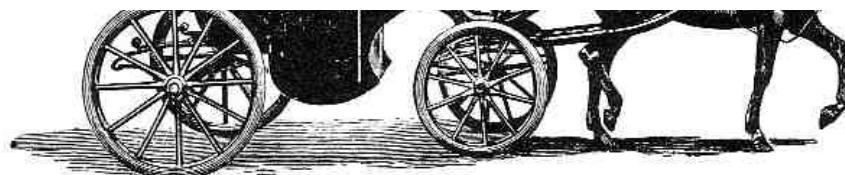


Carri
Harr
Whi
Rob

STOCK MUST

WE HAVENT ROOM for the Parrot
the Stock must go. Big clearance in
the line. Special reductions in Sun
vehicles, generally. A well-built, styl
Kelly or Hartford solid rubber tires, for
OTHER BARGAINS JUST AS GOOD.

AUTO VEH
SUCCESSION
PARROTT CARRIAGE
Cor. Tenth and



What Are The New Jobs?

- Yes, there will be traditional jobs which require, e.g.,
 - Creativity
 - Empathy
 - Entrepreneurship
 - Social Skills

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Aside:
Requires changing our
educational goals and
methods!

What About New Jobs?

- Yes, there will be traditional jobs which require, e.g.,
 - Creativity
 - Empathy
 - Entrepreneurship
 - Social Skills
- But, as technology improves it will continue to take away jobs

Department of Artificial Empathy?

What About New Jobs?

- Yes, there will be traditional jobs which require, e.g.,
 - Creativity
 - Empathy
 - Entrepreneurship
 - Social Skills
- But, as technology improves it will continue to take away jobs
- And, those that remain are low paying.

Wait a Second. Hmm.

- Where are the exponential job losses?
Around the corner?
- What about new jobs?
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How long do they remain
in human domain?
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- Rate of productivity increase has slowed
Not, really.
Average doesn't tell the whole story.

Remember the Horses ...



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With respect to human labor:
TR3 is the last Technology Revolution

Plenty of Resources

- TR3 economy produces an abundance of goods and services
- Most people are unemployable
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- Most jobs are substituted or destroyed
- Those that remain are low pay
- (some are created for a limited time.)

What Should You Do Today?

- Study for 213 final.

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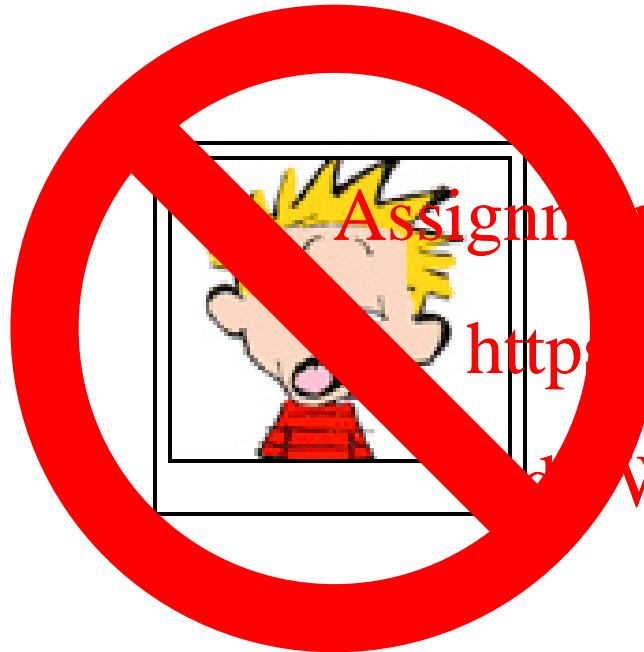
<https://powcoder.com>

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What Should You Do Today?

- More seriously:
 - Learn to learn
 - Be flexible
 - Expect to continue to learn
- Its not only STEM
 - <https://powcoder.com>
- In fact, soft skills dominate as most important components of high-end jobs.

What does this mean?



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Horror or Opportunity?

- TR3 poses 2 existential questions for most everyone:

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- How to get ~~the resources needed for life?~~ <https://powcoder.com>

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- How to find meaning and dignity?

We Need a Change in Perspective

Plenty of Resources

- TR3 economy produces an abundance of goods and services
- Most people are unemployable
(Technology is just cheaper,
Assignment Project Exam Help
- What do they do?



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What will we do?

- Activities which require either:
 - Super-Creativity
 - Empathy on the part of the consumer
- Play

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How Will  You Do it?

Today

- Beyond Moore's Law
- Technology & Labor
- What is Money?
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- 213 Final
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A new look at Money

- What makes money work:
 - A metric of value
 - A method of accounting
 - Trust that <https://powcoder.com>

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Today's Money

- What makes money work:
 - A metric of value
 - A method of accounting
 - Trust that <https://powcoder.com>
- So today's currency is:
 - A static token
 - Backed by the state



Today's Money

- What makes money work:
 - A metric of value
 - A method of accounting
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But remember, it has no intrinsic value!



TR3 & Money

- Currency doesn't need to be static token.
- Nor backed only by the state.

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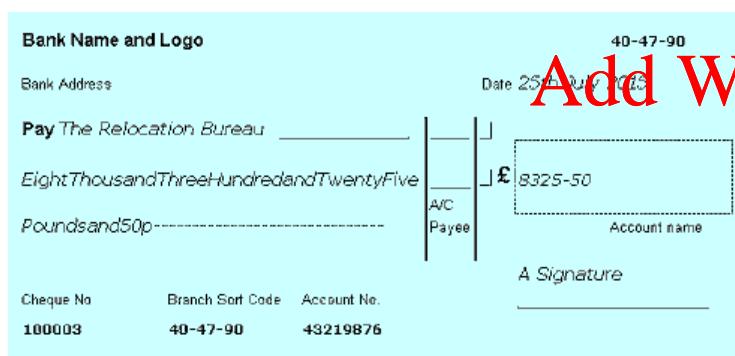
- Can we harness reputation with
<https://powcoder.com>
computation and networks to create a
new form of money? Add WeChat powcoder
- Goal: Monitize IOUs
(I.e., Micro-bearer bonds)

Before TR3

- Irish Banking Crisis ('60, '70, '76)
 - Banks closed
 - Checks can't clear
 - People used check as money

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→ Good? →



Reputation Authority

Before TR3

- Irish Banking Crisis ('60, '70, '76)
 - Banks closed
 - Checks can't clear
 - People used check as money
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<https://powcoder.com>

- Banknotes

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Before TR3

- Irish Banking Crisis ('60, '70, '76)
 - Banks closed
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https://powcoder.com](https://powcoder.com)
- Banknotes Add WeChat powcoder
- Credit networks for resource allocation

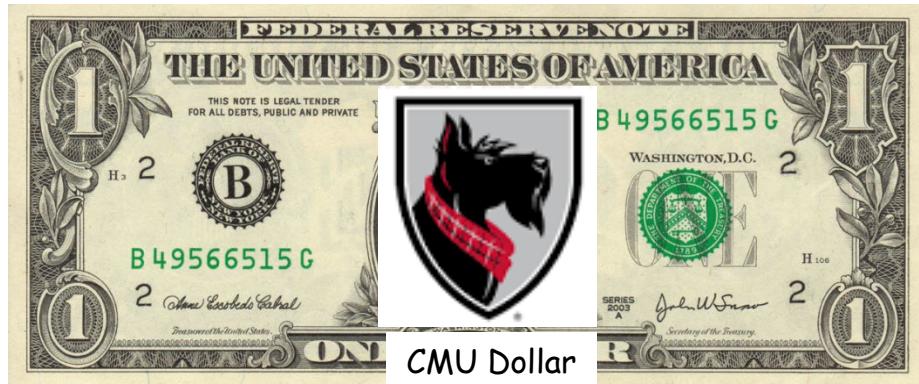
TR3 & Money

- Currency doesn't need to be static token.
- Nor backed only by the state.

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- Imagine that everyone can issue their own money backed by their reputation.
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Who accepts Seth-Dollars?

- Certainly, I must.
- Anyone who expects to trade with me.
- People in my communities
- Most anyone who expects to trade with someone I ~~Assignment Project Exam Help~~ ~~https://powcoder.com~~ traded with, etc.
- The further ~~Add WeChat~~ ~~the less likely.~~
- Everyone will decide their risk ↑



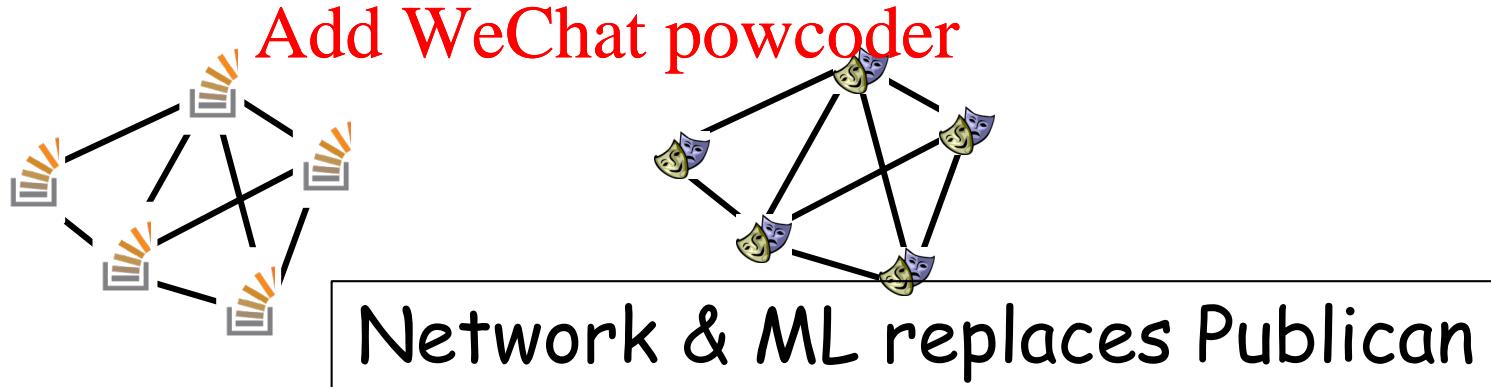
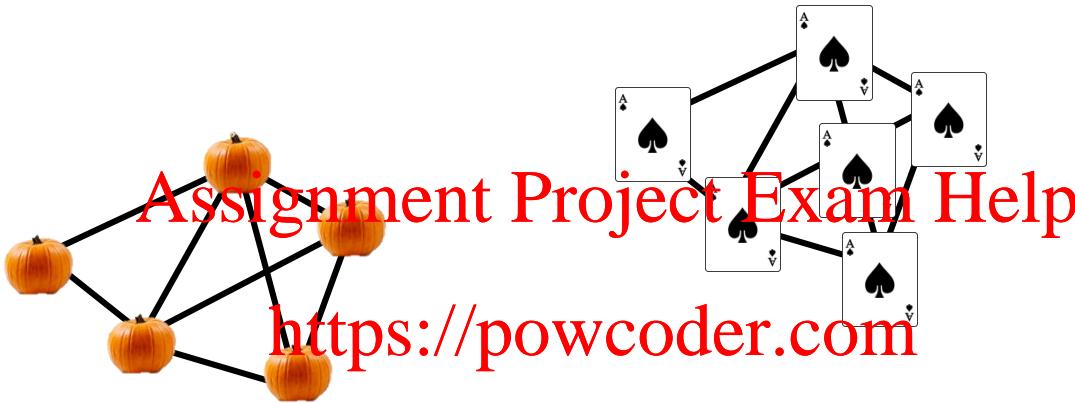
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- Most anyone who expects to trade with someone I ~~Assignment Project Exam Help~~ <https://powcoder.com> traded with, etc.
- The further ~~Add WeChat~~ the less likely.
- Everyone will decide their risk tolerance.



Currency is "executable" and can have means to reduce risk.

We Are All Members of Multiple Communities



Money Requirements



- Transactions must be:
 - Secure
 - Fast
 - Low cost
 - Concurrent (High BW for system)
- Currency itself must be
 - Forgery proof
 - Maintain value
- Controllable by Central Bank

Money Requirements



- Transactions must be:
 - Secure ✓
 - Fast ✓
 - Low cost ✓
 - Concurrent (High BW for system) ✓
- Currency itself must be
 - Forgery proof ✗
 - Maintain value ✓
- Controllable by Central Bank ✓

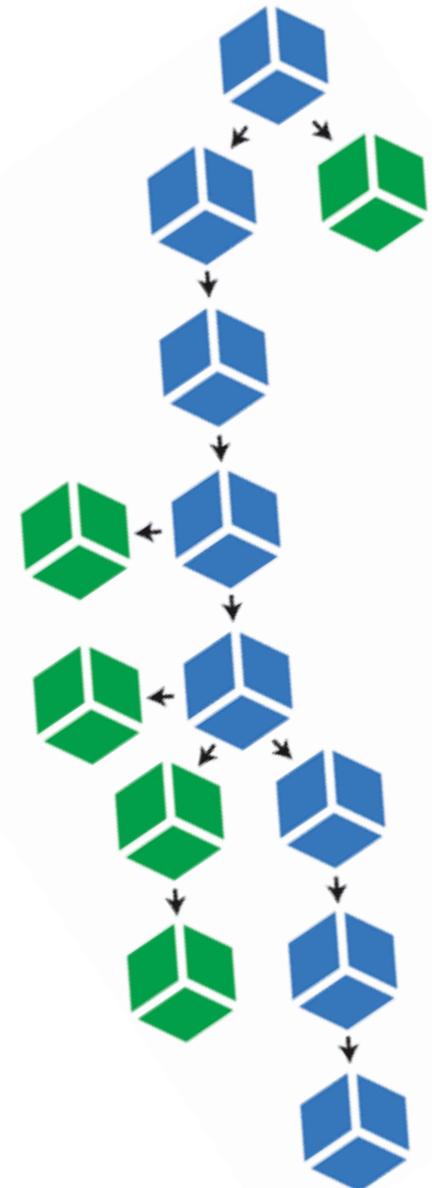
Money Requirements



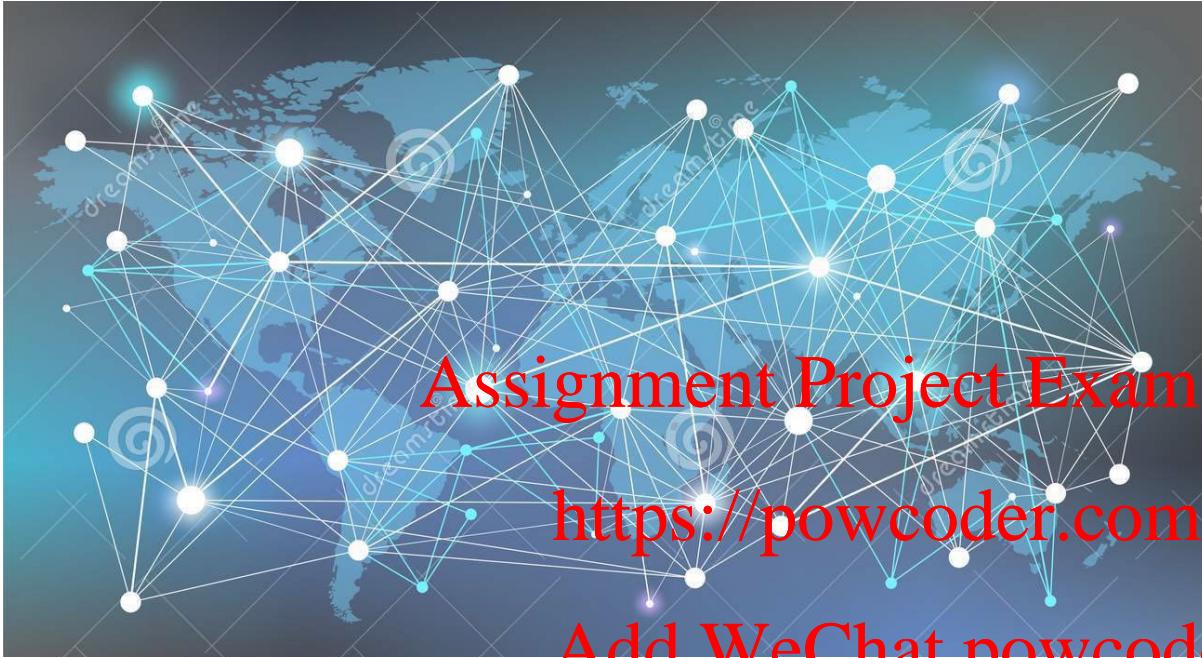
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 - Fast ✓ ✗
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 - Concurrent (High BW for system) ✓ ✗
- Currency itself must be
 - Forgery proof ✗ ✓
 - Maintain value ✓ ✓
- Controllable by Central Bank ✓ ✗

Blockchain

- Used to track transactions
- Distributed
- Simple rule to resolve data races maintain consistency -
<https://powcoder.com>
longest chain wins.
- Implications:
 - Need to wait to see if transaction went through
 - Need to have copy of all blocks everywhere

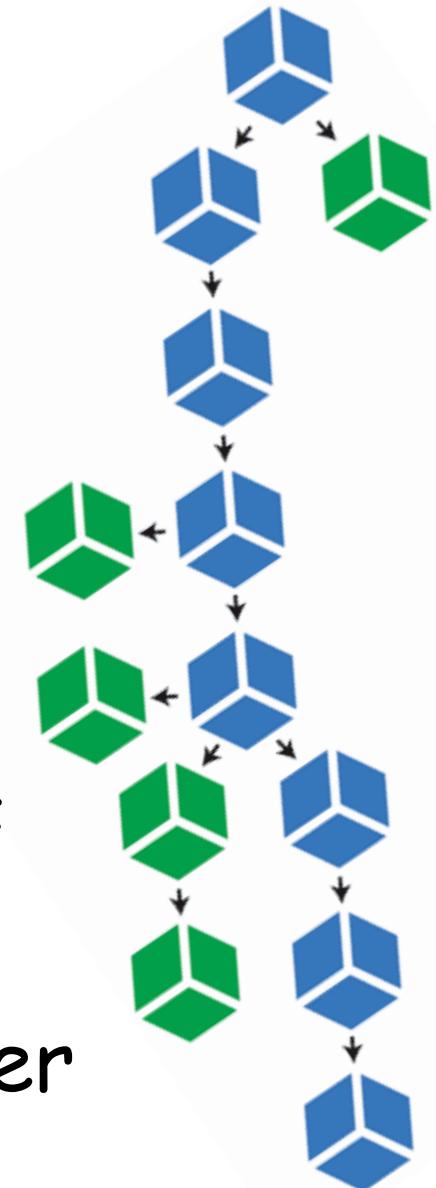


Block chain



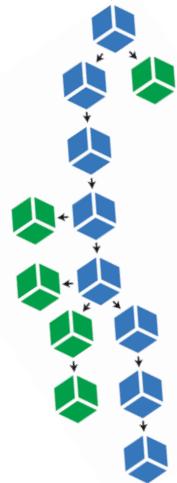
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- Worldwide network has copies of the blockchain - a public ledger
- Longest chain is the official ledger
- For safety transactions must be broadcast everywhere



Blockgraph: Principle of Locality

Pittsburgh



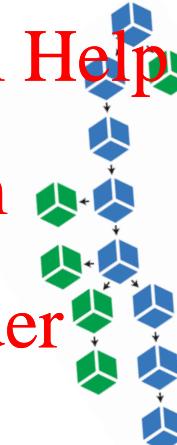
New York

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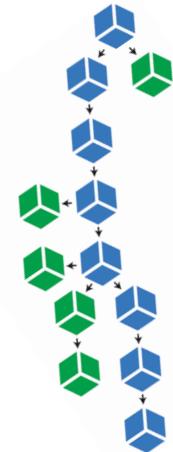
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Tokyo



Paris



Most transactions are local, so they stay local

Tied together with a global chain



Money Requirements



- Transactions must be:

- Secure



- Fast



- Low cost

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Concurrent (high BW for system)



Currency itself must be

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- Forgery proof



- Maintain value



- Controllable by Central Bank



Shameless plug

- Interested in working on this for the summer? [Assignment Project Exam Help](https://powcoder.com) <https://powcoder.com>
- If so, Send me an email [Add WeChat powcoder](#)

Impacts of TR3

- Without Plan

- Massive disr
 - Increased w
 - Bad stuff



- With Planning

- An amazing future
- Best chance for success is a bottom-up, distributed system that uses the market
→ Reinvent Money based on Reputation

Shameless Plug - part 2

- How to revive economy in time of pandemic?
- Businesses and People need loans to get by til everything re-opens
Assignment Project Exam Help
- Monitize crowd-sourced IOUs!
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Shameless Plug - part 2

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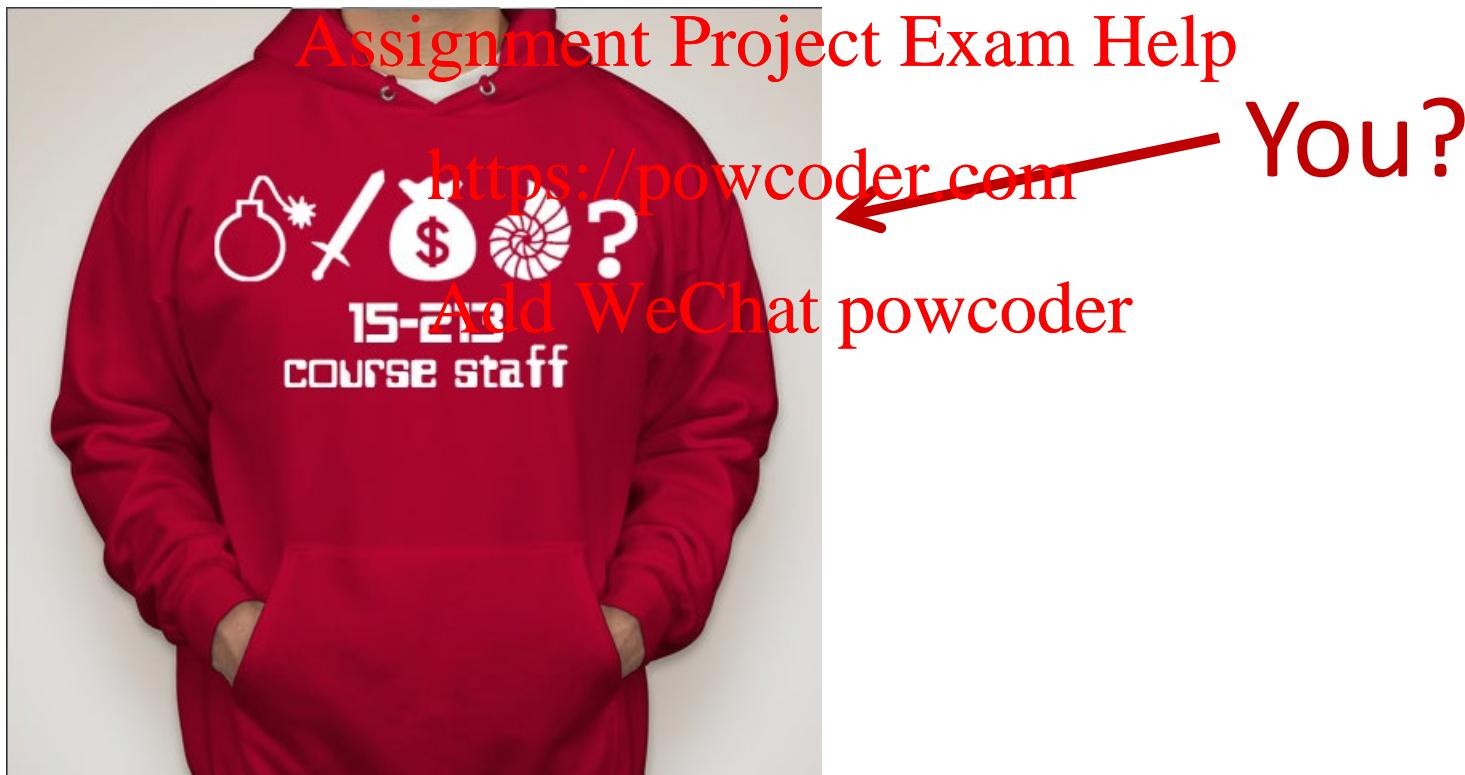
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- Interested? send me an email!

TAs for Fall 2020

- The instructors for 15/18-213/513/613
need you
please apply if you did well in 213 and want to be a TA



<https://www.ugrad.cs.cmu.edu/ta/F20/>

Final Exams and Grade

- Please study well
imitate machine learning
- Attend the Final Review
May 3, 6PM EDT Zoom (see Piazza for link)
Assignment Project Exam Help
- Remember the exam is cumulative
<http://www.cs.cmu.edu/~213/exams.html>
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- Grading algorithm: (almost) no curving
exam/lab/quiz/PS distribution:
<http://www.cs.cmu.edu/~213/syllabus/syllabus.pdf>
weight of labs: <http://www.cs.cmu.edu/~213/assignments.html>
- Double-check your scores
get in touch with us if anything looks wrong in autolab

A screenshot of a Microsoft Internet Explorer window displaying a final exam page. The page header includes fields for "Andrew ID (print clearly!)" and "Full Name". Below this, the text "15-213/18-213, Fall 2012" and "Final Exam" is shown, along with the date "Monday, December 10, 2012". A section titled "Instructions" contains several bullet points about the exam rules. At the bottom of the page is a table for scoring, with columns for individual problems and a total score.

1 (18)	2 (06)	3 (06)	4 (08)	5 (10)	6 (12)	7 (06)	8 (10)	9 (12)	10 (10)	TOTAL (98)

Page 1 of 20

Course Evaluation

- Please fill out the course evaluation you should have and will receive email about it
- Please provide constructive comments this is your chance to make 213 better
- Please be fair with your scores the university administration analyzes these numbers
- TA evaluation

<https://www.ugrad.cs.cmu.edu/~15200/feedback/>



15-213/18-213/15-513: Introduction to Computer Systems (ICS)

18-613: Foundations of Computer Systems

Notes on links

- **pptx** links are to Powerpoint versions of the lectures
- **pdf** links are to Adobe Acrobat versions of the lectures
- **code** links are to directories containing code used for class demonstrations
- **tar** links are to archive files in TAR format. Use the tar command on a linux machine to unpack these

Date	Lecture/Recitation	Lec	Reading	Labs
Jan 14	Recitation 1: No recitation--Semester starts with first lecture			
Jan 15	Overviews: Logic, Code, Machine	bl	1.1-1.2	L0 (cprogramminglab) out (pdf , tar)
Jan 17	Bits, Bytes, & Integers I (pdf , code , video)	bl	2.1	
Jan 20	TBD Linux/Git Bootcamp in Rashid Auditorium (bootcamp-slides)			
Jan 21	Machine Language Recitation			
Jan 22	Bits, Bytes, & Integers II (pdf , code , video)	bl	2.2-2.3	L1 (cmlab) due
Jan 24	Floating Point (pdf , video)	ff	2.4	
Jan 28	Recitation: Data Lab (pdf , handout , handout-solutions)			
Jan 29	Machine Prog: Basics (pdf , video)	scg	3.1-3.5	
Jan 31	Canceled due to weather			L1 due, L2 (bomblab) out
Feb 4	Recitation: Bomb Lab (pdf , handout)			
Feb 5	Machine Prog: Control (pdf , video)	bl	3.6	
Feb 7	Machine Prog: Procedures (pdf , video)	bl	3.7	
Feb 11	Recitation: C Review (pdf , handout , handout-solutions)			
Feb 12	Machine Prog: Data (pdf , video)	scg	3.8-3.9	
Feb 14	Machine Prog: Advanced (pdf , video)	scg	3.10	L2 due, L3 (attacklab) out
Feb 18	Recitation: Attack Lab (pptx , handout)			
Feb 19	Code Optimization (pdf , video)	bl	5	
Feb 21	The Memory Hierarchy (pdf , video)	bl	6.1-6.3	L3 due, L4 (cachelab) out
Feb 24	7pm - 9pm C Bootcamp in Rashid Auditorium (bootcamp-slides)			
Feb 25	Recitation: Midterm Review (pdf)			
Feb 26	Cache Memories (pdf , video)	bl	6.4-6.7	

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Thank you!