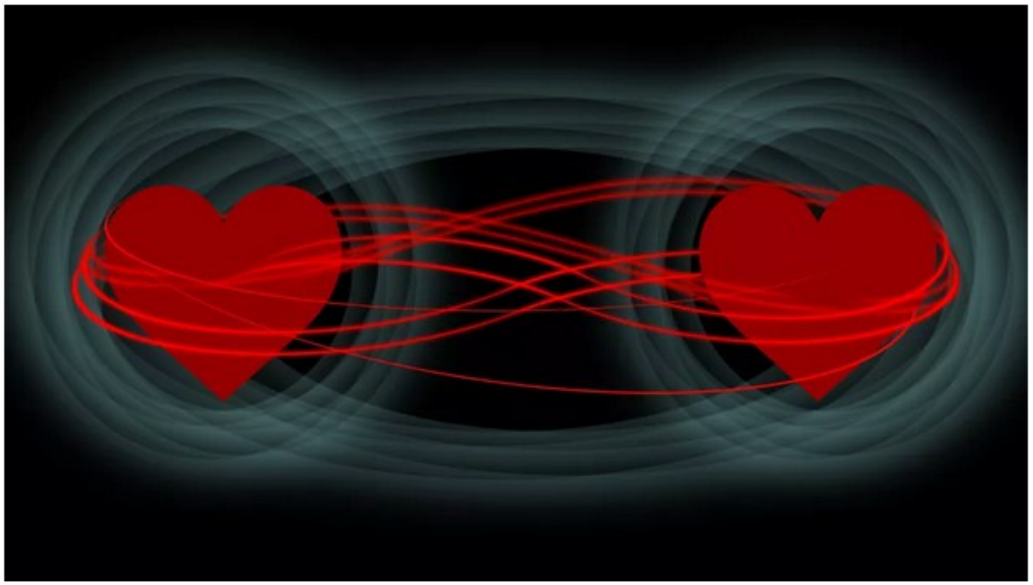
Quantum Computing *and* Romance Novels

Quantum Entanglement: Love on a Subatomic Scale

By Jesse Emspak February 14, 2016



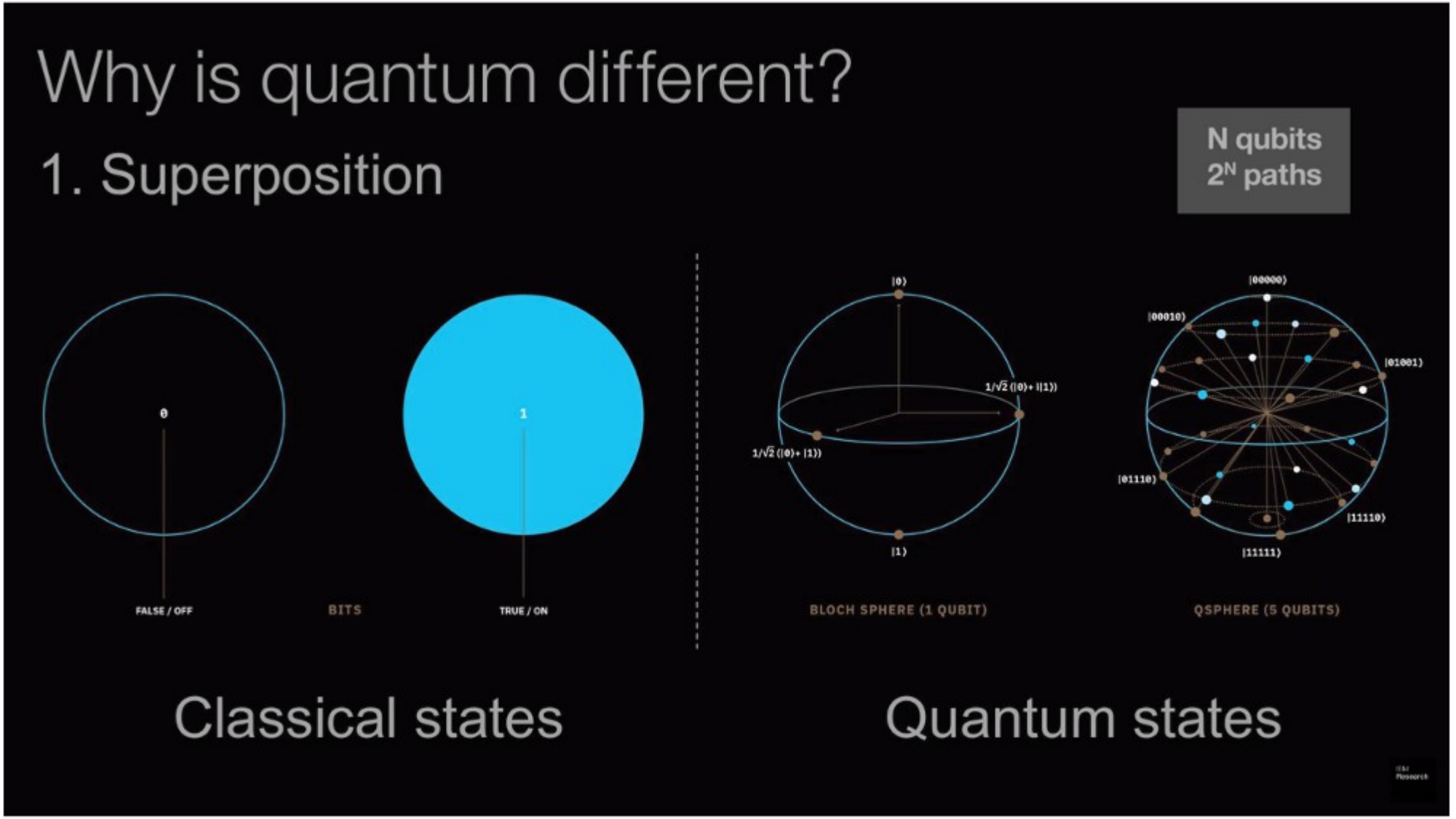
Technology used to study the "love" between entangled particles is also being used in research to improve deep-space communications.
(Image: © NASA/JPL-Caltech)

When talking about love and romance, people often bring up unseen and mystical connections.

Such connections exist in the subatomic world as well, thanks to a bizarre and counterintuitive phenomenon called quantum entanglement.

The basic idea of quantum entanglement is that two particles can be intimately linked to each other even if separated by billions of light-years of space; a

Quantum Computing



One-Slide Quantum Summary

- A **quantum computer** manipulates **quantum bits**; such qubits can represent a **superposition** of possible states.
- Quantum computers are **probabilistic**. **Grover's Algorithm** (for linear search in sub-linear time) and **Shor's Algorithm** (for factoring integers in polylog time) are common quantum algorithms.
- When you use a quantum computer to “try everything in parallel” you get back a **random answer**.

Quantum quantified

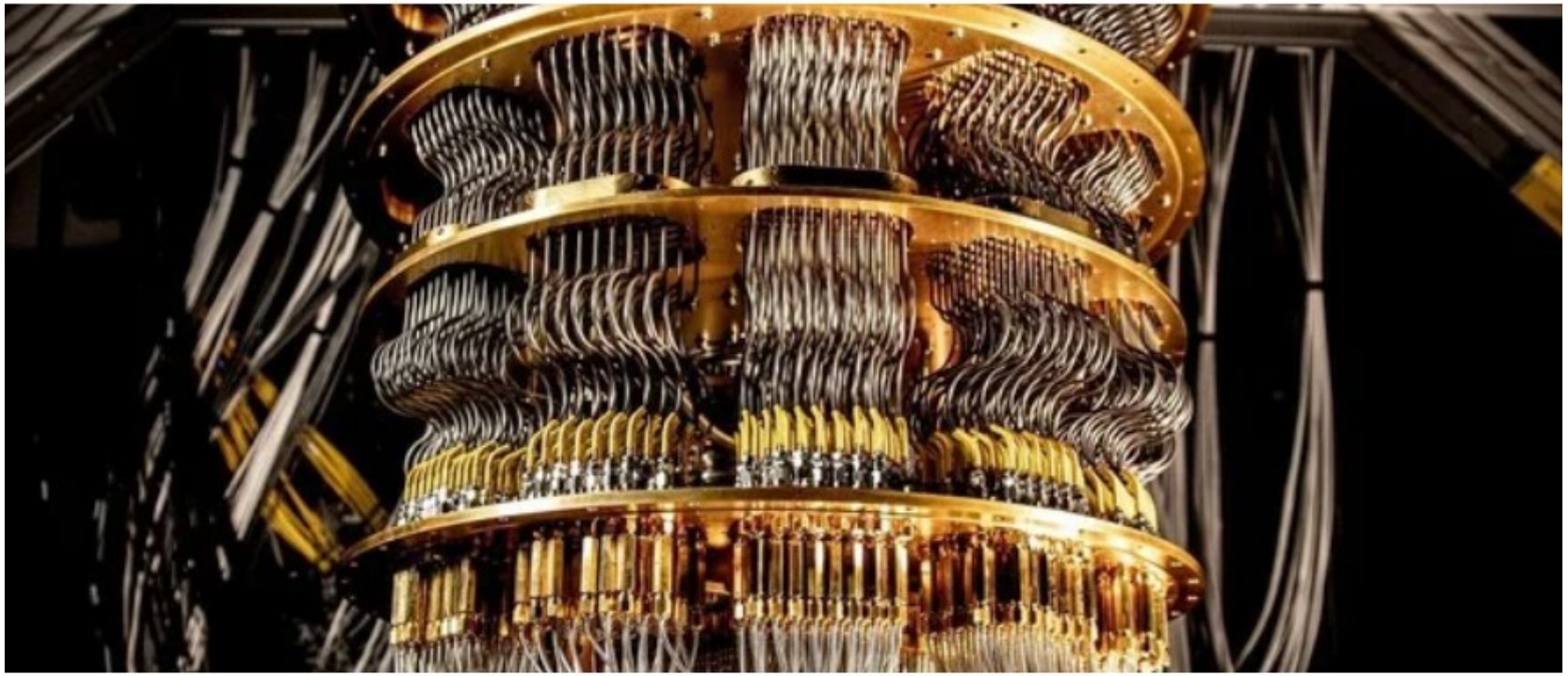
Jan 29th 2014, 13:18 by Economist.com | Timekeeper | Tweet 19

QUANTUM computers are a grand idea. By harnessing the famous strangeness of quantum mechanics, they should be able to perform some (though not all) calculations far faster than any ordinary computer. But building one has proven tricky. The idea was first floated in the 1970s. Four decades later quantum computers are still small, fragile devices confined to the laboratory bench—with one exception. In 2011, to a great fanfare, a Canadian firm called D-Wave announced a commercially available quantum computer, the $10m D-Wave One. Deals with Google, NASA and Lockheed Martin, a weapons firm, followed.

Admittedly, D-Wave's device is a very specialised sort of computer, restricted to a single area of mathematics called discrete optimisation. But it was big news, and many scientists were rather sceptical. In the past couple of years the firm has published enough papers about its device to convince academics that it has indeed built a quantum-mechanical machine. Now the question is whether it is any faster than the competition.

Google Claims Latest Quantum Experiment Would Take Decades On Classical Computer

Research Matt Swayne • July 4, 2023



Insider Brief

- Google scientists are reporting in a new study that it completed a computational task on a quantum computer that would take a classical supercomputer 47 years to complete.
- The task was a random circuit sampling calculation.
- The experiment was carried out in the latest version of the Sycamore processor that has been boosted to 70 qubits.
- Image: Google Quantum AI

The Key

- The key to quantum algorithms is to make a bunch of parallel worlds that all have something (part of the right answer) **in common**.

Shor's Algorithm Prelude

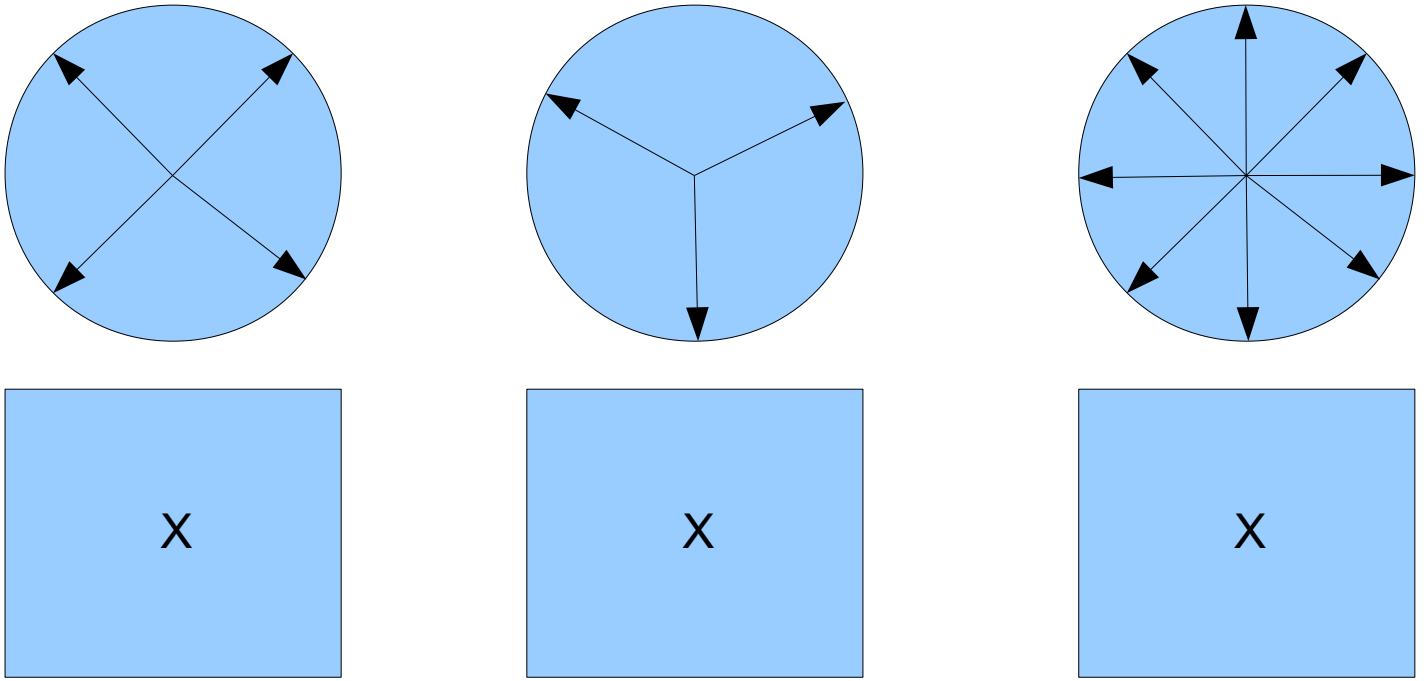
- Goal: find factors of large integer N = p * q
- Let's assume we've made our superposition
  - x mod N, x^2 mod N, x^3 mod N, x^4 mod N, ...
- So, given a superposition of elements in a periodic sequence, how do we extract the period?
  - If we find it, Euler gives us (p-1)(q-1), and we win
- We use the **Quantum Fourier Transform**
  - The heart of **Shor's Algorithm** (1994)
- Reasoning by analogy time!

Groundhog Day

- Say you're on a 27 hour “personal day cycle”
- Let's imagine that your bedroom has many alternate clocks in it
  - One clock has 27 hours per cycle
  - One clock has 3 hours per cycle, etc.
  - Each hour is still 60 minutes on all clocks
- Each clock has its own posterboard with a thumbtack in it – mounted below the clock
  - When you wake up, you move each thumbtack in the direction of its clock's hour hand

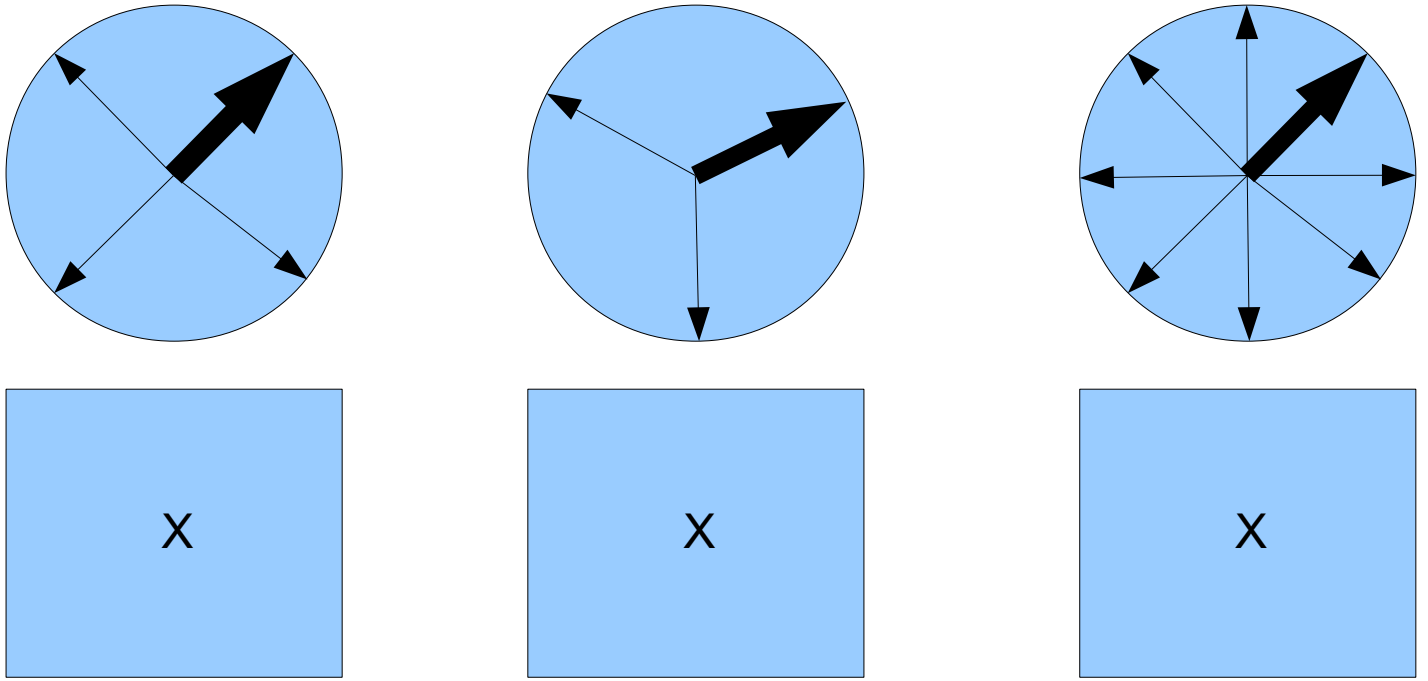
Bedroom Of Doom!

- Three of your clocks: 4-hour, 3-hour, 8-hour:



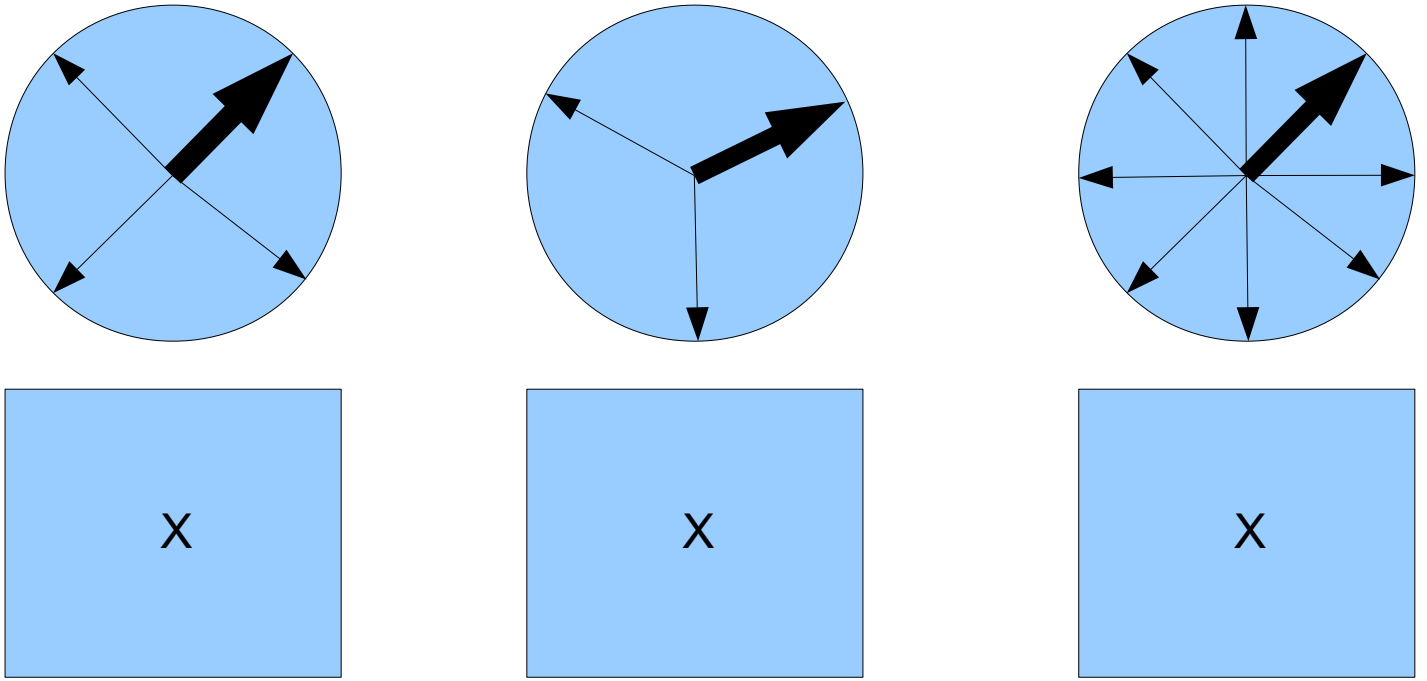
Bedroom Of Doom! (1pm)

- Let's say the current time is 1pm on all clocks.



Bedroom Of Doom! (1pm)

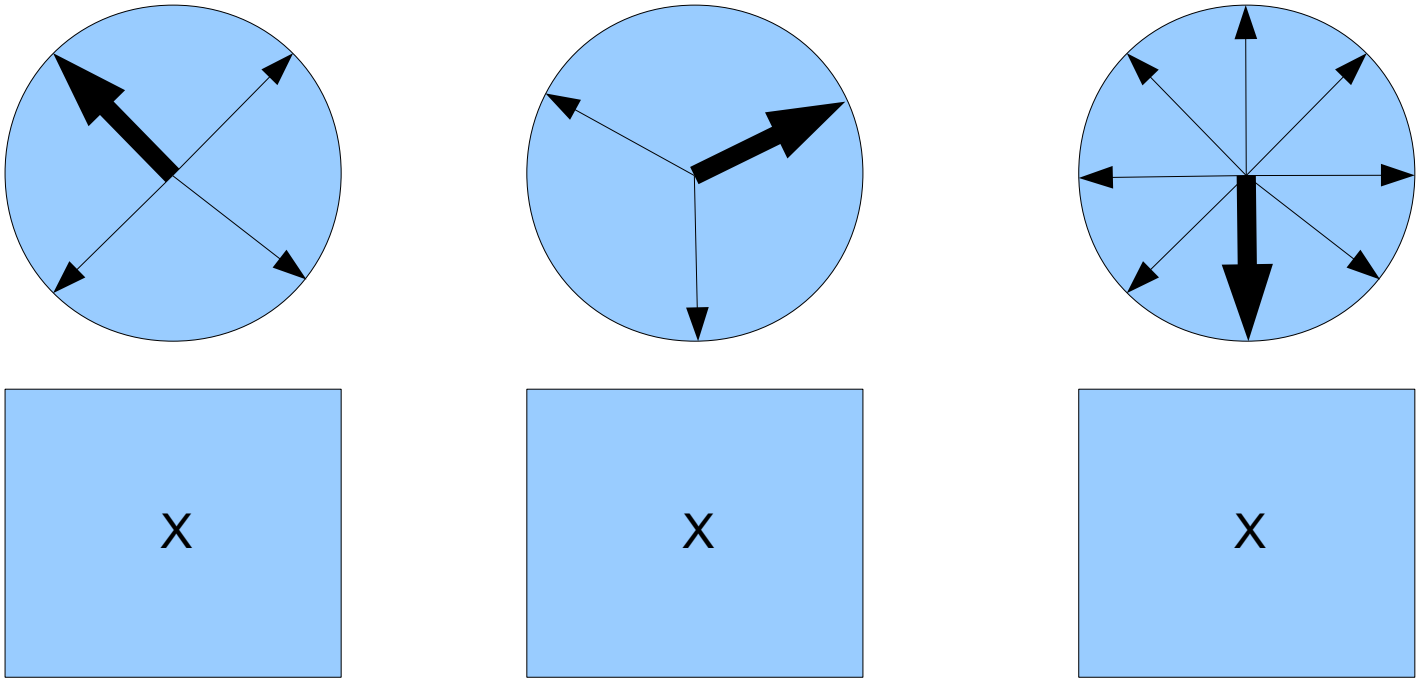
- Let's say you're on a 3-hour day, so you wake up every three hours.



- So when next you wake up, it'll be three hours later ...

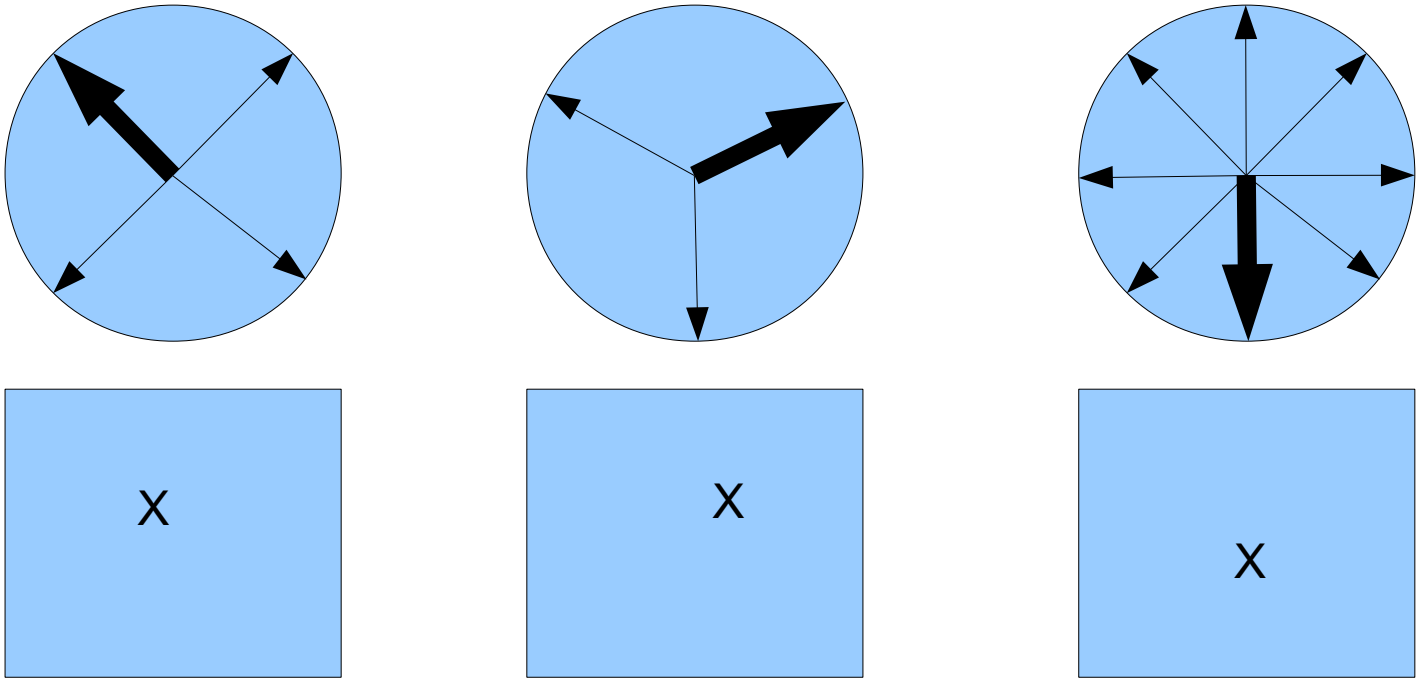
Bedroom Of Doom! (4pm)

- So you adjust the clocks



Bedroom Of Doom! (4pm)

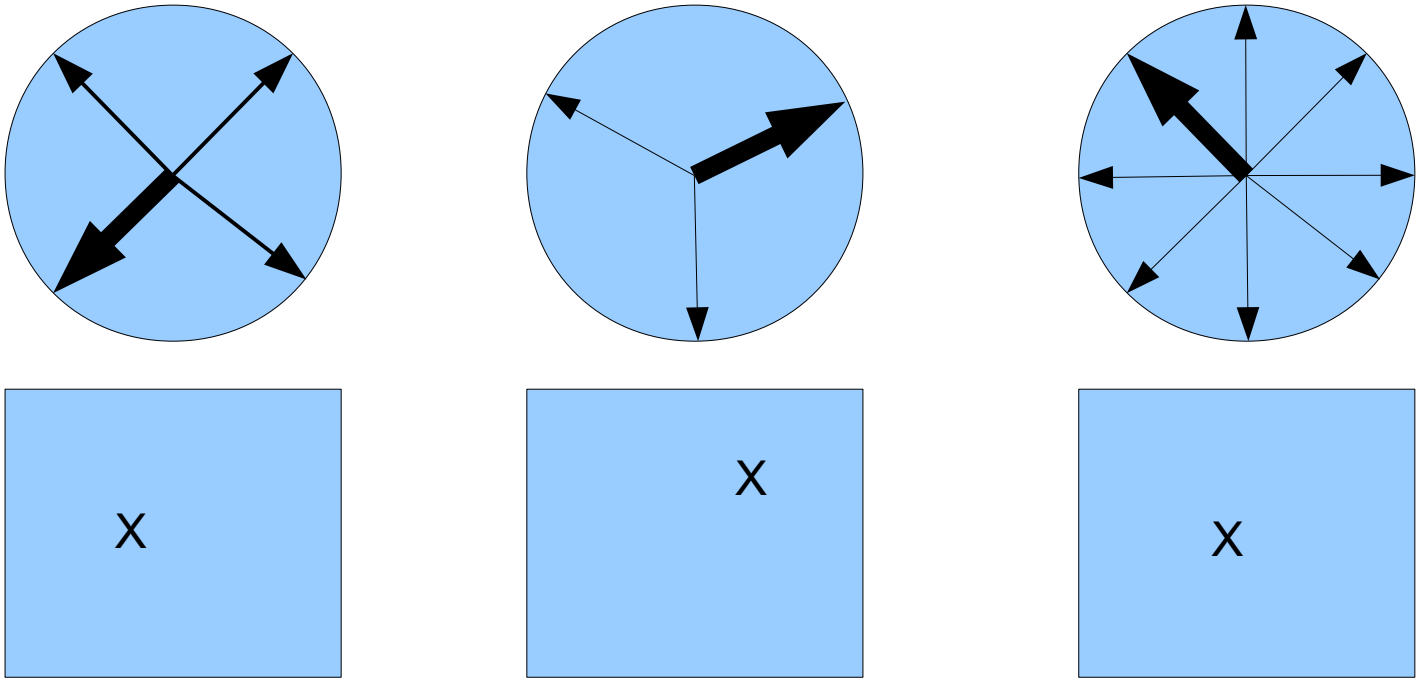
- So you adjust the clocks



- And move the thumbtacks ...

Bedroom Of Doom! (7pm)

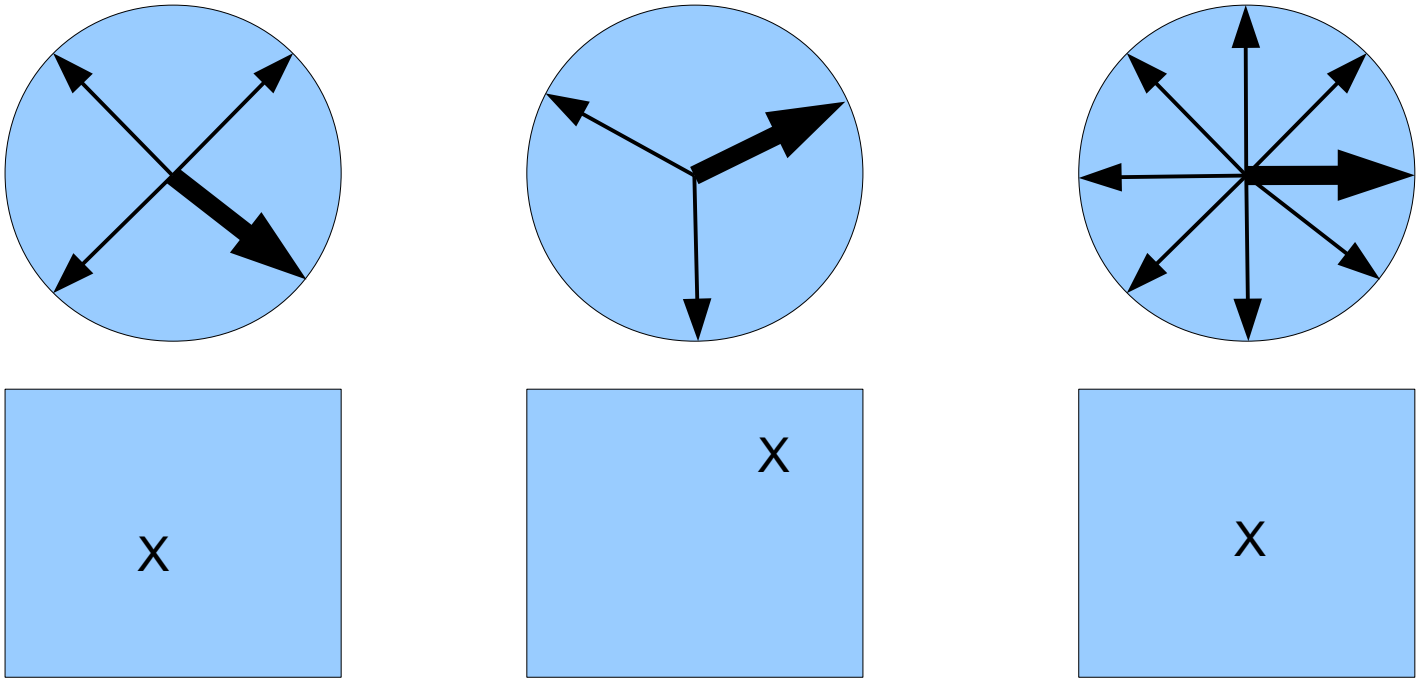
- Wakey Wakey! So you adjust the clocks



- And move the thumbtacks ...

Bedroom Of Doom! (10pm)

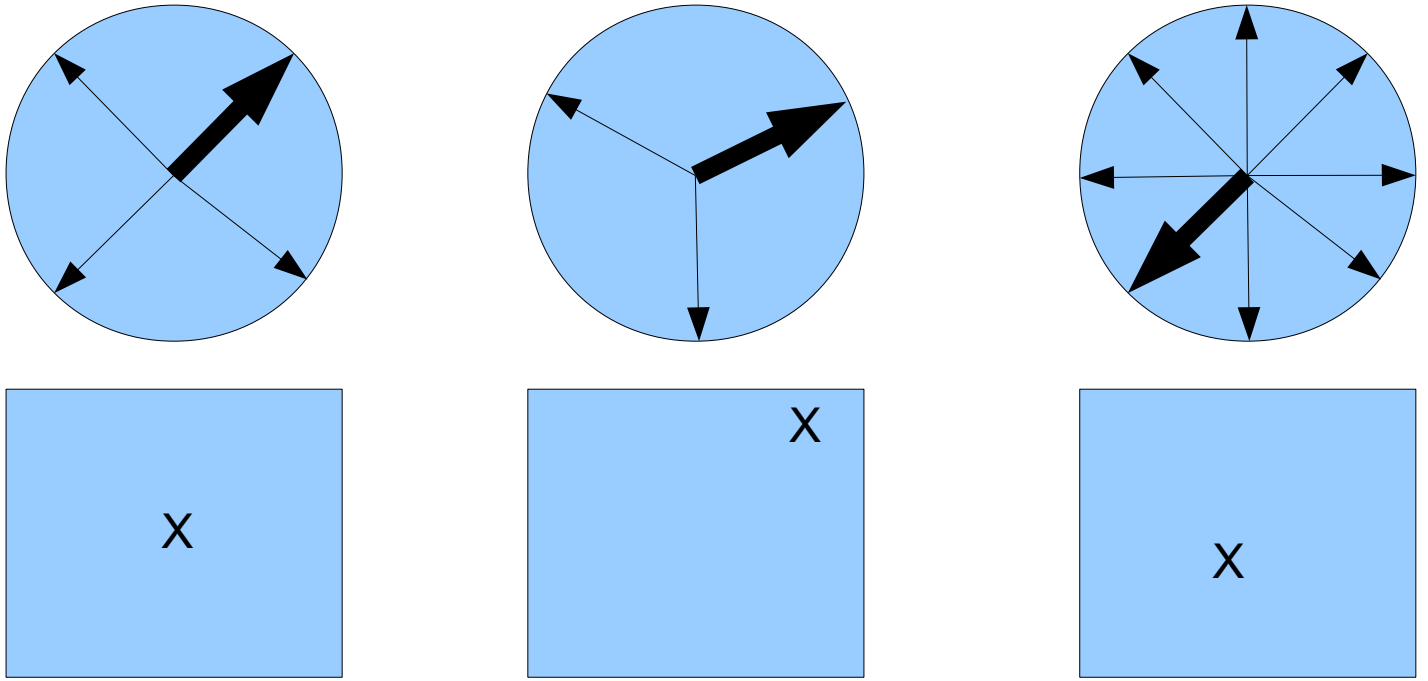
- Wakey Wakey! So you adjust the clocks



- And move the thumbtacks ...

Bedroom Of Doom! (1am)

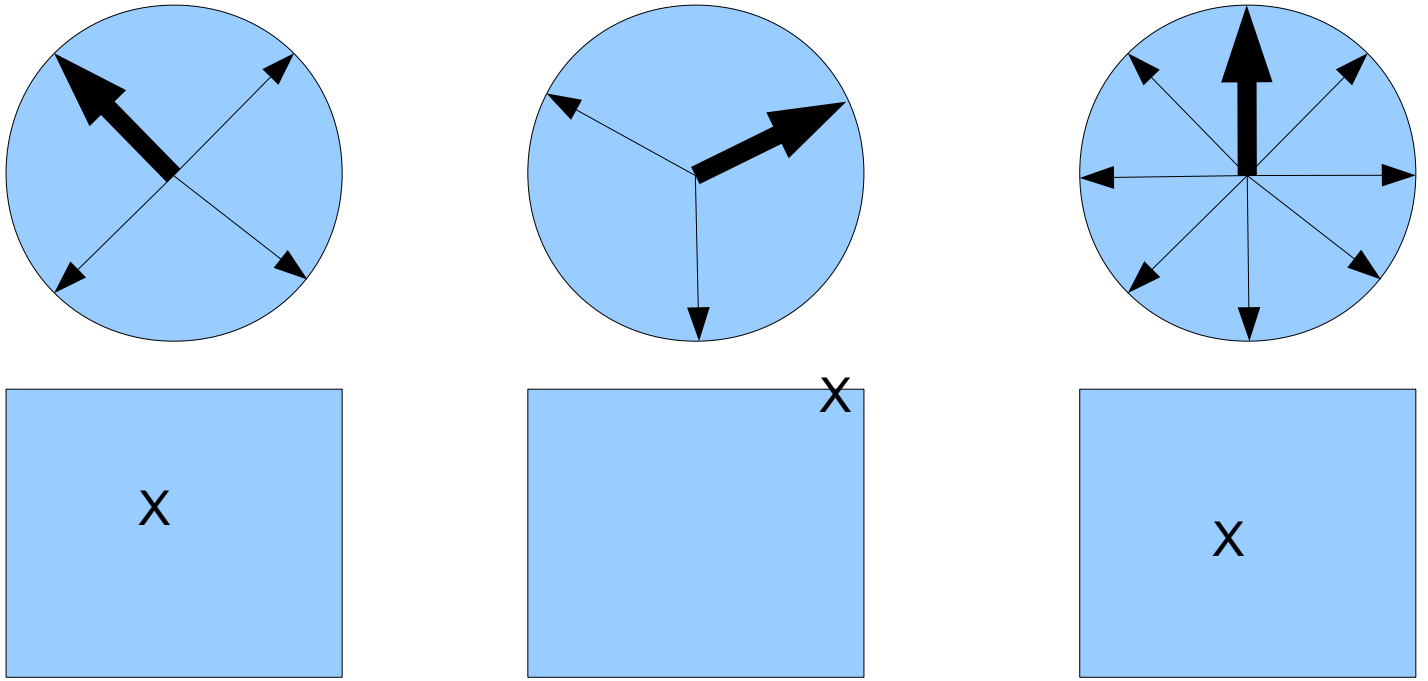
- Sigh! So you adjust the clocks



- And move the thumbtacks ...

Bedroom Of Doom! (4am)

- Sigh! So you adjust the clocks



- *How can you tell which clock matches the period length of your personal day cycle?*

Periodic Motion

It's Just A Jump To The Left

- If you're on a 3-hour cycle, the 4-hour clock's thumbtack drifts around a little, but every few days it returns to the center
  - All of the movements cancel each other out!
- On the other hand, from the perspective of the 3-hour clock you've been waking up at the same time each “morning”
  - **So you keep moving that thumbtack in the same direction!**
- So just find which thumbtack is farthest from the center and you've found the period.

QFT, QED.

- The **Quantum Fourier Transform** is a linear (unitary) transformation that maps a vector of complex numbers to another vector of complex numbers
- Input vector has nonzero entries every time I wake up, zero entries everywhere else
- Output vector records thumbtack positions
- In the end: it's a linear transform mapping quantum state encoding a periodic sequence to a quantum state encoding the *period* of the sequence!

Interference

- In quantum-land, probabilities are always non-negative but **amplitudes** may be negative, positive or even complex.
- Thus amplitudes corresponding to different ways of getting a particular answer can **interfere destructively** and cancel each other out
- In Shor, all periods from all observations (i.e., all alternate universes) other than the true one cancel each other out. Only for the true period do contributions from all observations (i.e., all universes) point in the same direction.

Shor's Algorithm

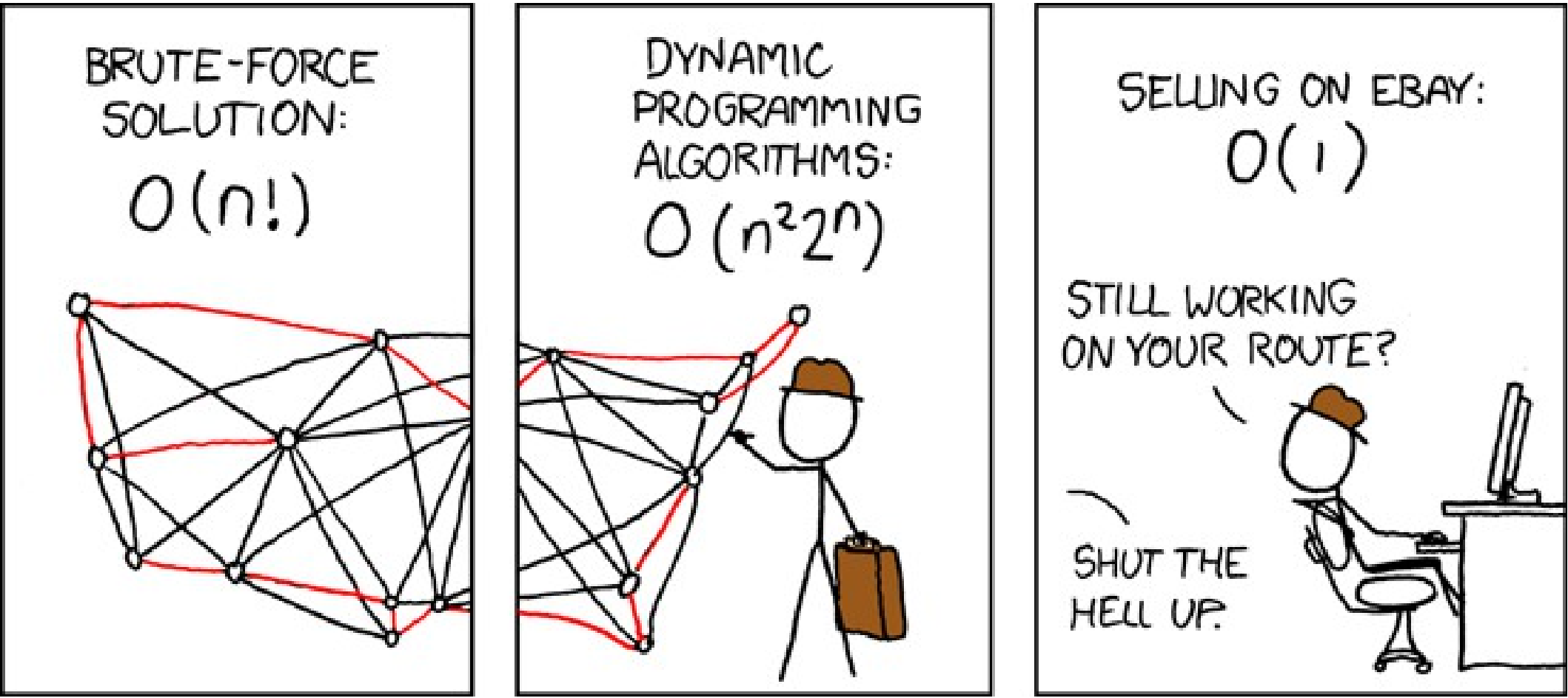
- On a quantum computer, **Shor's Algorithm** takes $O((\log N)^3)$ time to factor the integer N
  - Recall: best classical time ~$O(2^{\log N})$
- In 2001, a team at IBM implemented Shor's algorithm and factored 15 using 7 qubits
  - *Experimental realization of Shor's quantum factoring algorithm using nuclear magnetic resonance*
  - "We use seven spin-1/2 nuclei in a molecule as quantum bits, which can be manipulated with room temperature liquid-state nuclear magnetic resonance techniques."

Did We Win?

- A normal Turing machine can simulate a quantum computer (slowly ...)
  - So we do not gain any expressive power
  - Quantum computers do not solve the halting problem
- But quantum computers sure seem faster!
- The class of problems that can be solved efficiently by quantum computers is called **BQP** (bounded error, quantum, polynomial time).

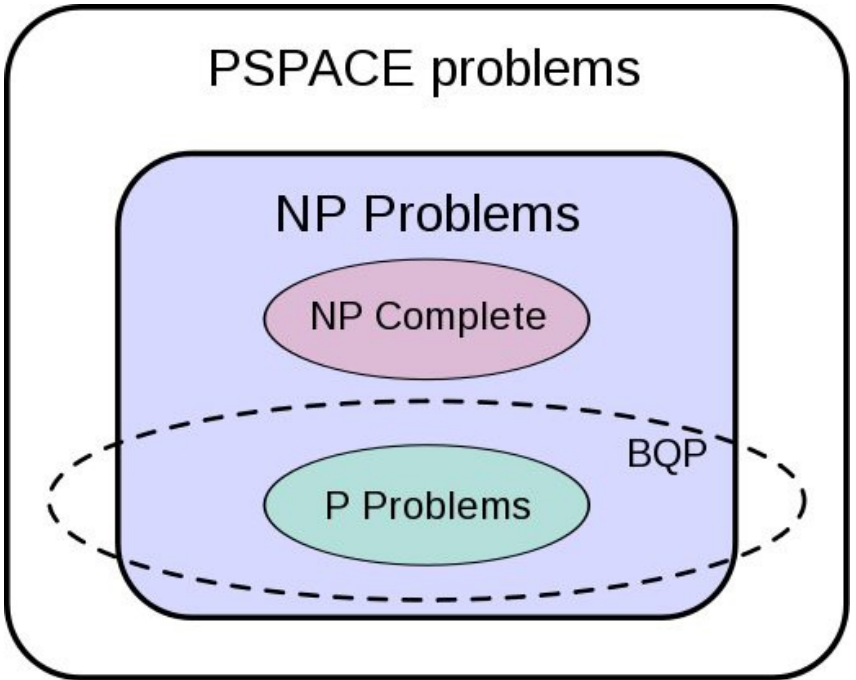
P = NP ?

- **So**: “quantum computers can solve NP-complete problems in polynomial time” ?



P = NP ?

- **Misconception**: “quantum computers can solve NP-complete problems in polynomial time”
- BQP is *suspected* to be a superset of P and disjoint from NP (this is *unknown*)



What Is Quantum Good For?

- BQP contains Integer Factorization
  - Believed to be in NP but not in P
- BQP contains Discrete Log
  - Believed to be in NP but not in P
- BQP contains Quantum Database Search
  - Can give an N^2 speedup on any NP-complete problem (by searching through all the answers), but that's still exponential time
- And that's currently about it.

Hype Seems High

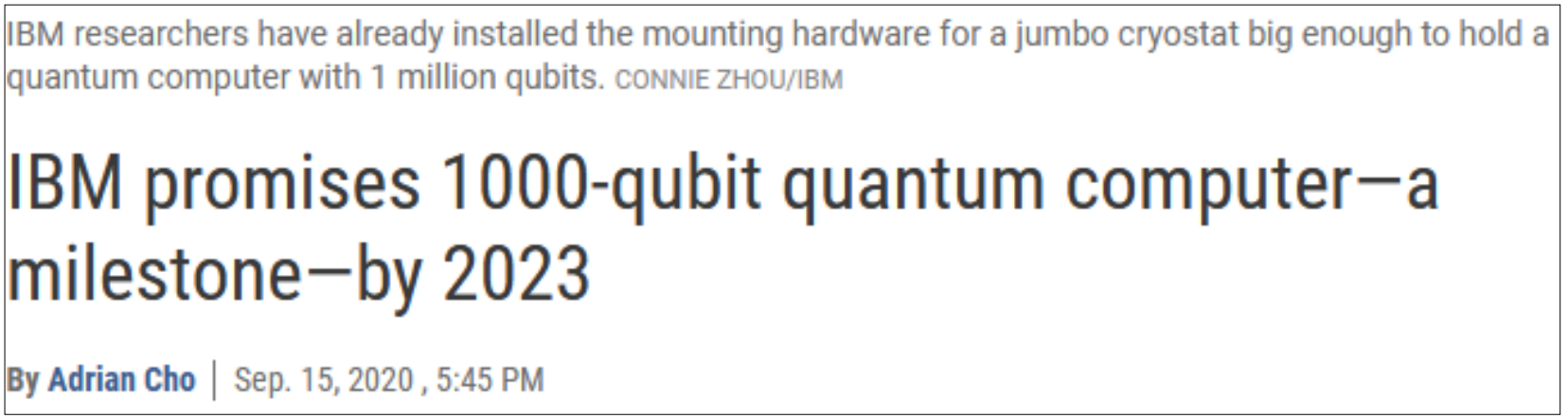
- 2001: Factoring
- 2011: Commercial
- Opinion: has been “around the corner” for two decades; more theory than practice
  - Need breakthrough: - error rate, + #qubits

The quantum computers of 2018

All the same, as of right now, nearly every quantum computer is a multi-million dollar borderline mad-scientist project that looks the part. You generally find them in R&D departments at large IT companies like IBM, or in the experimental physics wing of large research universities, like MIT. They have to be super-cooled to a hair above absolute zero (that’s colder than intergalactic space), and experimenters need to use microwaves of a precise frequency to communicate with each qubit in the computer individually. Needless to say, that doesn’t scale. But neither did the vacuum tubes of the earliest conventional computers, so let’s not judge this first generation too harshly.

Progress Seems Slow

- 2001: Factoring
- 2011: Commercial
- 2020: We'll have 1000-qubits by 2023!



IBM researchers have already installed the mounting hardware for a jumbo cryostat big enough to hold a quantum computer with 1 million qubits. CONNIE ZHOU/IBM

IBM promises 1000-qubit quantum computer—a milestone—by 2023

By Adrian Cho | Sep. 15, 2020 , 5:45 PM

Revised Estimates?

- Google Quantum AI now estimates:

MILESTONE 1

BEYOND CLASSICAL

Physical Qubits: 54

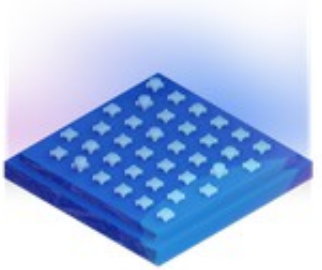
Logical Qubit Error Rate: -

MILESTONE 2

QUANTUM ERROR CORRECTION

Physical Qubits: 10^2

Logical Qubit Error Rate: 10^{-2}

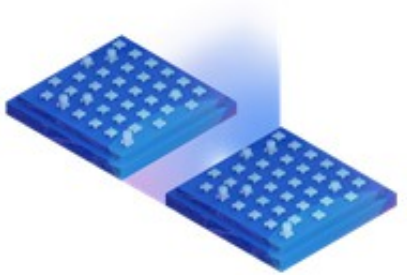


MILESTONE 3

BUILDING A LONG-LIVED LOGICAL QUBIT

Physical Qubits: 10^3

Logical Qubit Error Rate: 10^{-6}



MILESTONE 4

CREATING A LOGICAL GATE

Physical Qubits: 10^4

Logical Qubit Error Rate: 10^{-6}

2019 — 2023 — 2025+

Healthy Skepticism

- Opinion: has been “around the corner” for two decades; more theory than practice
  - Need breakthrough: - error rate, + #qubits

The quantum computers of 2018

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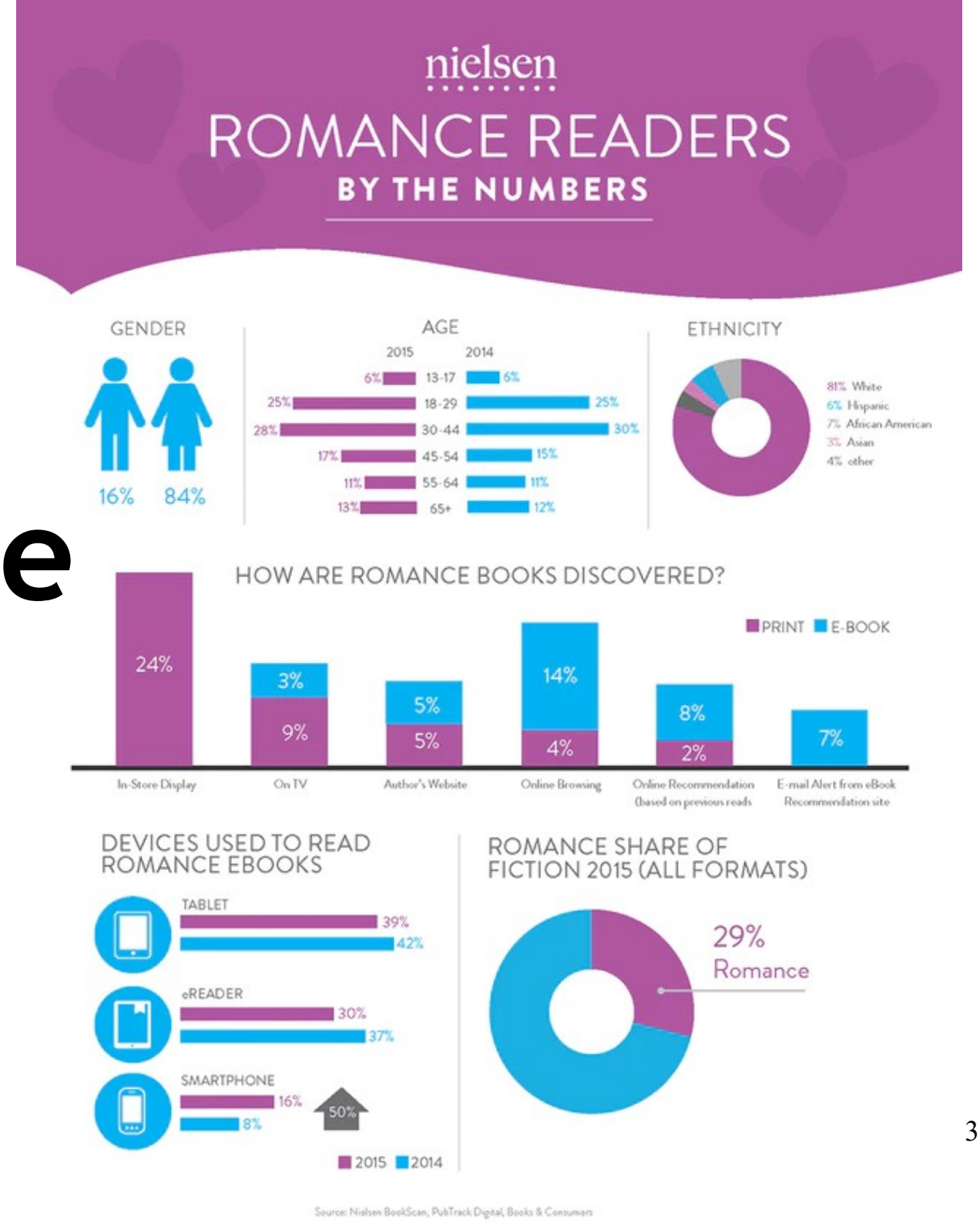
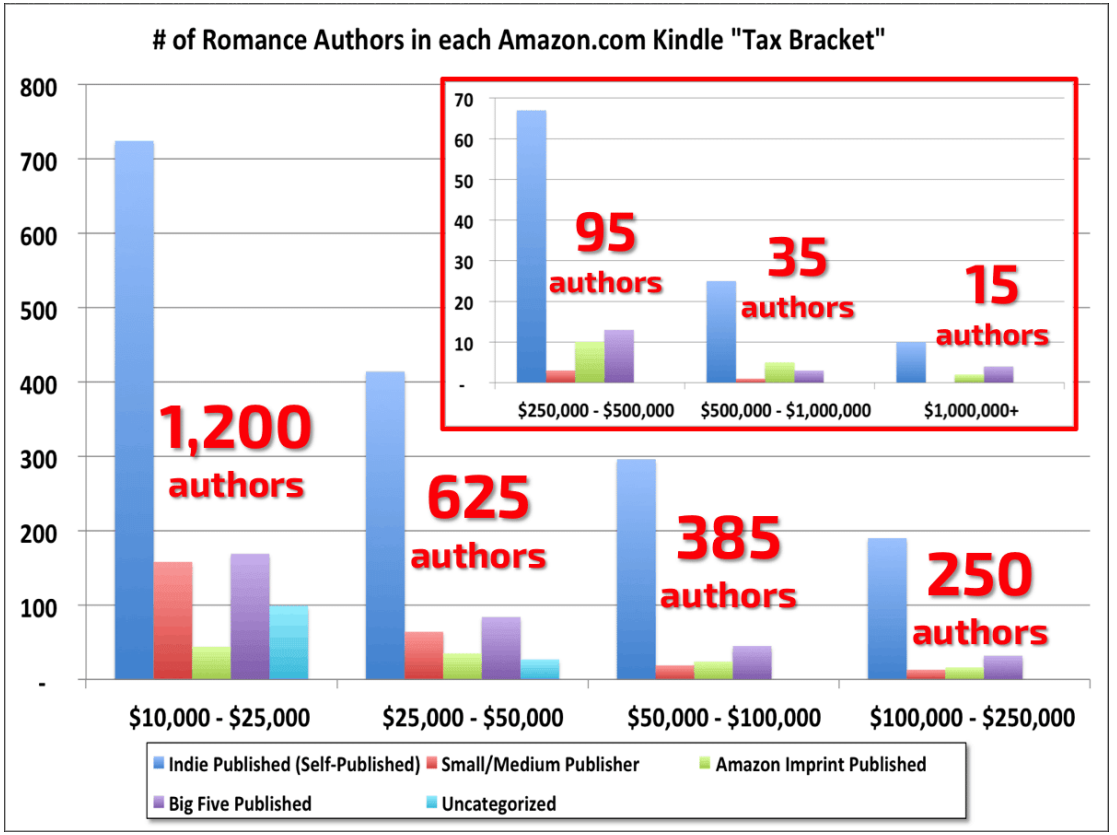
Romance Novels



Dispelling Romance Novel Myths

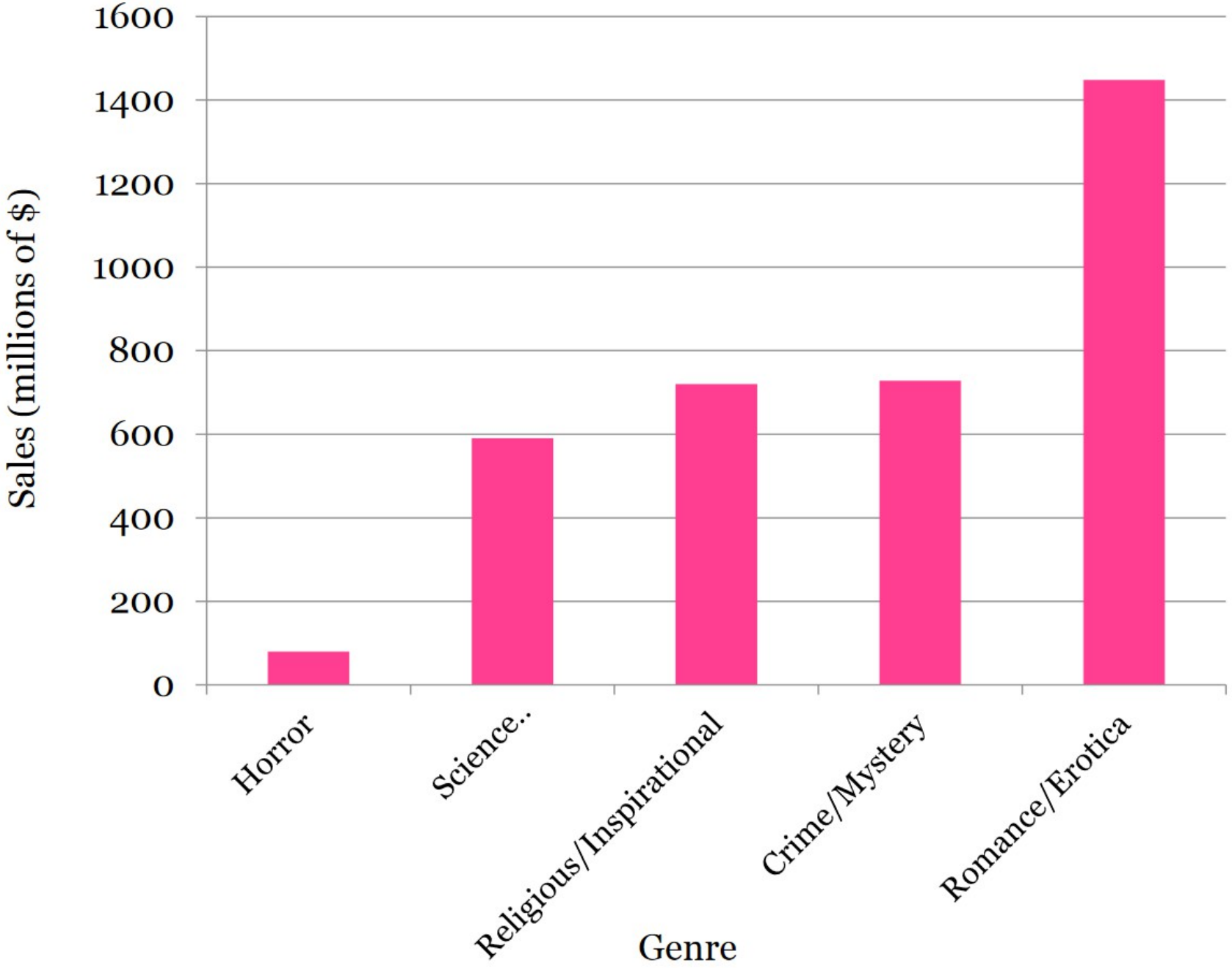
- Tell me something about romance novels …
  - Even if it's just an uninformed stereotype



Why Should We Care?

- In 2022, romances were 33% of all mass-market paperbacks sold
  - Most popular genre in modern literature
  - Printed romance novels increased by 36% since 2021
  - Sales for romance novels reached 47 million units in 2021, including print and digital formats
  - Also Europe & Australia, over 90 languages, etc.
- Romantic fiction generates over $1.438 billion in sales
  - 64 million people claimed to read at least one
  - 16% male, 50-50 married/single, 42% BA/BS
  - 28/190 world countries have GDP < $1.2 billion

Book Sales by Genre



2020 Most Lucrative Genres

- All Books Sales (Electronic and Paper):
  - Romance/Erotica – $1.44 billion
  - Crime/Mystery – $ 728.2 million
  - Religious/Inspirational – $ 720 million
  - Science Fiction/Fantasy – $ 590.2 million
  - Horror – $ 79.6 million
- Top 3 Kindle Categories By Sales:
  - Romance -> Contemporary
  - Literature & Fiction -> Contemporary Fiction -> Women
  - Romance -> New Adult & College

On The Street

- “Romance novels do better here than any other genre," says Anna Mickelsen of the Springfield City Library in Springfield, Mass in 2013. "Romance makes up 35% of our more-than-5,000-item collection but accounts for over 43% of the circulation. On average, romance paperbacks circulate more than eight times, while items in other genres circulate fewer than six. The cost of romance novels is generally less than [the cost of novels from] many of the other genres, and with high circulations this results in a better return overall on the library's investment."

What Are We Talking About?

- According to the Romance Writers of America, the main plot of a **romance novel** must revolve around the two people as they develop romantic love for each other and work to build a relationship together. Furthermore, a romance novel must have an "emotionally satisfying and optimistic ending."
- Nora Roberts claims "The books are about the celebration of falling in love and emotion and commitment, and all of those things we really want."

Freedom?

- Modulo societal taboos, almost anything can appear in a romance novel.
  - Castles, domestic violence, science fiction, disabilities, children, religion, date rape, medicine, suspense, exotic locales, chaste kisses, etc.
- So let's do a brief history and taxonomy of romance novels and occasionally use them as a lens for studying society

Ancient History

- 1740: Pamela, or Virtue Rewarded by Samuel Richardson
  - First popular novel based on heroine's perspective
- 1813: Pride and Prejudice by Jane Austen
  - Often critically considered “the best romance novel ever written”
  - Reinforces stereotype that women must marry?
- 1847: Jane Eyre by Charlotte Bronte
  - Orphaned heroine, gothic elements, Elizabethan drama, “demonstrated the flexibility of the romance novel form”

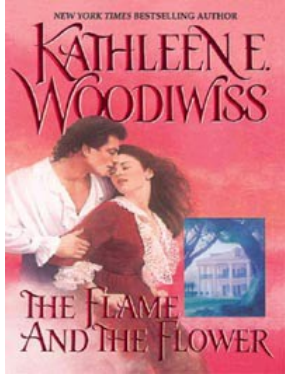
History

- 1919: The Sheik by E.M. Hull
  - Popular, movie with Valentino, hero kidnaps heroine and wins her affection through “forceful action”
    - One of the first to introduce the rape fantasy [Regis 2003]. Publishers believed that readers would only accept premarital sex in the context of rape. In this novel and those that followed, the rape was depicted as more of a fantasy; the heroine is rarely if ever shown experiencing terror, stress, or trauma as a result.
- 1921+: Many by Georgette Heyer
  - Set during English Regency Period (1811-1820)
  - Used setting as a plot device: characters would have modern day sensibilities (e.g., marrying for love) and would be marked as eccentric

Pre-Modern Era

- 1930+: Mills and Boon hardback romances
  - UK Company, sold in weekly two-penny libraries
- 1957: Harlequin sells M&B books in America
  - Had a “decency code”
    - cf. Hays Production Code in US Cinema, 1934-1968: replaced in modern era by MPAA ratings
    - Intimacy limited to chaste kisses between protagonists
- 1971: Harlequin purchases Mills & Boon
  - Chose to sell books “where the women are”: supermarkets, drug stores, etc.

The Modern Era

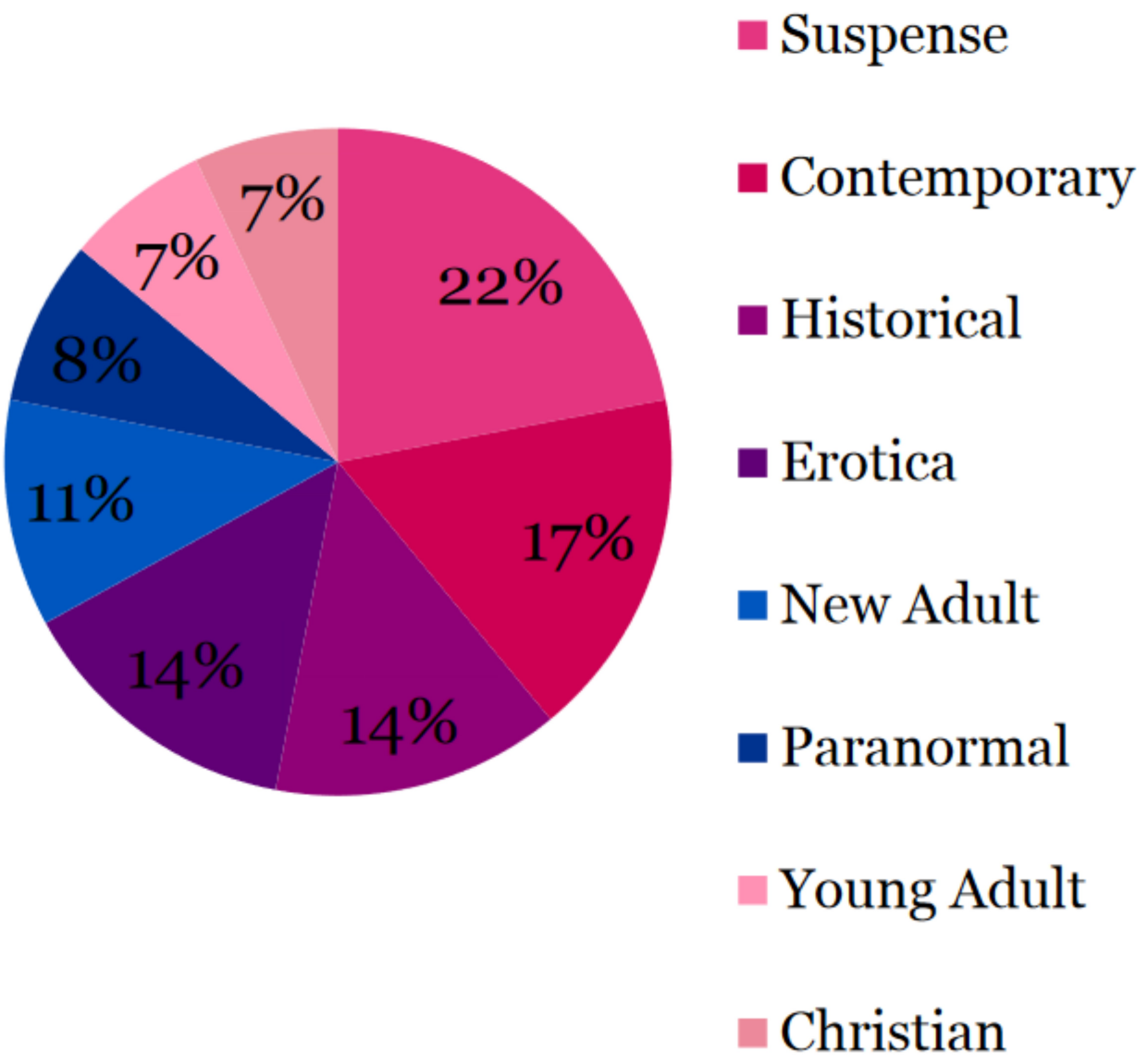


- 1972: The Flame and the Flower by Kathleen Woodiwiss (Avon publishers)
  - First romance novel “to [follow] the principles into the bedroom”; first to be published directly in paperback; was distributed in drug stores; went on to sell 2.35 million copies
- By 1975 Avon's 4 romances sold 8 million combined copies
- By 1976 over 150 historical romance novels were published selling over 40 million copies

Two Types Of Romance

- **Category Romances** (series romances)
  - Short: 200 pages; 55,000 words; multiple books in a line published each month
  - "pare the story down to its essentials. Subplots and minor characters are eliminated or relegated ..."
  - Wide distribution, staying on shelves until sold out or until next month's titles arrive
- **Single-Title Romances**
  - Longer: 350-400 pages, 1/year, remain on shelves
  - Not always stand-alone, often Author-driven

Romantic Subgenres



Social Mores: Romance Novels 1980s

- 1980: WSJ refers to "bodice-rippers" as "publishing's answer to the Big Mac: they are juicy, cheap, predictable, and devoured in stupifying quantities by legions of loyal fans"
- Contemporary romances: weak females falling in love with alpha males
- Historical romances: heroines active in the plot, but "passive in relationships with heroes"
- All genres: heroines 16-21 virgins, heroes ~30 not, all are beautiful

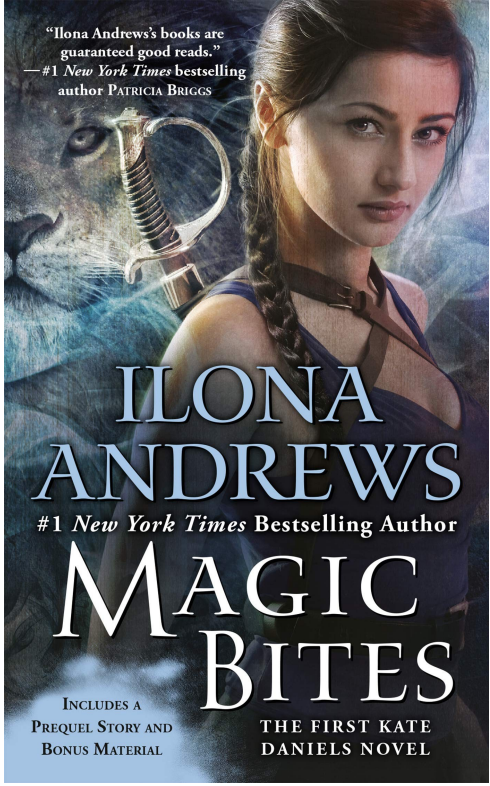
The Sun Also Rises And Falls

- 1975: Harlequin purchases a romance novel that takes place in America with American morals
  - In the late 70's they rejected Nora Roberts because "they already had their American writer"
- 1980: The Tawny Gold Man by Amii Lorin
  - First to waive the virgin heroine requirement
  - By 1983, sales of that line totaled $30 million
  - Similar lines soon had 90-100% monthly sellout rates
- 1984: Market Saturation (40% sellout rates)
  - "dampening effect of the high level of redundancy associated with series romances was evident in the decreased number of titles being read per month"

Social Changes

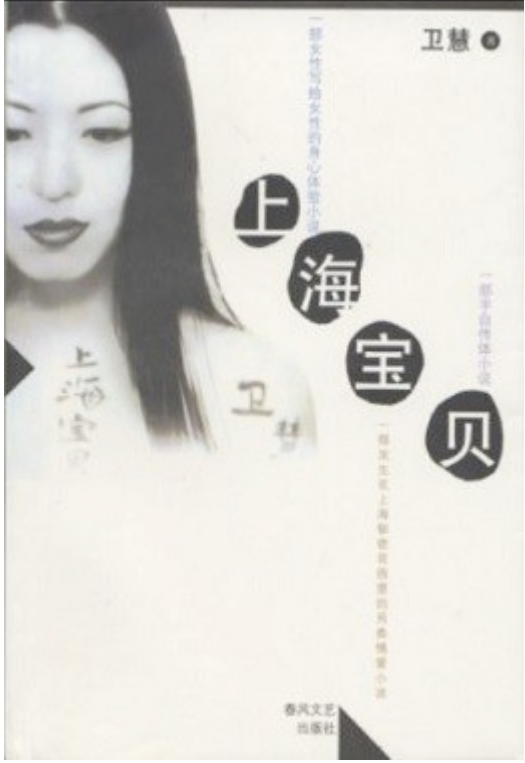
- 1983: lesbian heroine
- 1984: overweight, middle-aged hero
- 1987: ugly hero, heroine searching for birth mother
- Late 1980's: heroines in more male-dominated jobs
- 1990's: self-employed heroines, 30-40 year old women, sensitive men
  - Later: single parenthood, adoption, abuse
  - Taboos: terrorism, warfare, masculine sports
- 2000's+: “chick lit”, dystopian, paranormal, ...

More Recent Examples



- 2005: Twilight by Stephenie Meyer
  - Paranormal, blank slate, Mormon
  - Sold 120 million copies by 2011
- 2007: Magic Bites by Ilona Andrews
  - Indicative YA urban fantasy romance
  - Strong female lead, sarcastic and quippy, etc.
- 2011: Fifty Shades of Grey by E L James
  - Sold 125 million copies by 2015
  - Twilight fan fiction

Cultural Mores



- 1999: Shanghai Baby (上海宝贝) by Wei Hui
  - Semi-autobiographical heroine: 25-year novelist trying to publish explicit short stories
  - Also features a morphine addiction, an affair, a love triangle with a German man
  - Banned in China for being decadent

2010+

CULTURE

AO3's Hugo Award win is a long time coming for the fanfiction community

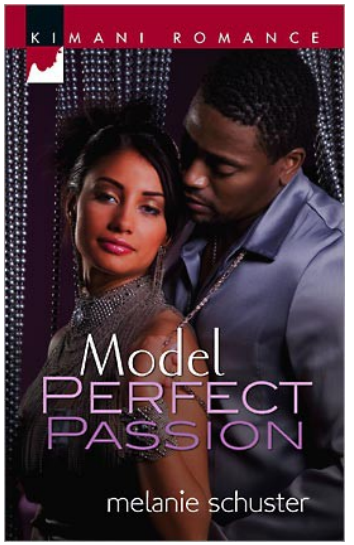
What an honor for Archive of Our Own means to those who championed it

By Petrana Radulovic | @Pet_rana | Updated Aug 19, 2019, 9:35am EDT

- Fan Fiction and Transformative Works
  - Fanfiction.net – 12M users
  - Archive Of Our Own – 6M users in 2023
    - 4.7M works in Aug 2019 → 11M in May 2023
- Web Serial Novels (webfiction, online novel)
  - cf. serial novels of 19th century (e.g., Dickens)
  - Particularly big in Asia (esp. Japan, China)
- Easier to try out writing in established setting

Demographics

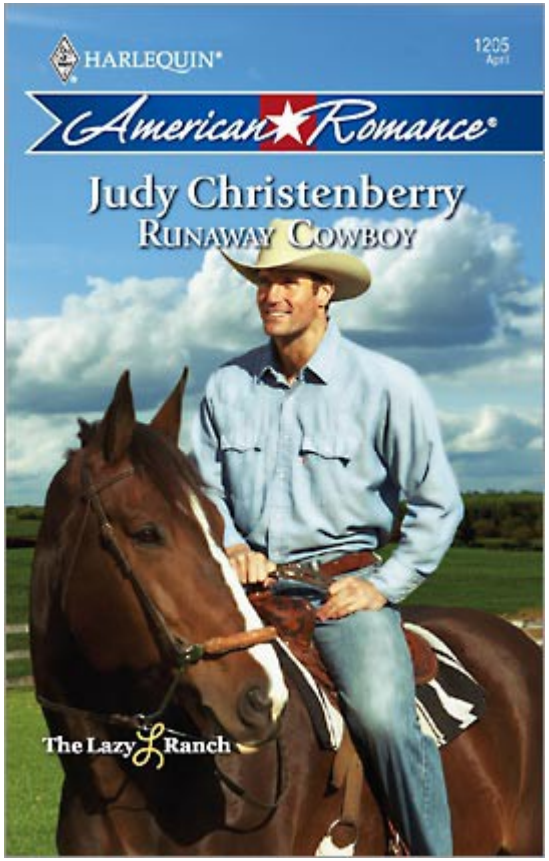
- In 2021, 92.2% of romance novels were written by white authors, 7.8% written by BIPOC authors
- 2021 readership is more balanced:
  - 73% of romance readers are white/caucasian
  - 12% are African-American
  - 7% are Latino/Hispanic
  - 4% are Asian/Asian American

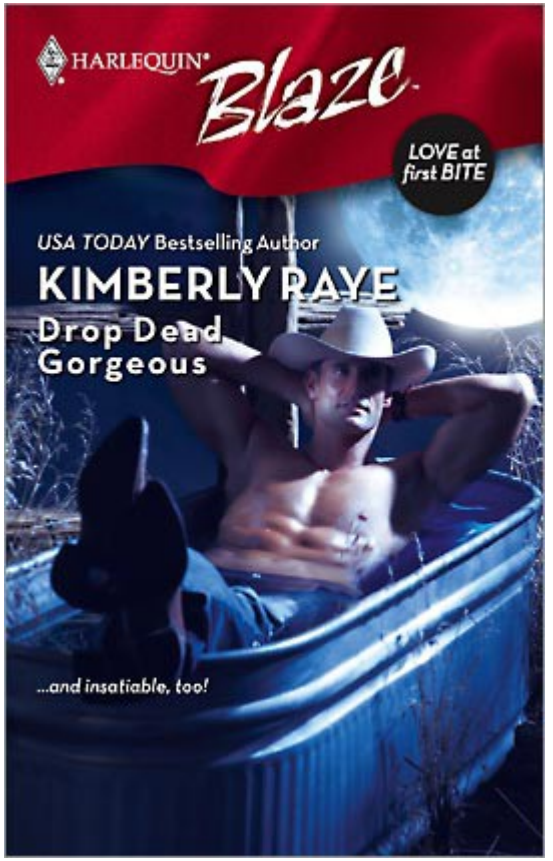


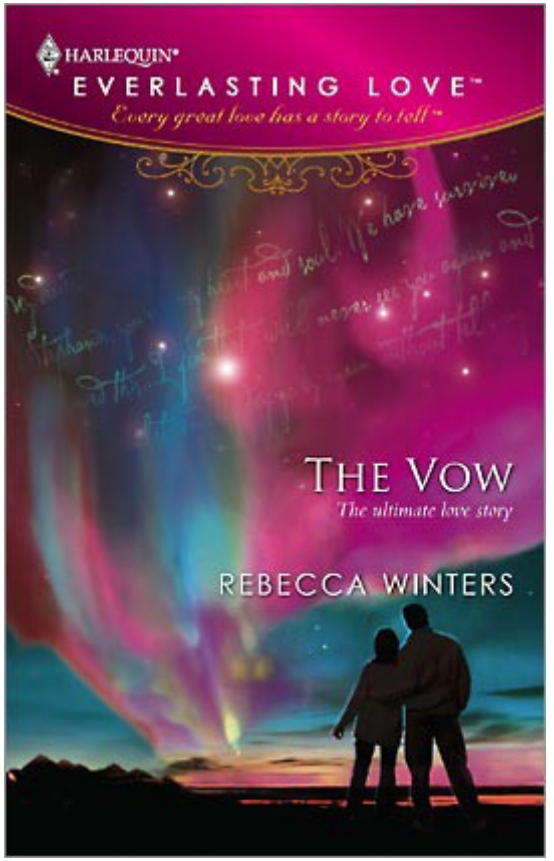
Category Romance

- Now a fun part ...
- I'll show you a bunch of different category romance lines
- You try to identify the **subgenre** and **target audience**

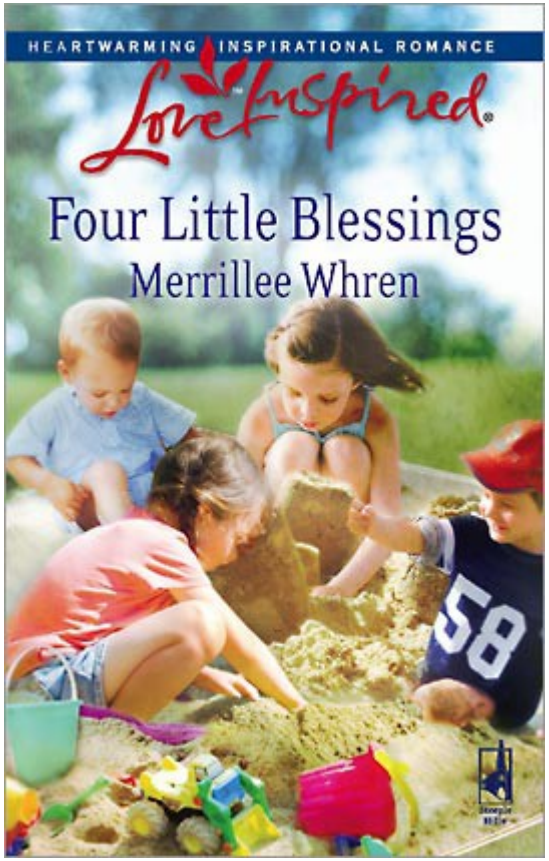
Category Romance In Pictures

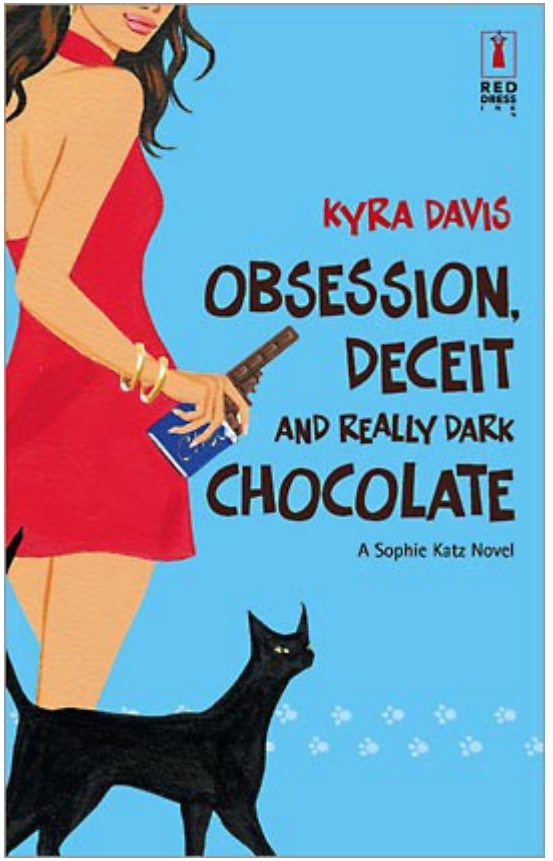


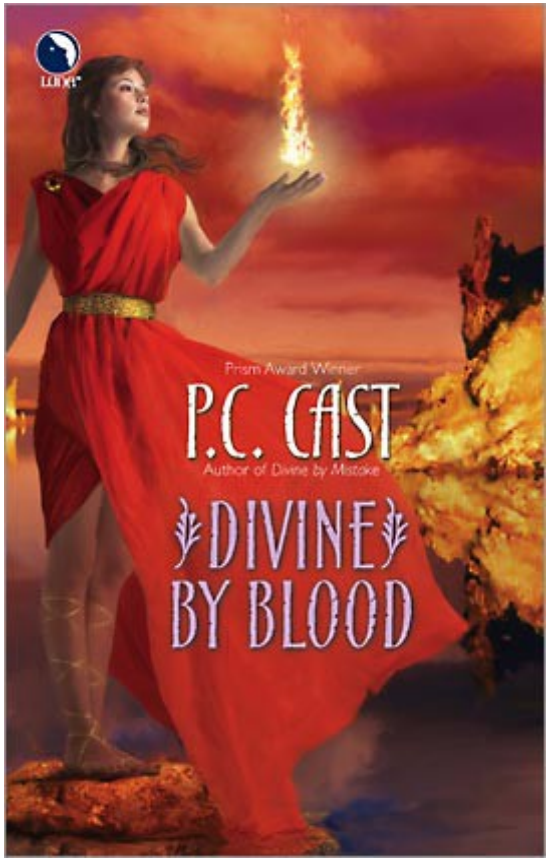




Category Romance In Pictures

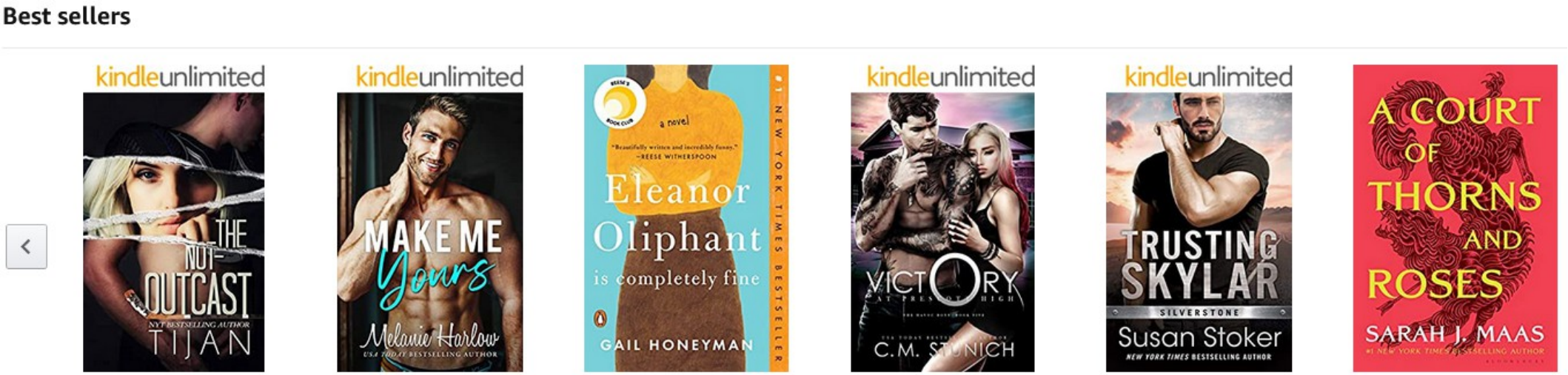






Category Romance (Popular)

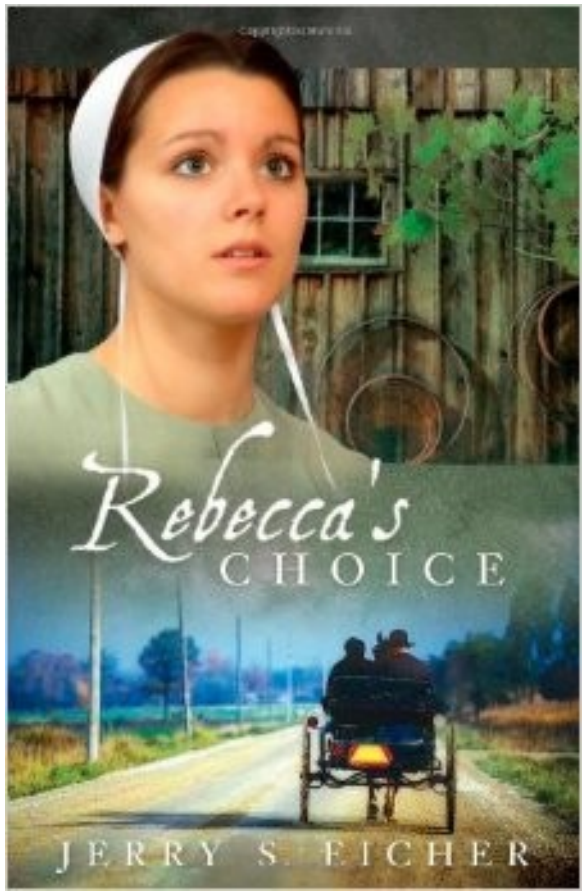
- Amazon Romance eBooks

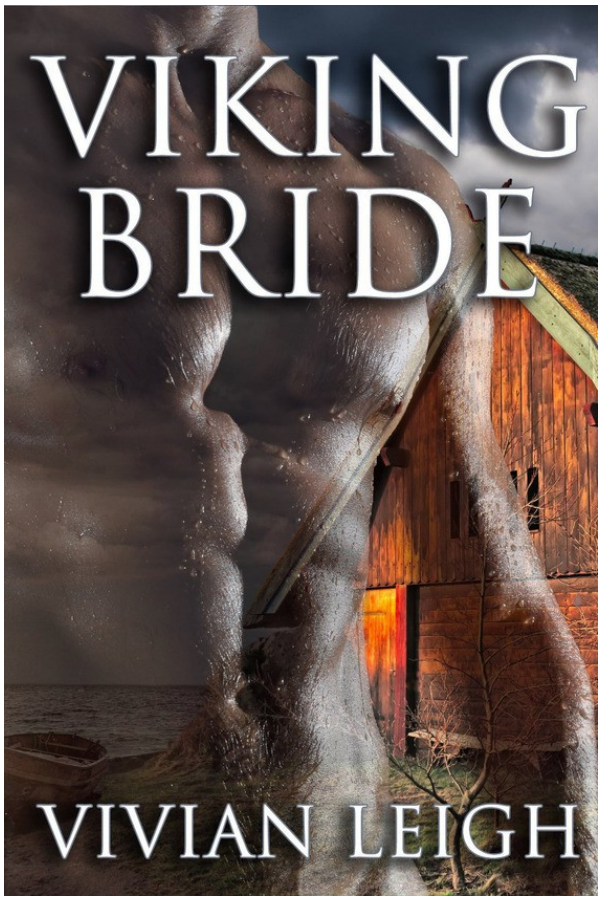


- Mix and match:

  Dad Next Door, High School Bad Boy, Humorous and Quirky, Military, Paranormal, Sports

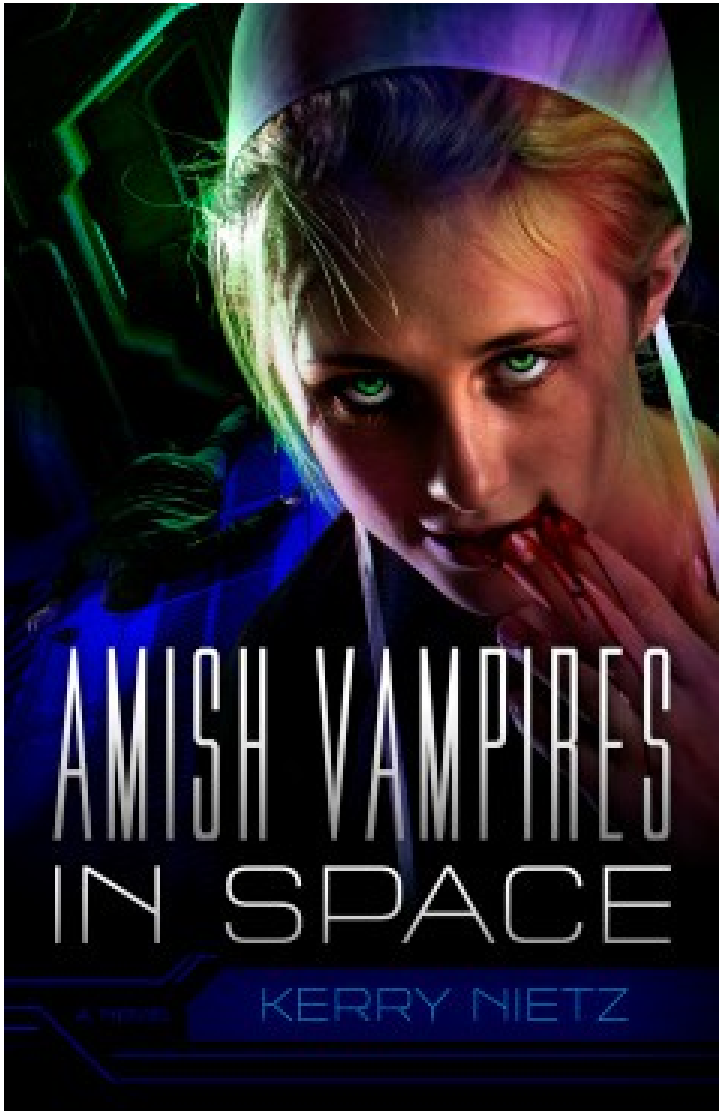
Category Romance (Niche)





We joke, but ...

- As of 2022, e-book sales account for 60% of total romance unit sales
  - And this doesn't include web serials, etc.
- It is easier than ever to appeal to, or participate in, niche markets!
- The romance market grows
  - Revealing cultural values



WHAT IF WE...
MERGED OUR CODE...
AND THERE WERE NO...
...MERGE CONFLICTS?...

Was this course easy?

“My favorite operational definition of engineering is '**design under constraint**.' Engineering is creating, designing what can be, but it is constrained by nature, by cost, by concerns of safety, reliability, environmental impact, manufacturability, maintainability, and many other such 'ilities.'”

[Bill Wulf, NAE President, The Urgency of Engineering Education Reform, 2008]

“[Software Engineering is] The Establishment and use of sound **engineering principles** in order to obtain **economically** software that is **reliable** and works **efficiently** on **real** machines.”

[Bauer 1975, S. 524]

One-Slide Course Summary: You Have Learned

Process (Risk), Measurement, Quality Assurance, Testing (Metrics, Inputs, Oracles), Code Inspection and Review, Dynamic Analysis, Static Analysis (Dataflow), Defect Reporting, Fault Localization, Profiling, Automated Debugging (Delta Debugging), Requirements (Specifications, Elicitation), Design Patterns, Design for Maintainability, Human Productivity and Bias (Brains, Pair Programming, Interviews), Multi-Language Projects, Automated Program Repair, Program Synthesis, and Program Management

I hope you enjoyed this class and learned something from it. I did (Winter 2022).

Life

Weimer recommends that you take classes on philosophy until you've covered epistemology, free will, logic, the philosophy of science, and “what it is like to be a bat”. Take cognitive psychology classes until you've covered perception and the Flynn effect. Take speech or rhetoric classes until you've covered persuasion. Take anthropology as well as gender studies classes until you've covered Mead and Freeman and you have a better feel for which behaviors are socially constructed and which may be essential. Take classes in statistics until you can avoid being fooled. Take classes in religion or ethics until you've covered the relationship between unhappiness and unrealized desires. Take classes in physics until you can explain how a microphone, radio and speaker all work. Take classes on government until you have an opinion about the feasibility of legislating morality. Take classes on history until you are not condemned to repeat the mistakes of the past.