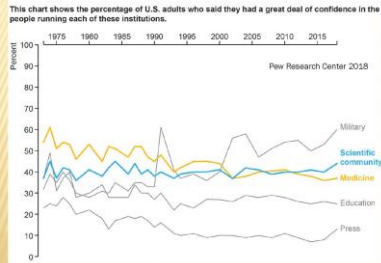# Teaching Astronomy in the Age of Misinformation
Chris Impey, University of Arizona

Science and the General Public

Public Trust in Scientists is High

This chart shows the percentage of U.S. adults who said they had a great deal of confidence in the people running each of these institutions.

Pew Research Center 2018

Military · Scientific community · Medicine · Education · Press

But They Have Some Weird Beliefs

Paranormal Beliefs

- 19.1% Some people can move objects with their mind
- 13.5% Bigfoot is a real creature.
- 46.6% Places can be haunted by spirits.
- 14.1% Astrologers, fortune tellers, and psychics can foresee the future.
- 24.7% Aliens have come to Earth in modern times.
- 39.6% Ancient, advanced civilizations, such as Atlantis, once existed
- 27% Aliens visited Earth in our ancient past.

The Chapman University Survey of American Fears 2016 — CHAPMAN UNIVERSITY

And They Question Settled Science

51% don't think the Big Bang happened

40% don't believe in evolution

40% doubt the Earth is billions of years old

40% are unsure or don't believe in global warming

AP-GfK Poll

Not Speaking the Same Language

Terms that have different meanings for scientists and the public

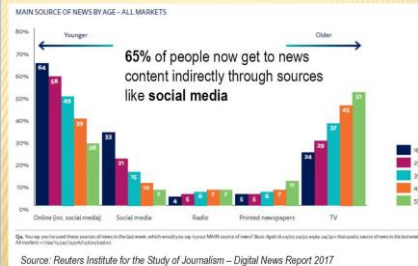| Scientific term	Public meaning	Better choice
enhance	improve	intensify, increase
aerosol	spray can	tiny atmospheric particle
positive trend	good trend	upward trend
positive feedback	good response, praise	vicious cycle, self-reinforcing cycle
theory	hunch, speculation	scientific understanding
uncertainty	ignorance	range
error	mistake, wrong, incorrect	difference from exact true number
bias	distortion, political motive	offset from an observation
sign	indication, astrological sign	plus or minus sign
values	ethics, monetary value	numbers, quantity
manipulation	illicit tampering	scientific data processing
scheme	devious plot	systematic plan
anomaly	abnormal occurrence	change from long-term average

Source of Information and Misinformation
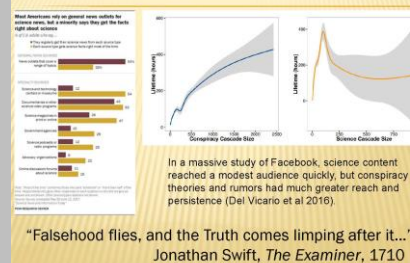
Sources of Science Information

- About 60% of students turn to the Internet first to find information. **Only 2% turn to a book first.**
- In science classes, students get their information online (70%), **textbooks come in last** (7%).
- Their most important information sources are teachers (90%), Internet (80%), **Wikipedia (50%).**
- Among middle and high school students, doing research equals using Google for 95%.

College students turn primarily to the Internet for science information, although teachers are seen as more reliable. Books are rarely used, despite being authoritative sources.

How People Get Their News

MAIN SOURCE OF NEWS BY AGE - ALL MARKETS
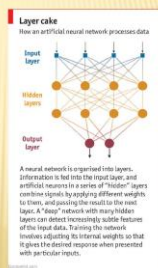
Younger → Older

65% of people now get to news content indirectly through sources like social media

Online (inc. social media) · Social media · Radio · Printed newspapers · TV

18-24 · 25-34 · 35-44 · 45-54 · 55+

Source: Reuters Institute for the Study of Journalism – Digital News Report 2017

Traveling at the Speed of Lies

In a massive study of Facebook, science content reached a modest audience quickly, but conspiracy theories and rumors had much greater reach and persistence (Del Vicario et al 2016)

"Falsehood flies, and the Truth comes limping after it…"
Jonathan Swift, *The Examiner*, 1710

The Internet is Full of Pseudoscience

Ghost	141,000,000
Auras	126,000,000
UFO/UFOs	45,500,000
Tarot Cards	38,100,000
Astrology	30,500,000
Paranormal	28,700,000
Psychic	21,800,000
Divination	21,000,000
Reiki	19,700,000
Reincarnation	16,600,000
Acupuncture	16,300,000
Christian Science	14,100,000
Chiropractic	13,900,000
Séance	10,400,000

The sum of the top 100 terms is 1.3 billion pages. The number of "Science" pages is less, 1.1 billion.

Mitigation by Machine Learning

Human and Machine Approaches

HOW TO SPOT FAKE NEWS

- CONSIDER THE SOURCE — Click away from the story to investigate the site, its mission and its contact info.
- READ BEYOND — Headlines can be outrageous in an effort to get clicks. What's the whole story?
- CHECK THE AUTHOR — Do a quick search on the author. Are they credible? Are they real?
- SUPPORTING SOURCES? — Click on those links. Determine if the info given actually supports the story.
- CHECK THE DATE — Reposting old news stories doesn't mean they're relevant to current events.
- IS IT A JOKE? — If it is too outlandish, it might be satire. Research the site and author to be sure.
- CHECK YOUR BIASES — Consider if your own beliefs could affect your judgement.
- ASK THE EXPERTS — Ask a librarian, or consult a fact-checking site.

Layer cake — How an artificial neural network processes data

Input Layer · Hidden Layers · Output Layer

A neural network is organised into layers. Information is fed into the input layer, and artificial neurons in a series of "hidden" layers combine signals by applying different weights to them, and passing the result to the next layer. A "deep" network with many hidden layers can detect increasingly subtle features of the input data. Training the network involves adjusting its internal weights so that it gives the desired response when presented with particular inputs.

Testing on Climate Change and Evolution

Techniques of Science Denial — FLICC

- F — Fake Experts
- L — Logical Fallacies
- I — Impossible Expectations
- C — Cherry Picking
- C — Conspiracy Theories

Procedure:
- Curate equal size sets of real and fake non-technical articles
- Use state-of-the-art neural nets created by Google
- Split the real and fake data into three equal parts
- One part to train the neural net
- One to test/improve algorithms
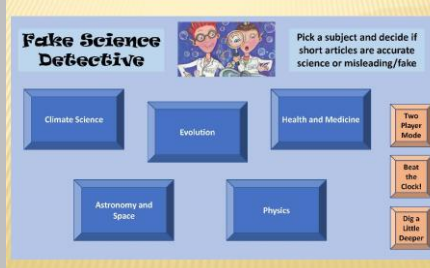- One to carry out a blind test

Results:
- 93% accuracy on climate
- 96% accuracy on evolution

Next:
- Run on hundreds of thousands of articles from CommonCrawl
- Random hand-check accuracy
- One neural net across domains?

John Cook, George Mason University

Fake Science Detective Museum Kiosk

Fake Science Detective

Pick a subject and decide if short articles are accurate science or misleading/fake

Climate Science · Evolution · Health and Medicine · Astronomy and Space · Physics

Two Player Mode · Beat the Clock! · Dig a Little Deeper

Browser Extension and Smartphone App

FAKE|SCIENCE