

“The Data Says Otherwise” – Towards Automated Fact-checking and Communication of Data Claims



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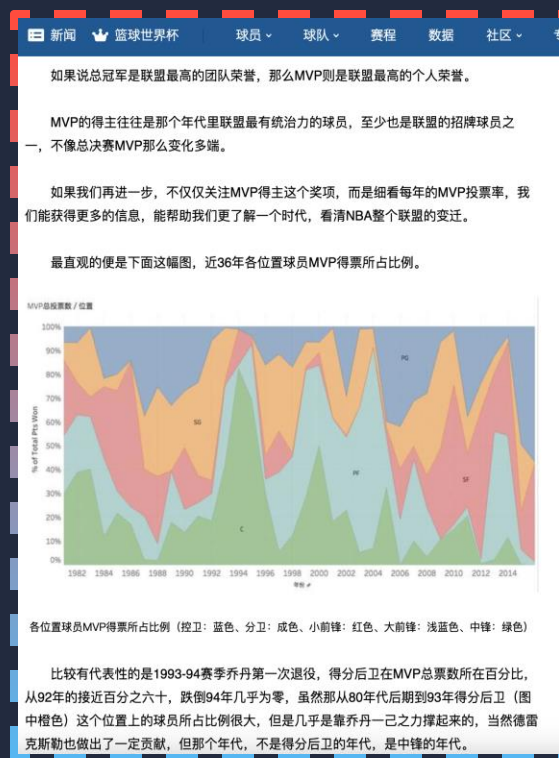
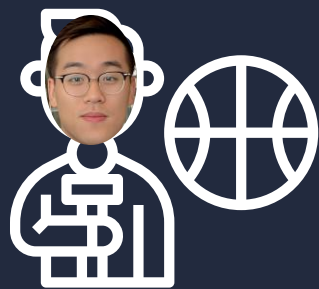
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Not professional!



Data-driven narratives are increasingly prevalent across various media



The Washington Post
Democracy Dies in Darkness



Empty seats are seen at the Gerald Neufeld Funeral Home in March 2022. The funeral home in the Elmhurst neighborhood of Queens previously had been overwhelmed with deaths from covid-19. (Spencer Platt/Getty Images)

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The waning of the pandemic led to fewer deaths in the United States in 2022 than in 2021, according to preliminary data from the Centers for Disease Control and Prevention. But heart disease and cancer deaths rose, and covid-19 remained remarkably lethal, killing more than 500 people a day.

The report shows an overall drop of 5.3 percent in the death rate from all causes, a signal that the country last year had exited the worst phase of the pandemic. Deaths from covid dropped 47 percent between 2021 and 2022.

But covid has not magically become like the flu or a new type of cold. Even though the population had built up high levels of immunity from vaccination and natural infection, covid was the fourth-leading cause of death in 2022, behind heart disease (699,659 deaths), cancer (607,790) and “unintentional injury,” which includes drug overdoses (218,064). The CDC estimated that covid was the underlying cause of 186,702 deaths and a contributing factor in another 58,284.

WSJ Listen (7 min) Save AA

reduce the deficit. Some in the administration are struggling to see a path forward in the talks, according to people familiar with the matter.


Republicans and Democrats are digging into the weeds of the federal budget, looking for creative and narrowly targeted ways to cut spending in order to close their differences. Among other things, Graves told reporters that negotiators were looking at whether funds already allocated for some programs could be either rescinded or diverted to other priority programs, in effect freeing up money to allocate toward cuts.


President Biden separately put out [his own budget plan](#) earlier this year that proposes tax increases to cut the deficit, but it went nowhere in Congress.

Other parts of the talks include a potential tightening of work requirements on benefit programs and rescinding unspent Covid-19 aid. Republicans and Democrats are nearing an agreement on the latter issue, people familiar with the matter said.

House Republicans’ starting point in the talks was their [Limit, Save, Grow Act of 2023](#), which narrowly passed the chamber in April. That bill would return the government’s discretionary spending to fiscal year 2022 levels and cap annual spending growth at 1% for a decade. Discretionary spending excludes mandatory expenditures such as Medicare and Social Security as well as debt payments.

McCarthy has committed to cutting spending but hasn’t specified a goal of rolling it back to 2022 levels. He has prepared his conference for the likelihood that any deal he strikes with Biden would cut spending by less than what House Republicans passed.



 Americans, including 62 percent of eligible seniors, our most vulnerable group, have gotten their booster shots.

I got my booster shot as soon as they were available. And just the other day, former President Trump announced he had gotten his booster shot. It may be one of the few things he and I agree on.

People with booster shots are highly protected. Join them. Join us. It’s been six months or more since my second shot. If it’s been six months or more for your second shot — when I got my booster — you can get yours today if you’ve been six months or more since your second shot.

Another question that folks are asking is: Are we going back to March 2020 — not this last March 2021, but March 2020 — when the pandemic first hit? That’s what I keep getting asked.

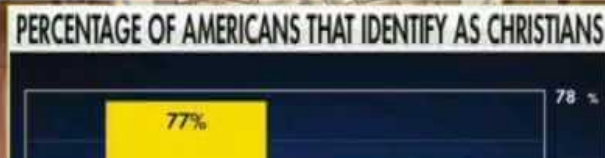
The answer is absolutely no. No.

Here are three big differences between then and now: One — number one — the first one — more than 200 million Americans have been fully vaccinated. In March of 2020, no one was fully vaccinated. What that means is, today, as cases — a case of COVID-19 for a fully vaccinated and boosted person will most likely mean no symptoms or mild ones similar to the common respiratory viruses.

Over 200 million Americans should have the peace of mind that they did not have in March of 2020: They’re protected from hospitalization, and they’re protected from death.

Second point: We’re prepared today for what’s coming. In March of 2020, we were not ready. Today, we’ve spocktiled [sic] enough — we’ve stockpiled enough gowns, masks, and ventilators to deal with the surge of hospitalizations among the unvaccinated.

Today, we’re ready.



POLITIFACT
The Poynter Institute

Viral image

stated on August 26, 2023 in an Instagram post

“CDC says new cases are more contagious than vaccinated people. CDC says unvaccinated.”

FACEBOOK FACT-CHECKS

CORONAVIRUS



facebook

SOURCE: Sharyl Attkisson, Facebook, 1.7M views

DETAILS

Flawed Reasoning: The post compares differences in the number of reported cases between vaccinated and unvaccinated people, but does not account for the fact that age distribution differs between the two groups. Older people are more likely to be unvaccinated and also more likely to die from COVID-19.

Factually inaccurate: At no point in the video does Attkisson mention that fully vaccinated people are less likely to die from COVID-19.

CLAIM

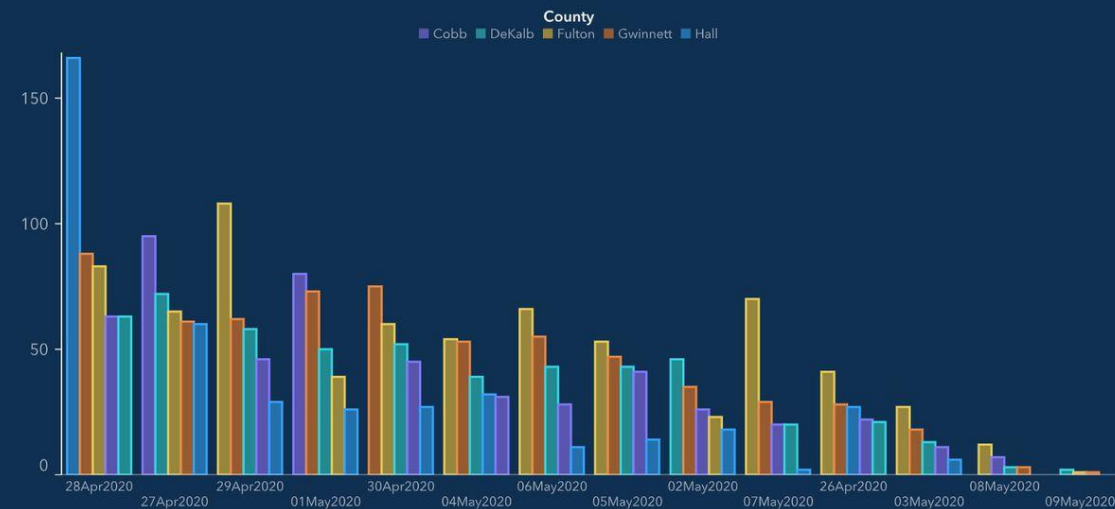
“As more people got vaccinated for Covid, more people got Covid.”

VERDICT

FLAWED REASONING

Top 5 Counties with the Greatest Number of Confirmed COVID-19 Cases

The chart below represents the most impacted counties over the past 15 days and the number of cases over time. The table below also represents the number of deaths and hospitalizations in each of those impacted counties.



Errors and faulty data reasoning can transform these narratives into **misinformation**

Data-driven misinformation can occur because...

Making it up/data validity

Outdated
data

Misinterpretation

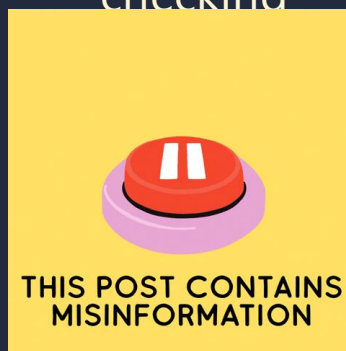
Errors

Lack context



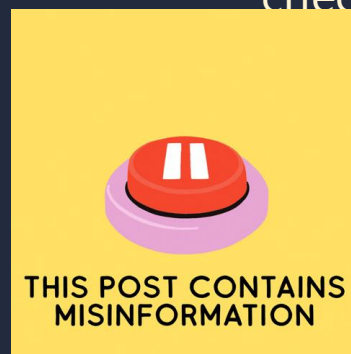


Fact-
checking





Automated Fact-checking



Automated Fact-checking

"Let's help!!"



Data Mining



AI/NLP

ClaimBuster

Transcript

0:00 The fact is — the fact is, in the eight years before I became governor, taxes and fees were raised at the state level 115 times.
 0:05 In the eight years before I became governor, spending was increased 56 percent.
 0:10 And in the eight years before I became governor, taxes and fees were raised at the state level 115 times.
 0:15 In the eight years before I became Governor, spending was increased 56 percent, and in the eight years before I became governor, there was zero net private sector job growth in New Jersey.
 0:20 Zero.
 0:25 For eight years.
 0:30 So, what did we do?
 0:35 We came in, we balanced an \$11 billion deficit on a \$29 billion budget by cutting over 800 programs in the state budget.
 0:40 We brought the budget into balance with no tax increases.
 0:45 In fact, we vetoed five income tax increases during my time as governor.
 0:50 We cut business taxes \$2.3 billion, and we cut regulation by one-third of what my predecessor put in place.
 0:55 And, what's happened since?
 1:00 A hundred ninety-two thousand private sector jobs in the five and a half years I've been governor.
 1:05 We have a lot of work to do in New Jersey. But I am damn proud we've brought our state back.

Click the button. Check-worthy factual claims will be highlighted. Note that it may take a while.

Detect Check-Worthy Factual Claims

Naeemul et al. (2017)

Claim:

Ibuprofen worsens COVID-19 symptoms

Evidence abstract:

Covid-19 and avoiding Ibuprofen.

... a potential increased risk of COVID-19 infection was feared with ibuprofen use

... At this time, there is no supporting evidence to discourage the use of ibuprofen

Label: **REFUTES**

Wadden et al. (2021)

1. Factual Revision Flagging

The revision (s_{t-1}, s_t) is factual because it modifies when the first COVID-19 case was identified

2. Fact Verification

The following claim is **refuted** by s_{t-1} and **supported** by s_t :
 "COVID-19 outbreak was identified before December"

COVID-19 Pandemic

WIKIPEDIA

Revision ID: 945689803

s_{t-1}

The outbreak was first identified in Wuhan, Hubei, China in December 2019 and recognized [...].

s_t

The outbreak was first identified in Wuhan, Hubei, China in 17 November 2019 and recognized [...].

3. Word-level Rationales

The anchoring words in s_t that support the claim are:

"first identified [...] in 17 November 2019 [...]"

4. Factually Consistent Generation

The contradictory s_{t-1} can be revised to state:
 "The outbreak [...] before December 2019 [...]"

Schuster et al. (2021)

Fact-checking websites



Claims
Extractor



Knowledge
Graph
Generator

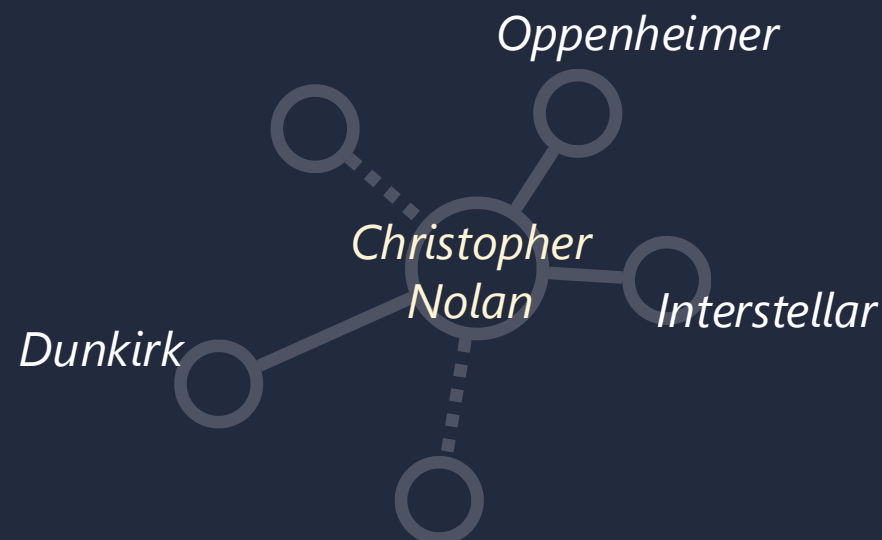
Virtuoso



Statistics
SPARQL Endpoint
ClaimsKG Explorer

Tchechmedjiev et al. (2021)

Fact-checking Data Claims



"The director of the movie 'Oppenheimer' also directed 'Interstellar.'"

V.S.

| | Gross | Director |
|--------------|--------|----------|
| Oppenheimer | \$957m | C. Nolan |
| Dunkirk | | |
| Interstellar | | |



"The total gross of 'Oppenheimer' accounts for 20% of the worldwide box office gross of all films directed by Christopher Nolan."

Fact-checking Data Claims

Accuracy
Complexity
Communication

Table 8: Verification accuracy on the test datasets.

| | AGGCHECKER | TAPAS | TABLE-BERT | SCRUTINIZER |
|---------------------------|------------|-------|------------|-------------|
| C19_{test} | 0.44 | 0.64 | 0.76 | 0.80 |
| IEA_{test} | 0.50 | 0.07 | 0.58 | 0.65 |
| BBL_{test} | 0.13 | 0.41 | 0.17 | 0.51 |

The evaluation of our solution over the test data shows that we obtain a precision of 0.329 and a recall of 0.205. While we expected a limited recall,

*Improve the
accuracy of
detection and
verification*

- Jo et al. (2018). Verifying text summaries of relational data sets.
- Jo et al. (2019). Aggchecker: A fact-checking system for text summaries of relational data sets.
- Karagiannis et al. (2020). Scrutinizer: A mixed-initiative approach to large-scale, data-driven claim verification.
- Saeed, M., & Papotti, P. (2021). Fact-Checking Statistical Claims with Tables.
- Rezgui et al. (2021). Automatic verification of data summaries.
- Wu et al (2014). iCheck: Computationally Combating “Lies, D—ned Lies, and Statistics”
- Asudeh (2020). On Detecting Cherry-picked Trendlines

Fact-checking Data Claims

Accuracy
Complexity
Communication

| name | games | category | ... |
|------------|-------|-----------------------------------|-----|
| A. Karras | 14 | personal conduct | |
| A. Jones | 20 | personal conduct | |
| L. Brazill | indef | substance abuse, repeated offense | |
| G. Miller | 4 | PEDs | |
| ... | | | ... |

(a) Raw relational data.

There were only **four** previous lifetime bans in my database — **three** were for repeated substance abuse, **one** was for gambling.

(b) Text document. Claims colored in blue. We focus on claimed result 'one'.

| Claim | Query Output | Evaluation |
|---------------|--------------|------------|
| 18 points | 18.0 | True |
| five rebounds | 5.0 | True |
| seven assists | 4.0 | False |

Table 2: Evaluation of the example.

The Memphis Grizzlies (5-2) defeated the Phoenix Suns (3 - 2) **Monday** 102-91 at the **Talking Stick Resort Arena** in Phoenix. The Grizzlies had a **strong** first half where they **out-scored** the Suns **59-42**. Marc Gasol scored 18 points, **leading** the Grizzlies. **Isaiah Thomas added** 15 points, he is **averaging 19 points on the season so far**.

*Handle more
complex data
claims*

- Jo et al. (2018). Verifying text summaries of relational data sets.
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Fact-checking Data Claims

Accuracy
Complexity
Communication

VIII. DESKTOP OPERATING SYSTEM
Speaking of the Linuxes, Ubuntu is tops among them with 12.3% of the entire OS market for developers. Fedora, Mint, and Debian accounted for 1.4%, 1.7%, and 1.9% of all responses, respectively.

Click ✓ mark if Query matches the text.
12.3% of the entire OS market for
Percentage of elements in
"Desktop_os" where
"Desktop_os" = "ubuntu"
(Query Result: 12.30)
View More Queries

(a) Marked up claims after initial processing. (b) Query description shown upon hovering.

Sentence: The average developer is 29.6 years old. Custom Query: The AVERAGE over ...
PICK THE QUERY THAT MATCHES TEXT SELECT AGGREGATED COLUMN
Query Description (Result) SHOW ALL OPTIONS
Average over "Age" (29.62)
Percentage of all elements where "Age_range" = "25-29" (24.92)
AGGREGATED COLUMN RECOMMENDATIONS
Age
Developer_experience

(c) Select query from top-5 likely candidates. (d) Construct query by selecting fragments.

Check the highlighted statement in the following text:
The average annual increase of 0.6 mbid between 2000 and 2017 drops to 0.4 mbid to 2025 and then 0.4 mbid for the 15 years after that.
Relation: World_Output_2016_NPS Primary Key Value: ROADoll_mbd Attribute Label: 2025-2040
Please check the solutions suggested below

| Formula | Formula Value | Assignments (Primary Key Value, Attribute Label, Variable Value) |
|-----------------|---------------|---|
| (a-b)/(y1-y2+1) | 0.012 | a:('ROADoll_mbd', 2040, 44.903) b:('ROADoll_mbd', 2025, 44.707) y1:2040 y2:2025 |

Figure 3: Example of the generated query (bottom) for the general claim in red in the sentence (top). Below the sentence are reported elements of the claim that have already been validated, such as the database, the key value and the attributes.

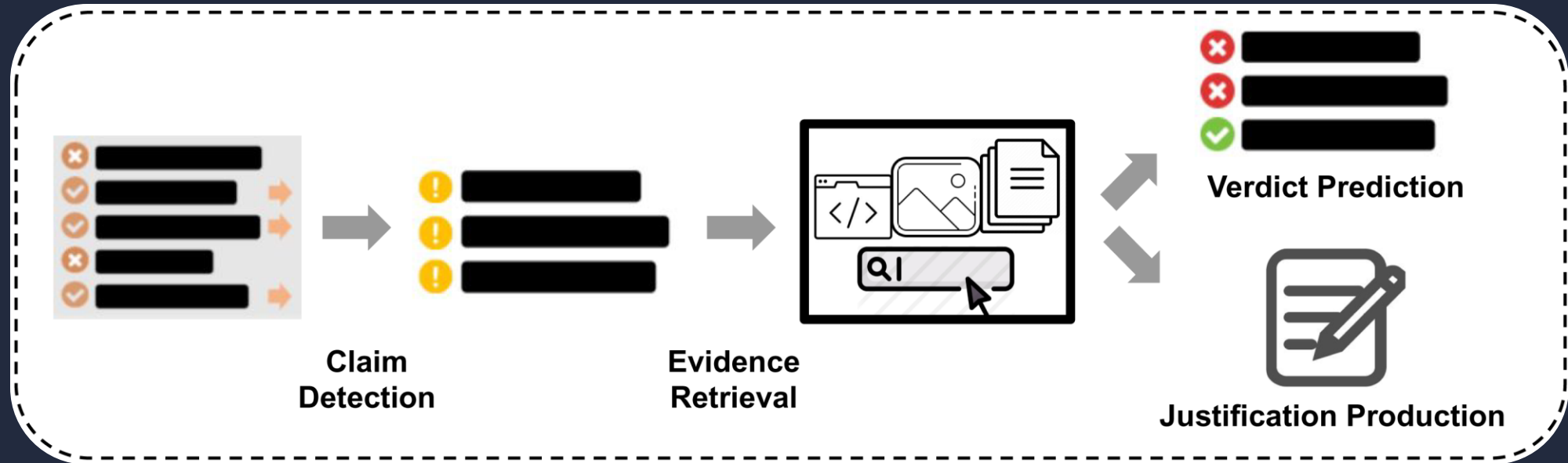


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Research Questions

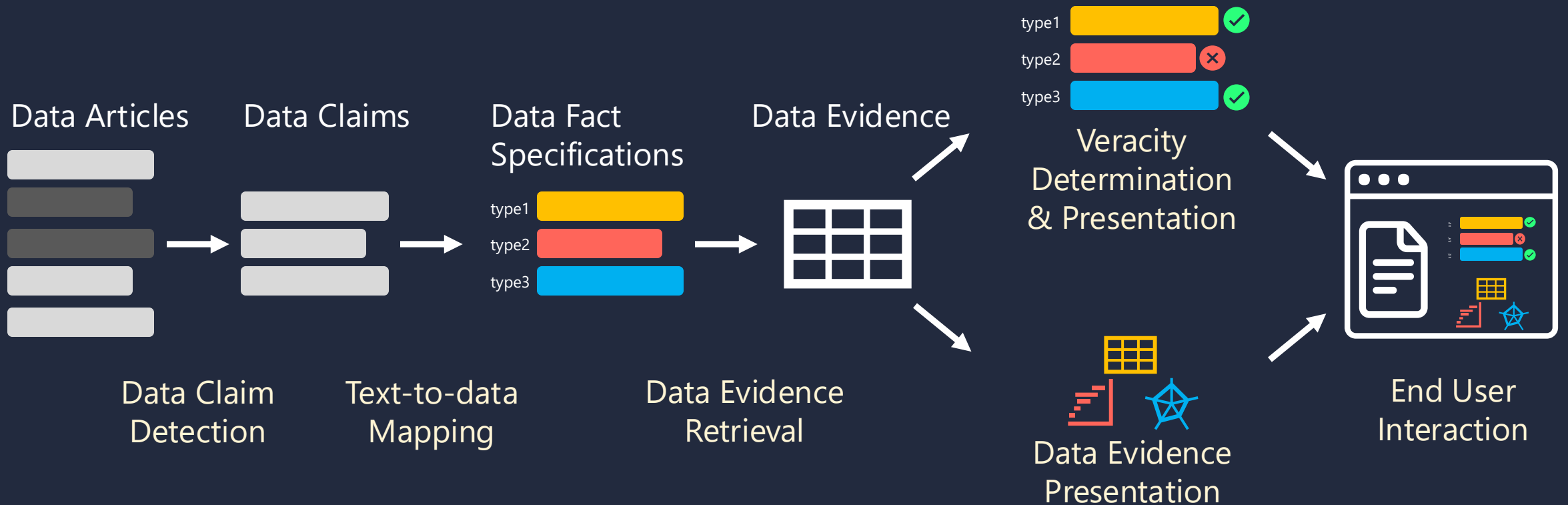
- RQ1: How do we enable out-of-the-box automated fact-checking for data claims?
- RQ2: How do we effectively represent and communicate data evidence?

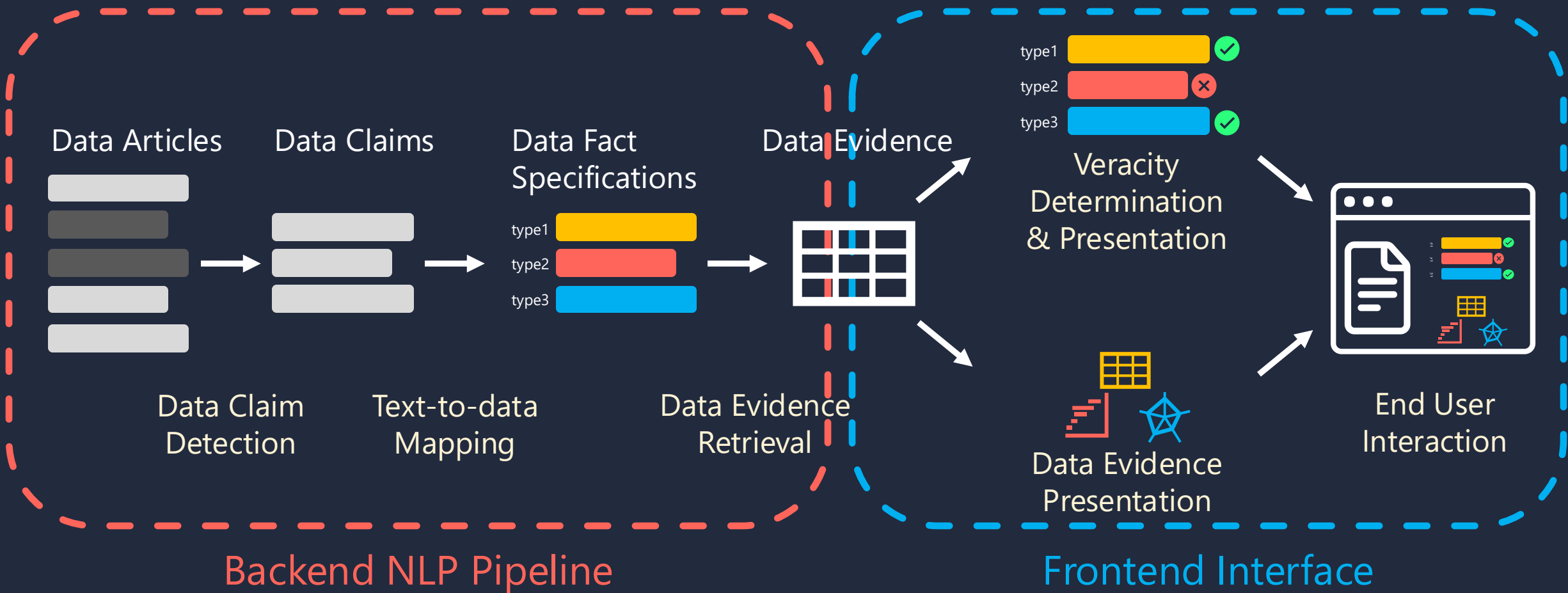
Framework for Automated Fact-checking



Guo et al. (2022) A Framework for Automated Fact-Checking

Framework for Automated **Data Claim** Fact-checking



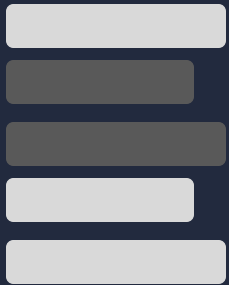


Aletheia



Backend NLP Pipeline

Data Articles



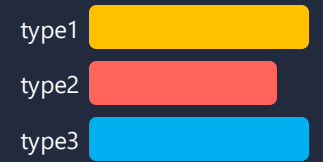
Data Claims



Individual
Data Facts



Data Fact
Specifications



Data Claim
Detection

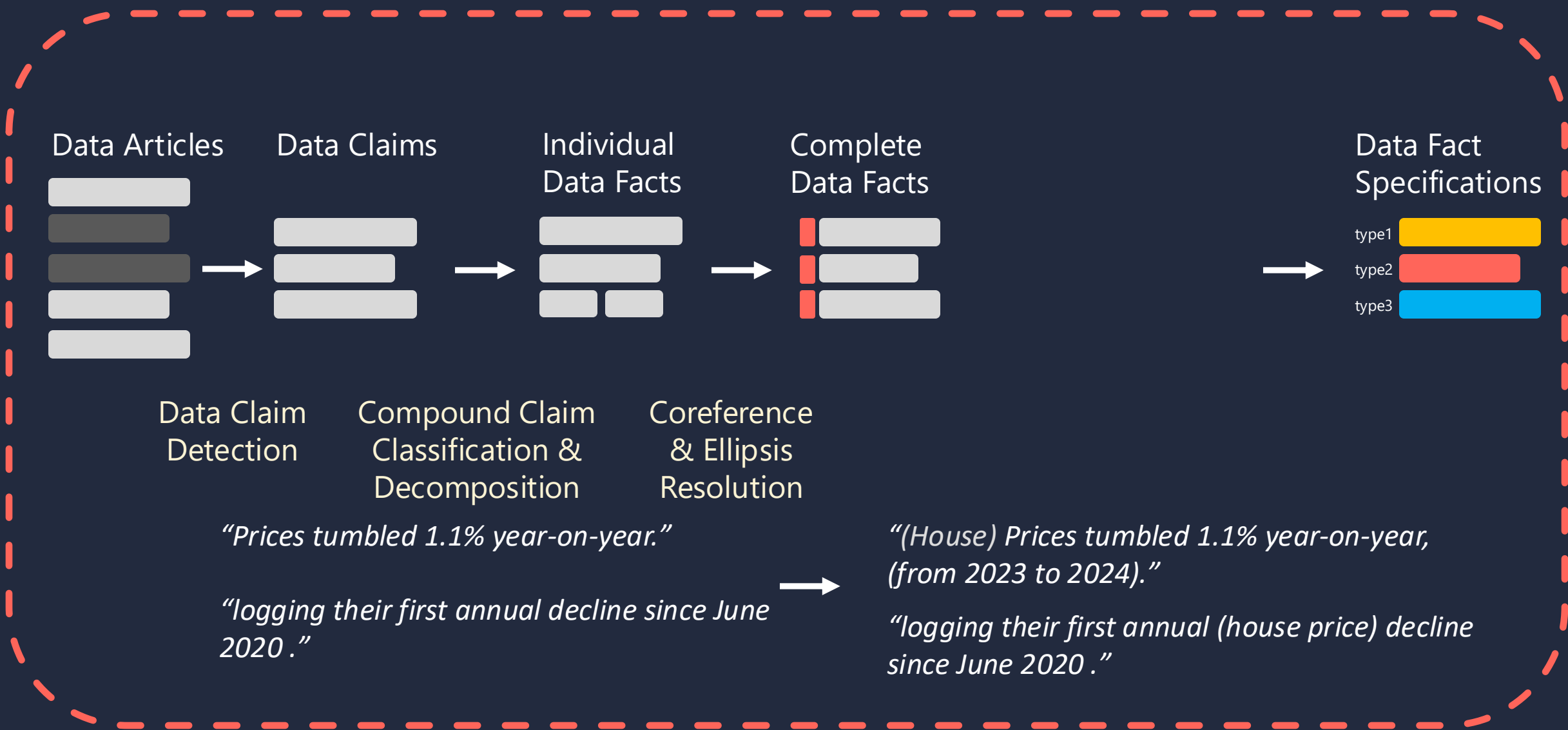
Compound Claim
Classification &
Decomposition

*"Prices tumbled 1.1% year-on-year, logging
their first annual decline since June 2020 ."*

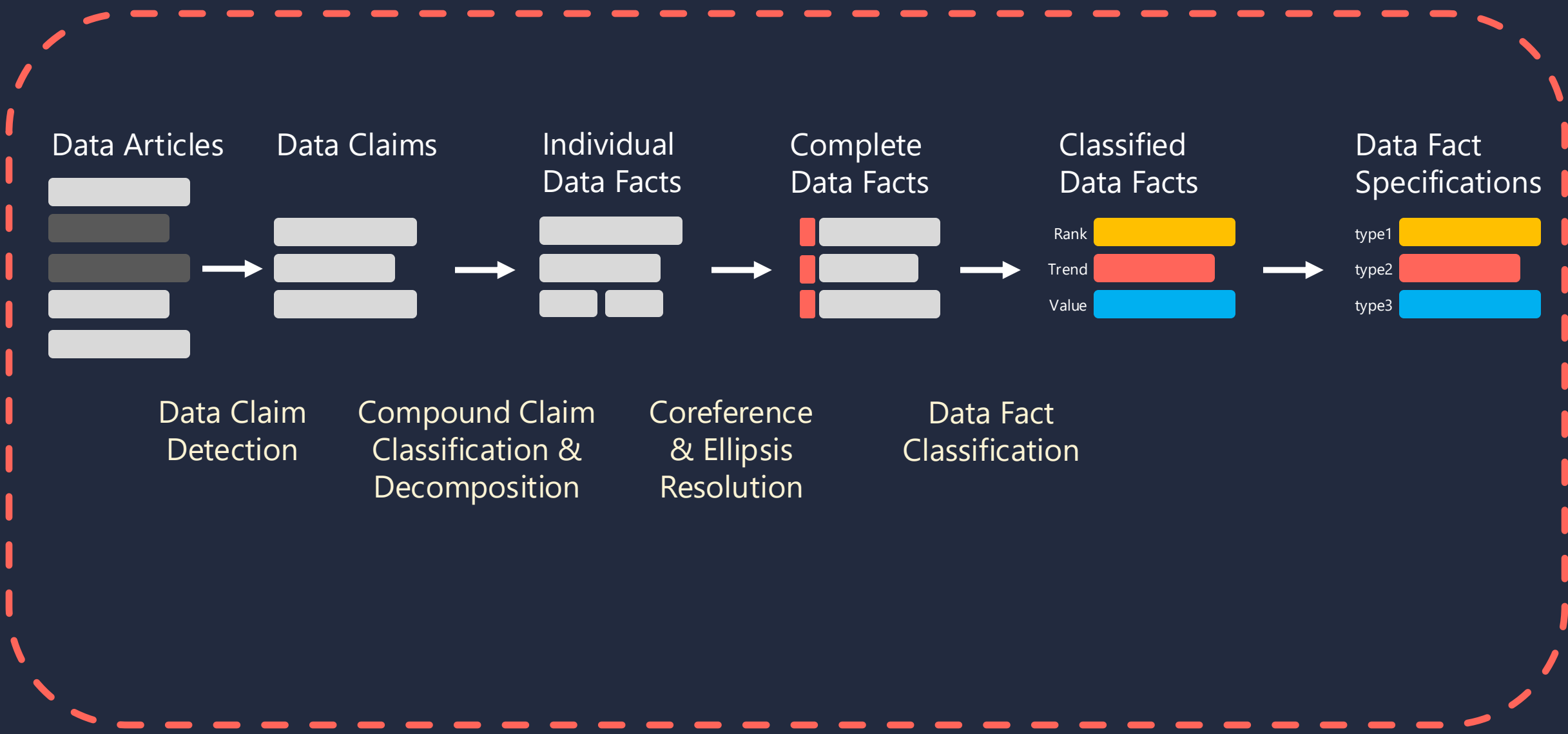
"Prices tumbled 1.1% year-on-year."

*"logging their first annual decline since June
2020 ."*

Backend NLP Pipeline



Backend NLP Pipeline



Backend NLP Pipeline

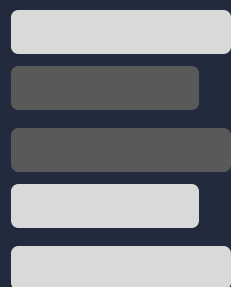
| Fact Types | Claim Examples | JSON specifications |
|----------------|--|--|
| Value | The average IMDB score for <u>horror movies</u> released in <u>2020</u> is <u>6.7</u> . | {"measure": "IMDB score", "value": 6.7, "aggregation": "average", "subspace": [{"genre"="horror"}, {"year"=2020}], "identifier_key": "movies"} |
| Proportion | In <u>2013</u> , Christopher Nolan's films comprised <u>34.8%</u> of the total <u>gross</u> for <u>movies</u> with an <u>IMDb score over 7</u> . | {"measure": "gross", "value": "34.8%", "focus": [{"director" = "Christopher Nolan"}], "subspace": [{"year" = 2013}, {"IMDb_score" > 7}], "identifier_key": "movies"} |
| Trend | From <u>March 2020</u> to <u>March 2021</u> , the <u>number of COVID-19 cases</u> in the <u>US</u> showed an <u>increase</u> . | {"measure": "case", "value": "increase", "subspace": [{"date" >= "March 2020"}, {"date" <= "March 2021"}, {"country" = "US"}]} |
| Extreme | <u>Glenlivet 18</u> has the <u>highest rating</u> among <u>whiskies</u> originating from <u>Scotland</u> . | {"measure": "rating", "value": "max", "focus": [{"brand" = "Glenlivet 18"}], "subspace": [{"origin" = "Scotland"}], "identifier_key": "whiskies"} |
| Rank | Among <u>players in point guards position</u> who played more than 60 games in <u>2023</u> <u>Trae Young</u> is ranked <u>4th</u> in <u>three-point attempts</u> . | {"measure": "3PA", "value": 4, "focus": [{"player"="Trae Young"}], "subspace": [{"position" = "PG"}, {"games_played" > 60}, {"year" = 2023}], "identifier_key": "players"} |
| Association | There's a <u>positive correlation</u> between a <u>movie's budget</u> and its <u>gross earnings</u> . | {"measure_x": "budget", "measure_y": "gross", "value": "positive", "identifier_key": "movies"} |
| Difference | During the <u>2019 NBA season</u> , <u>James Harden</u> outscored <u>Stephen Curry</u> by <u>6.1 points</u> . | {"measure": "points", "value": 6.1, "focus_x": {"player" = "James Harden"}, "focus_y": {"player" = "Stephen Curry"}, "subspace": [{"season" = "2019"}]} |
| Categorization | There are <u>seven movies</u> that have an <u>IMDb score over 9</u> and a <u>gross of more than 300 million</u> . | {"value": 7, "subspace": [{"IMDb_score" > 9}, {"gross">"300,000,000"}], "identifier_key": "movies"} |
| Distribution | The <u>acceptance rates</u> of <u>colleges</u> follow a <u>right-skew distribution</u> . | {"measure": "acceptance rates", "value": "right-skew distribution", "identifier_key": "colleges"} |
| Outlier | The <u>movie "Oppenheimer"</u> has a <u>gross</u> that's quite the outlier among <u>historical biopic</u> . | {"measure": "gross", "focus": {"movie" = "Oppenheimer"}, "subspace": [{"genre" = "historical biopic"}], "identifier_key": "movies"} |

SON}

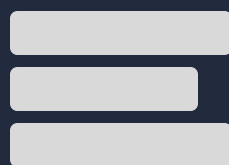
SON}

SON}

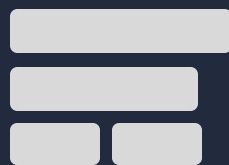
Data Articles



Data Claims



Individual
Data Facts



Complete
Data Facts



Classified
Data Facts



Data Fact
Specifications



Data Claim
Detection

Compound Claim
Classification &
Decomposition

Coreference
& Ellipsis
Resolution

Data Fact
Classification

Fact Specification
Transformation

| Fact Types | Claim Examples | JSON specifications |
|----------------|---|---|
| Value | The average IMDb score for horror movies released in 2020 is 6.7. | <pre>{ "measure": "IMDb score", "value": 6.7, "aggregation": "average", "subspace": [{"group": "horror"}, {"year": 2020}], "identifier_key": "movies" }</pre> |
| Proportion | In 2013, Christopher Nolan's film comprised 34.8% of the total gross for movies with an IMDb score over 7. | <pre>{ "measure": "gross", "value": "34.8%", "focus": [{"director": "Christopher Nolan"}], "subspace": [{"year": 2013, "IMDb score": 7}], "identifier_key": "movies" }</pre> |
| Trend | From March 2020 to March 2021, the number of COVID-19 cases in the US showed an increase. | <pre>{ "measure": "case", "value": "increase", "subspace": [{"date": "March 2020"}, {"date": "March 2021"}, {"country": "US"}] }</pre> |
| Extreme | Glenlivet 18 has the highest rating among whiskies originating from Scotland. | <pre>{ "measure": "rating", "value": "max", "focus": [{"brand": "Glenlivet 18"}], "subspace": [{"origin": "Scotland"}], "identifier_key": "whiskies" }</pre> |
| Rank | Among players in point guards position who played more than 60 games in 2021, Trae Young is ranked 4th in three-point attempts. | <pre>{ "measure": "3PA", "value": 4, "focus": [{"player": "Trae Young"}], "subspace": [{"position": "PG"}, {"games played": 60, "year": 2021}], "identifier_key": "players" }</pre> |
| Association | There's a positive correlation between a movie's budget and its gross earnings. | <pre>{ "measure_x": "budget", "measure_y": "gross", "value": "positive", "identifier_key": "movies" }</pre> |
| Difference | During the 2019 NBA season, James Harden outscored Stephen Curry by 6.1 points. | <pre>{ "measure": "points", "value": 6.1, "focus_x": [{"player": "James Harden"}], "focus_y": [{"player": "Stephen Curry"}], "subspace": [{"season": "2019"}] }</pre> |
| Categorization | There are seven movies that have an IMDb score over 9 and a gross of more than 300 million. | <pre>{ "value": 7, "subspace": [{"IMDb score": 9}, {"gross": "300,000,000"}], "identifier_key": "movies" }</pre> |
| Distribution | The acceptance rates of colleges follow a right-skew distribution. | <pre>{ "measure": "acceptance rates", "value": "right skew distribution", "identifier_key": "colleges" }</pre> |
| Outlier | The movie 'Oppenheimer' has a gross that's quite the outlier among historical biopics. | <pre>{ "measure": "gross", "focus": [{"movie": "Oppenheimer"}], "subspace": [{"genre": "historical biopic"}, {"identifier_key": "movies"}] }</pre> |

Backend NLP Pipeline

Data Fact Specifications

Rank {JSON}
Trend {JSON}
Value {JSON}

Data Evidence Retrieval

Data Evidence



Rank
Trend
Value

Veracity Determination & Presentation

Data Evidence Presentation

End User Interaction



Frontend Interface



Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights



Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights
- DG2. Streamline viewers' analysis of data evidence, facilitating **quicker judgments**

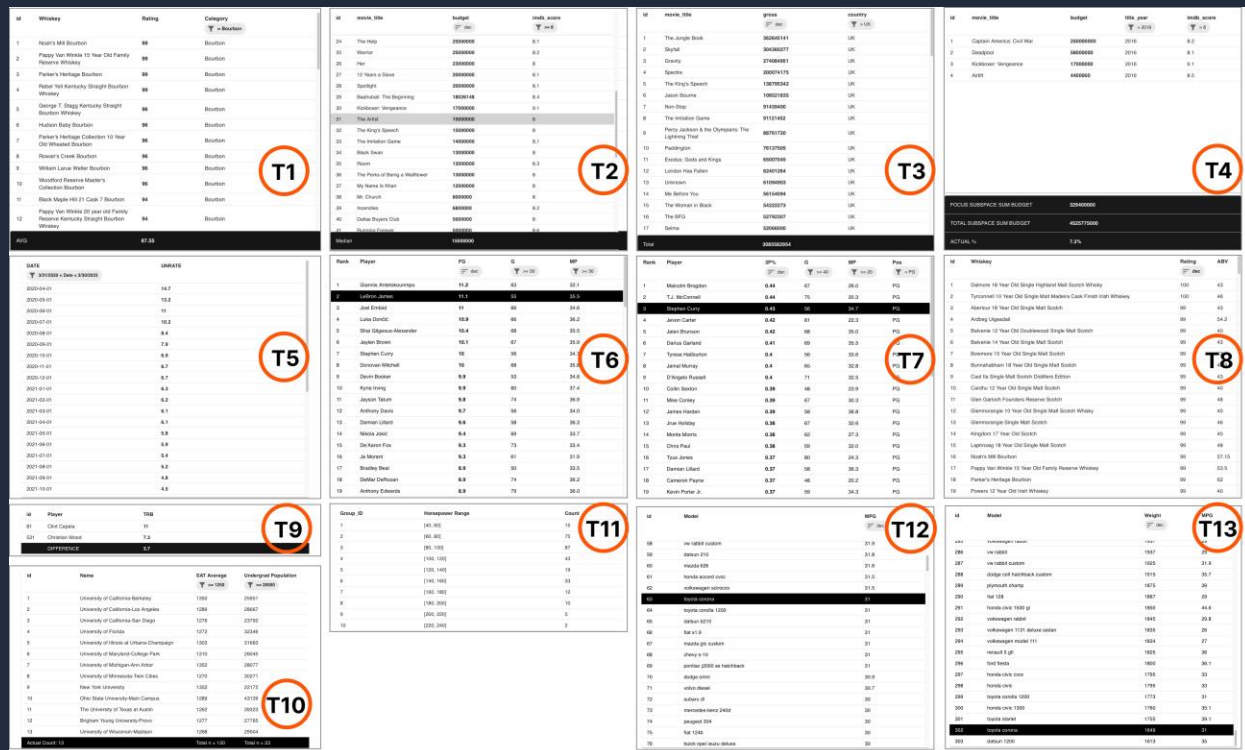


Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights
- DG2. Streamline viewers' analysis of data evidence, facilitating **quicker judgments**
- DG3. Bolster viewers' **confidence** in their assessments

Data Evidence Presentation Designs





Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights
- DG2. Streamline viewers' analysis of data evidence, facilitating **quicker judgments**
- DG3. Bolster viewers' **confidence** in their assessments

Design Requirements for User Interaction

- DR1. Facilitate **rapid reviewing** and **correction** of erroneous claims



Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights
- DG2. Streamline viewers' analysis of data evidence, facilitating **quicker judgments**
- DG3. Bolster viewers' **confidence** in their assessments

Design Requirements for User Interaction

- DR1. Facilitate **rapid reviewing** and **correction** of erroneous claims
- DR2. Enable user **intervention for AI mistakes**



Interface

Design Goals for Presenting Data Evidence

- DG1. Ensure **alignment** with the original data insights
- DG2. Streamline viewers' analysis of data evidence, facilitating **quicker judgments**
- DG3. Bolster viewers' **confidence** in their assessments

Design Requirements for User Interaction

- DR1. Facilitate **rapid reviewing** and **correction** of erroneous claims
- DR2. Enable user **intervention for AI mistakes**
- DR3. Support integration of additional reference data

Aletheia

Input Data Claims to Verify

The NBA has seen many memorable MVP races throughout its history, and this year, the battle between Joel Embiid and Nikola Jokić is one for the books. Both players have put forth incredible performances, but their styles of play and contributions to their respective teams set them apart.

Joel Embiid

Joel Embiid, the Philadelphia 76ers' star center, has been the epitome of dominance in the paint. Embiid is the leading scorer in the league. His physicality and agility have been unmatched. His ability to shoot from mid-range and even beyond the arc has added a unique dimension to his game, making him a nightmare for defenders. Embiid's defensive prowess, blocking shots and contesting opponents in the paint, has elevated the 76ers' status as one of the top defensive teams in the league. He ranks the 4th in blocking shots this year among centers who played at least 20 games and 15 minutes. He is one of the top scorers and has 4+ rebounds.

Nikola Jokić

On the other hand, Denver Nuggets position with his finesse and playmaking. Nikola Jokić has the highest efficient f played at least 50 games and over 25 10 field goals per game. Jokić's fitness strength. His versatility is evident in his number ranks 4th among all NBA players proven that he can score, rebound, and create plays for his teammates, becoming a central figure in the Nuggets' offensive scheme.

Fact-checking Results

Joel Embiid

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Select sample article
NBA MVP Article

Select New Dataset
NBA Player Stats (2022-23)

Filters: G >= 20 MP >= 15 Add New Filter

Focus: He: Joel Embiid

Quick Fix

He ranks the 4th 8th in blocking shots this year among centers who played at least 20 games and 15 minutes.

| Rank | Player | BLK | G | MP |
|------|-------------------|-----|----|------|
| 1 | Jaren Jackson Jr. | 3 | 63 | 28.4 |
| 2 | Nic Claxton | 2.5 | 76 | 29.9 |

Stats Comparison:

- Jokić shot 7% higher than Embiid does.
- Jokić has reached a second career-high assists per game, which is 5.1.
- Jokić ranks 1st in player efficiency rating.

— Accurate 4
— Inaccurate 4
— Unverifiable 2

Quick Fix

He is one of the only **three** **two** players in the league with 30+ pts and has 10+ rebounds.

| Rank | Player | PTS | REB | AST | PTS + REB |
|------|-----------------------|------|-----|------|-----------|
| 1 | Nikola Jokic | 34.5 | 9.9 | 12.1 | 44.4 |
| 2 | Domantas Sabonis | 24.1 | 7.9 | 34.0 | 58.0 |
| 3 | Deandre Ayton | 22.9 | 8.7 | 30.4 | 53.2 |
| 4 | Anthony Davis | 22.8 | 6.8 | 24.0 | 48.2 |
| 5 | Aaron Gordon | 22.6 | 6.8 | 20.2 | 43.2 |
| 6 | Giannis Antetokounmpo | 22.5 | 6.3 | 32.1 | 50.3 |
| 7 | Jae Crowl | 22.5 | 6.6 | 24.0 | 49.1 |
| 8 | Evan Mobley | 22.5 | 7.9 | 24.4 | 52.0 |
| 9 | Alperen Sengun | 22.5 | 7.5 | 28.9 | 50.7 |
| 10 | Myke Turner | 22.5 | 6.2 | 29.4 | 48.4 |
| 11 | Ben Ambrose | 22.4 | 7.5 | 24.6 | 44.9 |
| 12 | Jeremy Butler | 22.4 | 6.4 | 25.4 | 43.9 |

2 Players met all conditions

Filters: G >= 20 MP >= 15 Pos = C

Edit Filter:

- Attribute: Pos
- Operator: =
- Value: C

Quick Fix: He ranks the 4th 8th in blocking shots this year among centers who have played at least 20 games and 15 minutes.

Rewrite Suggestion Based on Your Modifications: Joel Embiid, who plays center, ranks fourth in blocking shots this year among centers who have played at least 20 games and 15 minutes.

The first screenshot shows a modal window with the message "This Claim is Not Verifiable With the Provided Data." Below this is a "Select New Dataset" button. A hand cursor icon points to the button. The second screenshot shows a list of available datasets with a "Referency Score" tooltip. The third screenshot shows the "Review Uploaded Data" table with a "Dataset ID" input field.

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Select sample article

NBA MVP Article

Select New Dataset

NBA Player Stats (2022-23)

VERIFY

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— Accurate 4 — Inaccurate 4 — Unverifiable 2



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Select sample article

NBA MVP Article

Select New Dataset

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VERIFY

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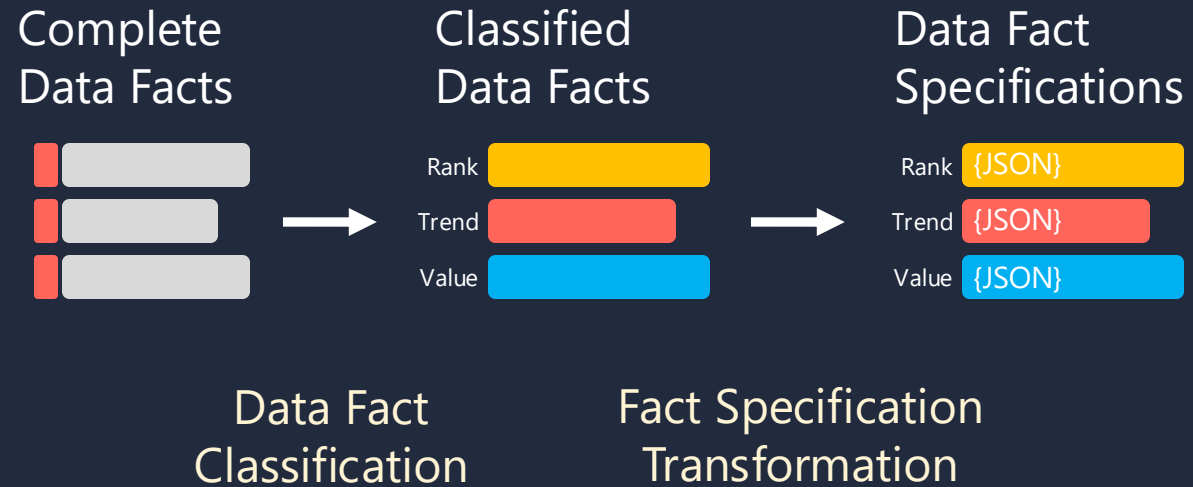
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— Accurate 8 — Inaccurate 0 — Unverifiable 2



Evaluation I:

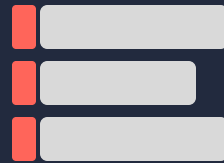
The performance of our core NLP steps



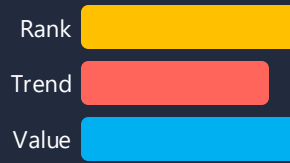
Evaluation I:

Ground Truth Data Curation

Complete
Data Facts



Classified
Data Facts



Data Fact
Specifications



"Stephen Curry ranks 3rd in 3P% among players who played the PG position and played more than 40 games."

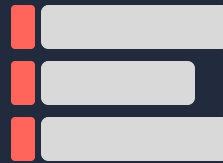
Rank

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    },  
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  ],  
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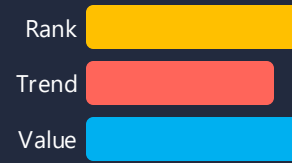
Evaluation I:

The performance of Data Fact Classification

Complete
Data Facts



Classified
Data Facts



| Type | Classified Type | | | | | | | | | | Recall |
|----------------|-----------------|-------|----------------|--------------|-------|---------|---------|------------|-------------|------------|--------|
| | Trend | Value | Categorization | Distribution | Rank | Extreme | Outlier | Proportion | Association | Difference | |
| Trend | 100% | | | | | | | | | | 100% |
| Value | | 100% | | | | | | | | | 100% |
| Categorization | | | 100% | | | | | | | | 100% |
| Distribution | | | | 100% | | | | | | | 100% |
| Rank | | 7.5% | | | 92.5% | | | | | | 92.5% |
| Extreme | | 10% | | | | 90% | | | | | 90% |
| Outlier | | | | | | | 100% | | | | 100% |
| Proportion | | | | | | | | 100% | | | 100% |
| Association | | | | | | | | | 100% | | 100% |
| Difference | | 7.5% | | | | | | | | 92.5% | 92.5% |
| Precision | 100% | 88% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |

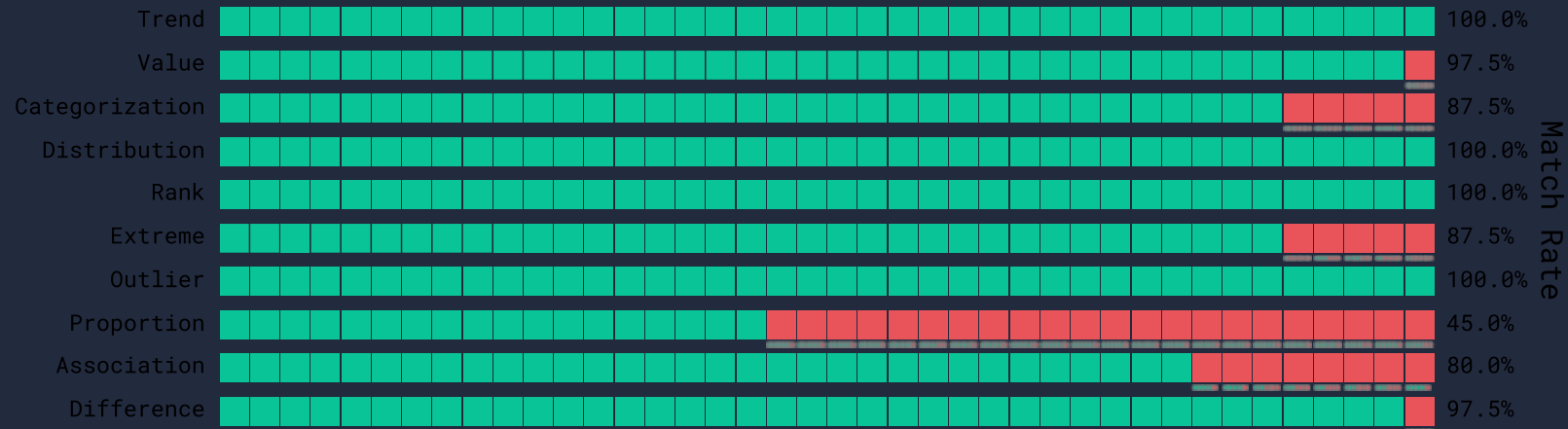
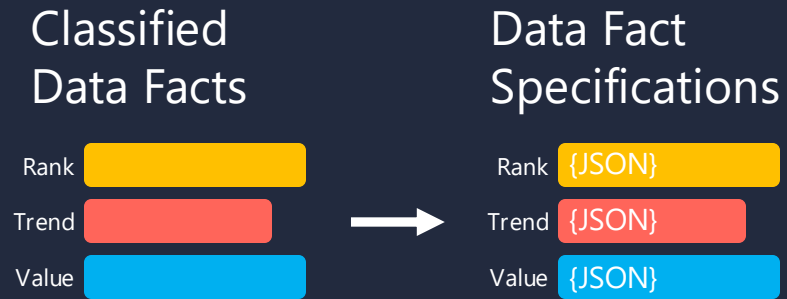
GPT-3.5

| Type | Classified Type | | | | | | | | | | Recall |
|----------------|-----------------|-------|----------------|--------------|------|---------|---------|------------|-------------|------------|--------|
| | Trend | Value | Categorization | Distribution | Rank | Extreme | Outlier | Proportion | Association | Difference | |
| Trend | 100% | | | | | | | | | | 100% |
| Value | | 100% | | | | | | | | | 100% |
| Categorization | | | 100% | | | | | | | | 100% |
| Distribution | | | | 100% | | | | | | | 100% |
| Rank | | | | | 100% | | | | | | 100% |
| Extreme | | | | | | 100% | | | | | 100% |
| Outlier | | | | | | | 100% | | | | 100% |
| Proportion | | | | | | | | 100% | | | 100% |
| Association | | | | | | | | | 100% | | 100% |
| Difference | | | | | | | | | | 100% | 100% |
| Precision | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |

GPT-4

Evaluation I:

The performance of Data Fact Specification Transformation



Evaluation II:

The effectiveness of our data evidence representations



Time spent



Confidence level
& Preference



Accuracy



Qualitative
Feedback

User Study Procedure (Phase 1)

N = 10
(Table)

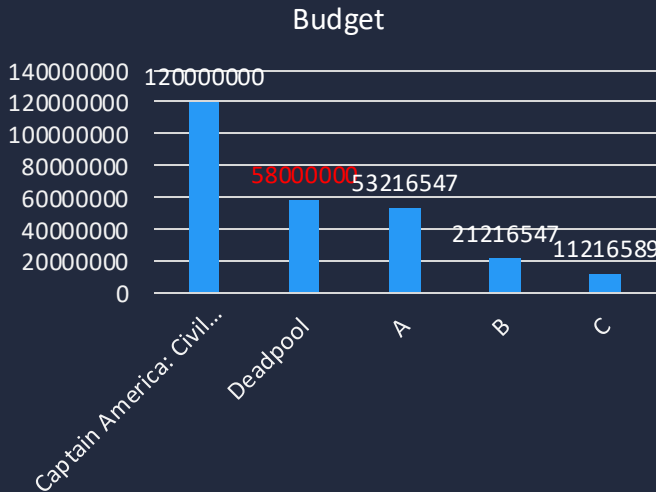


| | Genre (= action) | Year (= 2016) | Budget (sort by desc) |
|----------------------------|---------------------|------------------|--------------------------|
| Captain America: Civil War | Action | 2016 | 120000000 |
| Deadpool | Action | 2016 | 58000000 |
| Movie C | Action | 2016 | 53216547 |
| ... | | | |

N = 10
(Vis)



Data claim:
The movie Deadpool has the highest Budget among all action movies in 2016




Time spent

Confidence level

Accuracy

User Study Procedure (Phase 1)

N = 10
(Table)

A group of 10 stylized human icons arranged in two rows of five, representing the participants for the 'Table' condition.

Aletheia

TUTORIAL SESSION 1 SESSION 2

Data Evidence

Session 1 - Claim 3
LeBron James has the most field goal made (FG) among players who played at least 50 games and over 30 minutes per game.

Dataset to verify against:
NBA Player Stats (2022-23)

VERIFY

N = 10
(Vis)

A group of 10 stylized human icons arranged in two rows of five, representing the participants for the 'Vis' condition.

Aletheia

TUTORIAL SESSION 1 SESSION 2

Data Evidence

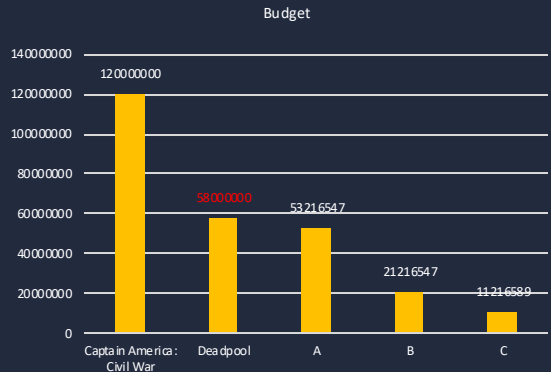
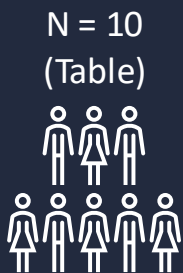
Session 1 - Claim 1
The median budget for movies that have a IMDB score over 8 is 12030000

Dataset to verify against:
Movies

VERIFY

✖ 2 ✖ 13 types

User Study Procedure (Phase 2)



Data claim:
The movie Deadpool has the highest Budget among all action movies in 2016



| | Genre (= action) | Year (= 2016) | Budget (sort by desc) |
|----------------------------|---------------------|------------------|--------------------------|
| Captain America: Civil War | Action | 2016 | 120000000 |
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| Movie C | Action | 2016 | 53216547 |
| ... | | | |



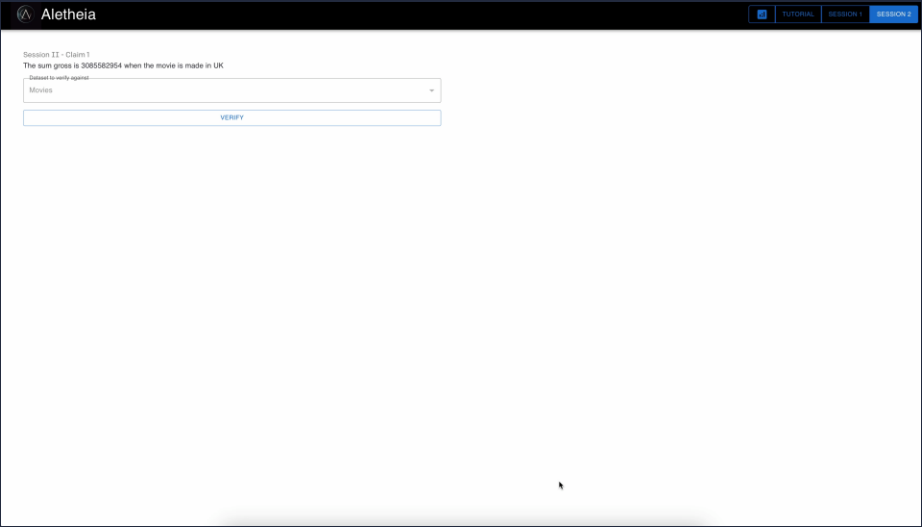
Compare confidence shift



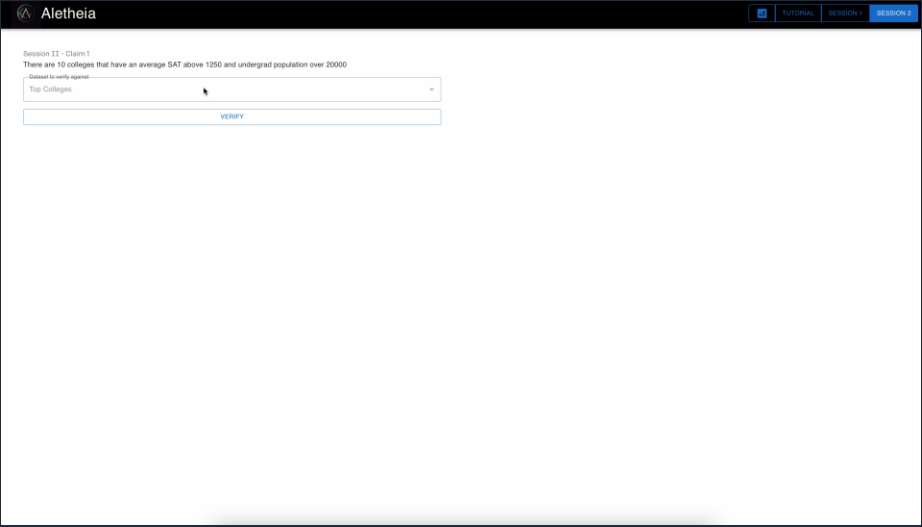
Preference

User Study Procedure (Phase 2)

N = 10
(Table)

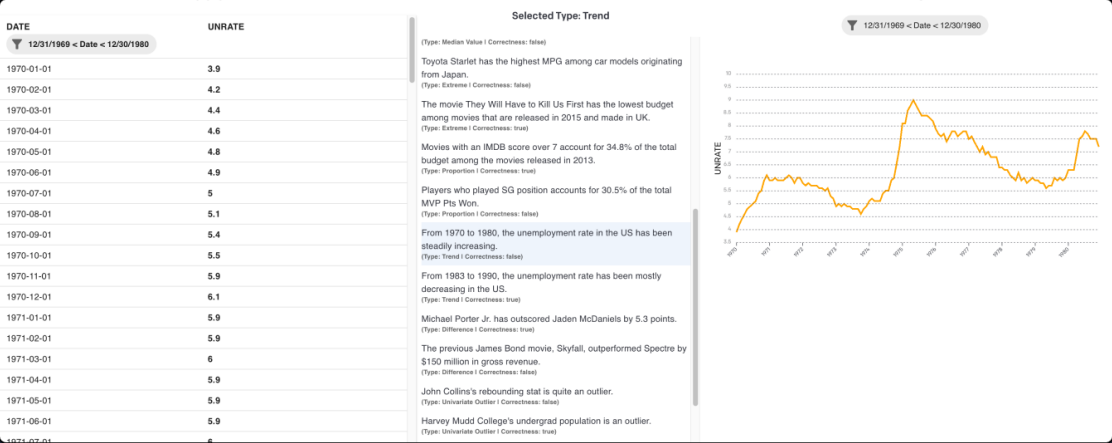
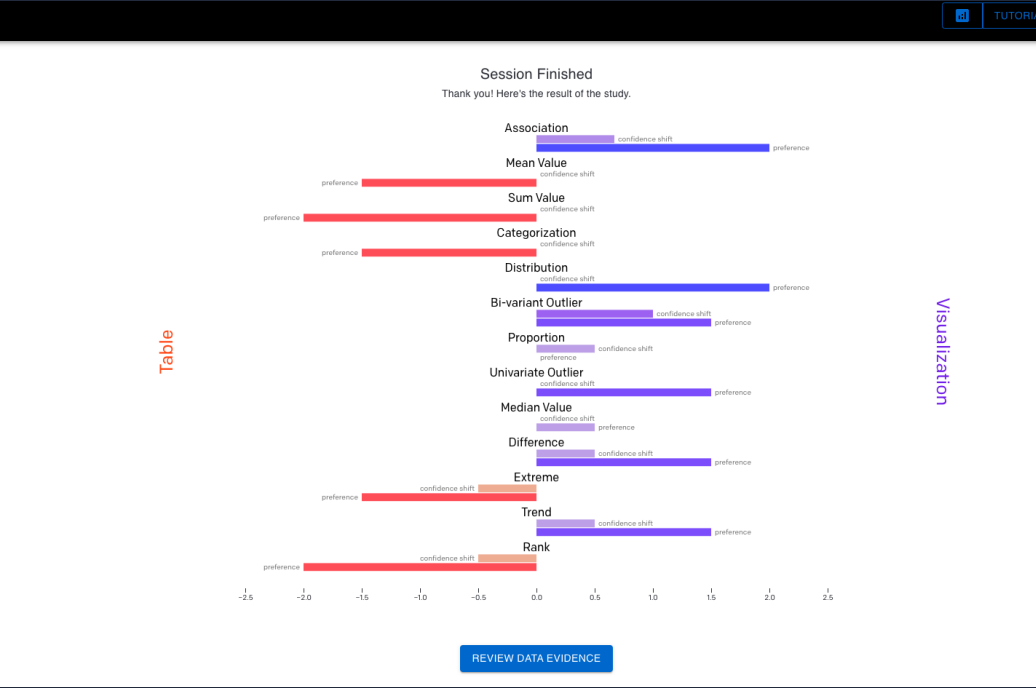


N = 10
(Vis)



✖ 2 ✖ 13 types

User Study Procedure (Phase 3)

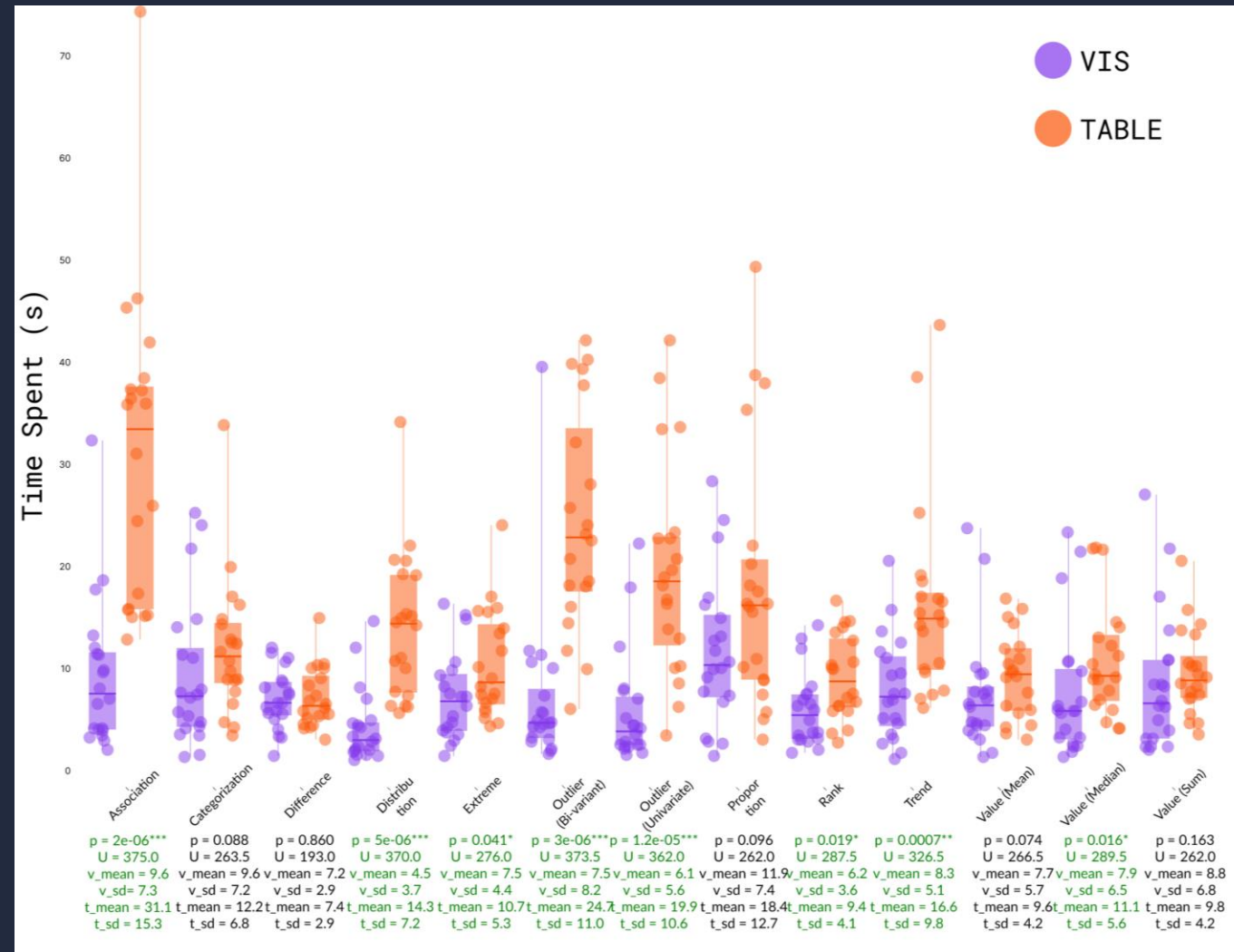


Qualitative Feedback

Evaluation II: Results



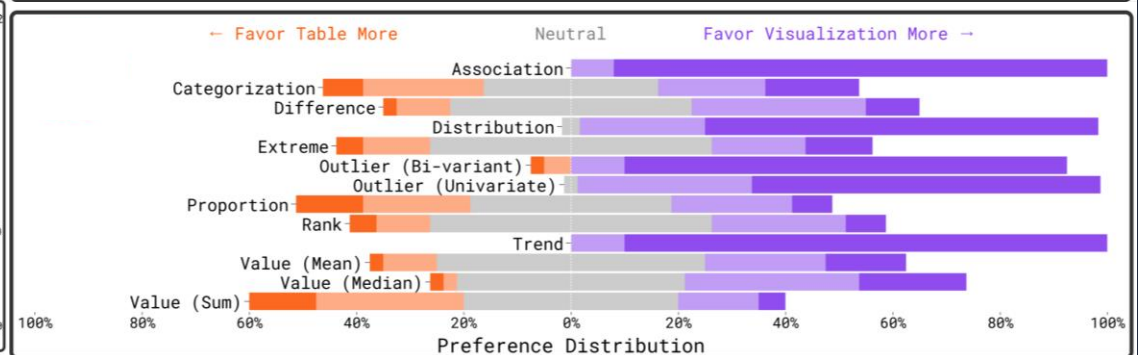
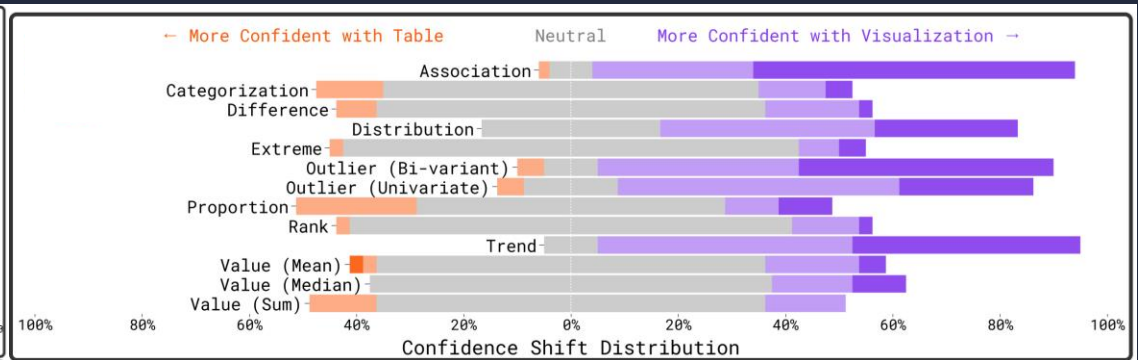
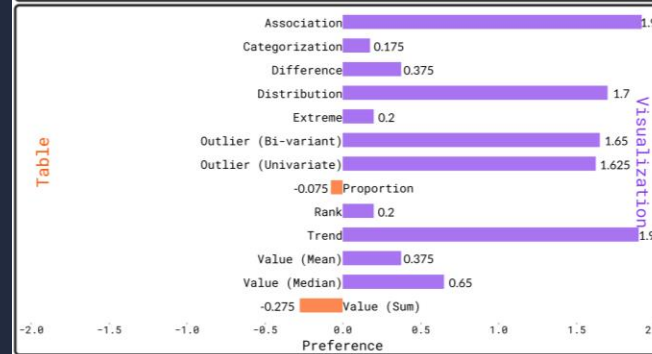
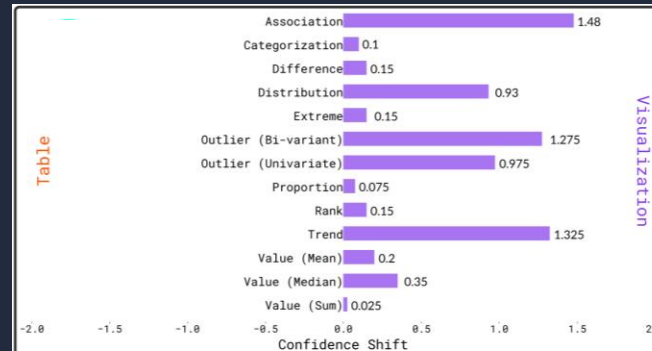
Time spent



Evaluation II: Results



Confidence level
& Preference



Evaluation II:

Results



| Claim Type | Overall Accuracy (%) |
|----------------------|--------------------------|
| Overall | 90.19 ($\sigma = 0.3$) |
| Rank | 100 |
| Proportion | 100 |
| Difference | 97.5 |
| Categorization | 95 |
| Value (Mean) | 97.5 |
| Value (Median) | 95 |
| Value (Sum) | 100 |
| Trend | 87.5 |
| Extreme | 100 |
| Outlier (Univariate) | 67.5 |
| Outlier (Bivariate) | 65 |
| Association | 78 |
| Distribution | 93.3 |

Findings and Takeaways



- Visualizations inherently offer advantages when fact-checking data claims related to patterns or distributions across numerous data points.
- Displaying data operation widgets accelerates assessment and boosts confidence.
- Unit representations enhance confidence, even when not scrutinized.
- Contextual information can be both reassuring and distracting in customized visualization

Recommendations for Presenting Data Evidence

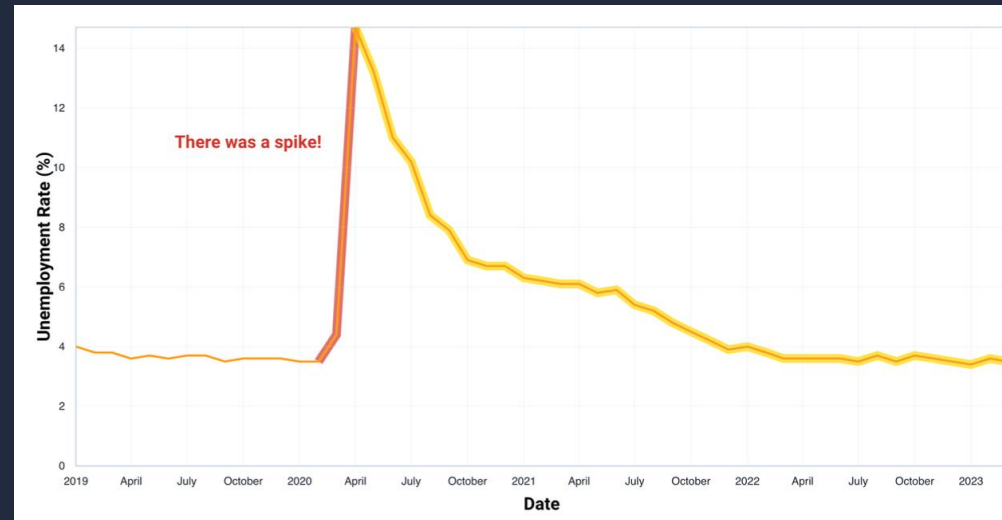
- Display data operations, especially the filters
- Make salient information more visually prominent
- Key information first, contextual information on demand
- Consider providing visual aids

Limitations

- Sole focus on fact-level assessment
- Require manual selection of reference dataset
- Lack of comprehensive optimization and evaluation of the LLM-based pipeline
- User study designs

Future Work

- Assessing and Communicating Plausibility of Data Claims On the Reasoning Level



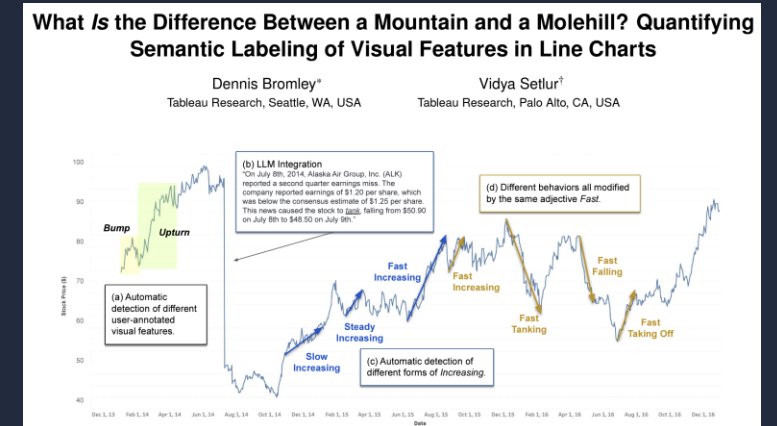
*"The unemployment rate experienced a decrease between April 2020 and March 2023, **indicating a strong job market.**"*

Future Work

- Assessing and Communicating Plausibility of Data Claims On the Reasoning Level

- **Fact-checking More Complex Data Claim**

- Claims that involve more complicated data operations
- Claims that include nuanced semantics



Bromley and Setlur (2023)

Thank you!



Yu Fu
Georgia Tech



Shunan Guo
Adobe Research



Jane Hoffswell
Adobe Research



Victor S. Bursztyn
Adobe Research



Ryan Rossi
Adobe Research



John Stasko
Georgia Tech