Rethinking the public value of science

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Outline

1. Science as a public good
2. How to value a public good
3. Public perceptions about CERN elicited via social media
4. Ways forward

Motivation

- Justification to the public about utility of investments in scientific projects

- Citizens perceptions may not be accurate with respect to public utility of research

- Public scrutiny about results

- Cost-Benefit Analyis criteria

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Science as a Global Public Good

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Public Good

Kenneth Arrow (1962) discussed properties of knowledge that make it a public good: it is not depleted when shared, and once it is made public others cannot easily be excluded from its use.

- **<u>Public good</u>:** a commodity or service that is provided without profit to all members of a society, either by the government or by a private individual or organization.

- <u>A global public good</u>: A public good beyond borders…open science!

Total Economic Value of Science (TEV)

TEV= Use Value+ Non-Use Value

- *Use value = patents, licences, cultural visits, ….*

- *Non-Use Value = Option value + Bequest value + Existence Value*

Non-Use Values

- Option value = A resource or service is of no use today, but maybe extremely valuable in the future….

- Bequest value = To transmit knowledge and cultural heritage to future generations…

- Existence value = Willingness to pay to preserve a resource or service that exists (blue whales…), but you may never enjoy it (not today nor tomorrow)…

Total Economic Value (TEV)

- TEV (all values) complex and somewhat unknown in the **short term**

- TEV can also be difficult to compute in the long term: **risk and uncertainty**

  - Scenario analysis

  - Time Preferences

How to value global public goods?

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How to value public goods?

- **Issue at hand**: No market prices

- **Citizens valuations**: *how much are you willing to pay for this type of research?*

- **Referenda type of questions**: public choice aspect

- **Information is crucial**: Stakeholder participation and perceptions

How to value public goods?

- **Direct approach**: ask citizens about their preferences (stated preference techniques)

- **Indirect approach**: obtain market information able to provide insights about how much we value science.

Direct Approach

Stated Preference Techniques: Contingent Valuation, Choice Experiments, etc…

- Different potential biases may arise
  - Hypothetical bias
  - Interviewer bias
  - Social desiderability bias….
  - Order bias
  - Multiple issues related to the bid design: anchoring, "gamming", …
  - Bad survey design….

Economics and Big Data Sources

- Einav and Levin (*Science*, 2014) describe how economic research has evolved in the area of big data and new private datasets.

  - A significant amount of questions can be addressed now

- New large and almost universal datasets are emerging, being complementary to administrative and public data sources.

Public perceptions about CERN: What people "think" about CERN?

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An approximation with Big Social Data

- Social media can be extremely useful to value global public goods

  ‣ Social Media Data sources: Unsolicited opinions about current topics

  ‣ Social Media Open Data: Twitter, Facebook, Youtube…

Issues with social media

- Atentification of users
- Data cleaning requirements
- Boots…
- Selection bias of users-not perfer representation of the overall population
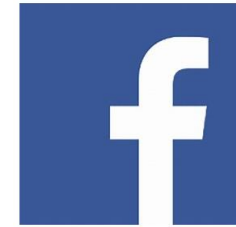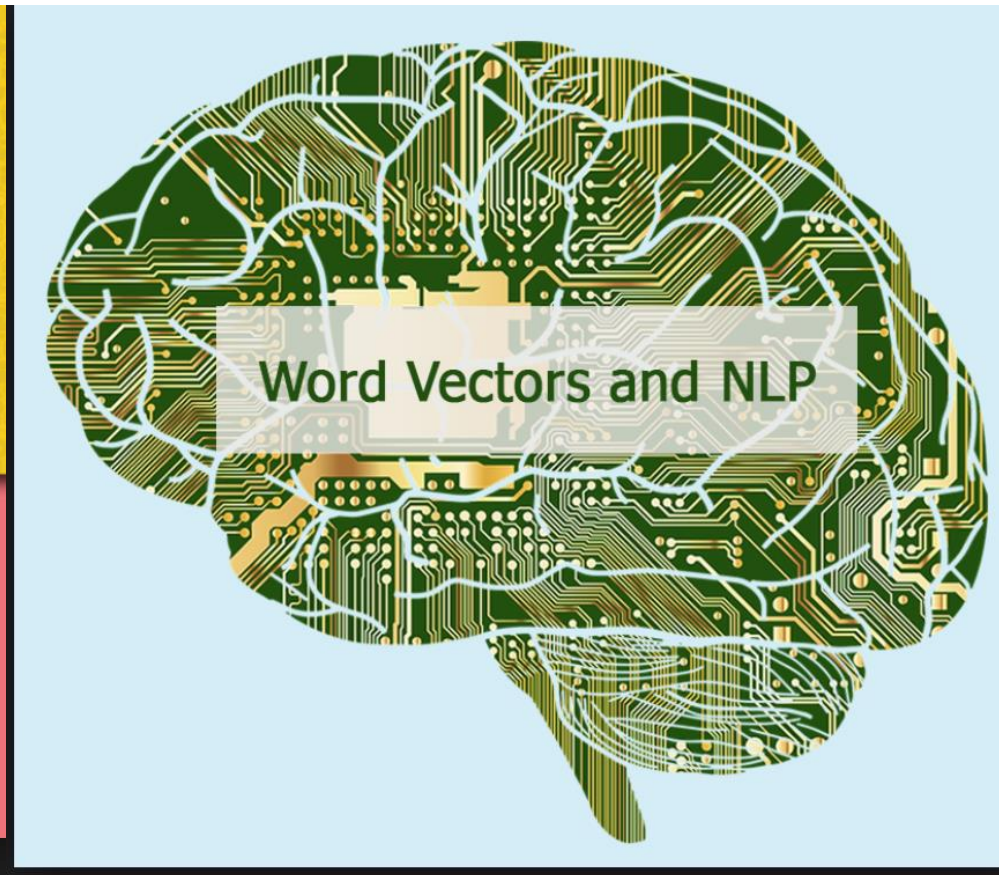
Example

- Data collected from Twitter API (English account)

- Spanish and English speaking users

- Data downloaded for the first two weeks of June 2019
  - @CERN
  - @AtlasExperiment
  - @LHC News, @CERN-LHC Live
  - @ALICE Experiment
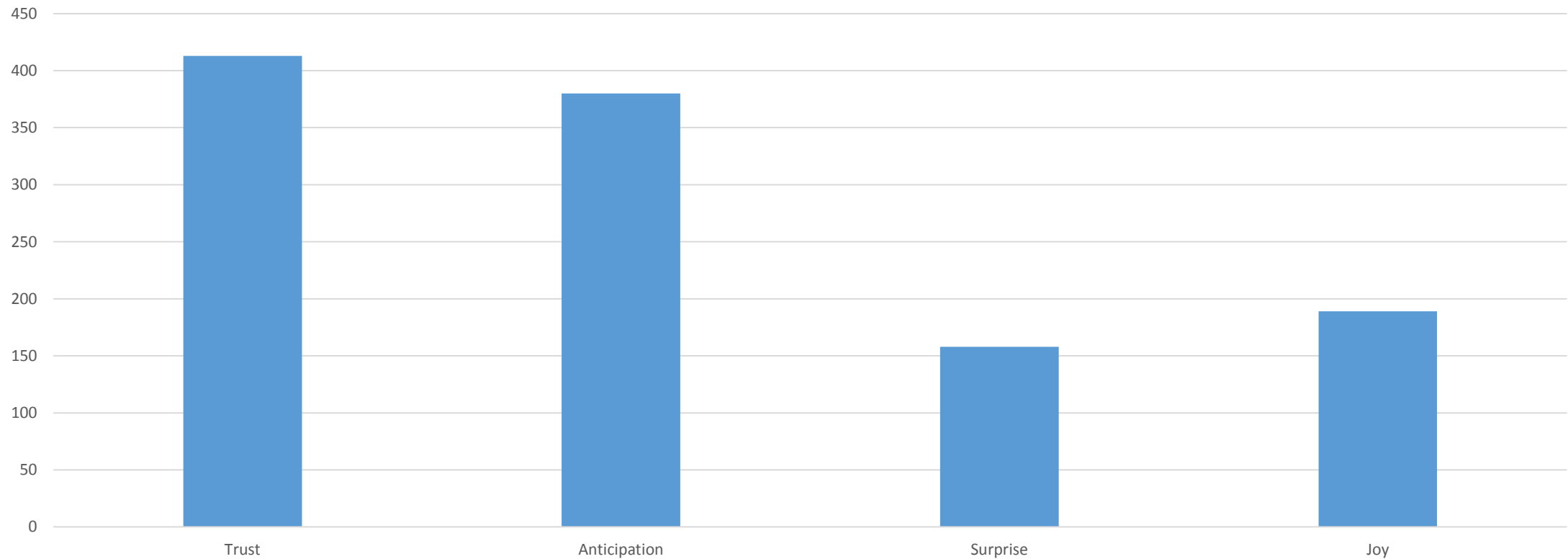 - @CMS Experiment
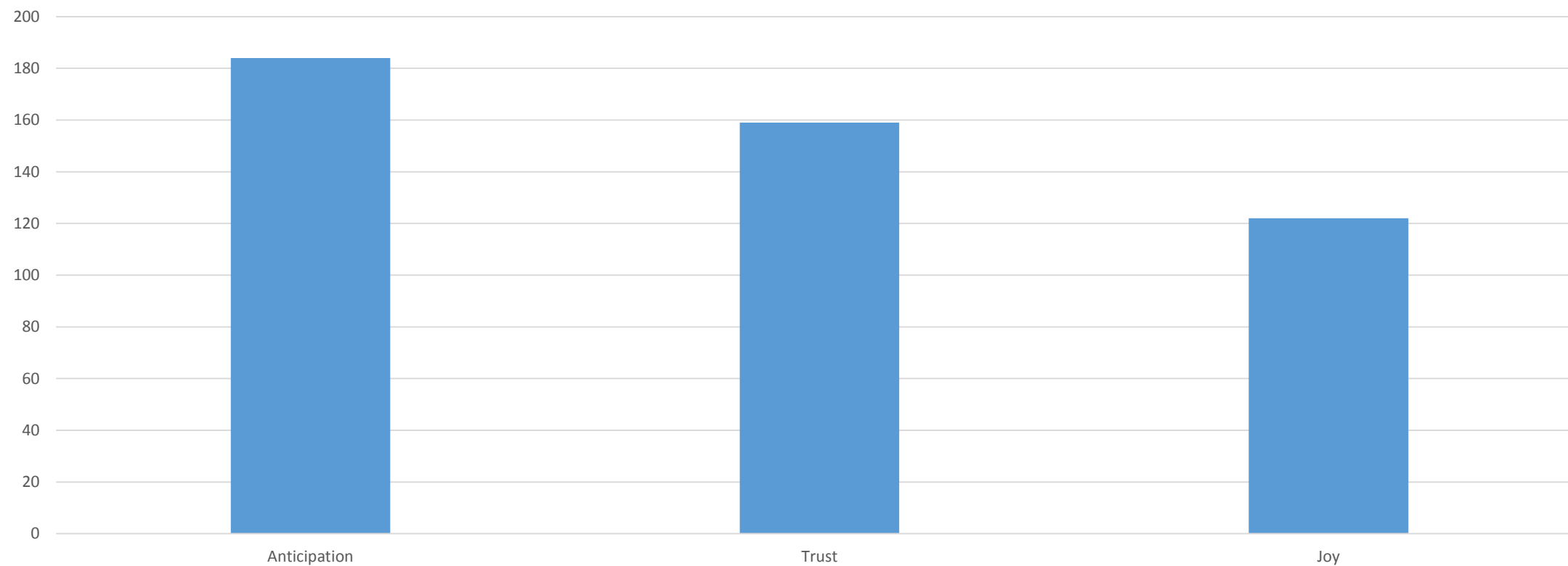
Methods: Sentiment Analysis

Tweets in English: Word Cloud

Tweets in English (first weeks of June 2019)

Sentiment Analysis-CERN Tweets

Tweets in Spanish:Word Cloud

Tweets in Spanish

CERN-Spanish Sentiment Tweets

What is the level of happiness?

- The Hedonometer tool: instrument created to measure the overall level of happiness or unhappiness in a particular corpus.

- 10,000 most frequently used word were collected from different sources: Google books, New York Times articles, Twitter messages....

- Mlab: Multiple languages with M-Turk input

- Each word received an evaluation from 1(sad)-9 (happy).

Algorithm for Hedonometer

We use a simple, fast method for measuring the happiness of texts that hinges on two key components:

1. human evaluations of the happiness of a set of individual words
2. naive algorithm for scaling up from individual words to texts

For the algorithm, we first use a pattern-matching script to extract the frequency of individual words in a given text T. We then compute the weighted average level of happiness for the text as

$$h_{avg}(T) = \frac{\sum_{i=1}^{N} h_{avg}(w_i)f_i}{\sum_{i=1}^{N} f_i} = \sum_{i=1}^{N} h_{avg}(w_i)p_i$$

Where:

f_i :frequency of the ith word w_i for which we have an estimate of average happiness, $h_{avg}(wi)$, and $p_i = f_i / \sum_{j=1}^{N} f_j$ is the corresponding normalized frequency

Evaluations

- For the evaluations, we asked users on Mechanical Turk to rate how a given word made them feel on a nine point integer scale. E.g.:

$$h_{avg} (laughter) = 8.50,$$
$$h_{avg} (food) = 7,44$$
$$h_{avg} (reunion) = 6,96$$
$$h_{avg} (truck) = 5,48$$
$$h_{avg} (hate) = 2,34$$
$$h_{avg} (funeral) = 2,10$$
$$h_{avg} (terrorist) = 1,30$$

As this small sample indicates, we find the evaluations are sensible with neutral words averaging around 5

Hedonometer Results

- How happy are you from 1 (unhappy) to 9 (very happy)?

- Tweets in Spanish: *h(ave)*=5.545564
- Tweets in English: *h(ave)*=5.353653

Ways forward

- Big social media will play a major role analyzing citizens preferences
  - On real time analysis
  - Global dimension
- Interesting heterogeneity in preferences may justify different interventions
  - Targeted educational programs

  - And optimally favor science communication and citizen engagement

In summary….

- Valuation of the public perceptions is a very relevant topic for supporting RI investment
  - Multiple types of values and potential users
- Future venues may contemplate additional criteria as well: multicriteria analysis….

Thank you!