Quantitative Analysis

of

Minority Representation Trends in Comic Books Over Time

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Abstract:
In this study, we investigate whether the representation of minority characters in comic books has significantly increased across the 14 years leading up to and following the new millennium, utilizing various Bayesian analytical techniques. Our findings indicate a notable difference in representation between the two periods.

Introduction:

The impact of media on socialization is profound, shaping identities and influencing self-perception across all age groups. Representation in media is critical not only for children but also for adults, as it helps individuals see themselves reflected in the stories that shape their worldviews. Historically, mainstream media, including prominent comic book publishers like Marvel and DC, have predominantly featured characters that represent privileged groups. This lack of diversity means that boys are rarely encouraged to be emotional and sensitive while girls seldom see themselves portrayed as scientists or engineers. Moreover, individuals from ethnic minorities or those with disabilities, along with women, often find themselves underrepresented or portrayed in stereotypical roles.

In recent years, there has been a growing awareness and demand for broader and more inclusive representation. This societal shift is particularly relevant in the realm of superhero narratives, where the portrayal of diverse characters can inspire and empower a wide audience. Our study aims to empirically examine whether there has been a significant increase in the representation of minority characters in comic books around the pivotal era of the early 2000s, a period marked by both technological advancements and significant cultural shifts. This investigation is not only relevant but essential for understanding the progress—or lack thereof—in media representation during a critical period of societal change.

- Research Question:

Has the representation of gender and sexual minorities, including women, in comic books significantly increased in the 14-year period from 2000 to 2013 compared to the 14 years preceding 2000?

Methods:

- Data Description:

The data for this analysis were sourced from an extensive database that aggregates character appearances and demographic information across Marvel and DC comics.

The study examines two distinct 14-year periods to evaluate trends in character representation:

- Pre-2000 Period**:** 1986 to 1999,
- Post-2000 Period**:** 2000 to 2013,

Variables:

- n_pre (Number of Characters Pre-2000): This variable represents the total number of comic book characters that appeared in issues published from 1986 to 1999.
- y_pre (Minority Characters Pre-2000): This variable counts the number of gender and sexual minorities, including women, appearing as characters within the same timeframe.
- n_post (Number of Characters Post-2000): Corresponds to the total number of comic book characters appearing in issues from 2000 to 2013.
- y_post (Minority Characters Post-2000): These variable measures the number of gender and sexual minorities, including women, featured in comics during this later period.

Overview of Statistical Analyses:

We began with basic descriptive statistics to provide an overview of the data, followed by Bayesian inference to understand deeper trends, and concluded with specialized Bayesian techniques to interpret the significance of our findings.

Descriptive Statistics:

Before delving into complex models, we first explored the dataset through basic descriptive statistics:

- **Counts and Proportions:** We calculated the total number of characters and the number of minority characters for both periods. This provided initial insights into the raw changes in representation.

Bayesian Inference with MCMC:

To perform a more nuanced analysis that incorporates prior knowledge and assesses changes in proportions with uncertainty, we employed Bayesian inference:

- Model Setup**:** We utilized a Bayesian model with priors appropriately chosen based on our assumptions about societal changes.

Motivation for Distribution Choices:

- Beta Distribution for Priors**:**
  - **pprep_{pre}ppre**: The `Beta(2, 5)` distribution was chosen to reflect underrepresentation of minorities. This distribution is skewed towards lower values, indicating a belief that fewer than 30% of characters were minorities, which aligns with historical perceptions and data prior to 2000.
  - **ppostp_{post}ppost**: The `Beta(1, 1)` distribution, a uniform distribution, was selected to represent a neutral stance on the proportion of minorities post-2000, allowing the data from this era to primarily influence the posterior beliefs.

- Binomial Distribution for Likelihoods**:**
  - The binomial distribution is naturally suited for data where outcomes are counts of successes in a series of independent and identically distributed Bernoulli trials. In this context, each comic book character's representation (minority or not) is treated as a trial, with the proportion of minority characters modelled as the probability of success.

- MCMC Simulation**:** Using PyJAGS, we implemented Markov Chain Monte Carlo (MCMC) methods to sample from the posterior distributions of our parameters of interest (p_pre and p_post). This approach allowed us to derive probabilistic estimates and understand the uncertainty in our estimates.

Region of Practical Equivalence (ROPE):

After obtaining the posterior distributions, we applied the ROPE technique to determine if changes in the proportions were practically significant:

- Defining ROPE**:** The ROPE was set around the null value of no change (zero difference) to determine if observed changes were significant beyond just statistical noise.
- Comparison**:** We calculated the proportion of the posterior distribution of the difference (diff = p_post - p_pre) that fell within the ROPE, providing a measure of practical significance.

Savage-Dickey Density Ratio:

Finally, to specifically test the hypothesis of no change, we used the Savage-Dickey density ratio:

- Density Estimation**:** We estimated the posterior and prior densities at diff = 0 using kernel density estimation from the MCMC samples.
- Ratio Calculation**:** The Savage-Dickey density ratio was calculated by dividing the posterior density by the prior density at diff = 0. This ratio provided a direct Bayes factor estimate for the null hypothesis of no change.

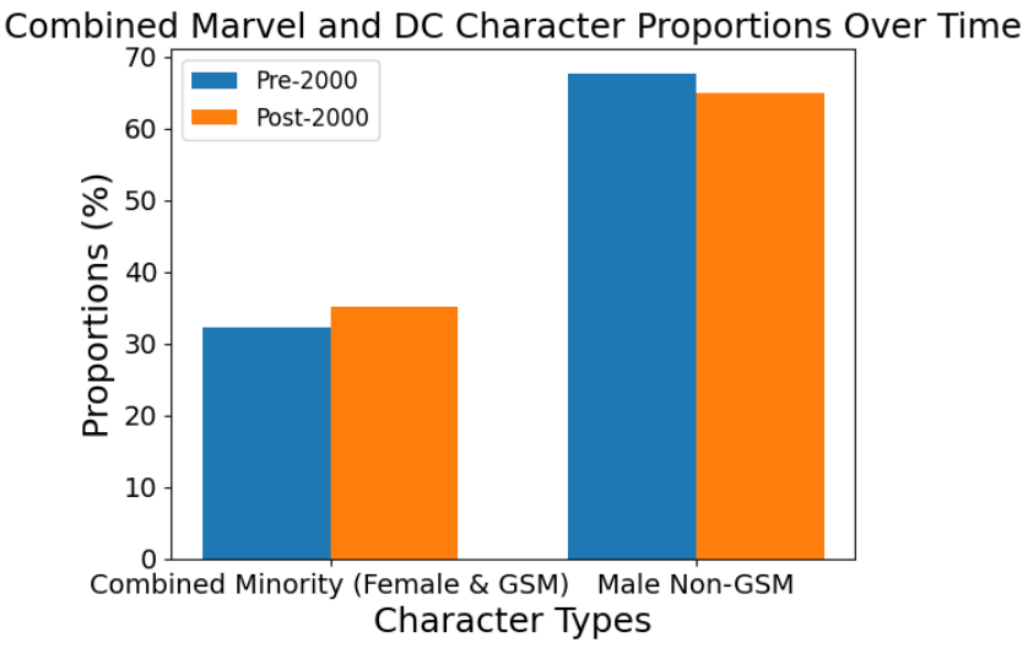
Results:

The analysis of the data reveals several interesting findings regarding the representation of gender and sexual minorities, including women, in Marvel and DC comics across two periods, from 1986 to 1999 and 2000 to 2013.

Descriptive Statistics and Proportions Over Time:

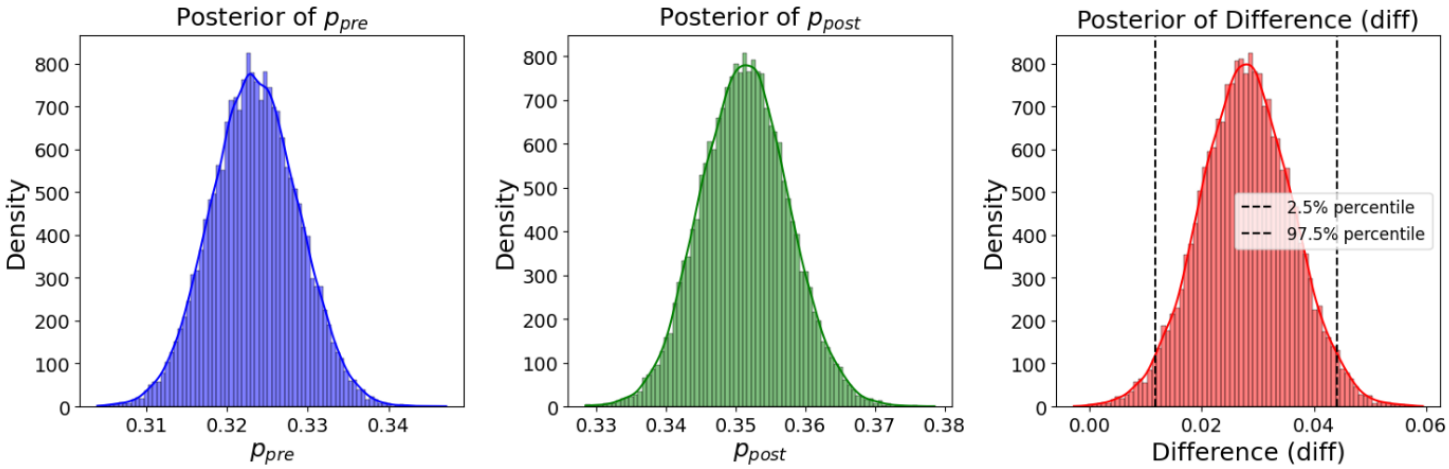
- Pre-2000 vs. Post-2000**:**
  - For both Marvel and DC, the proportion of combined minority characters (Female & GSM) shows a modest increase from the pre-2000 to the post-2000 period. Specifically:
    - Marvel: 31.76% to 35.22%
    - DC: 33.33% to 34.94%
    - Combined: 32.34% to 35.12%
  - This trend suggests a slight shift towards greater inclusivity in character representation following the millennium.

The bar graph demonstrates an apparent increase in the representation of minority characters in both Marvel and DC comics.



Bayesian Statistical Analysis:

- Posterior Distributions:
    - The posterior distributions for p_pre and p_post clearly indicate distinct shifts in the probabilities, with p_post showing a higher median value than p_pre, consistent with the descriptive statistics.
    - The posterior distribution of the difference (diff) emphasizes a mean increase of about 2.79% in the proportion of minority characters from the pre-2000 to the post-2000 period.

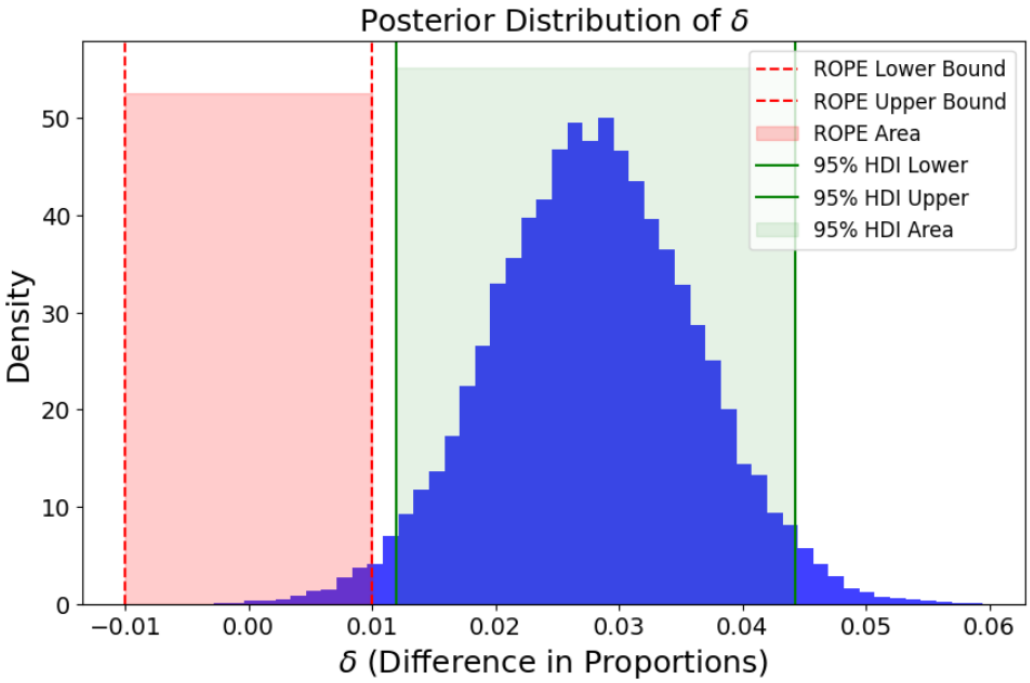


    - These plots effectively visualize the certainty of the estimates, showing how posterior beliefs have shifted based on the observed data.

Statistical Significance and Practical Relevance:

- 95% Credibility Interval**:** The interval for the difference [0.01176, 0.04416] does not include zero, which statistically confirms the increase in minority representation is significant.

- Region of Practical Equivalence (ROPE)**:** Only about 1.5% of the posterior distribution of the difference falls within the ROPE range, suggesting that the change is not only statistically significant but also practically relevant.



This plot is particularly illustrative of the statistical and practical significance, with the HDI completely outside the ROPE area, further supporting a meaningful change.

Savage-Dickey Density Ratio (SDDR):

The low value of 0.052 indicates strong evidence against the null hypothesis (no change). The posterior density at diff = 0 is substantially lower than the prior density, reinforcing this conclusion.

Conclusions:

Our study rigorously examined the trend in representation of gender and sexual minorities, including women, across two distinct periods in the realm of Marvel and DC comics. The findings reveal a statistically significant increase in the proportion of minority characters post-2000. This upward trend is supported by both descriptive and Bayesian statistical analyses, indicating a notable change towards inclusivity in these major comic book franchises.