NIH Grant Activity Classifier

Erica Zhao, Crystal Kao

What is the NIH?

- Under United States Department of Health and Human Services (HHS)
  - *"NIH's mission is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability."*

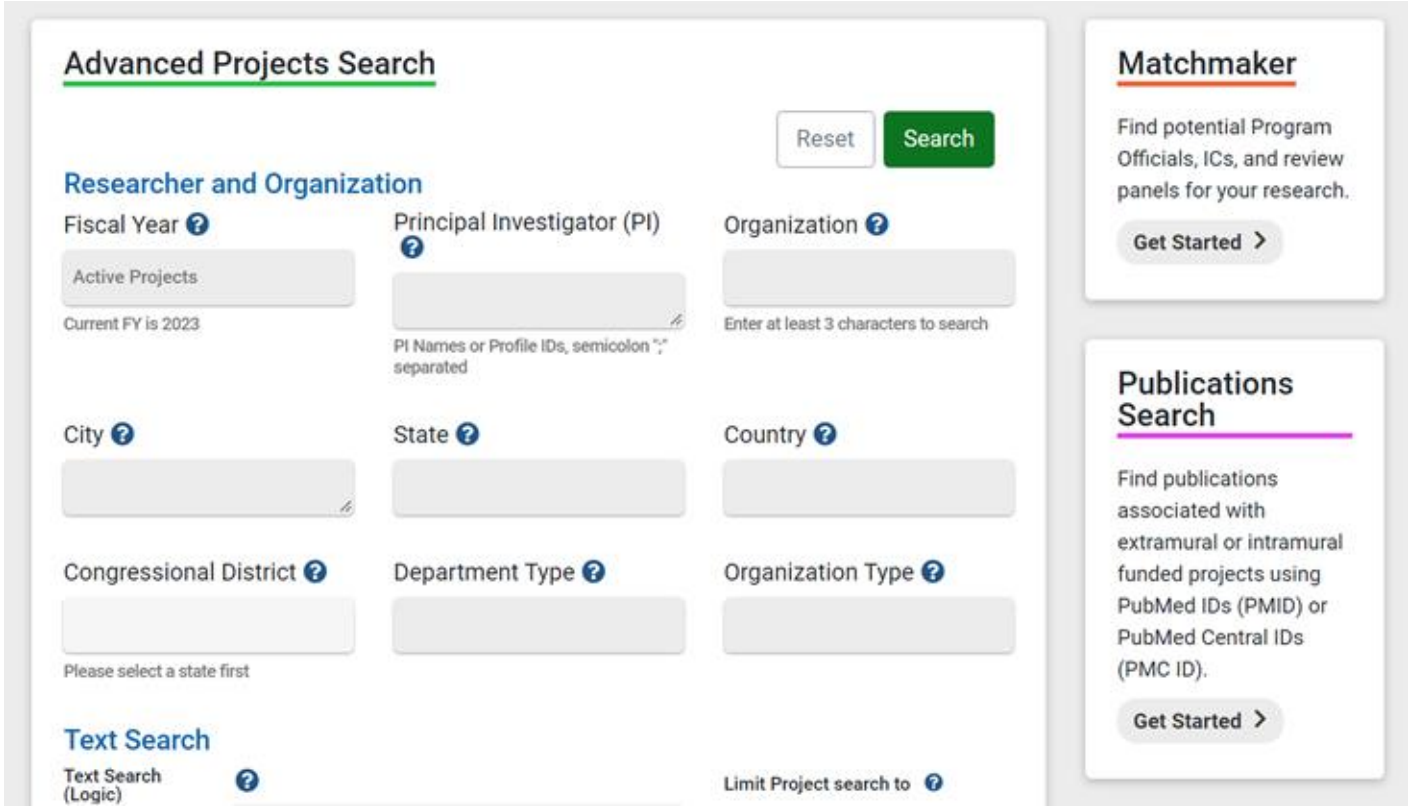
- The NIH consists of 27 institutes and centers (ICs) that each focus on a specific scientific area or function
  - Budget of $48 billion in FY23
  - 83% of NIH funding is awarded to extramural research

Analysis Objective

- The goal of our analysis is to create a model that can categorize the type of grant based on cost and grant length fields
  - The main activity codes of interest are the following 4 because they are the most common pipeline for a PI's (Primary Investigator) development:
    - F: Fellowship grants (for pre- and post-doctorates)
    - T: Research Training grants (also pre- and post-doctorates)
    - K: Career Development Awards (early career)
    - R: Research Grants (for established PIs)
- This analysis may be useful for POs (Program Officer) and data analysts within the NIH to predict what type of grants are coming in and help evaluate the career pipeline

Data Source

- NIH RePORTER (Research Portfolio Online Reporting Tools Expenditures and Results): https://reporter.nih.gov/



Cleaning the Data

- Base: Adapted from p2_c2_s5_tree_based_models case study.
- Loading Data: Imported FY18-FY23 from NIH RePORTER (118,355 rows)
- Creating Target Variable: Derived from "Activity" codes for grant categorization.
- Filtering: Focused on grant types crucial to analysis - R, K, F, and T series.
- Splitting Data: Allocated 80% for training, 20% for validation (test file is separate).
- Feature Alignment: Removed non-uniform features across datasets.
- Pruning Columns: Excluded non-essential data fields from analysis (project title, contact PI, etc.).
- Handling Missing Data: Imputed using field mean to maintain data integrity.

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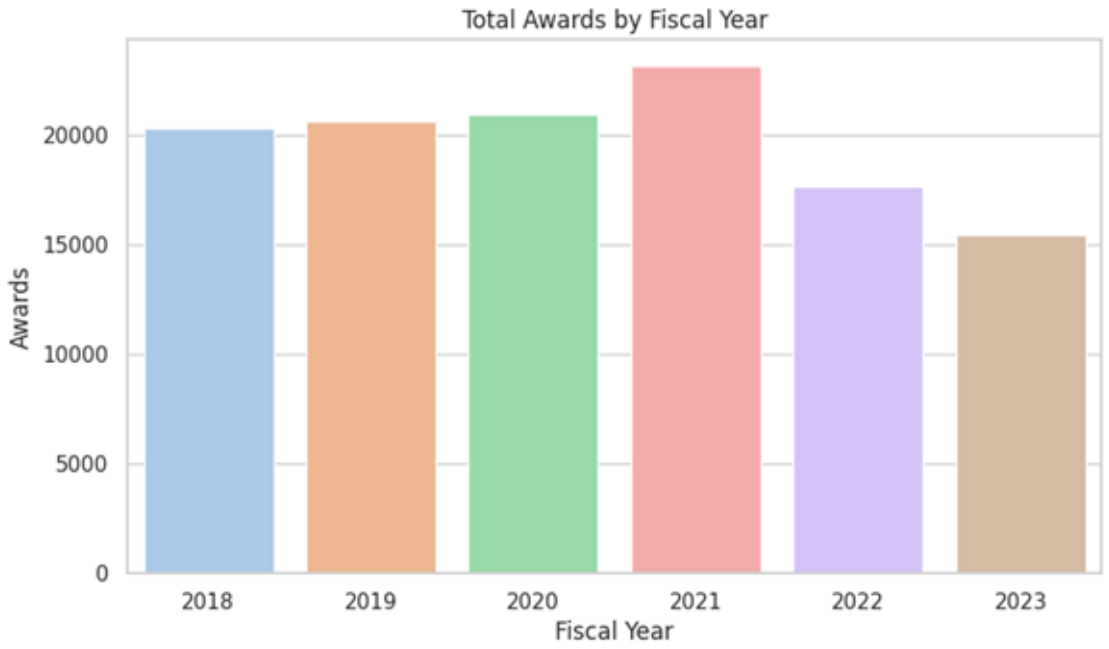
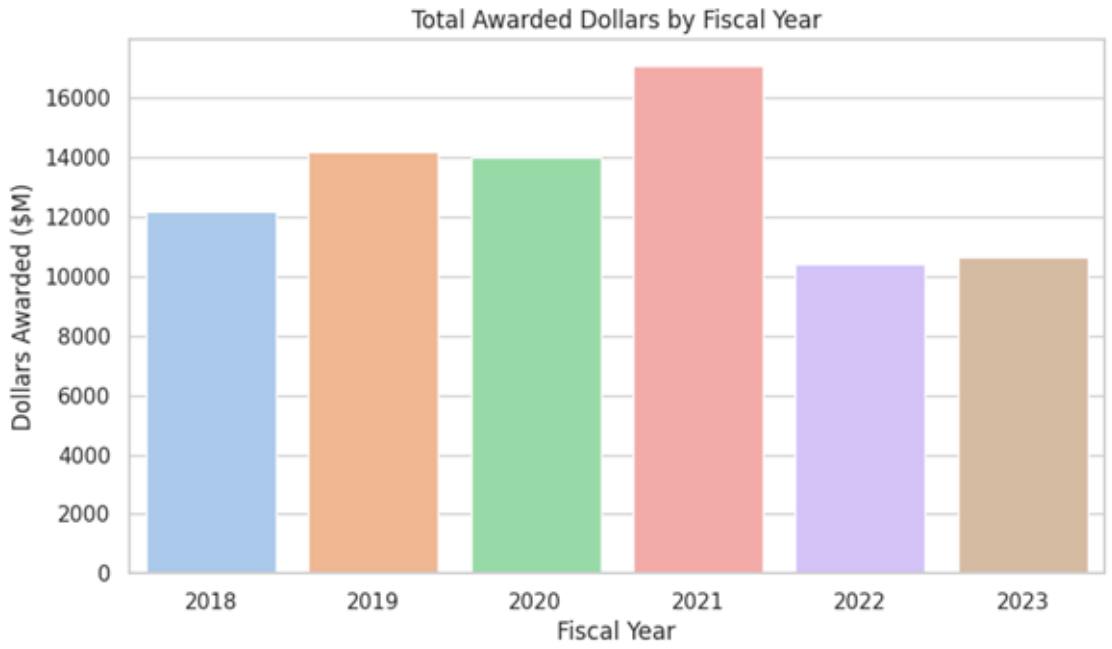
Exploratory Visualizations

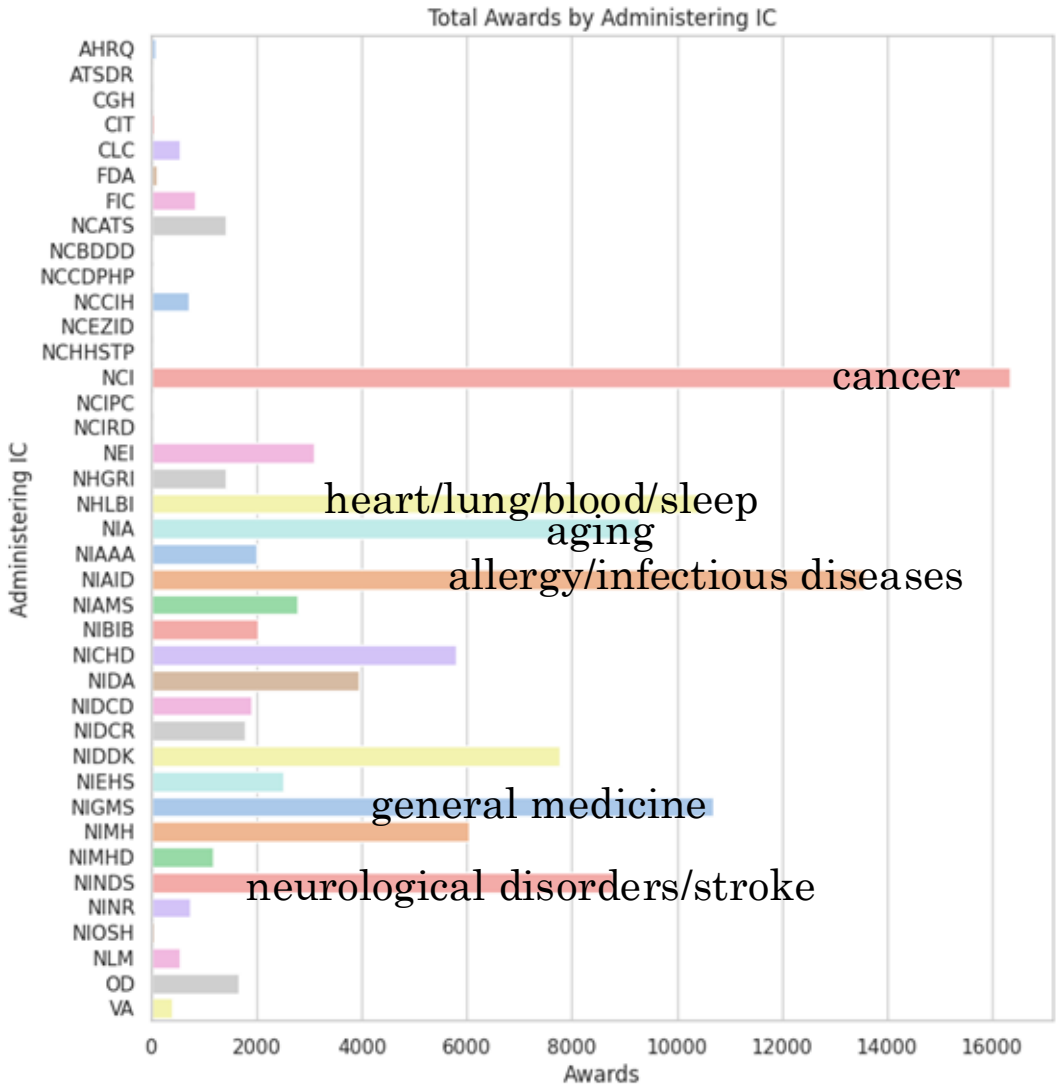
NIH Awards and Funding

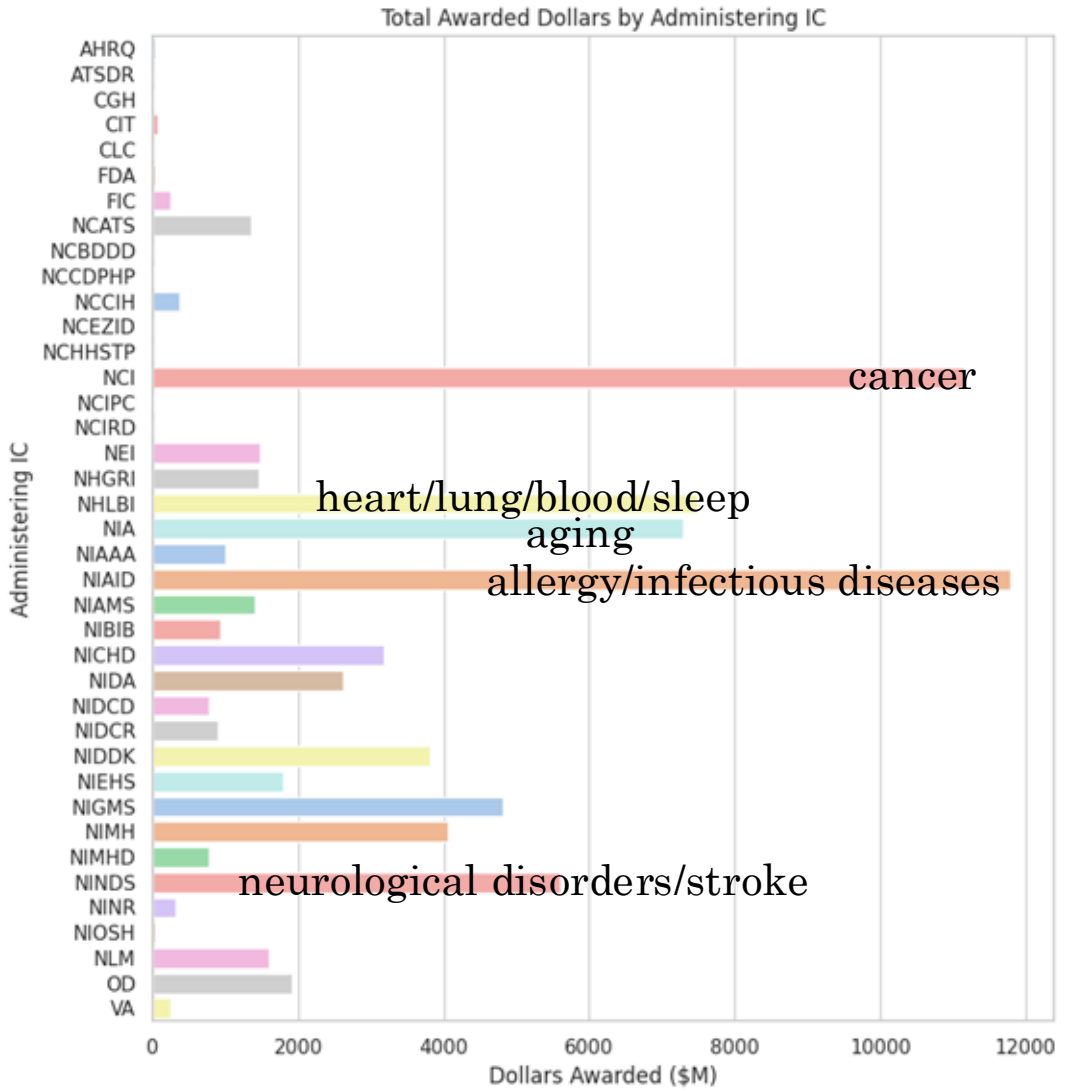
- For the past 6 years, the NIH has awarded ~15,000 - 25,000 grants per FY, with a decrease in the last 2 FYs





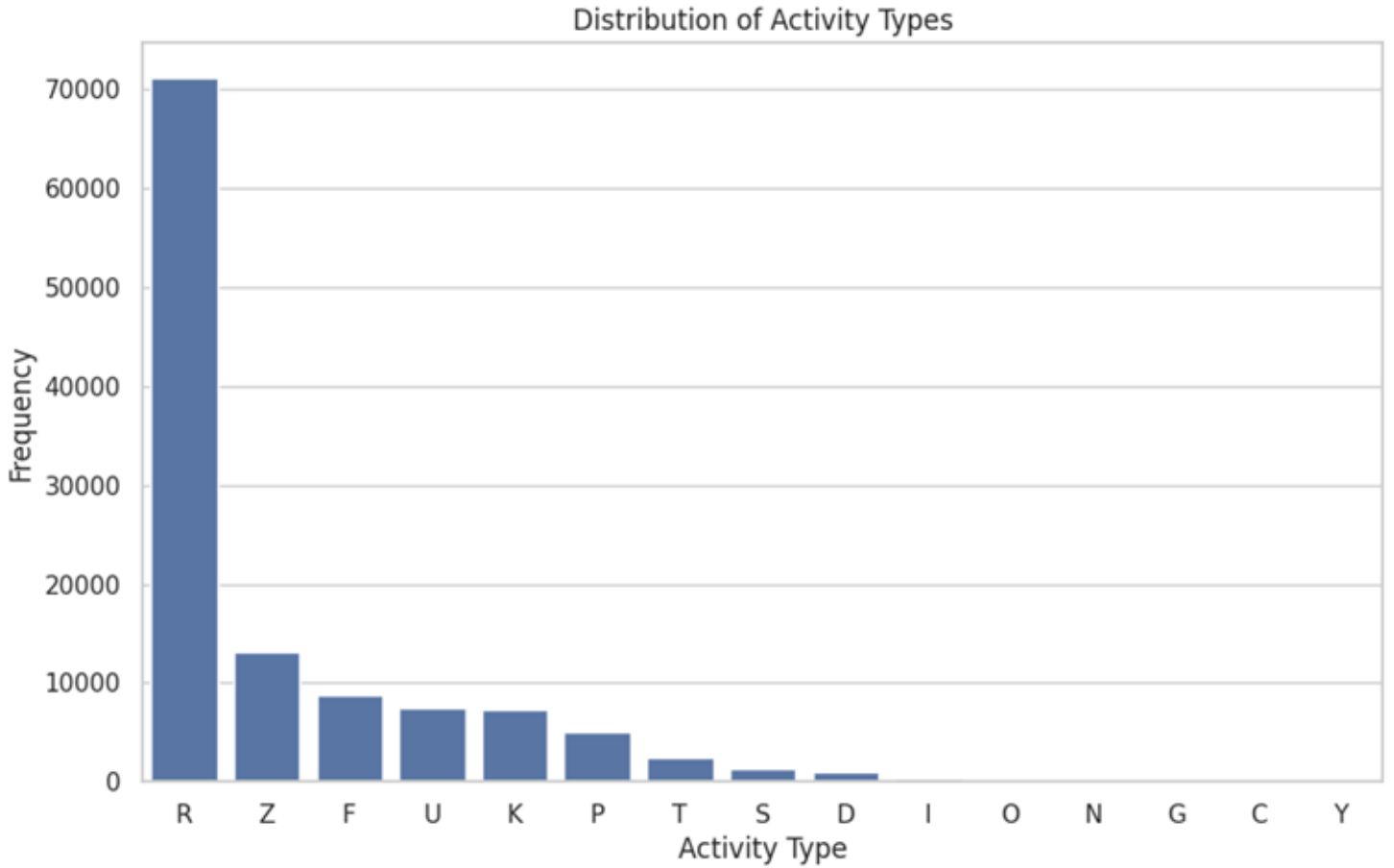
Awards and Funding by IC





Frequency of Activity Types

- Z was excluded to those being intramural (internal to NIH) grants
- F, T, K, and R are the part of the typical PI development pipeline

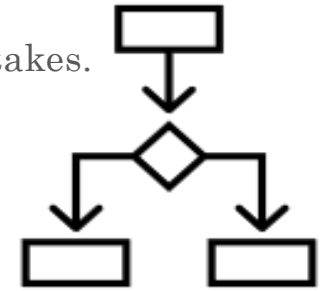


Modeling

Models

- The following 4 models were used in our analysis as our goal is to classify grants into activity types:

1. MLP Classifier
   - Why: Captures complex relationships through its layered structure.
   - Benefit: Adapts well to high-dimensional data, offering nuanced categorization.
2. Logistic Regression
   - Why: Provides a probabilistic approach for binary and multiclass classification.
   - Benefit: Easy to interpret, allows for straightforward assessment of feature impact.
3. Random Forest Classifier
   - Why: Ensemble of decision trees that improve predictive accuracy and control over-fitting.
   - Benefit: Handles categorical data effectively and provides importance scores for features.
4. Histogram-Based Gradient Boosting Classifier
   - Why: Robust to outliers and scalable to large datasets.
   - Benefit: Utilizes gradient boosting to improve prediction as it learns from previous mistakes.



Empirical Results

Model Selection Overview

- **Histogram-Based Gradient Boosting**: Best Score
  - **Score**: 0.92961
  - **Key Parameters**: Learning Rate = 0.1
- **MLP Classifier:** Good Performance
  - **Score**: 0.901421
  - **Key Parameters**: Alpha = 1e-05
- **Decision Tree Classifier**: Close Competitor
  - **Score**: 0.925928
  - **Key Parameters**: Min Samples Leaf = 1
- **Logistic Regression:** Requires Further Tuning
  - **Score**: 0.818733
  - **Key Parameters**: C = 10, Tolerance = 1e-05

	best_score	best_param	best_estimator
0	0.929621	{'model__learning_rate': 0.1, 'model__min_samp...	(HistGradientBoostingClassifier(min_samples_le...
1	0.925928	{'model__min_samples_leaf': 1, 'model__min_sam...	((DecisionTreeClassifier(max_features='sqrt', ...
2	0.901421	{'model__alpha': 1e-05, 'model__learning_rate_...	(MLPClassifier(alpha=1e-05, early_stopping=Tru...
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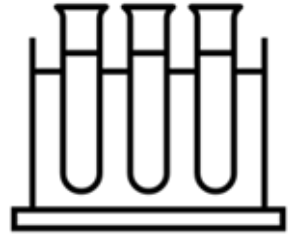
Conclusion



Data Preparation: The Foundation of Our Analysis

- Refined Data: Carefully curated from extensive NIH records.
- Targeted Approach: Target variable crafted from 'Activity' codes for precise analysis.
- Validated Methods: Data split and cleaning methods ensure robust model training.
- Missing Data Strategy: Mean imputation preserves data structure, preventing bias.

Impact:

- **Enhanced Clarity**: Categorizes NIH's diverse funding streams with accuracy.
- **Operational Efficiency**: Streamlines grant processing, saving time and resources.
- **Data-Driven Strategy**: Supports informed decision-making within NIH.
- **Transparency**: Allows taxpayers to see how funds are allocated in medical research.

Forward Path:

- Integrate these models for robust, real-time analysis.
- Utilize insights for strategic funding and health policy development.

References

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