Simplifying NASA Earth Science Data and Information Access through Natural Language Processing Based Data Analysis and Visualization

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Zhong Liu[1,2] (Zhong.Liu@nasa.gov), Shimei Pan[3], Jianwu Wang[3], Angela Li[1], and David Meyer[1]

[1]GES DISC; [2]CSISS, George Mason University; [3]Univ. of Maryland, Baltimore County

Abstract

NASA Earth science data collected from satellites, model assimilation, airborne missions, and field campaigns, are large, complex and evolving. Such characteristics pose great challenges for end users (e.g., Earth science and applied science users, students, citizen scientists), particularly for those who are unfamiliar with NASA's EOSDIS and thus unable to access and utilize datasets effectively. For example, a novice user may simply ask: what is the total rainfall for a flooding event in my county yesterday? For an experienced user (e.g., algorithm developer), a question can be: how did my rainfall product perform, compared to ground observations, during a flooding event? Nonetheless, with rapid information technology development such as natural language processing, it is possible to develop simplified Web interfaces and back-end processing components to handle such questions and deliver answers in terms of text, data, or graphic results directly to users.

In this presentation, we describe the main challenges for end users with different levels of expertise in accessing and utilizing NASA Earth science data. Surveys reveal that most non-professional users normally do not want to download and handle raw data as well as conduct heavy-duty data processing tasks. Often they just want some simple graphics or data for various purposes. To them, simple and intuitive user interfaces are sufficient because complicated ones can be difficult and time-consuming to learn. Professionals also want such interfaces to answer many questions from datasets. One solution is to develop a natural language based search box like Google and the search results can be text, data, graphics and more. Now the challenge is, with natural language processing, can we design a system to process a scientific question typed in by a user? In this presentation, we describe our plan for such a prototype. The workflow is: 1) extract needed information (e.g., variables, spatial and temporal information, processing methods, etc.) from the input, 2) process the data in the backend, and 3) deliver the results (data or graphics) to the user.

Motivation

NASA:

- The Research Access initiative is part of the agency's framework for increasing public access to scientific publications and digital scientific data.
- The initiative follows the release of White House Office of Science and Technology Policy's (OSTP) memorandum "Increasing Access to the Results of Federally Funded Research," to ensure federally funded research is available to the public within one year of publication.
- NASA answered the mandate by creating an agency plan entitled "NASA Plan for Increasing Access to the Results of Scientific Research" and associated policy, NPD 2230.1, *Research Data and Publication Access*.

Principles in NASA SMD Strategic Plan for Scientific Data and Computing:

- Continued free and open access to scientific data for any use
- Improved ease of use and discoverability
- Enhanced science applications and new use cases
- Incorporates best practices and "state of the art" through partnerships

Earth Data and Systems are Evolving:

- Increasing archive and file sizes; more complicated data structures
- More user-friendly, with additional data services
- What is the future direction?

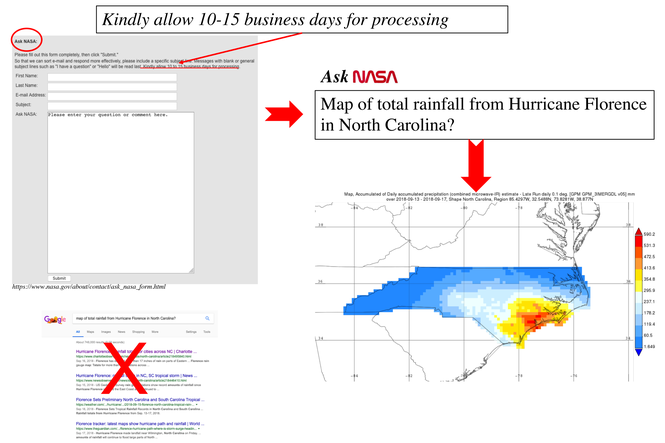
Challenges in data access:

- "Decision Support Systems Analysts, the General Public, and University Undergraduates report the lowest levels of CSI" according to the 2017 CSI (Customer Survey Index). Over 50% of users.
- Surveys reveal that most non-professional users normally do not want to download and handle raw data as well as conduct heavy-duty data processing tasks.

Source: *https://www.nasa.gov/open/researchaccess/public-access-results*

	2016	2016	2016	2017	2017	2017
	%	N	CSI	%	N	CSI
Type of User~						
General Public	14%	1,019	76	14%	1,037	76
Elementary, Middle, High School Teacher	1%	83	76	1%	86	77
University Professor	16%	1,129	80	16%	1,193	81
University Undergraduate Student	36%	2,550	76	9%	656	76
Other Education and Outreach	5%	349	79	5%	355	79
Earth Science Researcher	32%	2,304	79	32%	2,409	79
Earth Science Modeler	8%	574	78	9%	650	79
NASA-affiliated Scientist	2%	167	79	1%	102	80
Non-NASA-affiliated Scientist	4%	304	79	4%	320	78
NASA Science Team Member	7%	475	79	1%	68	80
Data Tool Developer/Provider	5%	359	77	5%	409	77
Decision Support Systems Analyst	5%	375	76	6%	429	76
University Graduate Student	0%	0	--	29%	2,204	77
Other User Type	8%	548	76	9%	656	77
Number of Respondents	**7,133**	**7,133**	**7,133**	**7,505**	**7,505**	**7,505**

2017 American Customer Satisfaction Index (ACSI) survey results, showing the lowest CSI scores are from non-professional users such as the general public.



"Ask NASA" won't help much, and it takes a long time (10 - 15 business days) to provide an response.

Solution and Activities

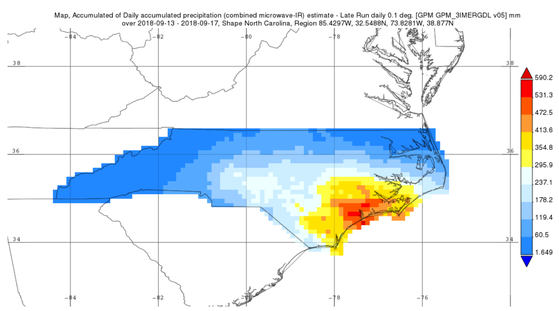
Solutions:

- Develop natural language processing (NLP) based data analysis and visualization infrastructure

Input (text, voice)
⬇
Processing (text, voice)
⬇
Analysis and Visualization
⬇
Result (text, voice, graphics)

Ask NASA: What is the total rainfall from Hurricane Florence in North Carolina?

- *Collect user input info. about where, when, what, etc. (total rainfall map, Hurricane Florence, North Carolina)*
- *Call a backend system to process the inputs and generate the result (the rainfall map)*



Activities:

- Work with NLP experts at UMBC
- Use case development
- System design and prototyping

Summary

- Many challenges exist for Earth science data and information access for users at all levels
- NLP provides a simple (but difficult to develop) interface to ordinary users
- NLP provides inputs for backend processing (data analysis and visualization)
- Working with NLP experts to develop a prototype

Giovanni: https://giovanni.gsfc.nasa.gov/ **GES DISC:** https://disc.gsfc.nasa.gov