

Biomedical Data Translator Funding Opportunity Announcement

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Participating Organization(s)	National Institutes of Health (NIH)
Components of Participating Organizations	National Center for Advancing Translational Sciences (NCATS)
Funding Opportunity Title	Biomedical Data Translator: Technical Feasibility Assessment of Reasoning Tool (OT3)
Activity Code	OT3 Multi-component Research Project - Other Transaction Award
Announcement Type	New
Related Notices	NOT-TR-16-014
Funding Opportunity Announcement (FOA) Number	NOT-TR-16-014
Catalog of Federal Domestic Assistance (CFDA) Number	93.350
Number of Applications	Only one application per qualifying team.

Funding Opportunity Purpose	As part of the Biomedical Data Translator Program, NCATS is utilizing its Other Transactions authority to invite interested applicants to submit innovative applications for research and development of reasoning software that autonomously integrates biomedical facts, models and inferences to answer important classes of translational research problems. Successful applicants will not only contribute their expertise and resources but also must be willing to collaborate to revolutionize translational science and propel new discoveries and best practices for practitioners across the translational spectrum, from biologists to chemists to computer scientists, from scientists doing target validation to clinicians seeing patients.
Related announcements	Link to the Notice
Program Background	www.ncats.nih.gov/translator
Objective Review	Objective review will be conducted in two phases. In the first phase, concept letters will be reviewed within 2 weeks of the concept letter due date. A subset of those authors will be invited to submit a full application and present their proof-of-concept to an objective review panel. Applicants will not receive written feedback from the reviews.
Concept Letter Due Date	September 22, 2017
Earliest Start Date	January 2018
Funding Instrument	Other: An assistance mechanism that is not a grant or cooperative agreement. Other Transactions awards are subject to the requirements of the NCATS Other Transaction Award Policy Guide for this initiative. Applicants may review this policy guide, available at https://ncats.nih.gov/files/NCATS-Translator-OT-Policy-Guide.pdf (insert date) by accessing (insert URL.)

Eligibility	<p>This Other Transaction initiative is open to U.S. and foreign organizations with an affiliated individual who is able to successfully complete the qualification challenge. U.S. citizens applying as individuals without an organization affiliation are also eligible to apply and to be direct recipients of an award, provided they are able to successfully complete the qualification challenge. Non-citizen individuals residing in the U.S. or foreign country who are not affiliated with either a U.S. or foreign organization are not eligible to be direct recipients of an award.</p> <p>See Eligibility section of this announcement.</p>
Funds Available and Anticipated Number of Awards	<p>NCATS intends to commit \$3,000,000 in FY 2018 to fund up to 3 awards.</p> <p>Future year support is not applicable.</p>
Award Budget	<p>Awards will be approximately \$1,000,000 total costs. Milestones should be proposed accordingly.</p> <p>Performance will be evaluated monthly and continued support will be based on the outcome of those evaluations.</p>
Award Project Period	10 months
Funding Opportunity Expiration Date	DATE

Glossary of terms

FOA: This document you are reading is a funding opportunity announcement; it provides readers with specific instructions on what funding NIH is offering and how to apply for the funding.

Challenge: In order to access the complete FOA before a required concept letter is due, prospective applicants must successfully complete a series of computational tasks. Successful completion of the tasks will demonstrate the appropriate skill set for developing a reasoning tool.

Concept letter: This is a required letter that must be submitted by the deadline in the Key Events table. This FOA document contains instructions for the content of that letter. Concept letters are submitted to the email address specified in the instructions.

Full application: This is the document submitted by the applicant in November that requests funding for the development of a reasoning tool prototype. Based on the objective review of the

concept letters, select applicants are invited to submit a full application. Instructions for submitting a full application will be provided separately.

Proof-of-concept project: This is a project that applicants are expected to present as part of their full application in November and will serve as preliminary data for the reasoning tool prototype research, development and testing. This project will be presented for evaluation by reviewers in a virtual meeting. Financial support is not provided for proof-of-concept development.

Prototype project: Reasoning tool prototypes will be developed & tested over a 10-month period with financial support from NCATS.

Other Transactions

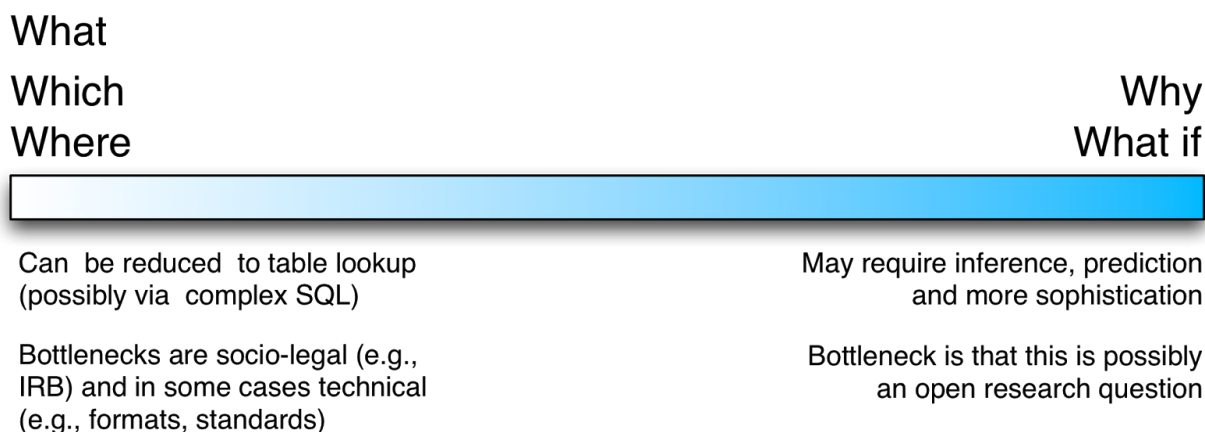
The use of other transactions (which are not grants, contracts or cooperative agreements) enables NCATS to manage projects in which developments and integration of ideas and expertise from various disciplines are essential to achieve a programmatic goal. This means proposed projects and/or components of the projects submitted may be expanded, modified, partnered, not supported, or later discontinued based on program needs, emerging methods, technologies, or approaches, and availability of funds. All awardees will be expected to collaborate and cooperate with NCATS staff, one another and potentially other contributors to the overall program to maximize the exploration of the potential capabilities of Translator and to understand technical feasibility and challenges of having multiple groups build a single resource.

Eligibility: Team qualification process

This Other Transaction initiative requires successful completion of the qualification challenge at: <https://ncats.io/challenge/start>. The challenge is designed to ensure that the applicants have the requisite skills to develop a reasoning tool prototype in a relatively short period of time. The challenge is a multi-level computational exercise. Upon successful completion of each level, additional sections of the funding opportunity will be revealed. Prospective applicants must successfully pass through all levels of the challenge to gain access to the complete funding opportunity announcement. Inability to pass through all levels will result in an inability to access all of the instructions necessary to submit the requisite concept letter. This Other Transaction initiative is open to U.S. and foreign organizations, academic institutions and commercial entities with an affiliated individual or team (subcontracts are allowed) able to successfully complete the qualification challenge. U.S. citizens applying as individuals without an organization affiliation are also eligible to apply and to be direct recipients of an award, provided they are able to successfully complete the qualification challenge. Non-citizen individuals residing in the U.S. or foreign country who are not affiliated with either a U.S. or foreign organization are not eligible to be direct recipients of an award.

Background: Data assessment and infrastructure design phase

In September 2016, NCATS issued the first five awards supporting [investigators from 11 institutions](#) for the Biomedical Data Translator (Translator). During the initial project period, Translator teams formulated a series of “translational” questions that should be answerable computationally, provided the right combination of data sources would be available. There are many types of questions possible, and we can place them on a spectrum of “engineering feasibility”, schematically shown below.



Questions on the left side correspond to (possibly complex) database queries which can be achieved if the appropriate data sources are merged, or connected. Fundamentally, these queries seek to pull out appropriate subsets of data from a set of data sources.

Questions on the right hand side are somewhat open ended and seek to identify an answer that may not be explicitly listed in any data source. These types of questions may involve inference or prediction. The reasoning tool is envisioned to ultimately be able to address questions on the right hand side of this spectrum.

This exercise is helping to not only identify high value data sources that would be needed for a comprehensive Translator, but also the infrastructure needed to support the interoperability of these data sources and methods for deriving knowledge from the integrated data.

It is envisioned that the output of the Translator would not simply be a statement addressing the question posed (“What is the answer to life, the universe and everything? Answer: 42”), but rather it would deliver a dossier of information that would allow the user to easily identify sources of information/knowledge and how the sources relate to one another. Thus, it enables the user to examine the information more deeply and draw their own conclusion or concur with the Translator’s conclusion when an analysis is provided.

This FOA is soliciting delivery of software, a reasoning tool, which can build dossiers by integrating biomedical facts, models and inferences that the existing Translator teams have assembled. Working with these existing components, the reasoning tool will optimize the application of the facts, models and inferences to a variety of important classes of translational research problems.

Applicants are encouraged to participate in a public meeting of the Biomedical Data Translator investigators in North Carolina, October 25, 2017 to learn about the current status of research efforts and infrastructure development.

Two-stage application process

There are two-stages to the application process once the eligibility challenge is met:

1. Submission of a **concept letter** describing a short **proof-of-concept** software project that if selected, will be presented for evaluation in November
2. Selected concepts will be invited to submit a full **application to develop a reasoning tool** and to demonstrate the operation of their initial **proof-of-concept** software and present their 10-month plan to an objective review panel .

Key Events	Dates	Action needed by applicants
Qualification challenge opens	September 4, 2017	Solve challenge puzzle to qualify for eligibility and access FOA
Concept letters due	September 22, 2017	Concept letter submitted following instructions provided through the qualification challenge before 11PM EDT*
Objective review of concept letters completed; successful teams will receive written notification with instructions for submitting a full application and giving a virtual presentation to review panel	September 29, 2017	
Biomedical Data Translator public meeting	October 25, 2017	Attend in person (Optional) Webex will be available
Written, full application for reasoning tool development including milestones due	November 20, 2017	10-month plan and milestones emailed by AOR (for organizations) or signing representative (for individuals) by 5pm local time*
SAM and DUNS number submitted	November 27, 2017	**Candidates e-mail their DUNS number and SAM account information

Objective review tier 2: Virtual presentations of proof-of-concept software and 10-month project plan	November 28-29, 2017	***Candidates individually participate in virtual meeting with review panel
Milestone negotiations begin	December 4, 2017	Candidates and AOR (if applicable)
Awards announced	January 2018	

*Letters and applications received after these times will not be accepted.

**[DUNS](#) and [SAM](#) number registration can take 6 weeks or more. Candidates should begin the registration process at least 6 weeks prior to this deadline to ensure completion in time to provide these to NCATS.

***Applicants should save-the-date to ensure availability for the virtual interview.

Reasoning tool proof-of-concept

In November 2017, applicants invited for a virtual interview will present:

1. a 10-month plan to build a reasoning tool and
2. their proof-of-concept software

The proof-of-concept software will serve as preliminary data to give the review panel a sense of the approach that will be taken, the quality of the software and speed with which development is able to progress.

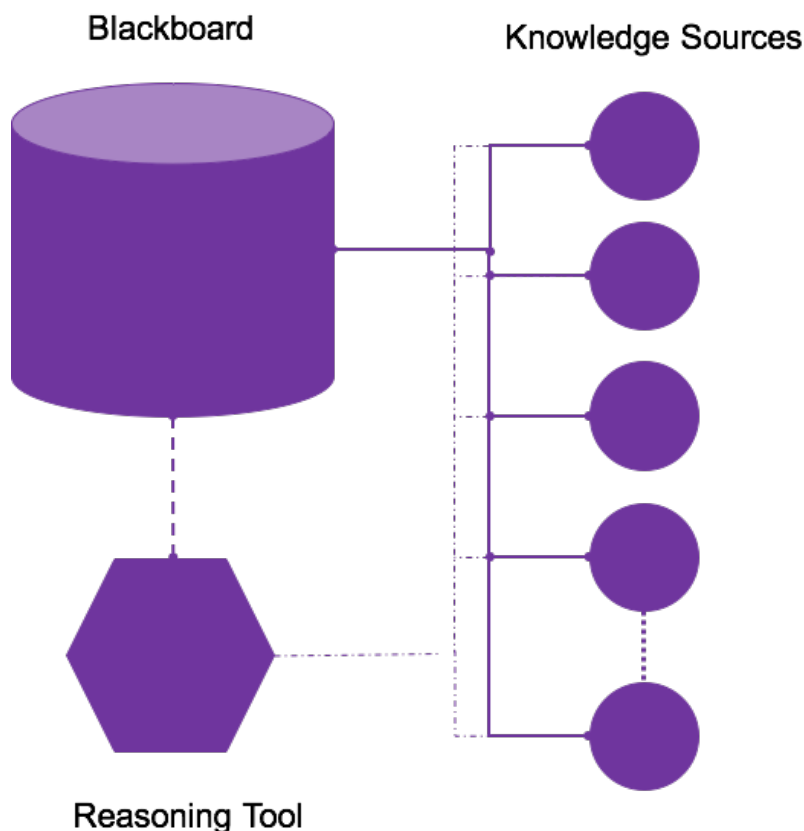
Proof-of-concept expectations

A key feature of any proposed reasoning tool is the ability to automate the process of answering a question. Currently, a question such as “*how does this drug induce a clinical outcome?*” could be answered by manually identifying the relevant data sources and data types followed by manually constructing API calls or SQL queries to retrieve the appropriate subsets of data. This would be followed by joining one or more datasets and then finally presenting the data or some computed output as the solution. Examples of such manually-constructed workflows can be found in the form of Python notebooks developed as part of the current project [[link](#) and [link](#)].

Proof-of-concept software is expected to provide reasonable and relevant answers for specific classes of research questions (see proof-of-concept questions below). Note that a specific input format for the reasoning tool is not being prescribed. While the questions, such as above, will be specified in plain English, the reasoning tool may parse it in any way that is appropriate (including manually), though automated and semi-automated approaches will be preferred. Operation of proof-of-concept software may require the assistance of the applicant to initiate its operation, but must be transparent to NIH staff. Once initiated, software is expected to complete its tasks without further operator input within a working period of twelve hours on cloud computing instances that will be provided by NCATS. The initial proof-of-concept may implement access to novel resources and algorithms, but development after November must be interoperable with existing components of the Translator (see *Further Information* below).

Prior to its demonstration in the virtual presentation, applicants are strongly encouraged to provide the objective review panel access to documentation or source code for those parts of the software responsible for substantive aspects of its operation and document sources of knowledge used. Accessibility of code will be a consideration of the evaluation (see *Collaboration, Sharing, and Intellectual Property Expectations* below).

Further information on Biomedical Data Translator



The general architecture currently employed by the Biomedical Data Translator is based on the [Blackboard architecture](#). This architecture is comprised of three components

- Knowledge Sources (KS) - this component corresponds to specific data or information sources. This can correspond to traditional databases such as Uniprot, ChEMBL or Entrez Gene. But a KS can also be an algorithm that has well defined inputs and outputs. See <https://github.com/NCATS-Tangerine/translator-knowledge-beacon/blob/develop/api/knowledge-beacon-list.yaml> for a description of some KS's currently used by the Biomedical Data Translator.
- Blackboard (BB) - this component represents a space within which data queried from KS's is collated. The Biomedical Data Translator project has two BB implementations <https://tkbio.ncats.io/> and <https://translator.ncats.io/blackboard>
- Reasoning tool - this component accepts a query, prioritizes KS's based on relevance to the query, coordinates requests to the KS's and computes on the retrieved data to produce an answer or a dataset that can be used by the user to formulate the answer. Currently, the reasoning tool function of the Translator is addressed by humans, and the actions of the reasoning tool are recorded in a Python Notebook. See [here](#) for a series of examples.

The goal of this solicitation is to support the research and development of a reasoning tool prototype to automate Translator operation as far as possible, and if not achievable, identify critical bottlenecks that must be resolved before such a reasoning tool can be implemented.

Goals for 10-month translator reasoning tool prototypes

- Demonstrate the potential utility of integrating different types of knowledge sources to address translational research questions, including biomedical facts, results from models of biology and inferences either imputed or extrapolated from existing data
- Demonstrate progress on the development of algorithms that enable answering “how?”, “what if?” and “why?” classes of translational research questions autonomously through:
 - the identification of relevant knowledge sources to answer a question
 - the construction of queries to those identified knowledge sources that retrieves relevant data
 - the analysis of the retrieved data to produce a final answer or dossier of information
- Demonstrate the potential to identify gaps in existing data sets and their associated metadata and strategies to address these deficits. It is especially important to identify such gaps that are critical bottlenecks for the proposed reasoning mechanism(s)
- Define the requirements for a comprehensive Translator -- its architecture and development path, that will catalyze getting more treatments to more patients more quickly

Collaboration, sharing, and intellectual property expectations

This project is intensely collaborative amongst research partners and NIH staff, including the unrestricted exchange of source code and software tools written as part of this program. Software is published into a program-directed source code repository, facilitating its reuse by others.

NIH believes that data sharing is essential for expedited translation of research results into knowledge, products, and procedures to improve human health. The NIH expects and supports the timely release and sharing of final research data, software and tools that support the publication of these data from NIH-supported programs for use by other researchers. The goal of this programmatic effort is to produce data, software and tools that are open source and completely publicly available for any user. The use of proprietary resources or tools will be considered if no equivalent resources are available without use restrictions.