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i2b2 Background and Overview

i2b2 (Informatics for Integrating Biology and the Bedside) is an NIH-funded National Center for Biomedical Computing based at Partners HealthCare System. i2b2 was developed as a scalable informatics framework designed for translational research. i2b2 was designed primarily for cohort identification, allowing users to perform an enterprise-wide search on a de-identified repository of health information to determine the existence of a set of patients meeting certain inclusion or exclusion criteria.

In layman terms, i2b2 allows researchers to determine feasibility of a study by identifying whether or not a sizable amount of patients exist with their study-specific criteria.

Search Criteria

The i2b2 repository contains detailed information on UW Health patients, drawn from the Epic Health Link electronic health record and Enterprise Data Warehouse. These data are made available to SMPH researchers through “self-service” access via the i2b2 user interface in this form:

Summary data only (patient counts) in which queries are limited to Limited Data Set views (dates — including dates of birth, cities, states and zip codes with other Protected Health Information (PHI) excluded); counts with less than 5 but greater than 0 will be reported as “less than 5”. This access has been certified by the IRB as not human-subjects related.

i2b2 as a National Resource

i2b2 is rapidly becoming the de-facto standard for cohort identification and hypothesis generation at research centers across the US and abroad. i2b2 is a widely adopted tool among Clinical and Translational Science Award (CTSA) sites and other Academic Medical Centers, and has also found increasing use at other organizations for research and clinical performance improvement initiatives.
Accessing i2b2

Access to i2b2 is available to UW Madison and UW Health personnel, but also requires following:

- HIPAA Training
- A request for an i2b2 account by submitting a BMI Consult form, checking “Preparatory to Research Activities” and “I need an i2b2 account (Informatics for Integrating Biology and the Bedside”.

i2b2 ACCOUNT REQUEST

<table>
<thead>
<tr>
<th>Request Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study/Request Title</td>
</tr>
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</table>

Please provide a brief description of your project or research interest:

My main interest is in:
- Preparatory to Research Activities
- Subject Recruitment & Enrollment
- Data Acquisition
- Data Computing & Storage Services
- I’d just like to start by talking to someone
- What I’m interested in isn’t on the list

I have an important due date:
- Yes
- No

Preparatory to Research Activities

My interest is in Preparatory to Research activities such as identifying potential research subjects or studying data collected during routine clinical care:
- I need an i2b2 account (Informatics for Integrating Biology and the Bedside)
- I would like to request i2b2 custom training
- I need assistance from the Clinical Research Data Service (CRDS) team

Check all that apply
# i2b2 TRAINING REQUEST

## Request Information

**Study/Request Title**
* must provide value

**Please provide a brief description of your project or research interest:**

**My main interest is in:**
* must provide value

- Preparatory to Research Activities
- Subject Recruitment & Enrollment
- Data Acquisition
- Data Computing & Storage Services
- I'd just like to start by talking to someone
- What I'm interested in isn't on the list

Check all that apply

**I have an important due date:**
* must provide value

- Yes
- No

## Preparatory to Research Activities

**My interest is in Preparatory to Research activities such as identifying potential research subjects or studying data collected during routine clinical care:**

- I need an i2b2 account (informatics for Integrating Biology and the Bedside).
- I would like to request i2b2 custom training.
- I need assistance from the Clinical Research Data Service (CRDS) team.

Check all that apply
To access the i2b2 program

Visit: https://i2b2-uw.uwhealth.org/i2b2 with NetID login credentials
Visit: https://i2b2.uwhealth.org/ with UW Health login credentials
Navigating the Workbench

Helpful Hints in this Guide
For those who prefer to learn a software tool by exploring independently rather than following a User Guide, a light bulb icon is used within this guide to highlight helpful and nonobvious tips.

Workbench Screen
Following the validation of your login credentials, the i2b2 Query & Analysis Tool screen is displayed and available for use. The basic i2b2 workbench screen provides six primary tabbed panes for identifying, building and running cohort discovery queries. These panes are indicated in the figure below and described in the accompanying text.

1. Navigate Terms - This is where you will locate search concepts using a hierarchical folder structure.
2. Find Terms - In this pane, you can find search concepts using a representative word, phrase or specific code to describe the concept
3. Workplace - This is where you will create personal folders for storing your queries.
4. Previous Queries - This pane shows a log of previous queries for the current user.
5. Query Tool - This is your main work area where you will define and refine the criteria for your query.
6. Query Status - You will be able to monitor progress and see results in this pane.
Navigate Terms

The numbers after the folders and/or concepts is the count of unique patients who have that documented.
To expand a folder, click the (+) and to close, click the (-)
Resize Workspace

The Resize Workspace icon will toggle between the default tabbed pane size and a vertically expanded view of the pane. This can help minimize the amount of vertical scrolling. Any tabbed pane that includes this Resize Workspace icon will allow you to expand the tab vertically to the full available height of the browser window. This is a very useful option!
Constructing and Running your Query

Selecting Query Criteria

The Navigate Terms pane provides a hierarchical tree of search concepts that can be used to find and specify query criteria. You can search through demographics, diagnoses, vitals, problems, procedures, and features of the visit.

Building Your Query (with a worked example)

Imagine that you want to conduct a trial of a new migraine drug and are designing your study and recruitment plan. You may want to know: how many patients in our database are women, 18 years or older, get migraine headaches with auras (ICD9 codes: 346.0, 346.00, 346.01, 346.02, 346.03), and who are not currently pregnant? Follow the pink boxes to see follow a sample cohort query.

Once you find the concept in the Navigate Terms or Find Terms tabbed pane,
1. Click, hold and drag the term from the Navigate Terms pane.
2. Drop it into the next available Group panel (e.g. Group 1 below) this will add it to the active query criteria.
• The search will turn up cases that meet any one of the criteria dropped into a single Group. In logical terms, these items are grouped by “OR”. A green informational message will pop up to remind you of this relationship; it will say “one or more of these”. In the example below, a patient will be included if she has any of the migraine diagnoses listed in Group 2.

• The criteria in one Group will be treated as an “AND” with items in another Group. In other words, both Groups will have to be true. In the example, the patients will have be female and have one of the diagnoses in Group 2.

Remember: Criteria placed in the same Group are evaluated to see if any one of them is true. In most cases, each demographic category should get its own group. So, for example, you would not place Gender criteria and Language criteria in the same group, or else you will get—say—patients who are either Female or speak Dutch.
Using “Find” Terms to Help Develop Your Query

Although Navigate Terms can often be used as the primary tool to build a query, Find Terms offers additional options for finding the criteria you need. These options include Search by Names and Search by Codes. Using Search by Names, you can find your query terms by searching for full words, partial words or phrases.

A pull-down menu allows you to choose what sort of match you want between the terms that are found and the words/phrase you have entered. You can choose: Containing, Exact, Starting with, or Ending with.

After selecting Find Terms, make sure you select Search by Names (it will be shown in lighter-greener shade of blue). Once you enter the search terms, click the Find button.

Here we have found the ICD9 codes for migraine headaches by using: Find Terms > Search by Name.
A second pull-down menu allows you to indicate the category of the term you are seeking. For example, in the search above for terms related to “migraine”, the option “Diagnoses ICD9” was chosen.

If your initial search turns up no matches, try using different names for the condition or therapy you are seeking. For example, many cancers are referred to “malignant neoplasms” in the Diagnoses ICD9 vocabulary.

If you know the code you are looking for and don’t want to have to navigate the hierarchy in the **Navigate Terms** tab, you can use the **Search by Codes** option under **Find Terms**. Make sure you click on **Search by Codes** after selecting **Find Terms**.

As with searching by names, when searching by codes, you have the option of limiting the search to certain categories.
Find Terms > Search by Codes only works if you provide the exact code. If you would like to search for terms using a code, but want to find all ICD9 or CPT codes that include a string (for example, you want all codes that have “346.” as part of the code including 346.00, 346.01, 346.02, etc.), you can use the Search by Names option and enter the code string. This works because all the terms that are searched by name include the code as part of the name. For example, “346.03 Migraine with aura, with intractable migraine, so stated, with status migrainosus”.

💡 Note that the Find Terms mode of finding criteria for your search does not allow you to specify modifiers (i.e. principal vs. secondary diagnosis) for your diagnostic criteria. However, if you mouse-over the folder icon to the left of a term once you have found it, you’ll see the full pathway for the term within the code hierarchy. You can use that information to go back to the Navigate Terms mode, navigate to the terms you are interested in, and select the modifiers you want.

**Demographics**

The age field searches for the patient’s age today (at the time of the search) as opposed to the age at the time of the clinical encounter.
Editing Your Query

1. To delete a criterion you have already dropped into a group, right-click on the icon to the left of the term and select **Delete**. (See number 1 in red circle below.)
2. To delete a whole group, click on the X on the upper right-hand corner of the Group box.
3. To create a new Group, which will appear to the right of the existing Groups, click **New Group**.
4. To clear all search information that is currently in the Groups of the **Query Tool** pane, click **Clear**.
Refining Your Query

Constraining Dates of Encounter

In some cases you will choose to restrict your search to encounters that took place within a certain time period. To include only certain dates, click on Dates at the top left of the given Group panel (see 1 in figure). A pop-up window will allow you to specify the date range (2) and once the dates are selected the word Dates will be underlined in the panel (1). Note that the date constraint function works best when applied to the diagnoses or procedures.
Adding Exclusion Criteria

You can create a group of criteria and then click **Exclude** (3) to exclude all patients that meet any of the criteria in the list. A pink informational message (4) reminds you that “none of these” will be included.

Here we exclude patients with pregnancy in their medical record.
Multiple Occurrences

In some cases you may choose to make your selection criteria more conservative (more specific) by choosing only to include patients who have a particular diagnosis (or treatment, etc.) in their record more than once. To do so, click on Occurs > 0x (see 1 in figure). The constraint window will pop up where you can specify the number of occurrences (2). The label on the group will change to reflect the additional constraint (1).
Running Your Query

Click on **Run Query** at the bottom of the Query Tool pane.

"Run Query" windows will pop-up. Before clicking **OK** you can rename the query. You may want to do this for easier reference when you retrieve the query at a later time. We recommend that you leave the time of the query (to the right of the "@").
Query Status Tab

The Query Status panel shows the result of the query for the aggregate number of potential patients. A query that returns results below a certain threshold will be obfuscated so that it is true to within 3 patients.

```plaintext
Finished Query: "Female -346.0: @15:05:59"
Compute Time: 5.3 secs

Number of patients for "Female -346.0: @15:05:59"
patient_count: 1492
```
Advanced Query Tools

Previous Queries

Every time you run a query it is listed in the Previous Queries tab of your workbench screen. It will be assigned a default name that includes the time it was run, unless you specified a new name before running the query. You can rename a query once it is logged in the list of Previous Queries.

You may want to retrieve a previous query to see the results again or to tweak some parameters and run the modified query. To do either of those, select the query in the Previous Queries tab, drag it to the text box labeled Query Name, and click the Run Query button. See screen shot below.

Temporal Constraint

In the default situation, all of the groups have to be true for a patient in order for the patient to be counted towards your cohort (this is the “AND” between the group panels) and the truth value of each group is found independent of the other groups. However, you have the option to constrain the query so that the groups will only be true if their events coincide with the timing of events in another group. So, for example, if you have entered a list of diagnosis codes in Group 1 and a list of procedure codes in Group 2, you can constrain the search for patients to those who have documented procedures in Group 2 during the same encounters when the diagnoses in Group 1 were documented in their record.
The option to constrain the criteria to common encounters, can be found in the pull-down menu for the **Temporal Constraint** (see 1 in the figure below) field in the Query Tool pane. The default is “Treat all groups independently.” You can choose “Selected groups occur in the same financial encounter” (2). Once you select the “same financial encounter” option, the headings of all the Group boxes with change to, “Occurs in Same Encounter” (3). Note that there is a bug in the software that sometimes causes problems when “Occurs in Same Encounter” is applied to a group that contains Demographics criteria. Therefore, we advise that you go to the heading of groups that include Demographics criteria and turn the heading (in the white bar) back to “Treat independently”. See, for example, Group 1 in the figure below. We are working on having this problem fixed.
Tips for Optimizing your Query

To optimize the search time for your query, choose the most restrictive criteria as your first Group and move to increasingly broad categories as you move to the right.

For example, if you are searching for males in their early 20’s who have broken their knee caps, the best way to construct the query is shown in the figure below. Group 1 narrows the cohort to only patients who have broken their patella (knee caps), Group 2 selects those aged 20-25 within that group, and Group 3 selects only the males from within that cohort.
Using Previous Queries

Users can drag a query from Previous Queries to the “Query Name” in the Query Tool to reload them.

Users may also drag a previous query into the query criteria and use it as a constraint like any concept. (For example: patients must be in the results of this previous query (in group 1) AND be 18-34 years of age (in group 2).

Previous Query Options: Users can set the display for the previous queries to show more queries, or change the sort order.
**Workplace:** the user can drag previous queries to their workspace in order to organize and keep track of important queries, final results, etc.

Additional folders can be created by right clicking on any folder in the workplace.

Queries in either the Workplace or the Previous Queries can be renamed at any time.
Example

White, not Hispanics with an allergy to penicillin

Number of patients

184

For Query "Not H-White-Penic@09:46:39"
Clicking the Print Query icon just above the results box shows the detail criteria of the query as well as the results.

<table>
<thead>
<tr>
<th>Group 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Path</strong></td>
<td><strong>Concept/Term</strong></td>
<td><strong>Other Information</strong></td>
</tr>
<tr>
<td>patient_information\patient_demographics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>patient_gender\patient_gender_female</td>
<td>Female Gender</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Path</strong></td>
<td><strong>Concept/Term</strong></td>
<td></td>
</tr>
<tr>
<td>Diagnosis\International classification of diseases\International classification of diseases [ninth edition]\001-999.99: diseases and injuries...\346.346.0: migraine with aura</td>
<td>346.0: Migraine with aura</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 3</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Path</strong></td>
<td><strong>Concept/Term</strong></td>
<td><strong>Other Information</strong></td>
</tr>
<tr>
<td>Diagnosis\International classification of diseases\International classification of diseases [ninth edition]\001-999.99: diseases and injuries\600-679.99: complications of pregnancy, childbirth, and the puerperium\650-650.00: normal delivery, and other indications for care in pregnancy, labor, and delivery</td>
<td>650-650.00: Normal delivery, and other indications for care in pregnancy, labor, and delivery</td>
<td></td>
</tr>
<tr>
<td>diagnosis_information\ccs_codes\ccs_dx_code\DX11\DX1104</td>
<td>Indications for care in pregnancy, labor, and delivery</td>
<td></td>
</tr>
</tbody>
</table>
Time Out Message:

![Image of Session Timing Out dialog box]

Error messages should not appear when everything is up and running.
Additional Help

Additional online help for the general i2b2 tool is available from the i2b2 organization and can be accessed by clicking Help in the upper right-hand side of the workbench.

If you would like an in-person demonstration of i2b2, please register to attend a regularly scheduled i2b2 course (https://is.gd/regi2b2) or submit a BMI Consult form.

If you have further questions, call the UW Health Help Desk at (608) 265-7777 (or 1-888-443-5511). You will be routed to the i2b2 team.

We will do our best to respond to your inquiry within 2-3 business days.