

TIES Cancer Research Network (TCRN) ITCR 2017 Meeting – Santa Cruz U24 CA 180921

May 31st 2017

Mike Becich, MD PhD – New TCRN PI



TIES^{v5}
information extraction



University of Pittsburgh
BIOMEDICAL INFORMATICS

Becich Conflicts of Interest (Disclaimer)

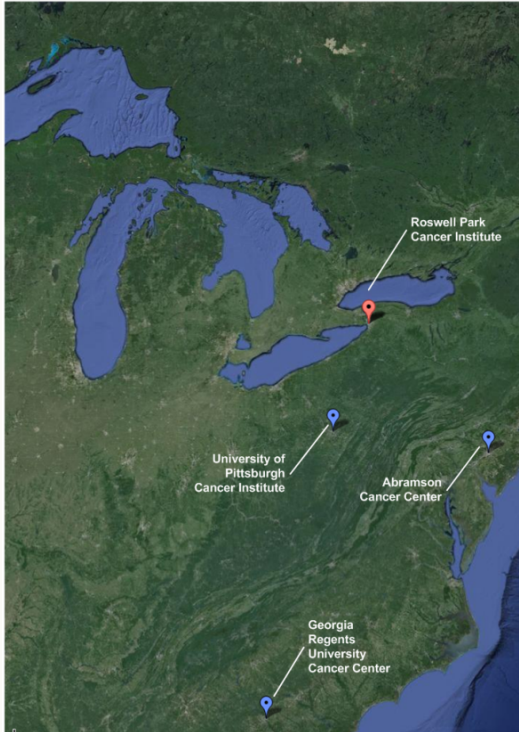
- SPDx (founder and stock) – computational pathology company
- Cancer Center Consultancies and EABs – Baylor, University of Colorado, University of Michigan and Wake Forest
- CTSA Consultancies and EABs – numerous (not a conflict for this talk except possibly for U of Chicago Institute for Translational Medicine)

Disclaimer – I am a member of NCI's Board of Scientific Advisors

What is TIES?

- An **NLP and IR system** for de-identifying, annotating, storing and retrieving pathology and radiology documents
- A system for **indexing research resources** (FFPE, FF, images) with document annotations
- An **GUI for querying** large repository of annotated documents and obtaining resources locally, using an honest broker model
- A platform to support **data and biospecimen sharing** among networks of cancer centers and other institutions

TIES Cancer Research Network



- University Pittsburgh Cancer Institute
- Abramson Cancer Center (Penn)
- Roswell Park Cancer Institute
- Georgia Regents Cancer Center
- **New partners are getting ready to join**
- Network Trust Agreements
 - IRBs agree that use of data for investigators is NHSR, no need for an additional IRB protocol even to access record level de-id data
 - Governance
 - Agreement to abide by SOPs
 - Instrument of Adherence

Table 2. TCRN case statistics for numbers of patients and cases (A) and the number of cases of rare tumors (B) and common cancer categories (C) based on final diagnosis

	GRU	RPCI	ACC	UPCI	Total
A. Case statistics					
Patients	76,404	72,376	465,717	1,840,156	2,454,653
Pathology cases	157,316	156,555	857,681	4,588,017	5,759,569
B. Rare tumors					
Adenoid cystic carcinoma	41	88	404	509	1,042
Adrenocortical carcinoma	5	20	59	63	147
Alveolar soft part sarcoma	3	15	10	25	53
Angioimmunoblastic lymphadenopathy	12	35	58	84	189
Chordoma	5	14	124	245	388
Follicular dendritic cell sarcoma	2	2	8	13	25
Merkel cell carcinoma	9	72	165	196	442
Ovarian granulosa cell tumor	4	10	23	34	71
Phaeochromocytoma	15	38	272	164	489
Pleomorphic xanthoastrocytoma	2	5	12	53	72
Pseudomyxoma peritonei	6	36	46	129	217
Rhabdomyosarcoma	34	70	86	270	460
Sebaceous adenocarcinoma	13	33	26	94	166
Sinonasal undifferentiated carcinoma	2	6	31	27	66
Thymoma	13	45	433	210	701
C. Common cancer categories					
Bladder carcinoma	345	1,618	3,873	6,711	12,547
Breast carcinoma	1,143	9,605	28,262	37,691	76,701
Colorectal carcinoma	465	2,530	6,898	11,608	21,501
Endometrial carcinoma	394	1,815	3,707	7,706	13,622
Esophageal carcinoma	63	1,477	2,452	3,514	7,506
Hepatic carcinoma	153	633	2,912	5,720	9,418
Lung carcinoma	820	4,264	10,208	17,955	33,247
Lymphoma	1,387	6,795	10,605	15,689	34,476
Malignant glial neoplasm	242	292	2,198	4,943	7,675
Malignant melanoma	335	2,675	5,180	7,068	15,258
Ovarian carcinoma	503	2,872	4,659	6,446	14,480
Pancreatic carcinoma	162	740	1,866	3,622	6,390
Prostate carcinoma	903	3,612	18,867	19,445	42,827
Renal cell carcinoma	364	1,319	3,183	10,950	15,816
Thyroid carcinoma	474	1,236	7,681	12,387	21,778

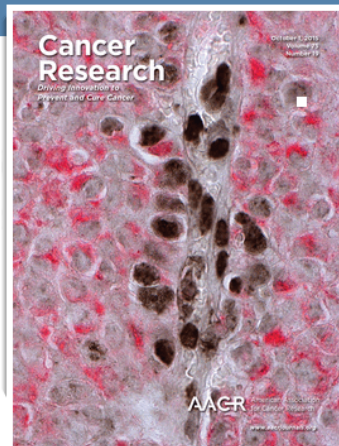
Use in Tissue Bank

- Honest Broker functionality is the key
- Order biospecimens and images from within TIES, or export manifest for another system
- Tags, Structured Data can be used to import info from LIMS, enabling search from within TIES
- Whole Slide Images
- Next phase of deliverables includes Computational Pathology Support

Cancer Research

The Journal of Cancer Research (1916–1930) | The American Journal of Cancer (1931–1940)

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• [View the Most-Cited Articles of Cancer Research](#)

Resource

A Federated Network for Translational Cancer Research Using Clinical Data and Biospecimens

Rebecca S. Jacobson¹, Michael J. Becich¹, Roni J. Bollag², Girish Chavan¹, Julia Corrigan¹, Rajiv Dhir¹, Michael D. Feldman³, Carmelo Gaudioso⁴, Elizabeth Legowski¹, Nita J. Maihle², Kevin Mitchell¹, Monica Murphy⁴, Mayurapriyan Sakthivel⁴, Eugene Tseytlin¹, and JoEllen Weaver³

Abstract

Advances in cancer research and personalized medicine will require significant new bridging infrastructures, including more robust biorepositories that link human tissue to clinical phenotypes and outcomes. In order to meet that challenge, four cancer centers formed the Text Information Extraction System (TIES)

policies, and procedures, enable regulatory compliance. The TIES Cancer Research Network now provides integrated access to investigators at all member institutions, where multiple investigator-driven pilot projects are underway. Examples of federated search across the network illustrate the potential impact on

Cancer
Research

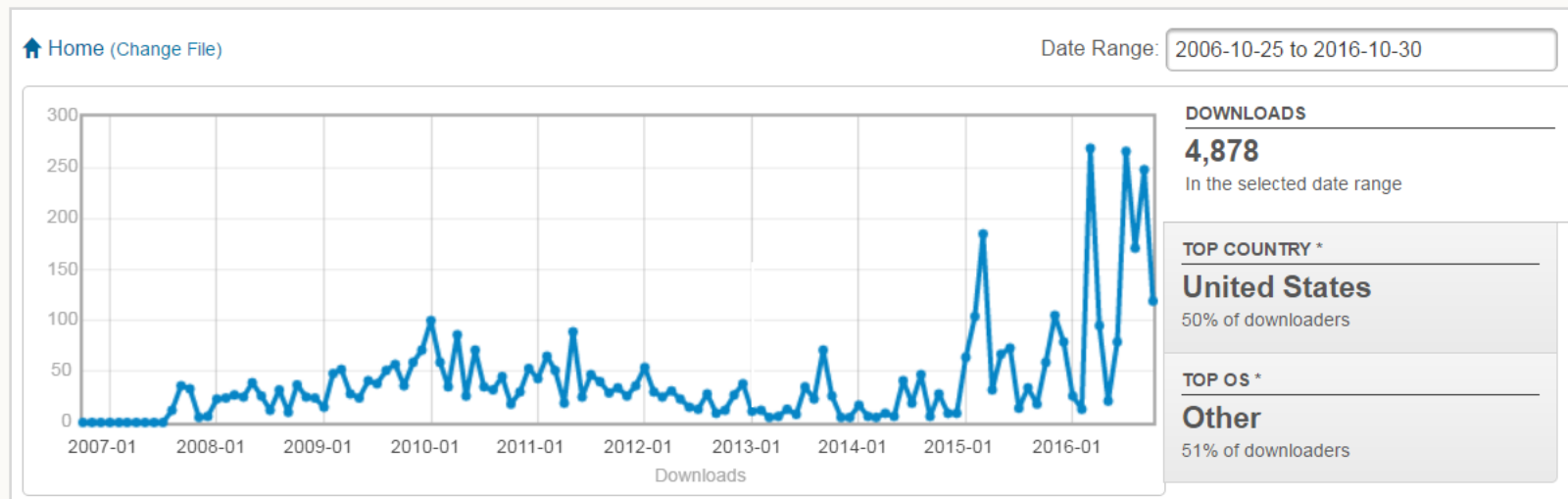


TIES^{v5}
information extraction



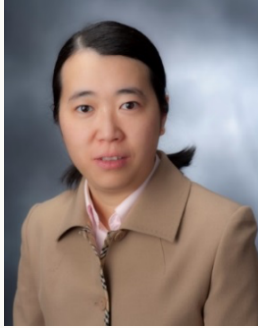
University of Pittsburgh
BIOMEDICAL INFORMATICS

TIES Downloads



ITCR

Example of TCRN Pilot Project



UPCI Investigator Yang Liu, PhD

Published OnlineFirst September 17, 2015; DOI: 10.1158/0008-5472.CAN-15-1274

Integrated Systems and Technologies

Cancer
Research

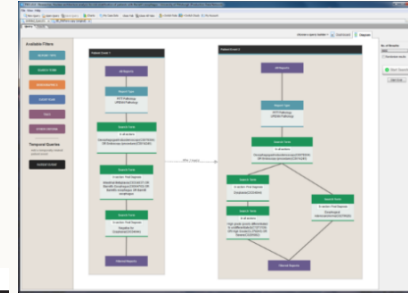
Early Prediction of Cancer Progression by Depth-Resolved Nanoscale Mapping of Nuclear Architecture from Unstained Tissue Specimens

Shikhar Uttam¹, Hoa V. Pham¹, Justin LaFace¹, Brian Leibowitz^{2,3}, Jian Yu^{2,3},
Randall E. Brand⁴, Douglas J. Hartman², and Yang Liu^{1,4,5}

Abstract

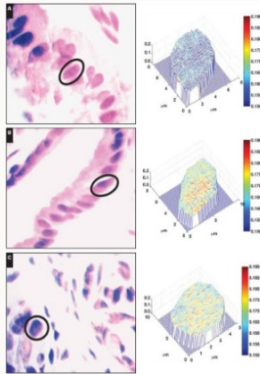
Early cancer detection currently relies on screening the entire at-risk population, as with colonoscopy and mammography. Therefore, frequent, invasive surveillance of patients at risk for developing cancer carries financial, physical, and emotional burdens because clinicians lack tools to accurately predict which patients will actually progress into malignancy. Here, we present a new method to predict cancer progression risk via nanoscale nuclear architecture mapping (nanoNAM) of unstained tissue sections based on the intrinsic density alteration of nuclear structure rather than the amount of stain uptake. We demonstrate that nanoNAM detects a gradual increase in the density alteration of nuclear architecture during malignant transformation in animal models of colon carcinoma

genesis and in human patients with ulcerative colitis, even in tissue that appears histologically normal according to pathologists. We evaluated the ability of nanoNAM to predict "future" cancer progression in patients with ulcerative colitis who did and did not develop colon cancer up to 13 years after their initial colonoscopy. NanoNAM of the initial biopsies correctly classified 12 of 15 patients who eventually developed colon cancer and 15 of 18 who did not, with an overall accuracy of 85%. Taken together, our findings demonstrate great potential for nanoNAM in predicting cancer progression risk and suggest that further validation in a multicenter study with larger cohorts may eventually advance this method to become a routine clinical test. *Cancer Res* 75(22): 4718–27. ©2015 AACR.



Doubled
Study N using
TCRN

UPMC: 46
Penn: 44



TIES v5.4 - Researcher, Nuclear architecture analysis for risk stratification of patients with Barrett's esophagus - University of Pittsburgh (Production Data Network)

File View Help

New Query Open Query Save Query Charts My Case Sets Close Tab Close All Tabs Switch Role Switch Study My Account

Unzipped_Query01 x BE_PittPenn copy (original) x

Query Results

choose a query builder > Dashboard Diagram

Available Filters

REPORT TYPE

SEARCH TERM

DEMOGRAPHICS

EVENT YEAR

TAGS

OTHER CRITERIA

Temporal Queries

Add a temporally related patient event

PATIENT EVENT

Patient Event 1

All Reports

Report Type
PITT Pathology
UPENN Pathology

Search Term
In all sections
Oesophagogastroduodenoscopy(C0079304)
OR Endoscopy (procedure)(C0014245)

Search Term
In section: Final Diagnosis
Intestinal Metaplasia(C0334037) OR
Barrett's Esophagus(C0004763) OR
Barrett's esophagus OR Barrett
esophagus

Search Term
In section: Final Diagnosis
Negative for
Dysplasia(C0334044)

Filtered Reports

After 1 Year(s)

Patient Event 2

All Reports

Report Type
PITT Pathology
UPENN Pathology

Search Term
In all sections
Oesophagogastroduodenoscopy(C0079304)
OR Endoscopy (procedure)(C0014245)

Search Term
In section: Final Diagnosis
Dysplasia(C0334044)

Search Term
In section: Final Diagnosis
Esophageal
Adenocarcinoma(C0279628)

Search Term
In section: Final Diagnosis
High grade (poorly differentiated
to undifferentiated)(C1273126)
OR High Grade(CL378245) OR
Severe(C0205082)

Filtered Reports

No. of Results:
5000

☐ Randomize results

Start Search

Start Over



Examples of Research Project

Thaer Khoury, MD

Roswell Park Cancer Institute



American Joint Committee on Cancer

Breast Cancer Staging

7th EDITION

T1 $>10-20\text{ mm}=T1c$
 $>1-5\text{ mm}=T1a$
 $>5-10\text{ mm}=T1b$

T2 $>20-50\text{ mm}$
T3 $>50\text{ mm}$

T4a Direct extension to chest wall not including pectoralis muscle.

Primary Tumor (T)

Tx Primary tumor cannot be assessed
T0 No evidence of primary tumor
Tis Carcinoma in situ
Tis (DCIS) Ductal carcinoma in situ
Tis (LCIS) Lobular carcinoma in situ

Tis (Paget's) Paget's disease of the nipple NOT associated with invasive carcinoma and/or carcinoma in situ (DCIS and/or LCIS) in the underlying breast parenchyma. Carcinomas in the breast parenchyma associated with Paget's disease are categorized based on the size and characteristics of the parenchymal disease, although the presence of Paget's disease should still be noted

T1 Tumor $\leq 20\text{ mm}$ in greatest dimension
T1mi Tumor $\leq 1\text{ mm}$ in greatest dimension
T1a Tumor $> 1\text{ mm}$ but $\leq 5\text{ mm}$ in greatest dimension
T1b Tumor $> 5\text{ mm}$ but $\leq 10\text{ mm}$ in greatest dimension
T1c Tumor $> 10\text{ mm}$ but $\leq 20\text{ mm}$ in greatest dimension
T2 Tumor $> 20\text{ mm}$ but $\leq 50\text{ mm}$ in greatest dimension
T3 Tumor $> 50\text{ mm}$ in greatest dimension

T4 Tumor of any size with direct extension to the chest wall and/or to the skin (ulceration or skin nodules). Note: Invasion of the dermis alone does not qualify as T4
T4a Extension to the chest wall, not including only pectoralis muscle adherence/invasion
T4b Ulceration and/or ipsilateral satellite nodules and/or edema (including peau d'orange) of the skin, which do not meet the criteria for inflammatory carcinoma
T4c Both T4a and T4b
T4d Inflammatory carcinoma (see "Rules for Classification")

TIES v5.31 - Researcher, Khoury, T_BDR 054114_Ulceration - University of Pittsburgh (Production Data Network)

File View Help

New Query Open Query Save Query Charts My Case Sets Close Tab Close All Tabs Switch Role Switch Study My Account

Untitled_Query01 x BRCA Ulceration Query x

Query Results

choose a query builder Dashboard Diagram

Available Filters

- REPORT TYPE
- SEARCH TERM
- EVENT YEAR
- TAGS
- GENDER
- AGE

Temporal Queries

Add a temporally related patient event

PATIENT EVENT

All Reports

Report Type

RPCI Pathology
PITT Pathology

Search Term

In section: Final Diagnosis
breast carcinoma(C0678222)

Search Term

In section: Final Diagnosis
ulceration(C0041582) OR Skin Ulcer(C0037299) OR Nipple Ulceration(C0235990)

Filtered Reports

UPCI and RPCI

Breast Carcinoma in Final Diagnosis (expands via NCIT)

Ulceration in Final Diagnosis (no negation)

No. of Results: 50

☐ Randomize results

Start Search

Start Over

Plans for Y4

ID	Specific Aim/Sub Aim	Duration	2013	2014				2015				2016				2017				2018		
			Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1	1.1 Implement "trust framework"; support regulatory workflow	131.43w																				
2	1.2 Paraffin registry development functionali	137.14w																				
3	1.3 TMA development functionality	130.29w																				
4	1.4 Virtual slide visualization	88.86w																				
5	2.1 Install TIES 5.2 at all sites	39.43w																				
6	2.2 Establish and maintain governance structure	261.86w																				
7	2.3 Execute trust agreements	48.29w																				
8	2.4 Develop and refine policies and processes	170w																				
9	3.1 Initial set of Pilot Projects	75w																				
10	3.2 Additional Pilot Projects	160w																				
11	4.1 Software releases (at least 2/year)	263.57w																				
12	4.2 Develop deployment and connection blueprints	75.71w																				
13	4.3 Dissemination activities	263.57w																				
14	4.3 Measure impact of TCRN	190w																				

Work to complete

Help with LIMS Integration
 Cancer Registry Integration
 New NobleCoder Integration
 Image Annotation Tools
 Computational Pathology framework
 Optional additional de-identifier

Other goals

Publications from users
 Dissemination at all sites
 Additional adoptions at other institutions

Adding Cancer Registry Data to TIES

- Identified as a high value development target from users
- We have secured additional funding from or Institution for Precision Medicine in Pittsburgh
- Senior Developer Mike Davis leads this effort.
- Starting with Breast Cancer first
- Work that we do here can immediately be leveraged by all of you to similarly add CR data to your TIES instances
- Result = deeper patient annotation and outcomes data

Data Elements

Demographics	Primary	Treatment	Outcome
Race	Primary Site	Surgery	Vital Status
Gender	Histology	Chemotherapy	Cancer Status
Age @ Diagnosis	Grade	BRM	Recurrence
Smoking	Path TNM	Hormonal	Cause of Death
Alcohol	Clinical TNM	Immunotherapy	
	Prognostic Factors (including site specific)	Rad Onc	

Version Release 5.7 Coming Soon

Winter 2016 Release – v5.7 – Anticipated June. 2017

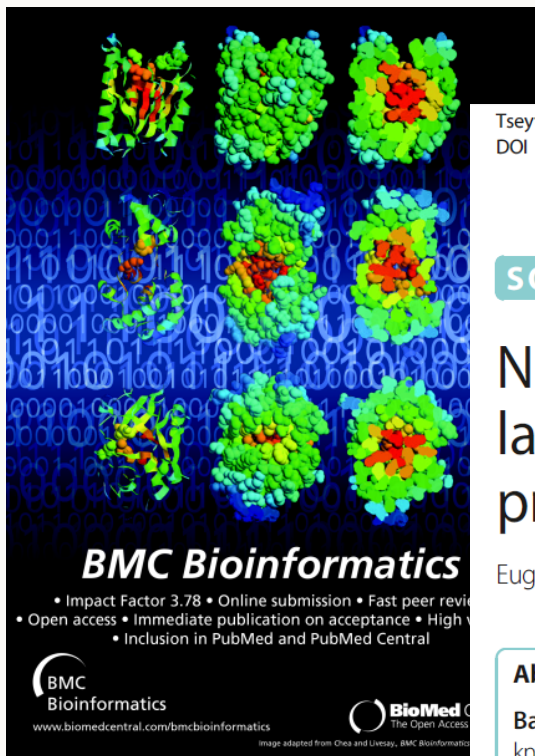
- Improved structured data import to support large batches and grouped data elements.

Backlog

- TMA support
- Expose uncertainty and temporality in search
- Standardize MetriQ data across sites for loading into TIES
- Free alternative to De-ID
- Patient level visualization
- Show patient MRN in selection tree for HBs for case sets
- Remove outside consult from cases

Development Plans

- New Coding Pipeline
 - Integrate NobleCoder v1.1. More accurate coding, faster coding. Uncertainty, polarity, experimenter and temporality annotations.
 - Latest NCIM terminology with more fine tuned sources.
- Cancer Registry data integration
- Email based management of account review and approvals.
- Patient level search index and visualization
- Manual Annotation Tool Enhancements
 - Link report text annotations to data in form fields.
 - Intelligent auto-highlighting and filling of form fields.
 - Library of forms to choose from, making it easy to share and reuse previously created forms.



Tseytlin et al. *BMC Bioinformatics* (2016) 17:32
DOI 10.1186/s12859-015-0871-y

BMC Bioinformatics

SOFTWARE

Open Access



NOBLE – Flexible concept recognition for large-scale biomedical natural language processing

Eugene Tseytlin, Kevin Mitchell, Elizabeth Legowski, Julia Corrigan, Girish Chavan and Rebecca S. Jacobson*

Abstract

Background: Natural language processing (NLP) applications are increasingly important in biomedical data analysis, knowledge engineering, and decision support. Concept recognition is an important component task for NLP pipelines, and can be either general-purpose or domain-specific. We describe a novel, flexible, and general-purpose concept recognition component for NLP pipelines, and compare its speed and accuracy against five commonly used alternatives on both a biological and clinical corpus.

NOBLE Coder implements a general algorithm for matching terms to concepts from an arbitrary vocabulary set. The system's *matching options* can be configured individually or in combination to yield specific system behavior for a

TIES and the TIES Cancer Research Network

TIES Team

Girish Chavan
Eugene Tseytlin
Kevin Mitchell
Julia Corrigan
Liz Legowski

Adi Nemlekar
Yining Zhao
Vanessa Benkovich
Liron Pantanowitz
Rajiv Dhir

Roswell Park

Carmelo Gaudioso
Monica Murphy
Mayurapriyan Sakthivel
Amanda Rundell

GRU

Roni Bollag
Samir Khleif
Jennifer Carrick
Nita Maihle
And more.....

Penn

Michael Feldman
Nate DiGiorgio
Tara McSherry
Joellen Weaver

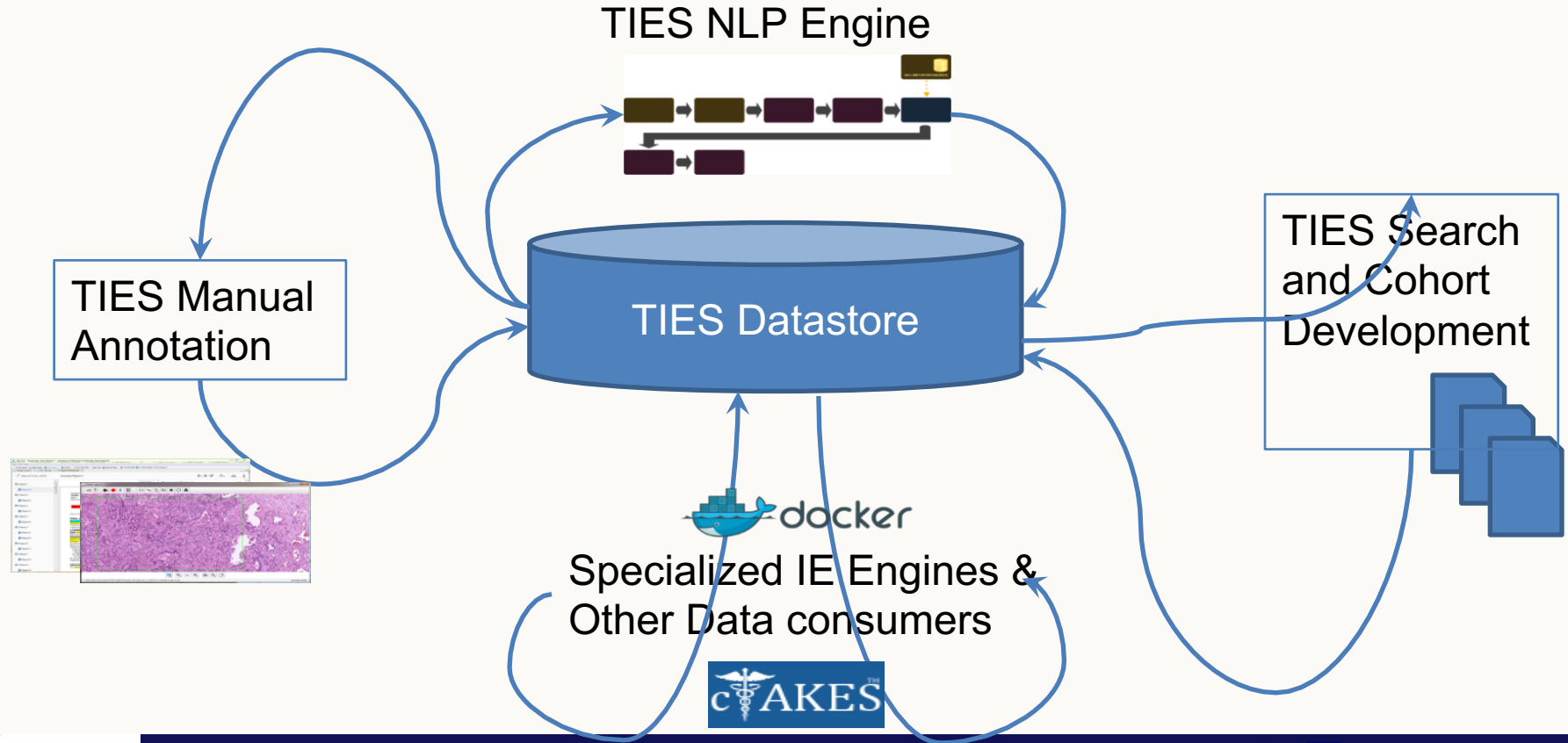
Funding

NCI U24 CA180921 Enhanced Development of TIES

Led by
Rebecca Jacobson, MD MSIS

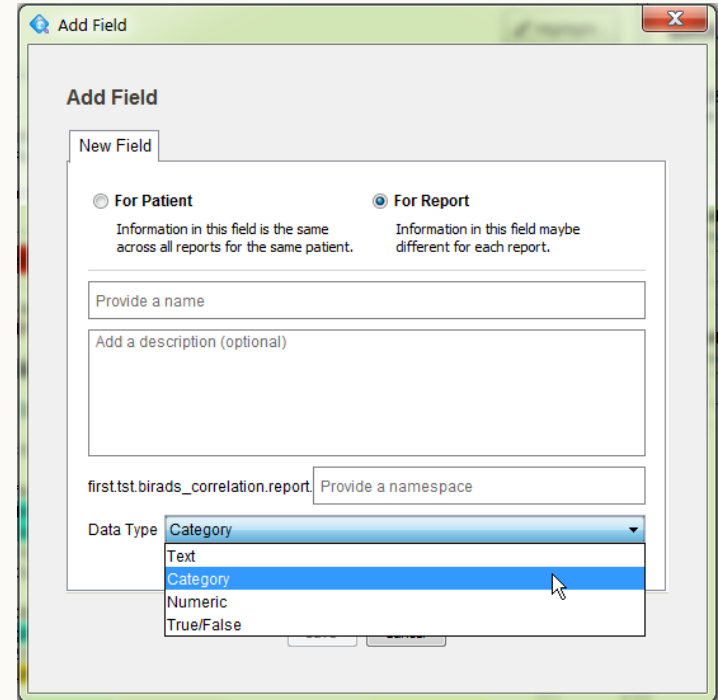
**I have some
pretty big shoes to fill...**

Annotation workflows



Manual Annotation Tool

- Allows you to manually enter structured data associated with case sets.
- Eliminates the need to store it in a separate spreadsheet as the expert reviews the reports.
- Data organized by forms and fields. Forms are study specific and can be shared with other study members or made public.
- Fields can be of Text, Number, Boolean and Category data types.
- Data is exported to Excel with each field stored in a separate column and a row for each report.
- Access the tool under the My Case Sets tab. Click Annotate from the Available Tasks menu under the name of the Case Set.



The screenshot shows a window titled "Add Field" with a close button in the top right corner. Inside the window, there is a tab labeled "New Field". Below the tab, there are two radio buttons: "For Patient" and "For Report". The "For Report" option is selected. Below the radio buttons, there are two columns of text: "Information in this field is the same across all reports for the same patient." and "Information in this field maybe different for each report." Below this, there is a text input field labeled "Provide a name". Below that is a larger text area labeled "Add a description (optional)". Below the description area, there is a text input field labeled "firsttst.birads_correlation.report" and a text input field labeled "Provide a namespace". Below these fields, there is a "Data Type" dropdown menu. The dropdown menu is open, showing a list of options: "Category", "Text", "Category", "Numeric", and "True/False". A mouse cursor is pointing at the "Category" option in the dropdown menu.

Manual Annotation Tool

TIES v5.6.2 - Researcher, Test Study - University of Pittsburgh (Test Data Network)

File View Help

New Query Open Query Save Query Charts My Case Sets Close Tab Close All Tabs Switch Role Switch Study My Account

Untitled_Query00 x My Case Sets x Second Test x

Second Test(0/2) Annotate Report 1

Text Data Images Highlight...

Patient 1 Report 1

Patient 2 Report 2

PATIENT ID: 4568716 DEIDENTIFIED ID: 4821464
GENDER: Male EVENT YEAR: 2002
RACE: Black or African American AGE AT EVENT: 76 Years
DATE OF BIRTH: -- de-identified -- TISSUE AVAILABILITY: Unknown

(Report de-identified by TIES)

PATHOLOGICAL DIAGNOSIS

A.B. BRAIN, SITE NOT SPECIFIED, EXCISIONAL BIOPSIES: GLOBLASTOMA MULTIFORME, MIB-1 PROLIFERATION INDEX: 14%.

SEE COMMENT.

Operation/Specimen: Brain.

Clinical History and Pre-Op Dx: with large heterogenous brain tumor. Past history of prostate cancer.

GROSS PATHOLOGY:

A. Received fresh, two fragments, 1.5 cm across in aggregate. Semi-firm, tanish-brown, focal necrosis. In total #1 and 2.

INTRAOPERATIVE CONSULTATION: Brain, smears: Spindle cell neoplasm (Glioma vs sarcoma, no carcinoma).

B.

SPECIMEN: Brain tumor.
FIXATIVE: None.
GENERAL: A. 4.3 x 3.3 x 1.0 cm. aggregate of brown-tan brain tissue with red clotted blood.
SECTIONS: X1-X3 - all submitted.

SPECIAL STAINS: Snook's reticulum, Masson's trichrome, and immunoperoxidase methods for GFAP, factor V and MIB-1 were performed on sections from block #4.

The Snook's and Masson's demonstrate reticulum fibers and collagen only in perivascular areas, and the GFAP demonstrates gliofibrillogenesis by

Form 1 Form 2

Form 1 Just for me

Is it true?
Check the box to indicate a true value.
☐ False ☐ Not Stated

This is a text box
Text Provide a text value.
 ☐ Not Stated

Category (For Patient)
Select a value from the list or provide a new one and press enter.
 ☐ Not Stated

Number
Number Provide a numeric value.
 ☐ Not Stated

ADD A FIELD

Annotation Options

True/False

Category

Various Field Annotation Options

Summary by Body System and Age at Diagnosis Report
UPMC Network Cancer Registry - Common Patients/Primaries Merged

Primary Site	Total	%	0 - 29	%	30 - 39	%	40 - 49	%	50 - 59	%	60 - 69	%	70 - 79	%	80 - 89	%	90+	%
Peritoneum, Omentum & Mesentery	392	0.2%	2	0.0%	4	0.1%	33	0.2%	73	0.2%	120	0.2%	105	0.2%	53	0.2%	2	0.1%
Other Digestive Organs	111	0.1%	0	0.0%	2	0.0%	9	0.0%	14	0.0%	24	0.0%	35	0.1%	23	0.1%	4	0.1%
RESPIRATORY SYSTEM	27,939	14.0%	69	1.3%	206	3.0%	1,328	6.6%	4,392	11.2%	8,110	16.0%	9,263	18.8%	4,223	16.5%	348	11.3%
Nose, Nasal Cavity & Middle Ear	487	0.2%	15	0.3%	32	0.5%	61	0.3%	120	0.3%	105	0.2%	89	0.2%	57	0.2%	8	0.3%
Larynx	2,203	1.1%	5	0.1%	33	0.5%	179	0.9%	524	1.3%	694	1.4%	537	1.1%	214	0.8%	17	0.6%
Lung & Bronchus	25,137	12.6%	26	0.5%	133	1.9%	1,075	5.4%	3,734	9.6%	7,294	14.4%	8,609	17.5%	3,944	15.4%	322	10.4%
Pleura	18	0.0%	1	0.0%	0	0.0%	1	0.0%	2	0.0%	3	0.0%	5	0.0%	5	0.0%	1	0.0%
Trachea, Mediastinum & Other Respir	94	0.0%	22	0.4%	8	0.1%	12	0.1%	12	0.0%	14	0.0%	23	0.0%	3	0.0%	0	0.0%
BONES & JOINTS	711	0.4%	245	4.6%	61	0.9%	74	0.4%	101	0.3%	94	0.2%	85	0.2%	49	0.2%	2	0.1%
Bones & Joints	711	0.4%	245	4.6%	61	0.9%	74	0.4%	101	0.3%	94	0.2%	85	0.2%	49	0.2%	2	0.1%
SOFT TISSUE	1,762	0.9%	224	4.2%	114	1.6%	247	1.2%	286	0.7%	312	0.6%	335	0.7%	208	0.8%	36	1.2%
Soft Tissue (including Heart)	1,762	0.9%	224	4.2%	114	1.6%	247	1.2%	286	0.7%	312	0.6%	335	0.7%	208	0.8%	36	1.2%
SKIN EXCLUDING BASAL & SQUAM	7,074	3.5%	498	9.3%	659	9.5%	1,095	5.5%	1,551	4.0%	1,321	2.6%	1,226	2.5%	652	2.5%	72	2.3%
Melanoma -- Skin	6,695	3.3%	481	9.0%	641	9.2%	1,063	5.3%	1,491	3.8%	1,252	2.5%	1,129	2.3%	583	2.3%	55	1.8%
Other Non-Epithelial Skin	379	0.2%	17	0.3%	18	0.3%	32	0.2%	60	0.2%	69	0.1%	97	0.2%	69	0.3%	17	0.6%
BASAL & SQUAMOUS SKIN	2	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	1	0.0%	0	0.0%
Basal/Squamous cell carcinomas of Sk	2	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.0%	1	0.0%	0	0.0%
BREAST	35,359	17.7%	145	2.7%	1,424	20.4%	6,304	31.5%	8,710	22.3%	8,417	16.6%	6,743	13.7%	3,233	12.6%	383	12.4%
Breast	35,359	17.7%	145	2.7%	1,424	20.4%	6,304	31.5%	8,710	22.3%	8,417	16.6%	6,743	13.7%	3,233	12.6%	383	12.4%
FEMALE GENITAL SYSTEM	14,435	7.2%	206	3.8%	729	10.5%	1,860	9.3%	3,464	8.9%	3,745	7.4%	2,816	5.7%	1,442	5.6%	173	5.6%
Cervix Uteri	1,851	0.9%	83	1.6%	353	5.1%	522	2.6%	356	0.9%	272	0.5%	182	0.4%	74	0.3%	9	0.3%
Corpus & Uterus, NOS	7,552	3.8%	17	0.3%	170	2.4%	749	3.7%	2,042	5.2%	2,311	4.6%	1,517	3.1%	683	2.7%	63	2.0%
Corpus Uteri	7,426		16		168		735		2,014		2,282		1,485		665		61	
Uterus, NOS	126		1		2		14		28		29		32		18		2	
Ovary	3,448	1.7%	84	1.6%	126	1.8%	420	2.1%	788	2.0%	825	1.6%	761	1.5%	392	1.5%	52	1.7%
Vagina	188	0.1%	0	0.0%	8	0.1%	17	0.1%	32	0.1%	41	0.1%	40	0.1%	40	0.2%	10	0.3%
Vulva	1,052	0.5%	16	0.3%	64	0.9%	131	0.7%	178	0.5%	180	0.4%	232	0.5%	216	0.8%	35	1.1%
Other Female Genital Organs	344	0.2%	6	0.1%	8	0.1%	21	0.1%	68	0.2%	116	0.2%	84	0.2%	37	0.1%	4	0.1%
MALE GENITAL SYSTEM	19,091	9.5%	325	6.1%	297	4.3%	684	3.4%	4,017	10.3%	7,095	14.0%	5,134	10.4%	1,427	5.6%	112	3.6%
Prostate	18,068	9.0%	6	0.1%	9	0.1%	498	2.5%	3,923	10.0%	7,047	13.9%	5,084	10.3%	1,395	5.5%	106	3.4%
Testis	871	0.4%	314	5.9%	282	4.0%	176	0.9%	74	0.2%	15	0.0%	6	0.0%	4	0.0%	0	0.0%
Penis	127	0.1%	1	0.0%	4	0.1%	4	0.0%	16	0.0%	30	0.1%	41	0.1%	26	0.1%	5	0.2%
Other Male Genital Organs	25	0.0%	4	0.1%	2	0.0%	6	0.0%	4	0.0%	3	0.0%	3	0.0%	2	0.0%	1	0.0%
URINARY SYSTEM	14,056	7.0%	133	2.5%	243	3.5%	923	4.6%	2,224	5.7%	3,565	7.0%	4,175	8.5%	2,471	9.7%	322	10.4%
Urinary Bladder	7,384	3.7%	22	0.4%	48	0.7%	282	1.4%	924	2.4%	1,759	3.5%	2,438	5.0%	1,665	6.5%	246	8.0%
Kidney & Renal Pelvis	6,144	3.1%	110	2.1%	193	2.8%	632	3.2%	1,257	3.2%	1,678	3.3%	1,554	3.2%	658	2.6%	62	2.0%
Ureter	426	0.2%	0	0.0%	2	0.0%	5	0.0%	30	0.1%	109	0.2%	151	0.3%	118	0.5%	11	0.4%
Other Urinary Organs	102	0.1%	1	0.0%	0	0.0%	4	0.0%	13	0.0%	19	0.0%	32	0.1%	30	0.1%	3	0.1%
EYE & ORBIT	361	0.2%	28	0.5%	11	0.2%	40	0.2%	46	0.1%	86	0.2%	103	0.2%	43	0.2%	4	0.1%
Eye & Orbit	361	0.2%	28	0.5%	11	0.2%	40	0.2%	46	0.1%	86	0.2%	103	0.2%	43	0.2%	4	0.1%
BRAIN & OTHER NERVOUS SYSTEM	6,703	3.4%	862	16.1%	477	6.8%	869	4.3%	1,323	3.4%	1,274	2.5%	1,137	2.3%	671	2.6%	90	2.9%