

**Title:** Searching Graphics and Text in Technical Documents: A Brief Overview and Plan

**Speakers:** Richard Zanibbi

**Collection/Series:** Theory + AI Symposium

**Date:** April 08, 2025 - 11:40 AM

**URL:** <https://pirsa.org/25040072>

**Abstract:**

What would effective and usable tools for searching text and graphics in research papers look like? In this talk we sketch a partial answer to this question, with reference to recent work in the Document and Pattern Recognition Lab at RIT. Two multimodal paper search prototypes, one for math (MathDeck) and one for chemistry (ReactionMiner search) will be used for illustration. A simple framework based on 'jars' of available information sources can organize and relate the actions performed by people and automated systems when retrieving, analyzing, and synthesizing sources. We will organize our answer sketch around this framework, and share open questions and research opportunities related to enhancing multi-modal search tools for expert and non-expert users.

Note: ReactionMiner was developed in collaboration with NCSA and the Han lab at the University of Illinois, Urbana-Champaign.

MathDeck demo: [[https://people.rit.edu/ma5339/mathdeck\\_landing](https://people.rit.edu/ma5339/mathdeck_landing)]([https://people.rit.edu/ma5339/mathdeck\\_landing](https://people.rit.edu/ma5339/mathdeck_landing))

ReactionMiner search demo:

[<https://reactionminer.platform.moleculemaker.org/home>](<https://reactionminer.platform.moleculemaker.org/home>)

**Biography:**

Richard Zanibbi is a Professor of Computer Science at the Rochester Institute of Technology (RIT, USA) where he directs the Document and Pattern Recognition Lab (dprl@RIT). His research focuses upon the recognition and retrieval of graphical notations, particularly for mathematics and chemistry. He is also a member of the Molecule Maker Lab Institute (MMLI), one of the first NSF AI Centers. He received his PhD from Queen's University (Canada), and was an NSERC Postdoctoral Fellow at the Centre for Pattern Recognition and Machine Learning (CENPARMI) at Concordia University before joining RIT.

# Searching Graphics and Text in Technical Documents

## A Brief Overview and Plan

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Director, Document and Pattern Recognition Lab ([dpri@RIT](mailto:dpri@RIT))  
Member, Molecule Make Lab Institute (**MMLI NSF AI Center @ UIUC**)  
**April 8, 2025**



# Motivation

What would **effective** and **usable** tools for **searching text and graphics** in research papers look like?



# Information Task Framework

## Information Tasks: The “Jar Model”

To characterize how sources are used when working with information, we adapt a framework commonly used for **sensemaking** tasks with three components.

- 1. Retrieval:** Locating relevant sources (**search**), and finding information in sources (**consulting**)
- 2. Analysis:** Organizing sources (**indexing**), and adding information to sources (**annotation**)
- 3. Synthesis:** Using available information from sources (**application**), and creating *new* sources (**synthesis**)



Zanibbi, R., Mansouri, B., and Agarwal, A. (2025) [Mathematical Information Retrieval: Search and Question Answering](#). [Foundations and Trends in Information Retrieval](#): Vol 19, No. 1-2, pp. 1-190.

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**Information Need:**

( **Background** ) Need description / question

**R1. Query**

- \_\_\_\_\_
- \_\_\_\_\_

**A1. Annotate**

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**S1. Apply**

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**R2. Consult**

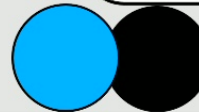
- \_\_\_\_\_
- \_\_\_\_\_

**A2. Index**

- \_\_\_\_\_
- \_\_\_\_\_

**S2. Communicate**

- \_\_\_\_\_



ReactionMiner

reactionminer-demo.platform.moleculemaker.org/reaction-miner

ReactionMiner. Chemical extraction, linking, and search

Tutorial About ReactionMiner

### Search Results

All Matches: 25 Documents: 1 Reactions: 5 Molecules: 10 Text: 10

**Document 1** Paper3\_Perspective\_2017

ineffective under these conditions. The synthesis of novel 2-arylflavonones was also reported from 2-trifluoroboratochromanone precursors (90).<sup>56</sup> Thus, in a relatively short time, single-electron transmetalation has emerged as a powerful platform for the design of new cross-coupling methods, affording access to unique products not easily obtained by traditional cross-coupling chemistry.<sup>53</sup> The ability to use these processes in the synthesis of highly enantioenriched products is certainly the next goal in this area. In addition to the opportunity to develop enantioconvergent protocols, this reaction scheme provides novel methods for differentiating between related C–B bonds based on their propensity to form

virtue of a protecting group on boron. After the desired coupling reaction, acid hydrolysis was employed to reveal the parent boronic acid which can be used for further cross-coupling.

Diborylated alkene **94**, in which one boron is protected by a dan group and the other as a pinacol ester,<sup>60</sup> was shown to undergo completely selective coupling at the internal Bpin group rather than the terminal Bdan. This is in sharp contrast to the excellent terminal selectivity observed in analogous bis(pinacolato)ester compounds,<sup>61</sup> a clear demonstration of the inhibitory effect of the Bdan group.

Burke's approach to boron protecting groups employed a

Extracted Matches(25)

1 Matched Keywords (0) TEXT

ll group demonstrated that invertive coupling could even be ed with an ester as the di recting group 37 b but only in ates such as 35 that are more reactive by virtue of having al boron substituents scheme 6 bottom .

**Reaction 4** REACTION

**Summary**

Reactants

diborylated alkene **94**

Products

**60**

**ent-30**

$$\text{Ar}^1\text{B}(\text{X})\text{Ar}^2 + \text{Ar}^3\text{OTf} \xrightarrow[\text{K}_2\text{CO}_3, \text{H}_2\text{O}]{\text{Pd}(\text{OAc})_2, \text{PCy}_3} \text{Ar}^1\text{Ar}^3\text{Ar}^2$$

$$\text{B}(\text{X}) = \text{B}(\text{F}_3\text{C})_2$$

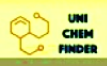
**Molecule 7** **60**

Shah, A.K., Dey, A., Luo, L., Amador, B., Philippy, P., Zhong, M. Ouyang, S., Friday, D.M., Bianchi, D., Jackson, N., Zanibbi, R., and Han, J. (2025) [Multimodal Search in Chemical Documents and Reactions](#). SIGIR 2025, Padua, Italy (to appear).



# UNICHEMFINDER

📖 How To 📄 About



cyclopropyl pyrazol oxy flourobenzonitrile prepared with pip

SMILES Query

Search

## Passage Results

**(5)** Rank: 3, Gene: GLP-1, PDF: WO2022040600A1.pdf, Page: 300 Expand View

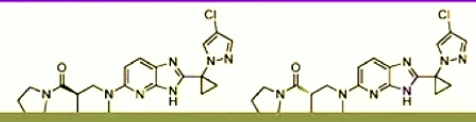
[0639] (S)-methyl 2-((4-(3-((4-cyano-2-fluorobenzyl)oxy)-4-isopropyl-1H-pyrazol-1-yl)piperidin-1-yl)methyl)-1-(oxetan-2-ylmethyl)-1H-benzo[d]imidazole-6-carboxylate (118d). To a mixture of 3-fluoro-4-(((4-isopropyl-1-(piperidin-4-yl)-1H-pyrazol-3-yl)oxy)methyl)benzonitrile (118c, 50 mg, 146.02 umol) in CH3CN (3 mL) was added K2CO3 (80.73 mg, 584.10 umol) at 20°C under N2 for 0.5 hour. Then (S)-methyl 2-(chloromethyl)-1-(oxetan-2-ylmethyl)-1H-benzo[d]imidazole-6-carboxylate (1k, 47.34 mg,

299



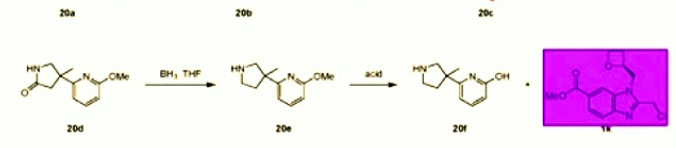
**(1)** Rank: 4, Gene: DGAT2, PDF: WO2013150416A1.pdf, Page: 246 Expand View  
LCMS retention time 4.739 min (Method R1).

Examples 216 and 217: ((3R,6S)-1-(2-(1-(4-chloro-1H-pyrazol-1-yl)cyclopropyl)-3H-imidazo[4,5-b]pyridin-5-yl)-6-methylpiperidin-3-yl)pyrrolidin-1-yl)methanone and ((3S,6R)-1-(2-(1-(4-chloro-1H-pyrazol-1-yl)cyclopropyl)-3H-imidazo[4,5-b]pyridin-5-yl)-6-methylpiperidin-3-yl)pyrrolidin-1-yl)methanone

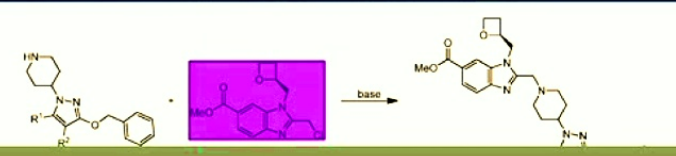


## Diagram Results

Page: 210  
IUPAC: (s)-methyl 2-(chloromethyl)-1-(oxetan-2-ylmethyl)-1h-benzo[d]imidazole-6-carboxylate Expand View  
SMILES: CICCC1=NC2=C(N1C[C@H]1OCC1)C=C(C=C2)C(=O)OC



Page: 130  
IUPAC: (s)-methyl 2-(chloromethyl)-1-(oxetan-2-ylmethyl)-1h-benzo[d]imidazole-6-carboxylate Expand View  
SMILES: CICCC1=NC2=C(N1C[C@H]1OCC1)C=C(C=C2)C(=O)OC



Dey, A., Stanley, N., and Zanibbi, R. *Targeted Multi-Modal Passage Search for Molecules and their Synthesis Pathways*. SIGIR 2025, Padua, Italy (to appear).







# Where to Next?

## A Sketch — Comments and Suggestions Welcome!

### Retrieval

- Improved graphics search (e.g., math formulas), **graphics + text** search, and **graphics ↔ text** search
- Search and navigation of **full models**, even across domains (e.g., for math; in progress w. Nickvash Kani, UIUC)
- Application to **Retrieval Augmented Generation (RAG)** for LLMs
- Conversational search, with interactive query intent clarification and refinement (per Star Trek)



# Where to Next?

## A Sketch — Comments and Suggestions Welcome!

### Synthesis

- **Online collection** for sharing/searching entity card collections (e.g., for MathDeck) or other small information ‘nugget’ sources
  - Q. Particularly useful in smaller community settings, e.g., classrooms and research labs?
- Improved **multi-modal search result pages** and graphics + text **navigation**



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Thank you for your attention.



MOLECULE  
MAKER LAB  
INSTITUTE



Document and Pattern Recognition Lab

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