Technology Tools for Research Integrity

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Research Integrity Specialist

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Technology tools used at every level

Institutional Level

- Data collection
- Data management and sharing
- Online training modules
- Auditing and Monitoring

Research Integrity Office Level

- Case management
- Email and data sequestration
- Forensic software
- Image manipulation detection
- Plagiarism detection
- AI

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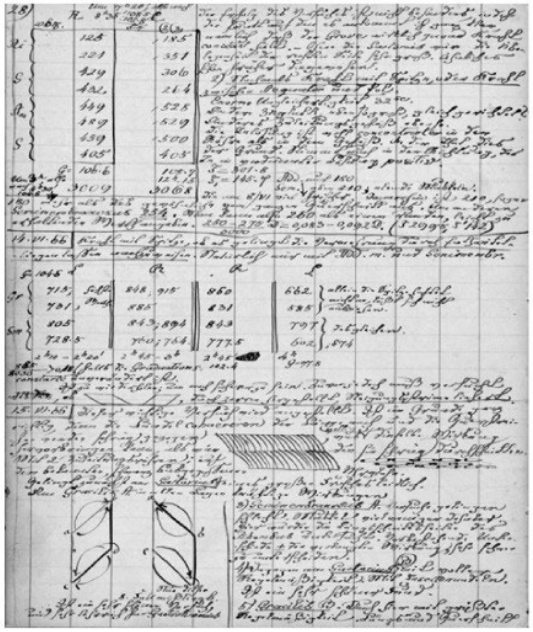
Data Collection

Electronic Lab Notebooks (ELN)

- Replicates much like a page in a paper notebook
- Enter protocols, observations, notes, data



A

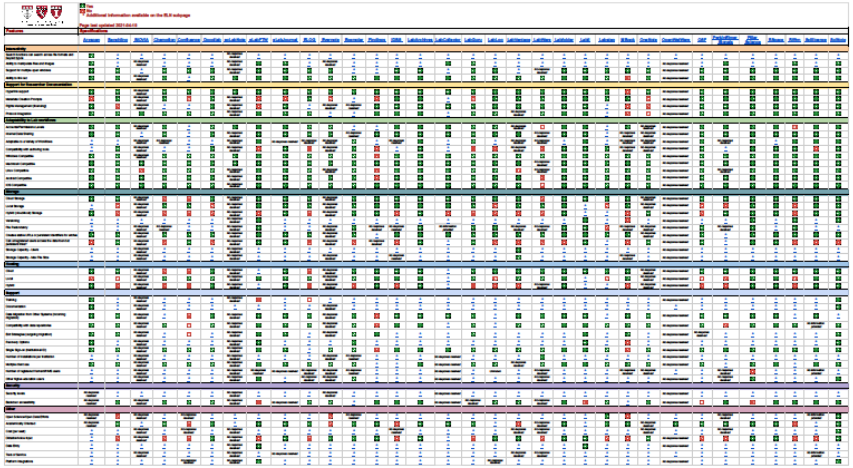
B

Dirnagl *et al.* 2016
Powell 2012

Selecting an ELN

Using an ELN facilitates good data management

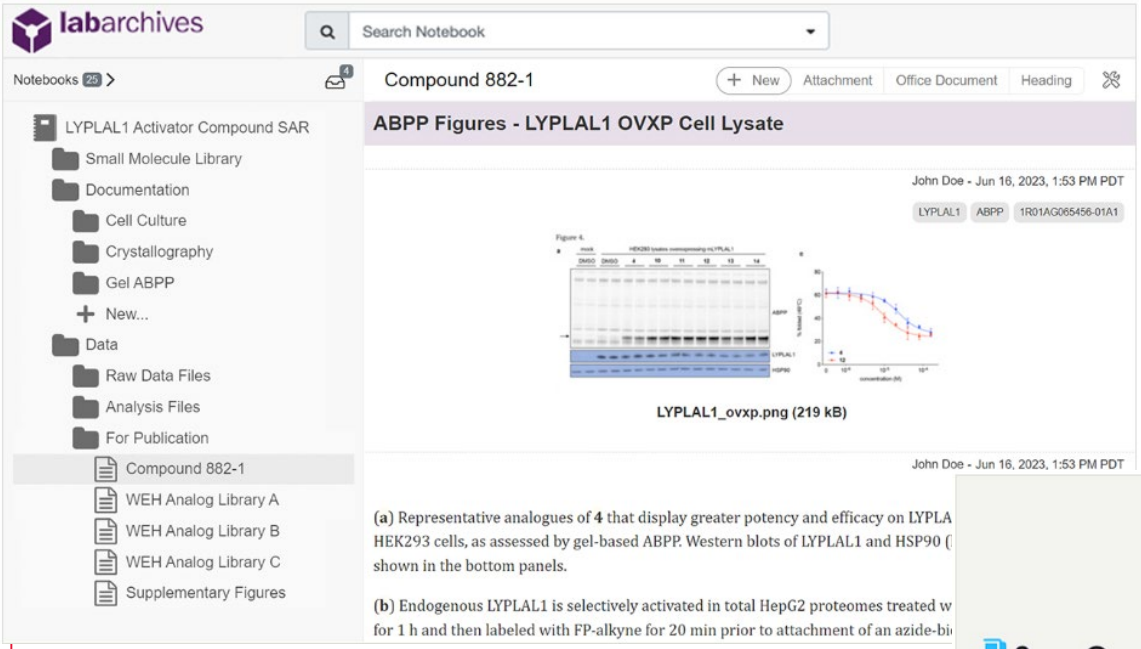
- Data security
- Supports auditing
- Promotes collaboration
- Manage inventories, supplies, equipment
- Integrates with common software

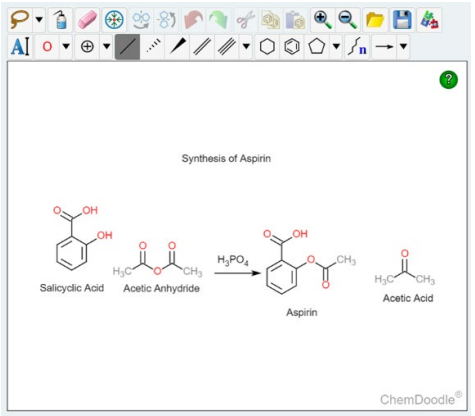


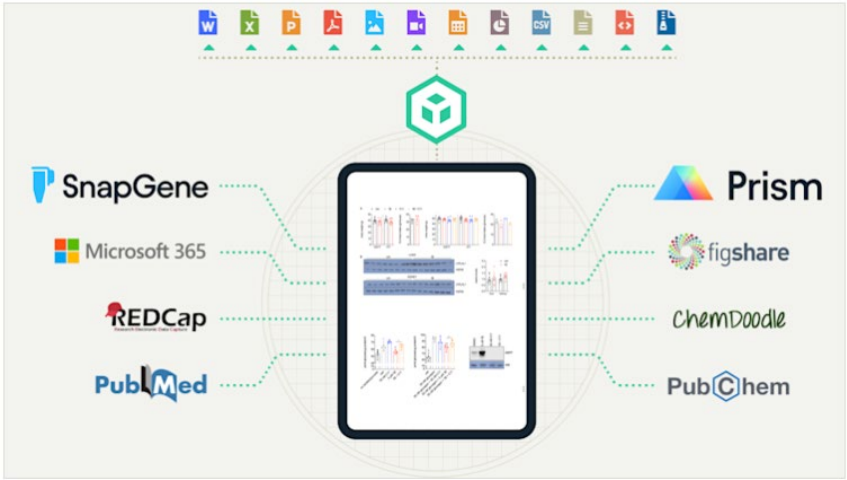
- Type of science?
- Institutional ELN policies?
- Security level of data?
- Budget?
- Training lab members?

Harvard Archived Martix 2021 https://zenodo.org/records/4723753

LabArchives







https://www.labarchives.com/

Data Management and Sharing: Data Lifecycle

Why share data?

- Supports open scientific inquiry
- Helps to verify and replicate studies
- Encourages new research and use of alternate methods
- Encourages collaboration
- Provides learning resources for students
- Protects against faulty or fraudulent data
- Improves visibility and impact of research projects

https://datamanagement.hms.harvard.edu/about/what-research-data-management/biomedical-data-lifecycle

Lab Servers: Saving data for local level access

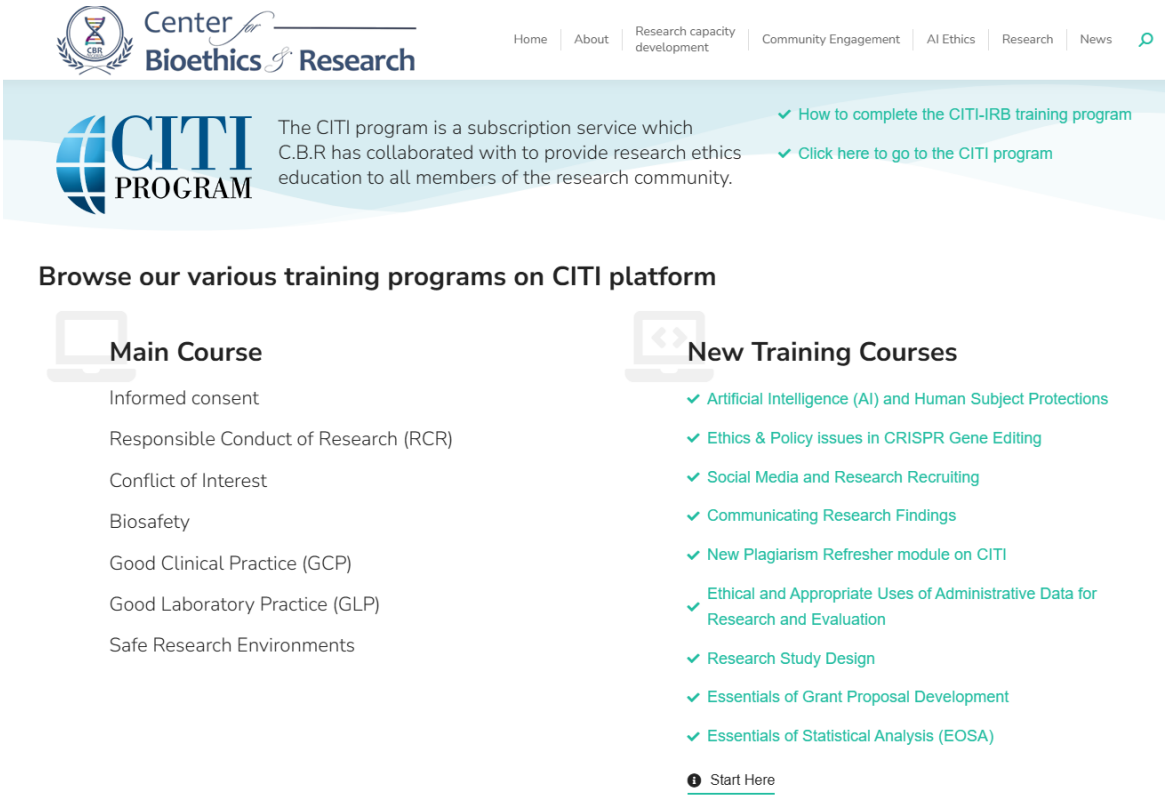
OneDrive and SharePoint (Microsoft)
DropBox.com
Box.com
Google drive
Cloud associated with ELN

Repositories: Broad sharing of data sets

Discipline-specific
Generalist
Institutional
Open or Controlled Access

Online Training Modules

CITI (Collaborative Institutional Training Initiative)



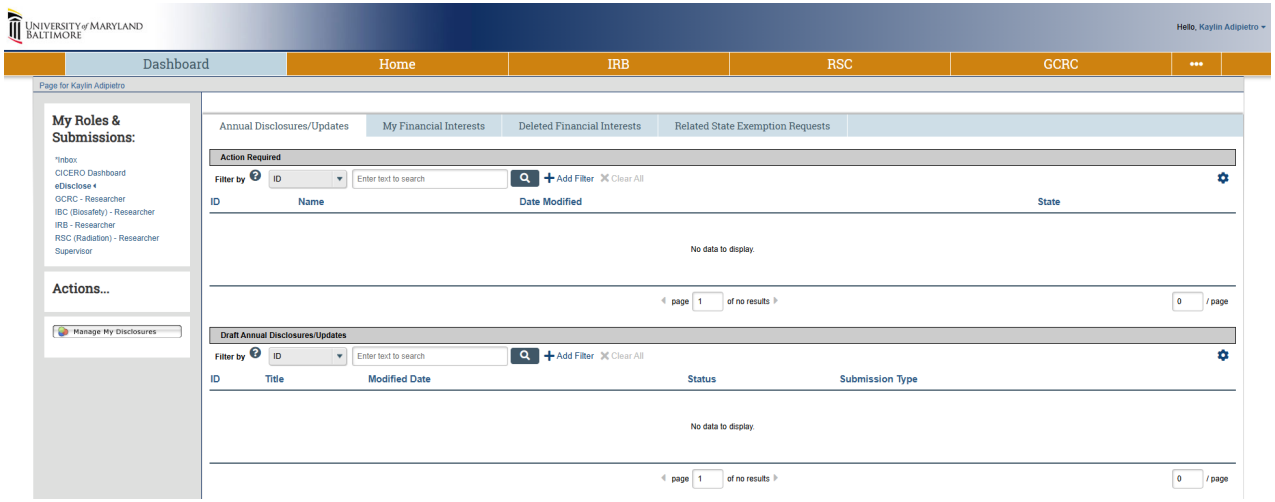
Compliance Auditing and Monitoring Systems

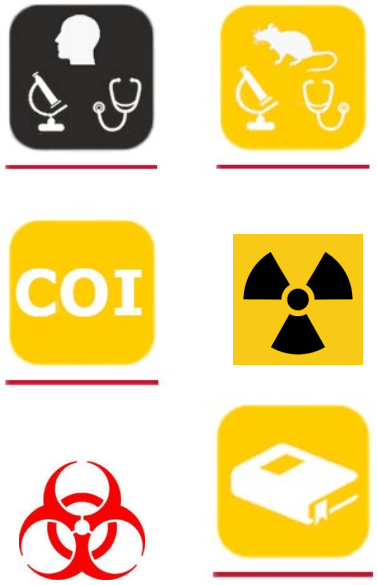
Electronic system for creating, submitting, reviewing, and routing protocols

CICERO Research Evaluation Portal

Welcome to CICERO (Collaborative Institutional Comprehensive Evaluation of Research Online) - the University of Maryland, Baltimore's Research Evaluation Portal.

CICERO is a comprehensive online solution for the review of human, animal, and in vitro research. It is a cooperative effort among multiple committees responsible for supporting the research community at the University of Maryland. CICERO is where research teams can create and submit online all the forms needed for evaluation and approval of research studies by the Institutional Review Board (IRB), the Institutional Animal Care and Use Committee (IACUC), the Institutional Biosafety Committee (IBC), the Radiation Safety Committee (RSC), and the General Clinical Research Center (GCRC).





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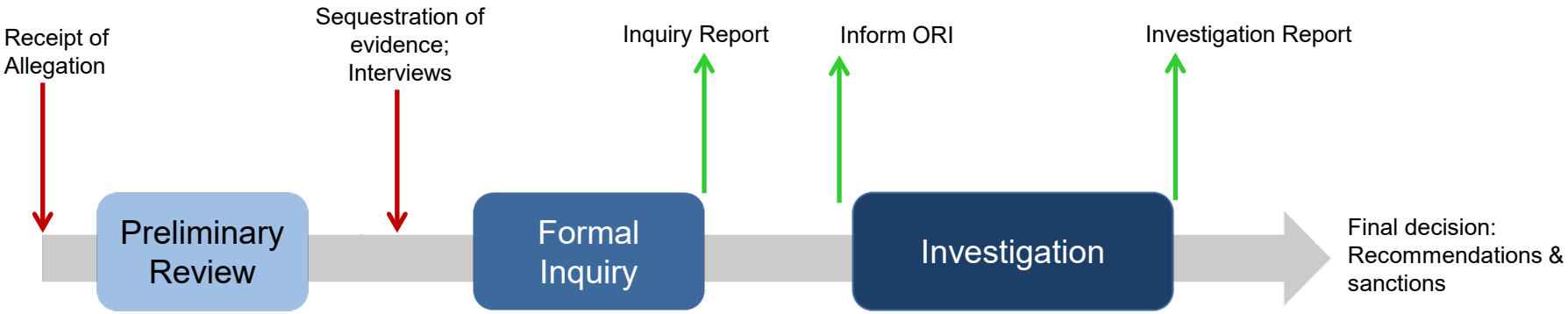
Research Integrity Office



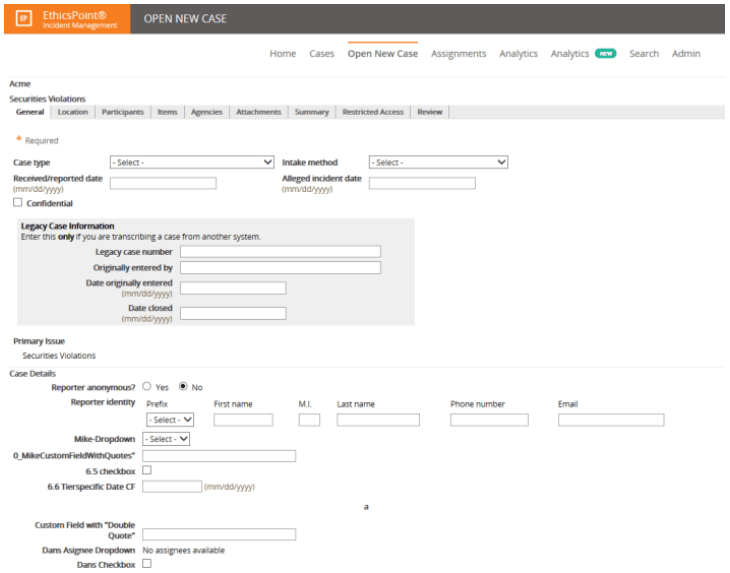
Where Technology is Needed

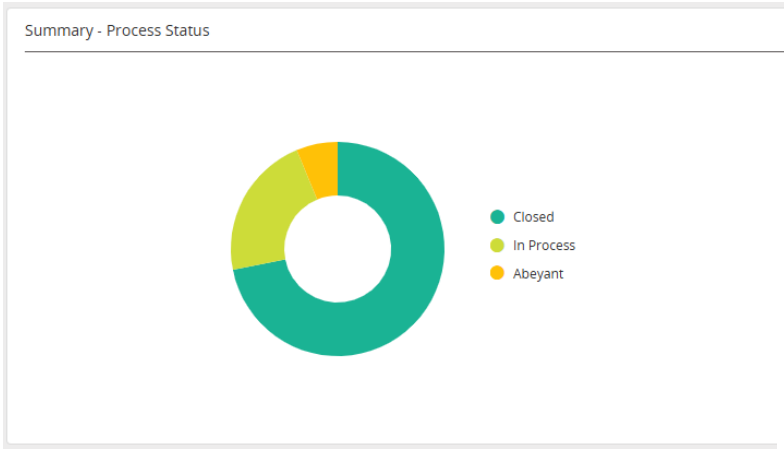
- Case Management
- Email sequestration
- Data sequestration
- Forensic software
- Plagiarism detection
- Image manipulation detection
- AI programs

Case management System

ETHICSPOINT®
Incident Management

HOTLINE





University of Maryland, Baltimore

Show All Cases opened in All dates

Drag a column heading here to group by that column.

Priority	Source	Case #	EPRS #	Date Opened	Tier	Primary issue	Status	Type	More Info
	Hotline	4842	4/10/2025-1482	04/10/2025	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	4837		04/04/2025	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	4795		03/17/2025	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Hotline	4583	10/23/2024-1370	10/23/2024	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	3447		08/22/2022	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	3396		06/23/2022	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	3331		04/12/2022	University of Maryland, Baltimore	Research	In Process	Allegation	More Info...
	Non-Hotline	4777		03/14/2025	University of Maryland, Baltimore	Research	Closed	Allegation	More Info...

https://secure.ethicspoint.com/

Email and data sequestration

RIO works with Center for Information Technology Services (CITS at UMB)

Digital

- Request emails archives as .pst file
- OneDrive folders
- University-run servers
- Hard drives

Physical sequestration

- Lab notebooks

Email analysis

basic

- Open .pst files in Outlook and employ search function
- Save pertinent files and attachments as PDFs

enhanced

Mail Xaminer	MailXaminer	Forensic email analysis	Windows	$1999 (Basic) $2499 (Pro)	Forensic email examination program with evidence and case management capabilities.
eDiscovery	eDiscovery	Forensic email analysis	Windows	Email examination program through Microsoft outlook	

Copy hardrives or make a Forensic copy (image file)

basic

- Copy computer data onto an external drive

enhanced

Forensic tool Kit Imager (FTK Imager)	ACCESSDATA	Forensic Copy	Windows	Free	Create Raw (dd), E01, SMART, AFF image type
Belkasoft Acquisition Tool	Belkasoft	Forensic Copy	Windows	Free	Pros/Cons
Macquisition	MACQUISITION™	Forensic Copy	OSX	$1,000	Macquisition is a dongle used to create forensic copy from Mac computers (Desktops, laptops) without removing the hard drive. No write blocker needed
Kali Linux Forensic boot CD/USB	KALI LINUX	Forensic Copy	Windows/OSX	Free	This alternative is useful in case the drive cannot be removed (Macs and hardware RAID devices for example). Kali is similar to Macquisition but might require more IT expertise
Tableau Forensic Imager (TX1 Imager)	GUIDANCE SOFTWARE	Forensic Copy	Proprietary	$3,000	TX1 is a computer that can copy 2 hard drives simultaneously on one destination drive. Write blocker is included. Nothing else is needed
Logicube Forensic Falcon-Neo	Logicube	Forensic Copy	Proprietary	$3,000	Same as TX1 imager

Data triage

basic

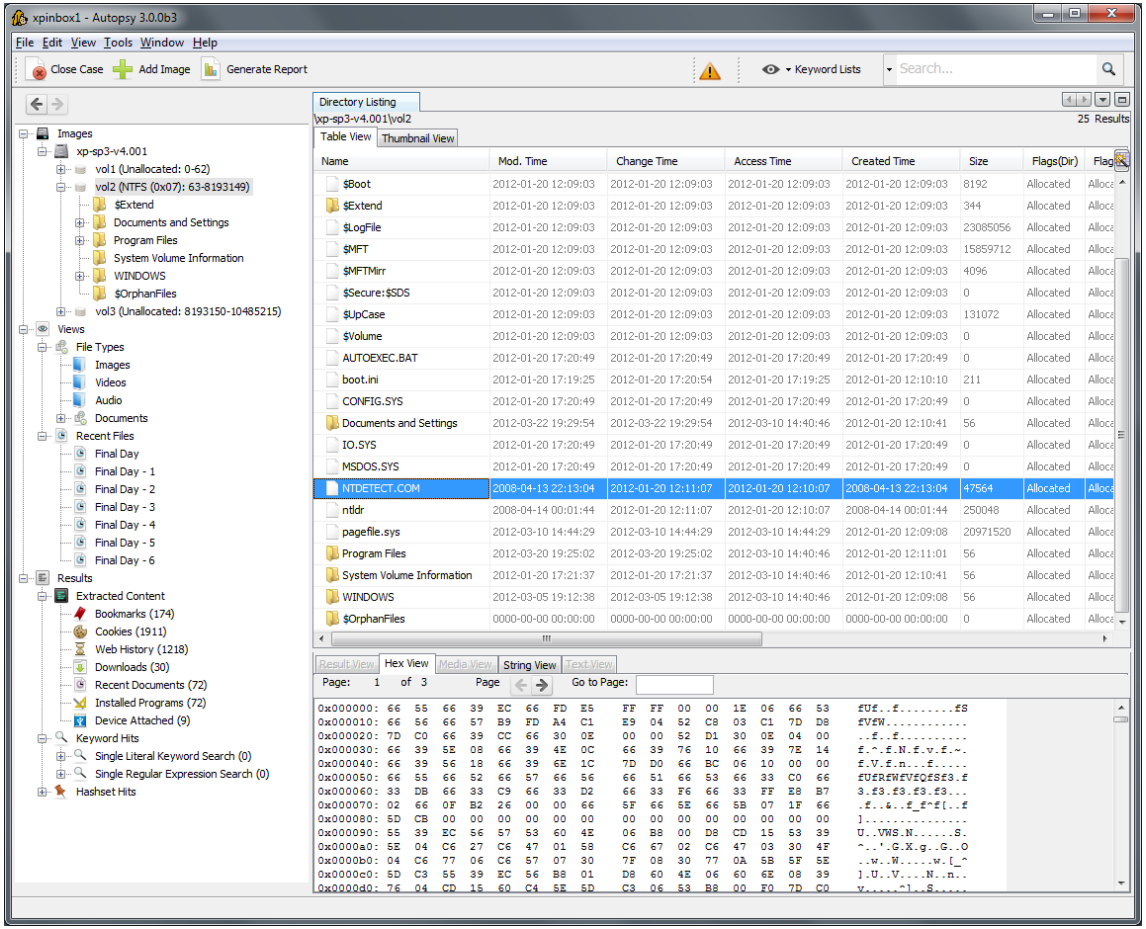
- Search hard drive copy
- Search hard drive copy using a Write-Blocker

enhanced

Encase v8	GUIDANCE SOFTWARE	Data Triage	Windows	$3,700	Encase is used by ORI, it can read most of the forensic formats (DD, E01, lx01). It also includes an acquisition tool such as FTK
E3:P2C	paraben corporation	Data Triage	Windows	$1,990	Similar to Encase with less flexibility in the format it can read (it reads DD, E01)
Forensic tool Kit (FTK)	ACCESSDATA	Data Triage	Windows	Free	FTK is free but has only basic search tools and does not allow the carving of data (searching for deleted files) offered by the paid solutions.
BlackLight	BlackBag TECHNOLOGIES	Data Triage	Windows/OSX	$1,700	Unlike Encase and E3:P2C BlackLight runs on Mac OS and Windows. More user friendly than Encase and E3
Autopsy		Data Triage	Windows/OSX	Free	Open source software sharing some of the features found in expensive solutions

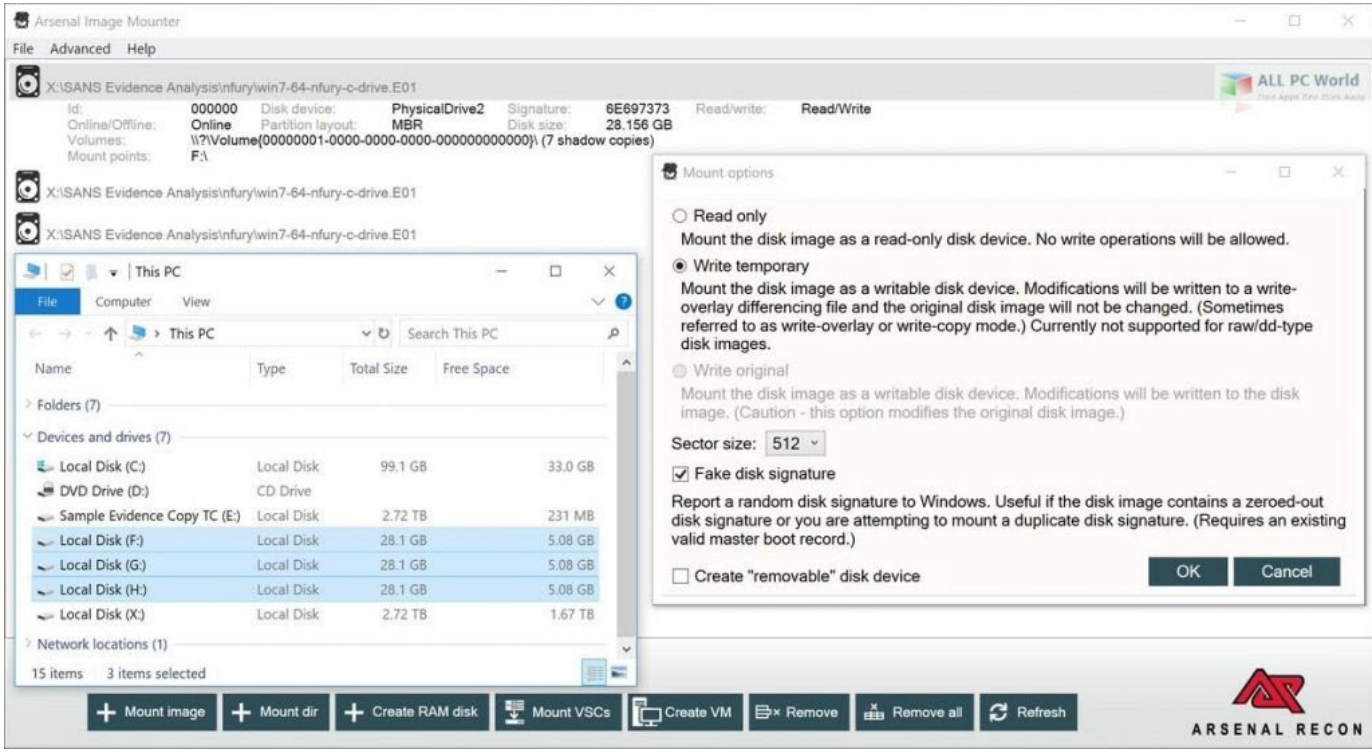
Autopsy

AUTOPSY
DIGITAL FORENSICS



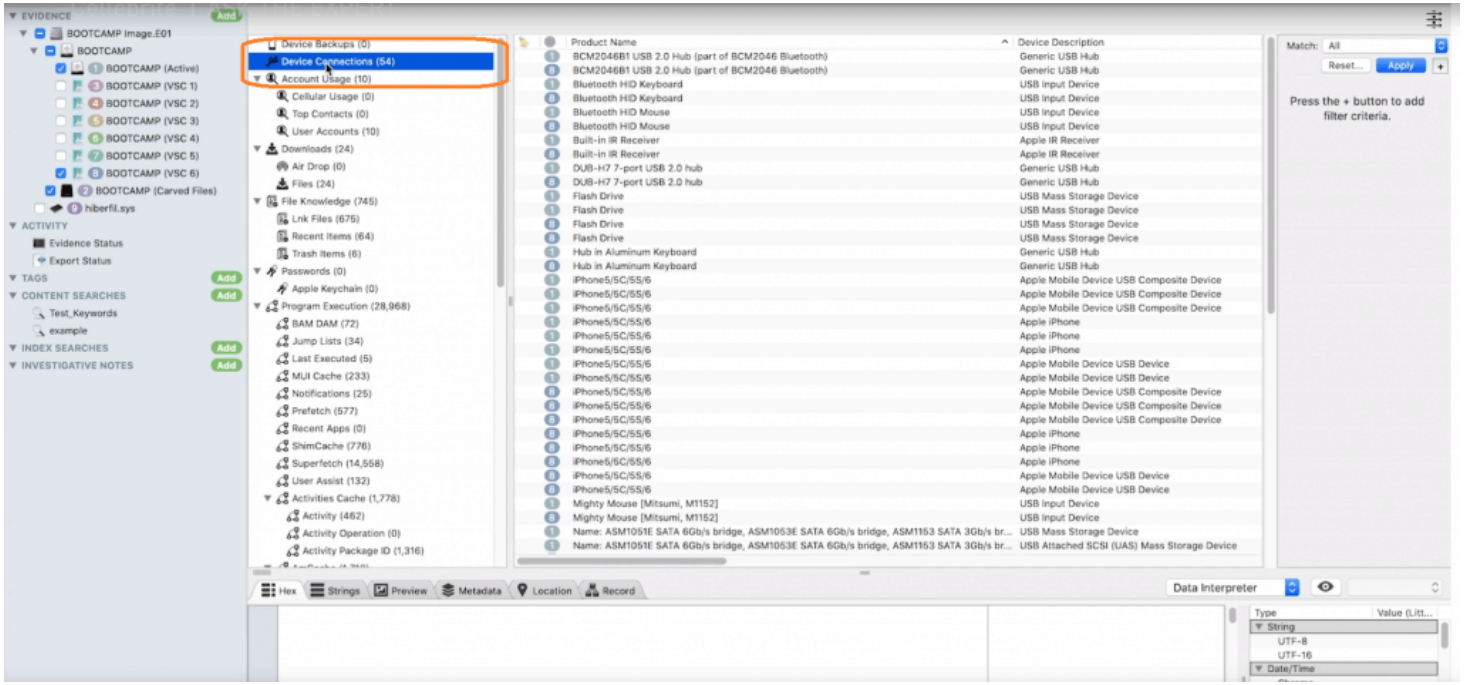
Arsenal image mounter

ARSENAL RECON



Cellebrite/Blacklight

Cellebrite



Plagiarism detection

Name	Website	Function	Operating System	Price
PapersOwl	https://papersowl.com/free-plagiarism-checker	Compare documents to a database	Windows/OSX	FREE
Duplichecker	https://www.duplichecker.com/	Compare documents to a database	Windows/OSX	Free trial then 100 submissions for $7/month
Quetext	https://www.quetext.com/	Compare documents to a database	Windows/OSX	Free trial then 200 pages for $9.99/month
Grammarly	ps://www.grammarly.com/plagiarism-checker	Compare documents to a database	Windows/OSX	FREE

Pros

- Free or Low Cost

Cons

- Poor Results—inconsistent, incomplete
- Slow to Process
- Word Limit (Duplichecker, Quetext)
- Security of Search or Documents
- Ethics of Provider

Plagiarism detection

Name	Website	Function	Operating System	Price
Google	http://www.google.com	Compare short sentence to a database	Windows/OSX	FREE
Google Scholar	https://scholar.google.com/	Compare short sentence to a database	Windows/OSX	FREE
Adobe Acrobat	https://adobe.com/	Side-by-side comparison	Windows/OSX	FREE TRIAL

Pros

- Free
- Fast
- Familiar/Easy to Use
- Good Place to Start

Cons

- Basic but limited searches
- Simple comparisons
- Security of Search or Documents

Plagiarism detection

Name	Website	Function	Operating System	Price
iThenticate	https://www.ithenticate.com/	Compare documents side-by-side or to a database	Windows/OSX	$100/submission (up to 25,000 words/submission)
CopyLeaks	https://copyleaks.com/	Compare documents side-by-side or to a database	Windows/OSX	Free trial then $10.99 for 25,000 words/month
SimTexter	https://people.f4.htw-berlin.de/~weberwu/simtexter/app.html	Side-by-side comparison	Windows/OSX	FREE
WCopyFind	https://plagiarism.bloomfieldmedia.com/software/wcopyfind/	Side-by-side comparison	Windows	FREE

Pros

- Some Free
- Some Standalone Programs
- Good Security
- Good Results
- Detailed Reports

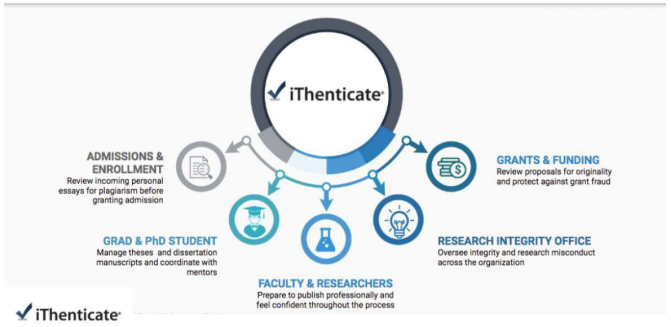
Cons

- Cost
- Time to Process

iThenticate

Software detects ***Text Duplication***
not Plagiarism

Using iThenticate Across the Organization



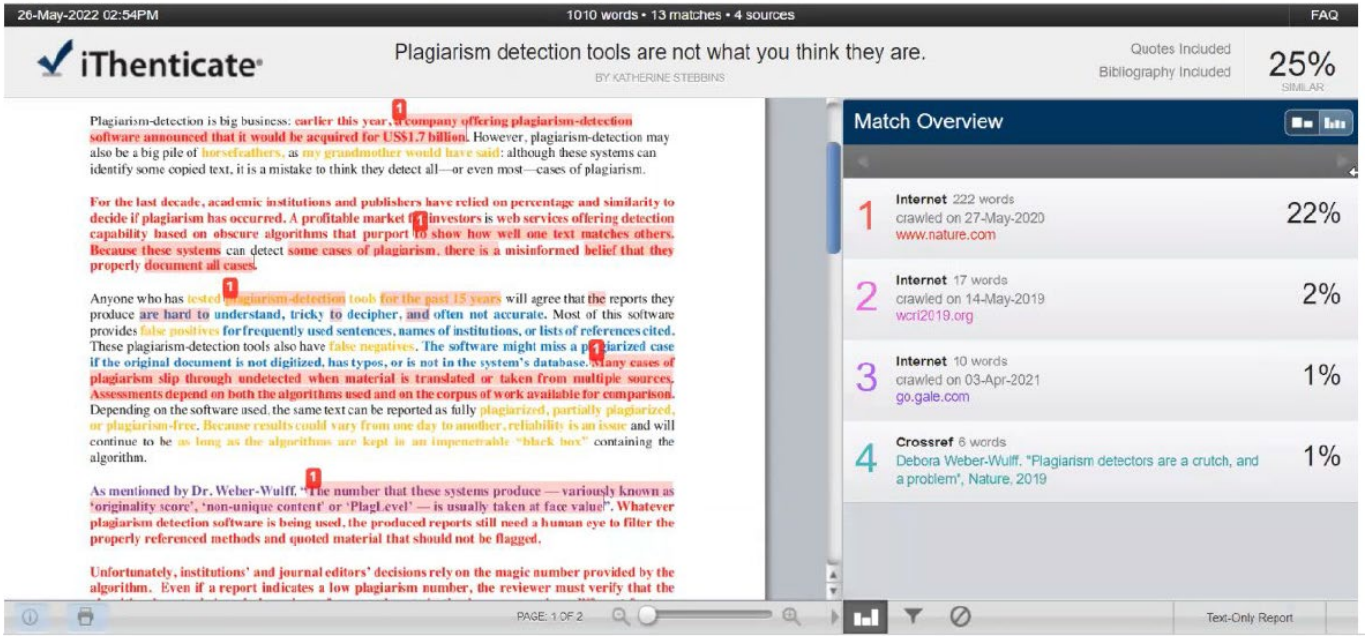
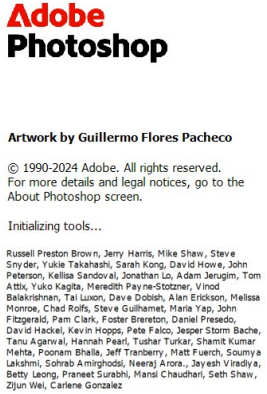


Image manipulation



U.S. Department of Health & Human Services
ORI THE OFFICE OF RESEARCH INTEGRITY

- Forensic Droplets

  Records and saves sequences of steps in the Actions Palette in Photoshop

  Forensic Gradient Maps Look Up Table (LUT) that has multiple cycles for contrast or color. Details in images with which contrast or artifacts will be better revealed.

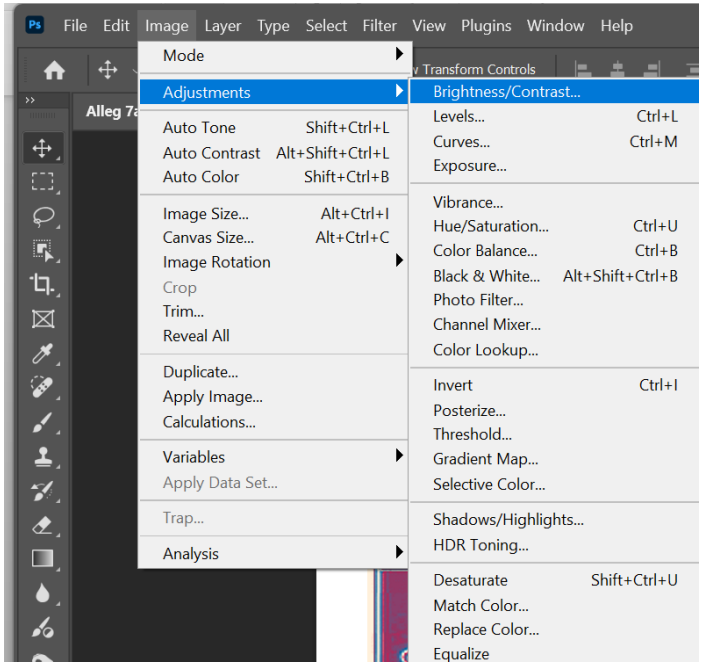
  Color Coded Overlay Overlays two images, and color codes each so that individual features in the overlap can be linked back to their respective image.

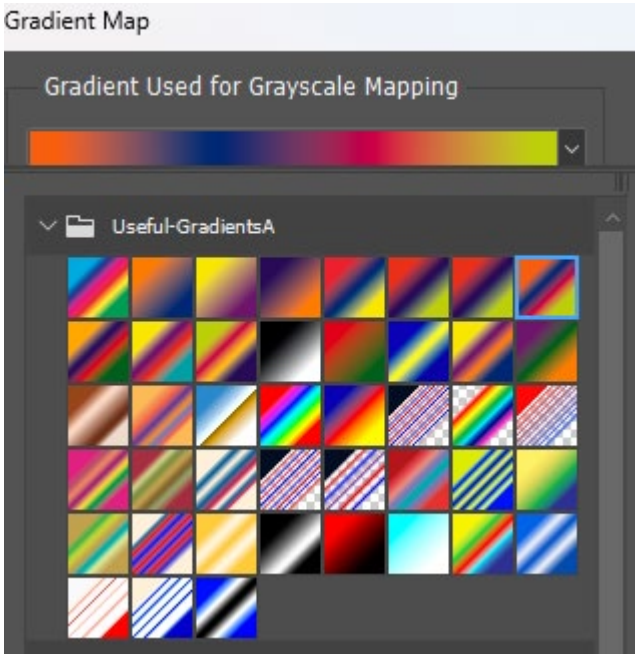
  Features overlap will appear RED, and areas of overlapping background will appear CYAN. Features unique to one or the other image will be WHITE or BLACK. If the same object is common to both images it 1) must be RED and 2) must have a uniform boundary of either BLACK or WHITE.

Photoshop

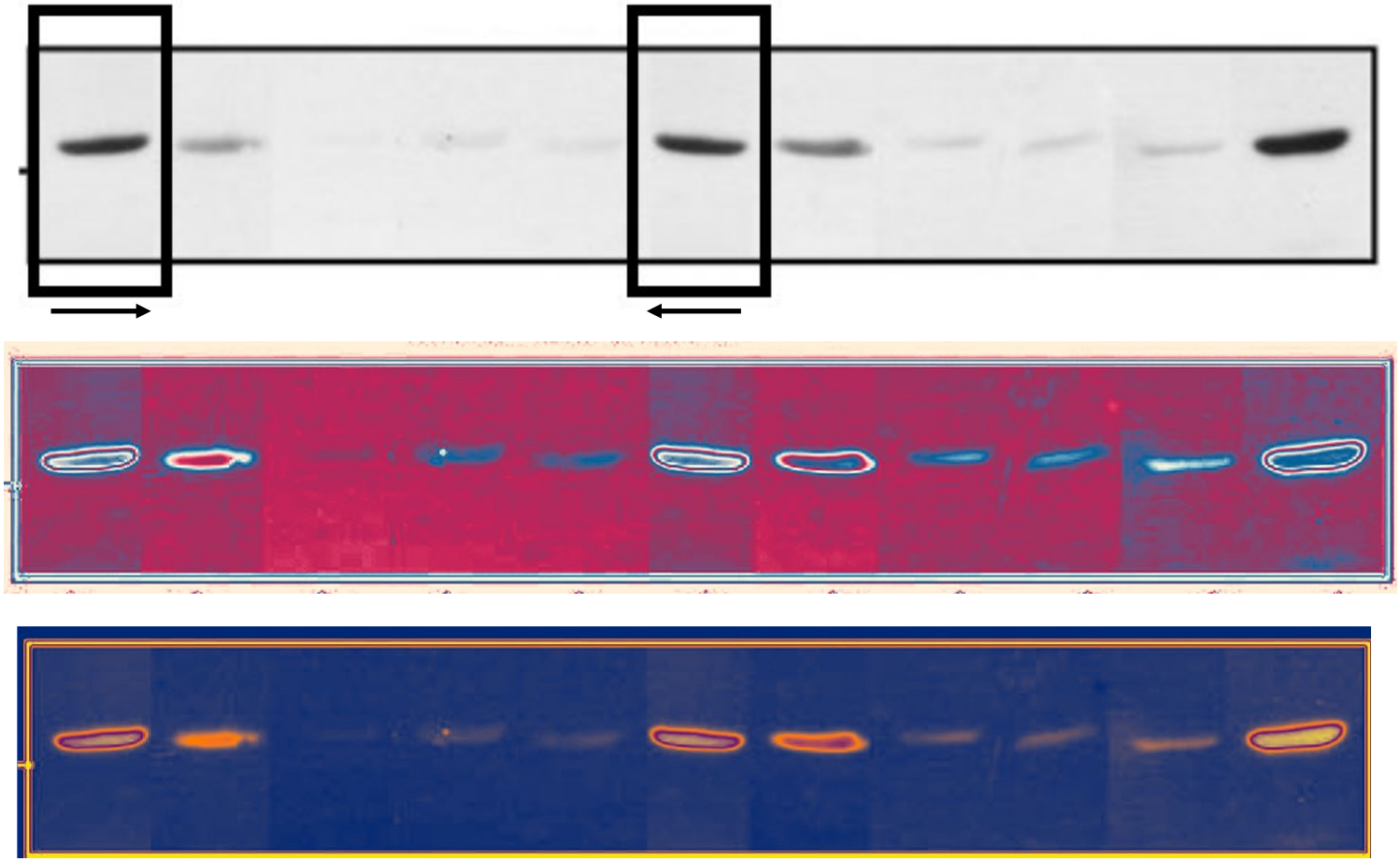
basic

- Adjust brightness and contrast
- Invert colors
- Gradient maps

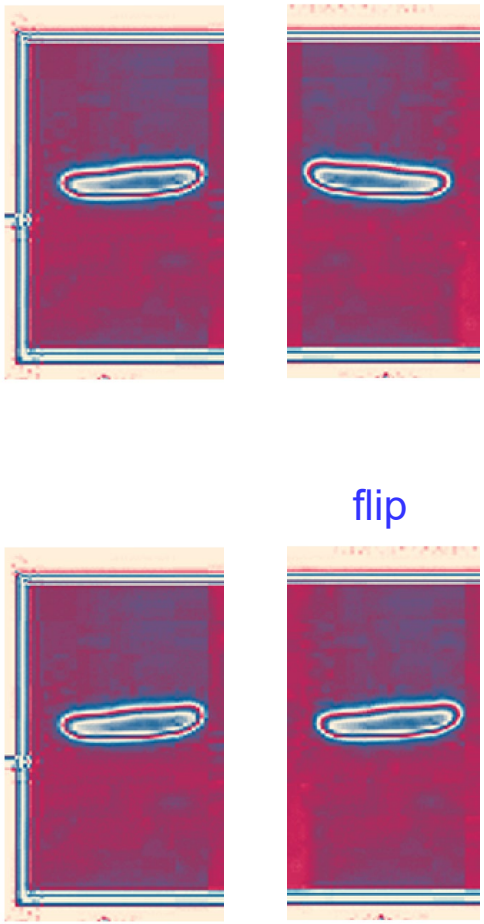


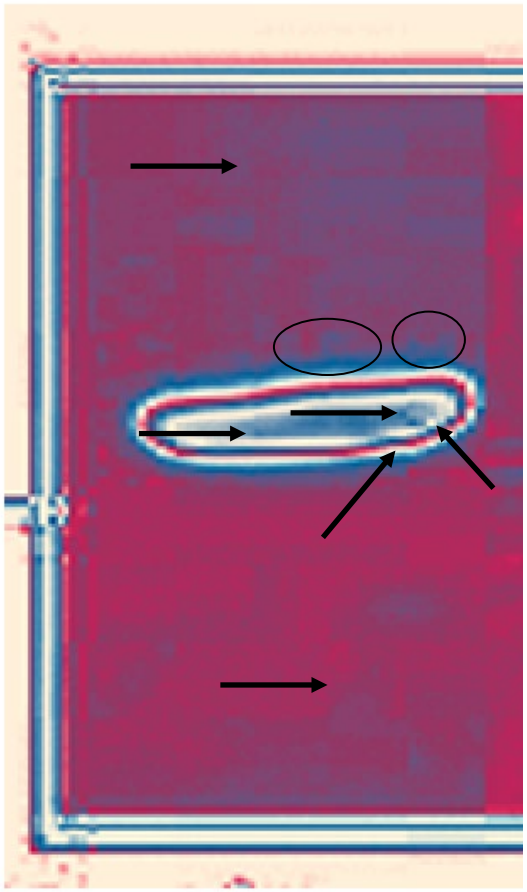


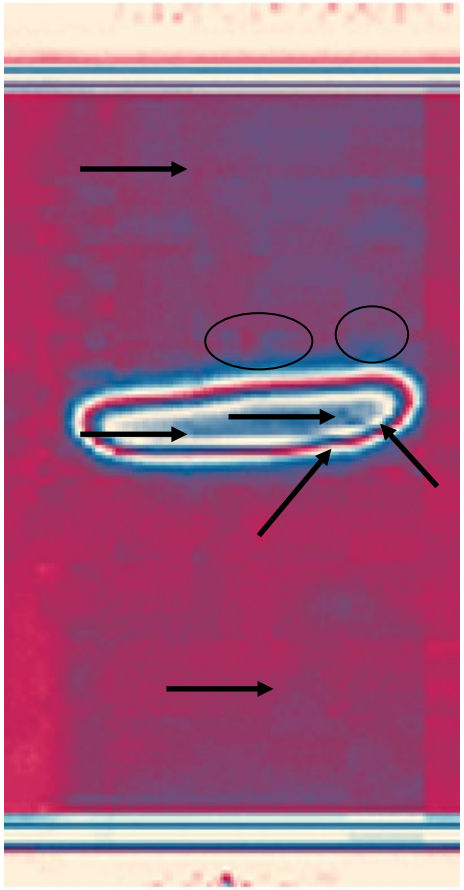
Gradient map



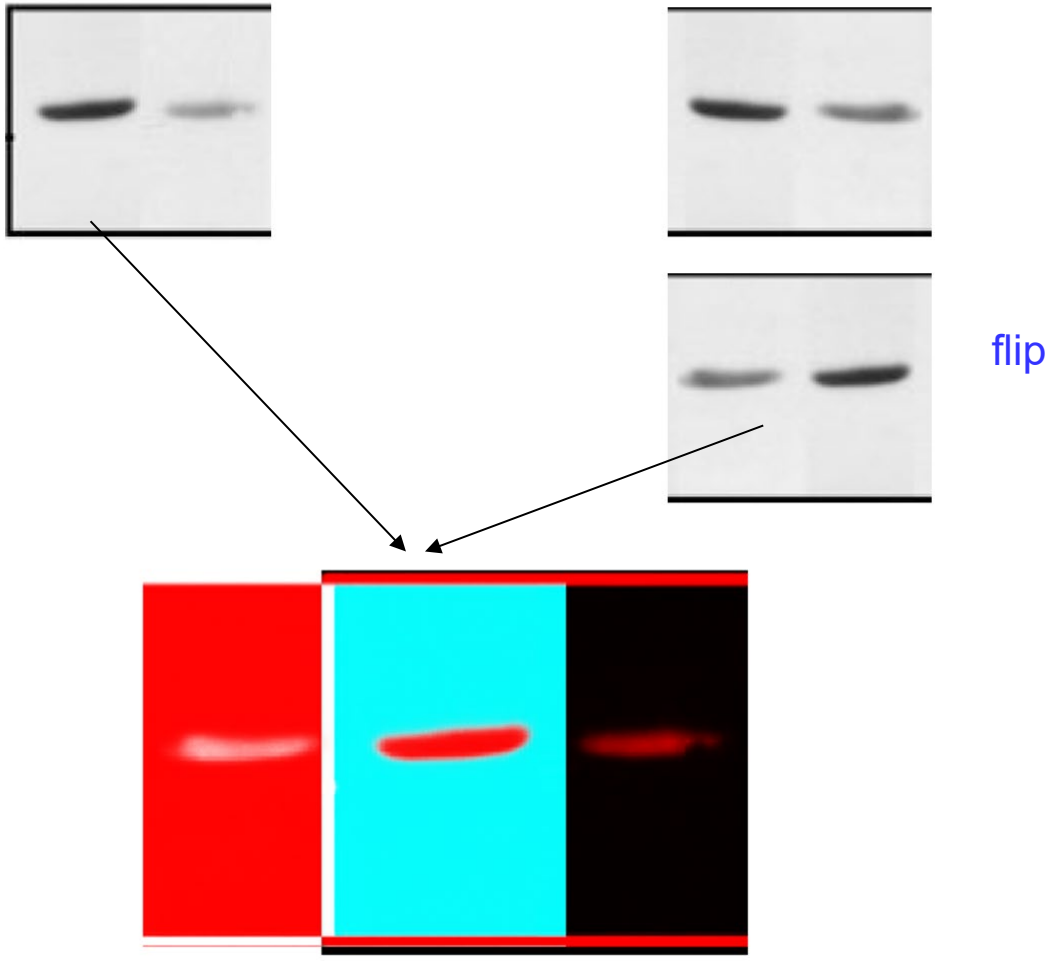
"Too similar to be different"







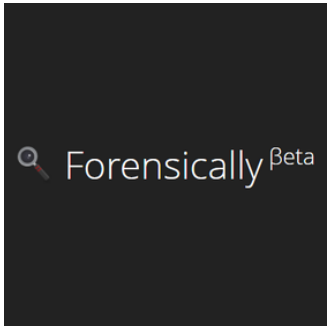
Overlay



Additional image analysis tools

- PowerPoint→ basic image brightness/contrast
- Image J→ image processing program from NIH
- Forensically→ Free online photo forensic tools
- AI…

ImageJ
Image Processing & Analysis in Java



AI tools to detect research misconduct

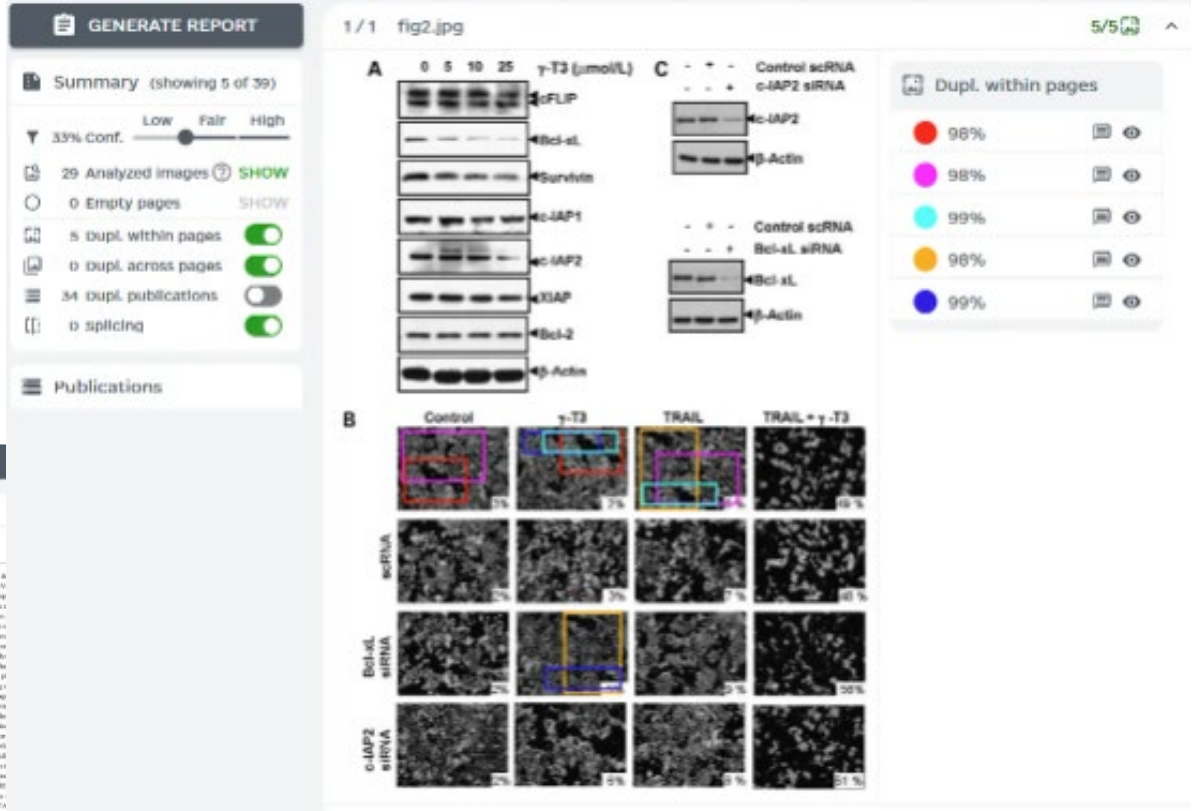
- Machine learning is predictive or problem solving that train algorithms on historical data
  - Imagetwin
  - Proofig
- Generative AI is a deep learning model that can create new content
  - Adobe Photoshop
  - ChatGPT etc

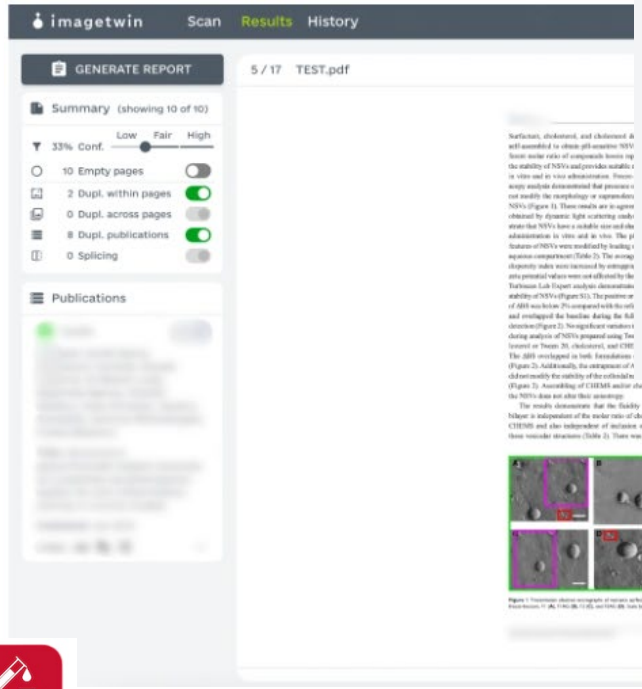
Imagetwin

- Plagiarism detection
- Image manipulation detection

- Compares images within a publication
- Compares against a database of over 50 million images

imagetwin


GENERATE REPORT
Summary (showing 5 of 39)
Low Fair High
33% Conf.
29 Analyzed images SHOW
0 Empty pages SHOW
5 Dupl. within pages
0 Dupl. across pages
34 Dupl. publications
0 Splicing
Publications
1 / 1 fig2.jpg
5/5
Dupl. within pages
98%
98%
99%
98%
99%
Control
γ-T3
TRAIL
TRAIL + γ-T3

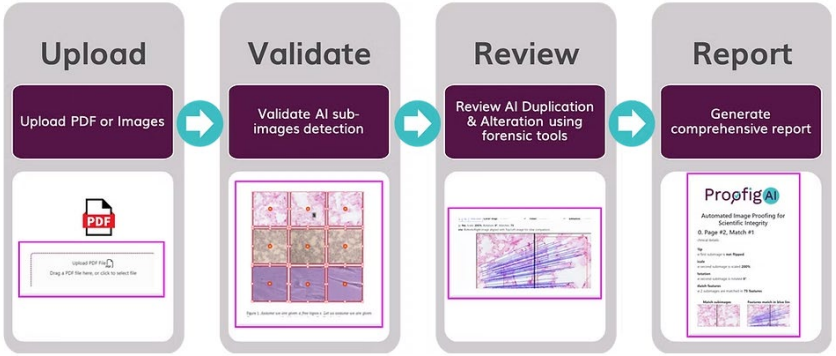

imagetwin
Scan
Results
History
GENERATE REPORT
5 / 17 TEST.pdf
Summary (showing 10 of 10)
Low Fair High
33% Conf.
10 Empty pages
2 Dupl. within pages
0 Dupl. across pages
8 Dupl. publications
0 Splicing
Publications

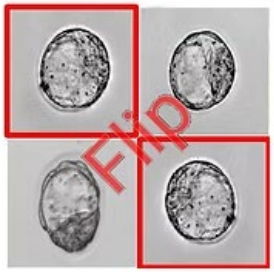
Proofig

- Plagiarism detection
- Image manipulation detection
- AI generated image detection

- Compares images within a publication
- Compares against PubMed
- Forensic tools within the application to analyze further

Proofig AI

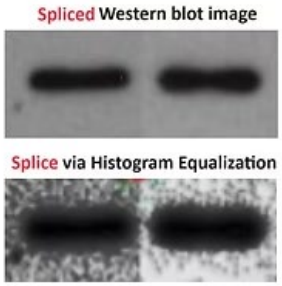

Upload
Upload PDF or Images
Validate
Validate AI sub-images detection
Review
Review AI Duplication & Alteration using forensic tools
Report
Generate comprehensive report
PDF

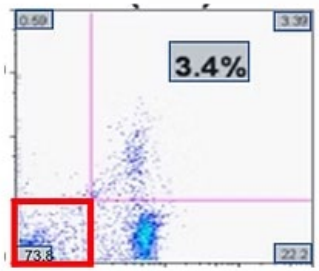

Flip

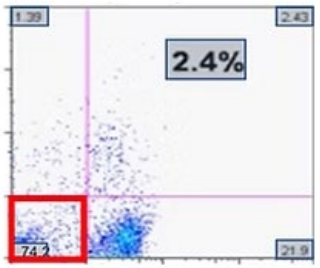

Crop & Rotate

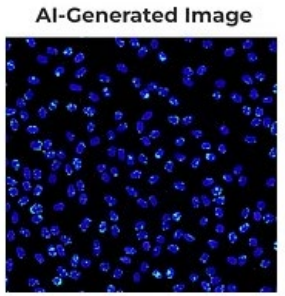

Rotate


Flip


Spliced Western blot image
Splice via Histogram Equalization


3.4%
0.59
3.39
73.8
22.2


2.4%
1.39
2.43
74.2
21.9


AI-Generated Image

AI tools to detect research misconduct

- AI applications are tools and not a determination of research misconduct
- AI cannot determine intentionally, knowingly, or recklessly
- AI detection tools can help assess allegations but should not replace forensic analysis by the RIO—**Supplement!**

AI tools to generate text fake data

- Already in use to generate text in publications
- Complex data and images will require more training
- Can make modifications to an image that may not be detectable

Institutional-level policies in development for acceptable use of AI programs

Questions?

UMB OAC

Research Integrity Office

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Baltimore, MD 21201

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