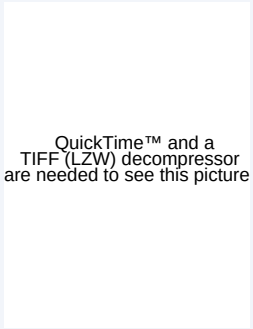
Slide Image Retrieval: A Preliminary Study



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Beyond Text in Digital Libraries

We'll focus on this

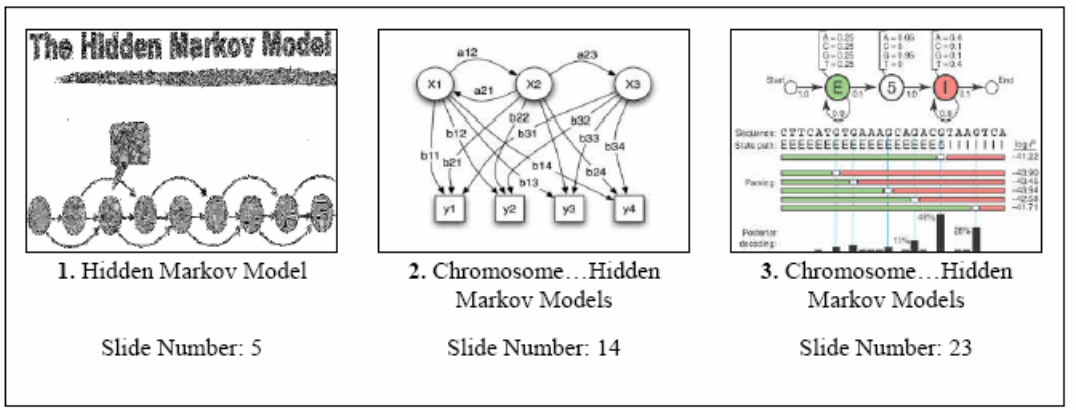
Papers don't store all of the information about a discovery

- **Dataset**
- **Tools**
- **Implementation details / conditions**

They also don't help a person learn the research

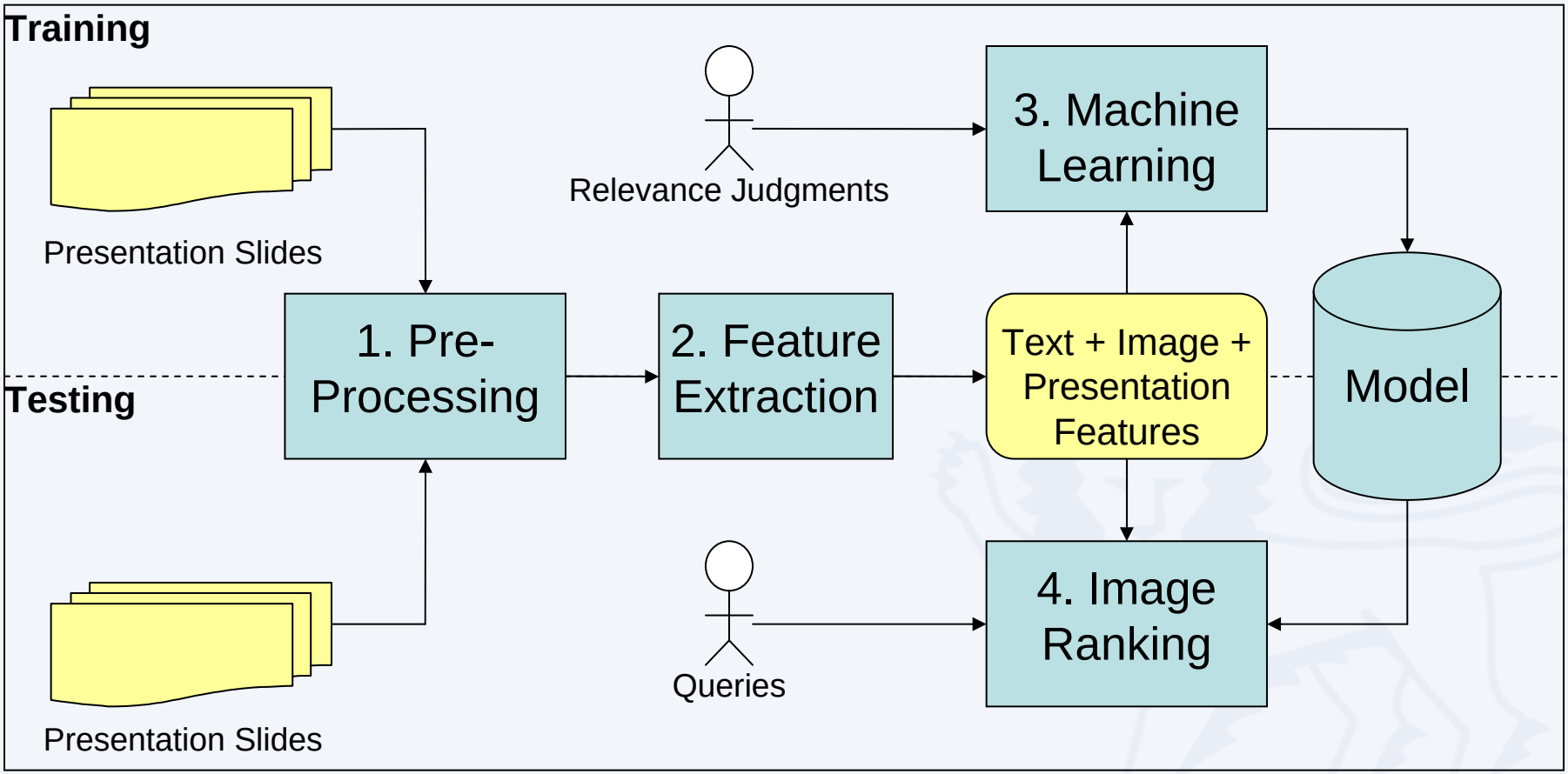
- **Textbooks**
- **Slides**

What is Slide Image Retrieval?

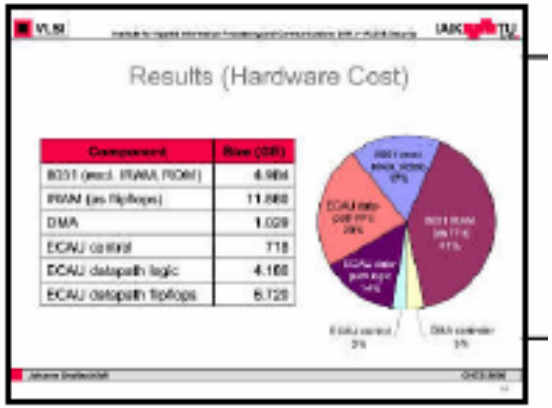


- **Hypothesis: image and presentation features can enhance text-based features**

Slidir Architecture



1. Preprocessing



Presentation Slide

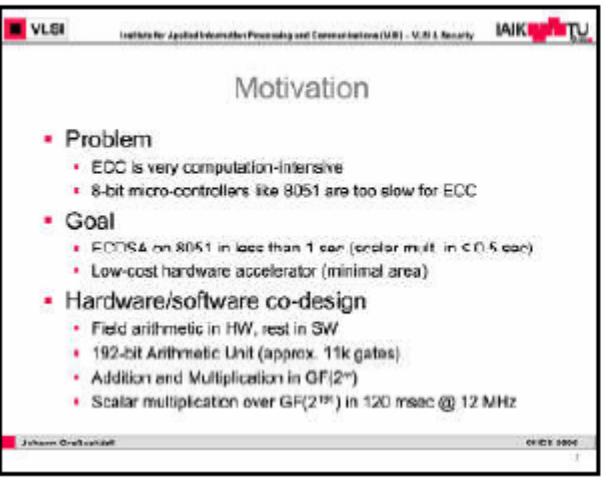
Simple preprocessing, not meant to be state-of-the-art

Generally consistent background → Perform collective separation

Top down approach using projection profile cuts with thresholds from PPT template

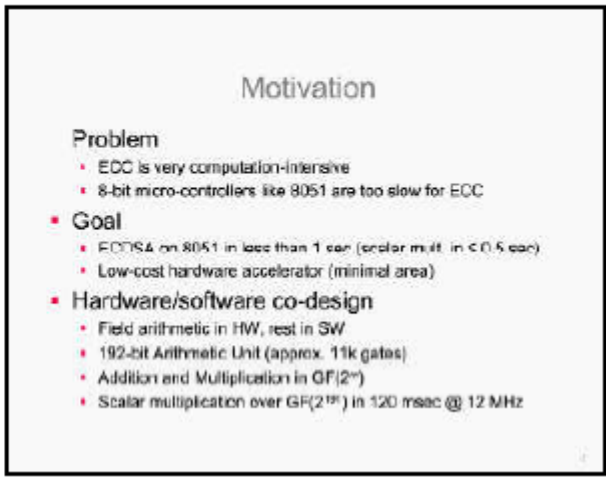
Sample Extraction Results

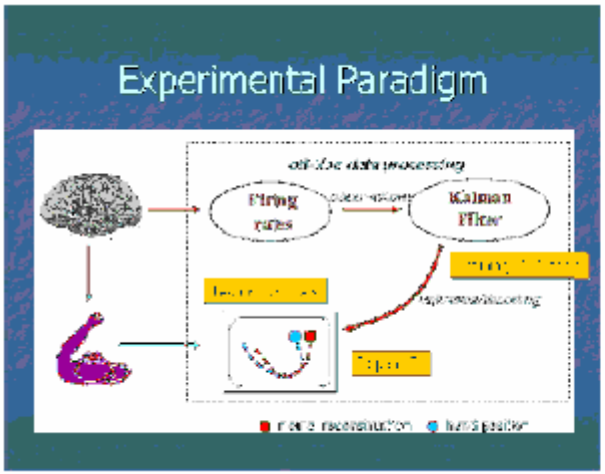
(a) Original Slide

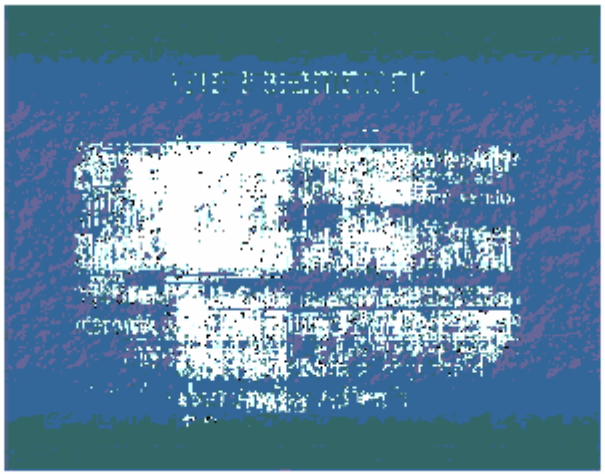


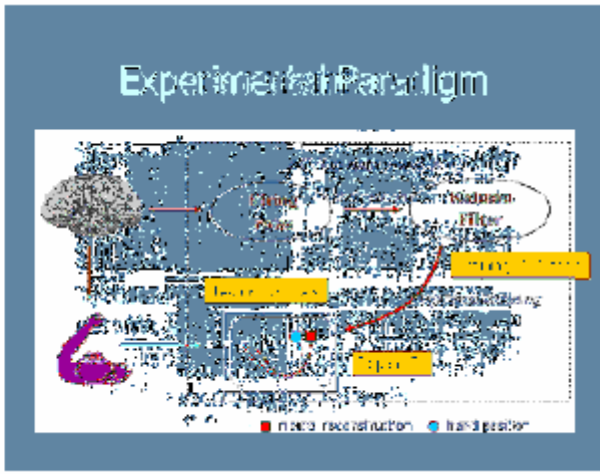
(b) Extracted Background

(c) Extracted Foreground









2. Feature Extraction

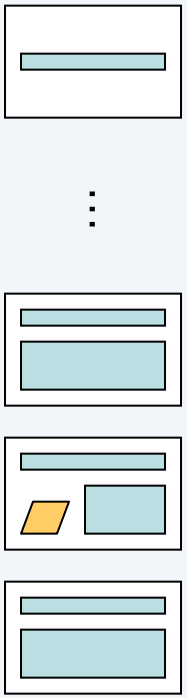
Utilizes textual, image and presentation features

- **Textual Features**
  - Main component of feature set
  - Most images identified by surrounding and embedded text
- **Image Features**
  - Supplement to textual features
  - Useful in ranking images with similar textual feature scores
- **Presentation Features**
  - Features unique to presentation slides

Sample Features

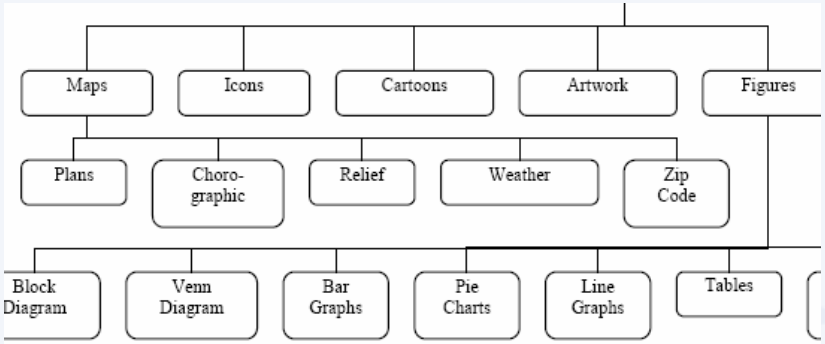
Textual

1. All text
2. Slide text
3. Next slide's text
4. Previous slide's text
5. Slide Title
6. Presentation Title
7. Slide Image Text



Image

- Image Size
- Image Colors
- NPIC image type (CIVR, 06)



Presentation

1. Slide Order
2. Image position on Slide
3. Number of Images on Slide

Machine Learning

Regression Model

- Relevance judgments and feature vectors input into machine learner
- Linear regression used to produce continuous output value for image ranking

Human Relevance Judgments

- 9 participants
- Four presentation sets of 10 queries each
- Participants rank up to five most relevant images to the query

Regression Analysis

- 10-fold cross validation
- System with fielded text features able to replicate human upper bound
- Image and presentation features further improve correlation

Still a gap to improve

	All text baseline	Fielded Text	With Presentation and Image Features	Inter-annotator
Mean absolute error (lower is better)	19.36	13.72	13.81	9.40
Correlation (higher is better)	-0.015	0.565	0.581	0.531

Looks pretty good

Comparison of mean absolute error and correlation

Binary Classification

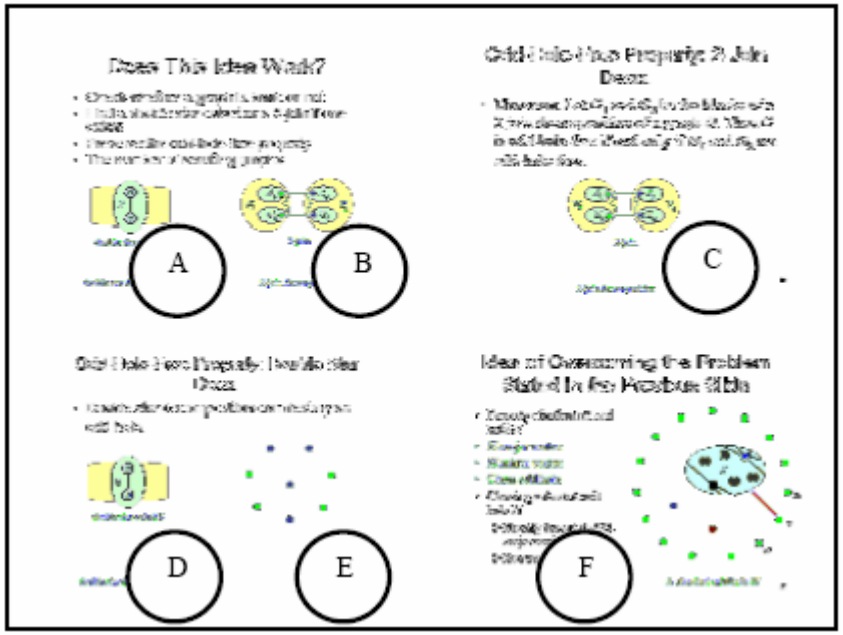
- Human participants judgments converted to binary
- Evaluated using SVM and J48 decision tree classifier
- General accuracy fairly good
- Decision tree algorithm slightly more precise → sequential testing adequate

	SVM (SMO)	J48 Decision Tree
Accuracy	**90.9%**	**92.5%**
Kappa	**.54**	**.59**
Relevant Class Precision	**.59**	**.70**
Recall	**.58**	**.58**
F_1	**.59**	**.63**

10-fold performance over 8062 instances

Feature Analysis

- Human subject study with 20 volunteers
- Subjects select most and least relevant images



Sample Human Subject Survey

Presentation Set 3							
For each query, choose the most relevant images from the slides and and rank them accordingly. Stop if no more relevant images (see sample)							
No.	Query	Most Relevant Image by Rank					Comments
		1	2	3	4	5	
1	Perfect Graphs	A	C	E	B	na	
2	Odd Hole						
3	2-join						
4	double star						
5	Xinming Liu						

Rank	SLIDIR Features	Regression Coefficients
1	Slide Title	-234.39
2	Slide Image Type	-124.09
3	Slide Text	-83.86
4	Slide Image Text	-83.64
5	Next Slide's Text	-29.42
6	Presentation Title	-9.85
7	Number of Images on Slide	-1.89
8	Slide Order	-0.674
9	Image Size	0.0
10	Slide Image Position	0.0
11	Number of Colors	0.0004
12	Previous Slide's Text	31.70

Textual features most important, image and presentation features still play significant role

Image Ranking Evaluation

- Online survey with 15 volunteers
- 8 given queries and sampled dataset of 100 images
- Volunteers indicate relevant images to query
- 53% of top 10 images are relevant (max of 15 relevant)
- Average precision of 0.74

	Precision at *n*	Recall at *n*
n = top 10	**.53**	**.73**
n = top 20	**.38**	**.95**
n = top 30	**.27**	**.98**
n = top 40	**.21**	**1.0**
Average Precision	**.74**	

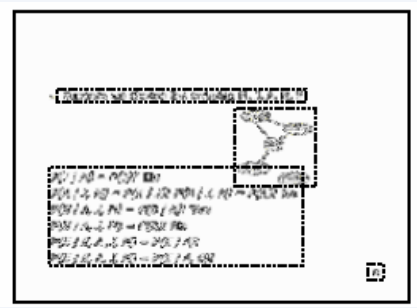
Future Work

Limitations

- Very small data set – 100 images from an AI course

Preprocessing

- Improve segmentation and collective extraction



Field Implementation – Ongoing work

- Incorporate with previous work on SlideSeer (JCDL, 2007) that aligns presentation and document pairs

More information:

Liew Guo Min(2008) **SLIDIR: Slide Image Retrieval**, Undergraduate Thesis, School of Computing, National University of Singapore.

SIGIR'08 SINGAPORE

See you in Singapore!
Next month or next year!

Questions?