

The Use of Digital Ink in Lecture Presentation

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<http://www.cs.washington.edu/education/dl/presenter/>

Classroom Presenter

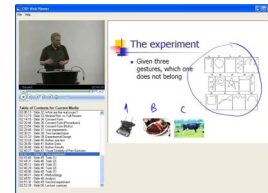
Classroom Presenter

- Tablet PC Based Presentation system
- In use since Fall 2002
- Estimated use – 50 courses *Usage: UW, Stanford, UVA, USD.*
- Goal
 - Increase instructor flexibility when delivering lectures using electronic slides
 - Support interaction with student devices.

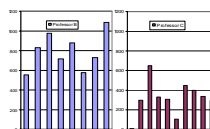
Instructor view of Classroom Presenter



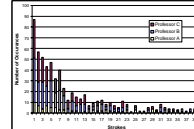
Professional Masters' Program class



Webviewer for lecture replay



Ink usage: strokes per lecture



Ink usage: stroke count per slide

	% of episodes			% of strokes		
	B	C	B+C	B	C	B+C
Attentive	77	74	76	49	53	51
Diagram	8	8	8	9	7	8
Writing	14	16	15	41	38	40
Other	2	2	2	1	2	1

Segmentation of ink strokes for two lectures

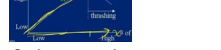
Classroom Ink Examples

Code tracing with isolated words

```

Example:
let class = "boolT";
let f = lambda (x) => x + 1;
let class = "int";
let f = lambda (x) => x * 2;
let class = "float";
let f = lambda (x) => x / 2;
let class = "string";
let f = lambda (x) => x + " ";
    
```

Code tracing with isolated words



Stroke segmentation

Multiple use of diagrams

Multiple use of diagrams

Writing example with inconsistent writing / speech (5000 vs 50000)

Slide corrections

Isolated words

Whiteboard example

Whiteboard example

Markov Blanket Sampling

How to calculate $P(X)$ (all other variables)?

Markov Blanket

So problem becomes calculating $P(X)$ (MIBK)

Fortunately, it is easy to solve:

$$P(X) = \prod_i P(X_i | Parents(X_i))$$

Diagrammatic ink with ties to content

Syntactic sugar

For syntactic convenience, any call can be written using dot notation:

$$f(x) = \lambda (x) . f(x)$$

Infix & prefix operators (e.g., \cdot) are really messages, too

Formula simulation with examples

Formula simulation with examples

$$f(x) = \lambda (x) . f(x)$$

Whiteboard example

Whiteboard example

Example

Initialization: $P(B|A) = \dots$ $P(C|B) = \dots$

E-step: $P(C=1) = P(B|A=0) \dots$

M-step: $P(B|A) = \dots$ $P(C|B) = \dots$

E-step: $P(C=1) = 0$ (converged)

Multiple attentional marks with values

Whiteboard usage with attentional markings

Whiteboard usage with attentional markings

Archival whiteboard usage

Archival whiteboard usage

Formula traversal

Process simulation

Attentional Markings

- Star
- Circle
- Square
- Triangle
- Rectangle
- Circle
- Triangle
- Rectangle
- Circle
- Triangle
- Rectangle

Attentional Markings

Content linking

	The quick	brown	fox	jumped
Correct?	1	1	1	1
Correct?	1	1	1	1
Incorrect?	1	1	1	1
Incorrect?	1	1	1	1

Content linking

Audience summarization

	The quick	brown	fox	jumped
Correct?	1	1	1	1
Correct?	1	1	1	1
Incorrect?	1	1	1	1
Incorrect?	1	1	1	1

Audience summarization

Formula traversal

Formula traversal

Diagrammatic ink

Diagrammatic ink

Overlapping attentional markings

$$Entropy(S) = -p_1 \log_2 p_1 - p_2 \log_2 p_2$$

Overlapping attentional markings

Ink simulation

Ink simulation

Results summary

- Archival vs. Ephemeral Ink Usage
 - The meaning of much the ink was dependent on the spoken context
 - Different types of ephemeral usage
 - Diagrammatic, attentional, process simulation
- Attentional Markings
 - Ink to provide a link between spoken utterance and slide content
 - Heavily used, often more than 50% of ink usage

- Attentional markings and hand gestures
 - Intriguing tie with linguistic work on hand gestures (McNeil – Hand and Mind)
 - Synchronous and co-expressive with speech
 - Non-combinatoric and lack standard of form
 - Gesture types: Iconic, metaphoric, deictic, cohesive, beats
- Breakdowns in display of persistent information
 - Loss of directional, temporal, and ordering information

- Possible enhancements to digital ink
 - Directional cues, boundaries
 - Fading or "drying"



Acknowledgments

We thank the many students, teaching assistants, and instructors who provided feedback on the system and participated in studies. We also thank innumerable colleagues at our institutions and in the Microsoft Research Learning Sciences & Technology group. This work was supported in part by grants from Microsoft Research and Hewlett-Packard.

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Classroom Presenter is available free for educational and research use:
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