

Document Analysis Issues in Reading Optical Scan Ballots

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Portion of an op-scan ballot

INSTRUCTIONS TO VOTERS
To vote, completely fill in the oval(s) next to your choice(s) like this: 

FEDERAL OFFICES	STATE OFFICES	COUNTY OFFICES
PRESIDENT AND VICE PRESIDENT VOTE FOR ONE TEAM	STATE REPRESENTATIVE DISTRICT 3B VOTE FOR ONE	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 5 VOTE FOR ONE
<input type="radio"/> JOHN MCCAIN AND SARAH PALIN Republican	<input type="radio"/> CAROLYN MCELFRICK Republican	<input type="radio"/> DONNA RAE ASP
<input checked="" type="radio"/> BARACK OBAMA AND JOE BIDEN Democratic-Farmer-Labor	<input checked="" type="radio"/> LOREN A. SOLBERG Democratic-Farmer-Labor	<input type="radio"/> write-in, if any
<input type="radio"/> CYNTHIA MCKINNEY AND ROSA CLEMENTE Green	<input type="radio"/> write-in, if any	TOWN OFFICES
<input type="radio"/> RÓGER CALERO AND ALYSON KENNEDY Socialist Workers	CONSTITUTIONAL AMENDMENT	TOWN SUPERVISOR SEAT B TOWN OF NORDLAND VOTE FOR ONE
<input type="radio"/> RALPH NADER AND MATT GONZALEZ Independent	Failure to vote on a constitutional amendment, will have the same effect as voting no for the amendment.	<input type="radio"/> RUTH ANN NELSON
	To vote for a proposed constitutional amendment, completely fill in the oval next to the word "YES" for that question. To vote against a proposed constitutional amendment, completely fill in the oval next to the word "NO" for that question.	<input type="radio"/> JOHN STEEBER
		<input checked="" type="radio"/> WAYNE DAVIS
		<input type="radio"/> write-in, if any

In a nutshell

Reading optical scan ballots presents an interesting and important challenge. In addition to our helping solve it, what can be learned?

- Task is extremely well specified (codified into law) and cannot be altered just to make pattern recognition problems easier.
- Like most pattern recognition problems, 100% accuracy may not be attainable, but in this case it is at least a reasonable goal.

Primary contribution of this work:

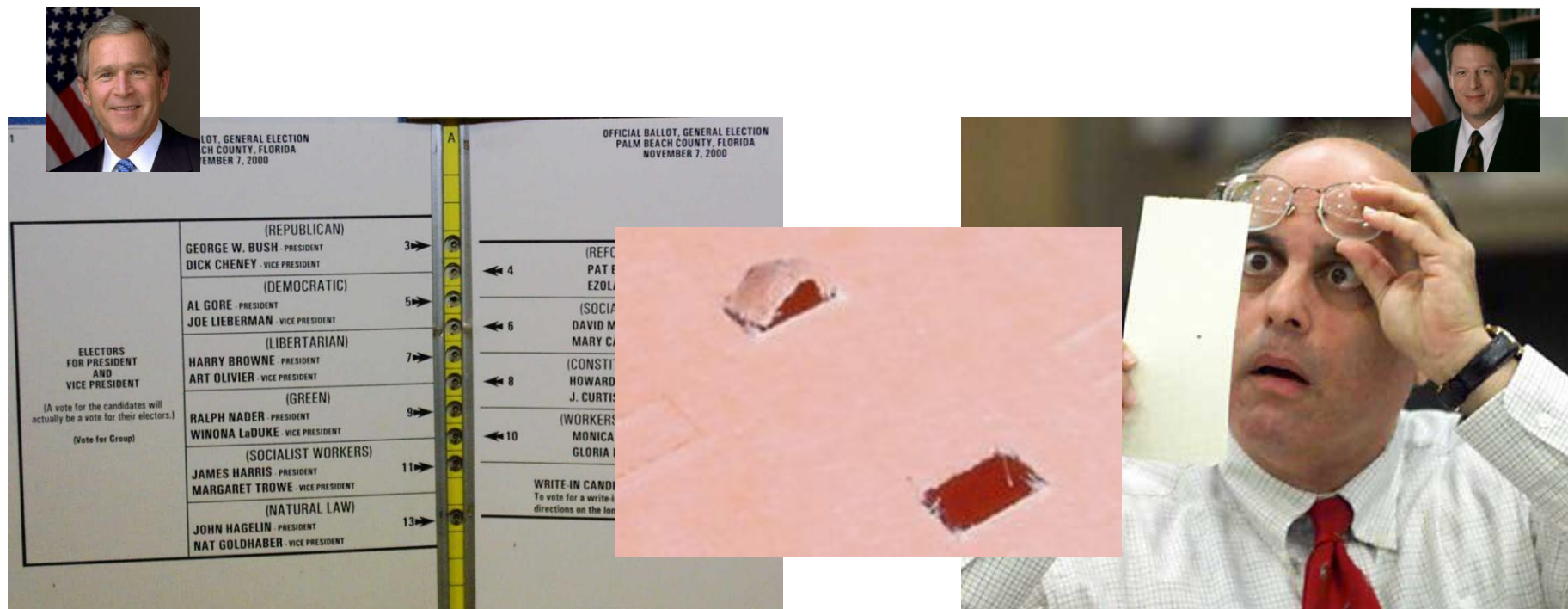
- Assembling and making openly available a large collection of real hand-marked ballots from a major election. (A “first”?)
- Proposing a paradigm for ground-truthing the collection.

Ballot reading vs. forms processing

Similarities to forms processing, but also some key differences:

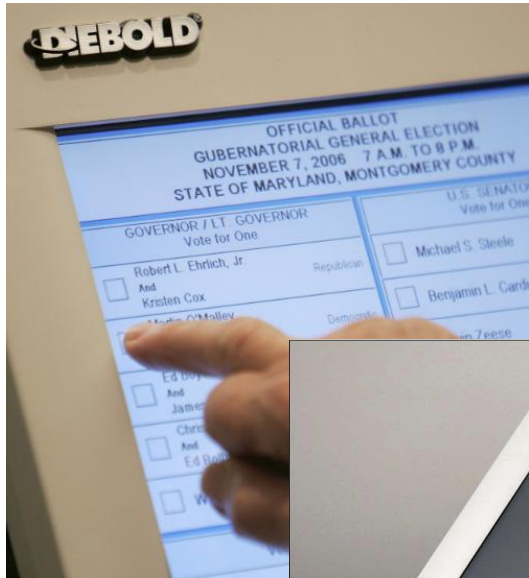
- Much broader range of users (education level, literacy, etc.) than for traditional forms applications.
- Ballots must preserve a voter's anonymity.
- Requirements legally mandated – cannot be circumvented.
- Demand to count votes and report results quickly.
- Elections are held infrequently, so voting equipment sits unused for long periods in storage.
- Poll workers often lack technical expertise.
- No *financial* interest in making sure votes are counted accurately, but there is tremendous *public* interest.

Misstep #1: Florida circa 2000



Bad ballot design combined with votomatic technology prone to paper jams. This led to hanging and dimpled chads, making it hard to determine *voter intent*, which provides the legal standard.

Misstep #2: Rush to DREs ...



... Misstep #2: Rush to DREs

Security Analysis of the Diebold AccuVote-TS Voting Machine

Electronic Voting Systems:
the Good, the Bad, and the Stupid

SECURITY ALERT: July 4, 2005

Critical Security Issues with Diebold Optical Scan Design

Security Assessment of the Diebold Optical Scan Voting Terminal

Pennsylvania voters: trust but verify

Poll finds most want ballot verification

Electronic Voting System Usability Issues

THE MACHINERY OF DEMOCRACY:
PROTECTING ELECTIONS
IN AN ELECTRONIC WORLD

**Hack-a-Vote: Security
Issues with Electronic
Voting Systems**

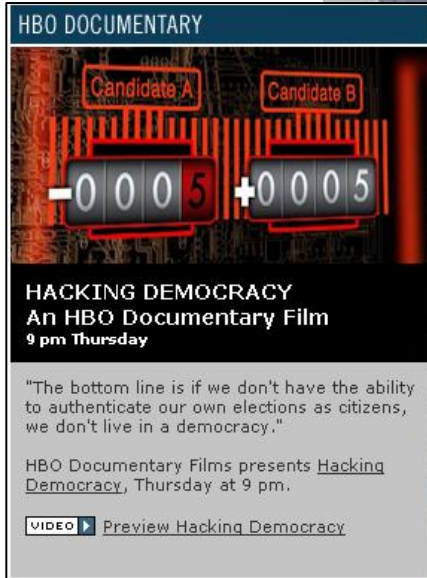
Analysis of an Electronic Voting System

Privacy Issues in an Electronic Voting Machine

SECURITY ALERT: May 11, 2006

Critical Security Issues with Diebold TSx

Trusted Agent Report
Diebold AccuVote-TS Voting System



HBO DOCUMENTARY

Candidate A Candidate B

-0005 +0005

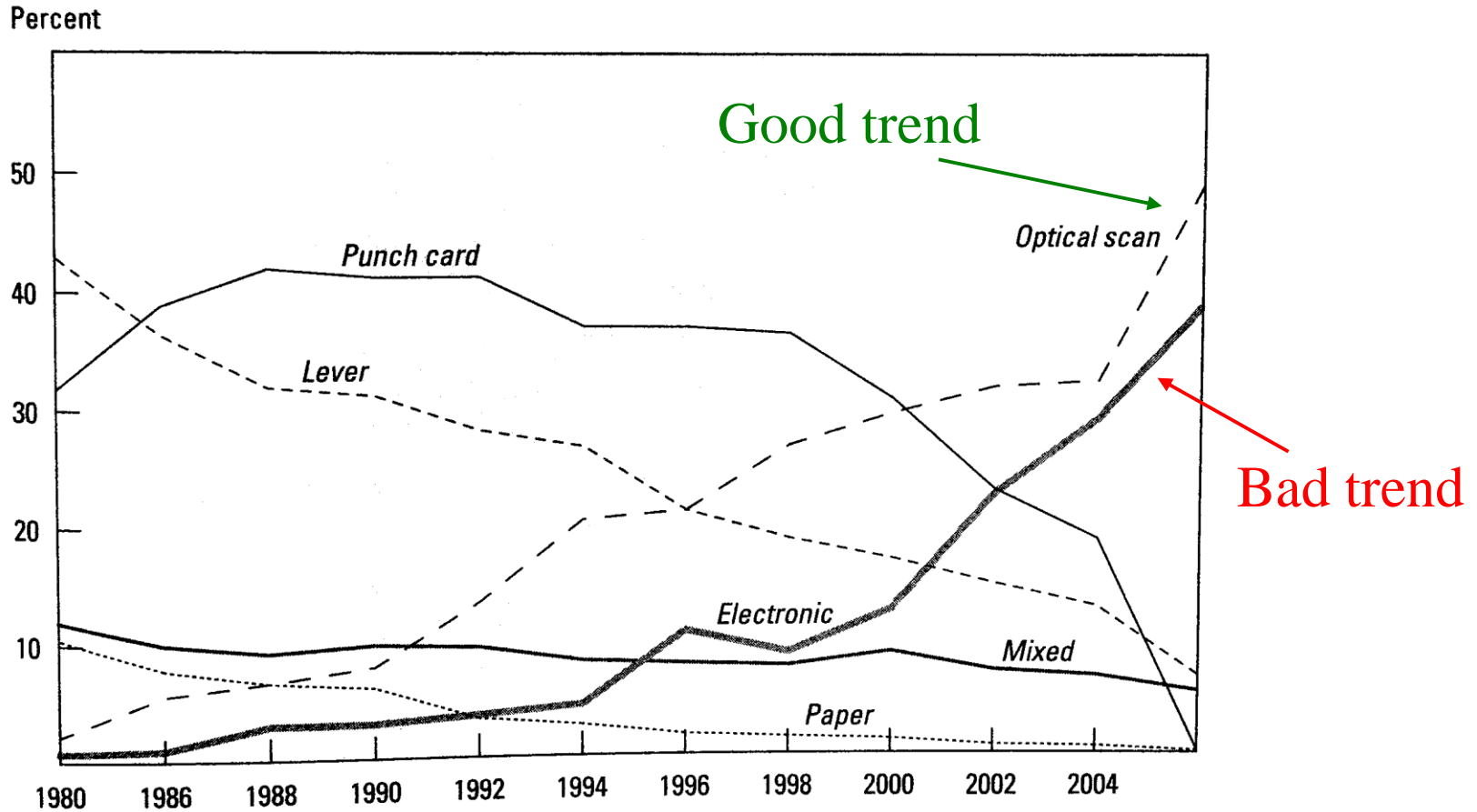
HACKING DEMOCRACY
An HBO Documentary Film
9 pm Thursday

"The bottom line is if we don't have the ability to authenticate our own elections as citizens, we don't live in a democracy."

HBO Documentary Films presents [Hacking Democracy](#), Thursday at 9 pm.

[VIDEO ▶ Preview Hacking Democracy](#)

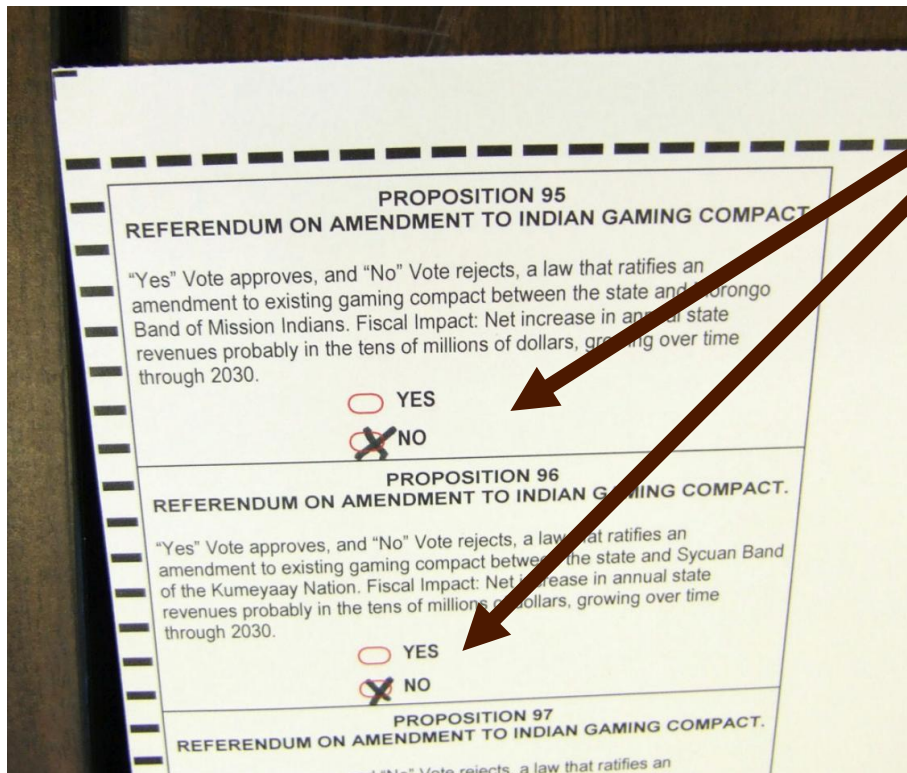
Voting system use in the U.S.



From *Voting Technology: The Not-So-Simple Act of Casting a Ballot*, by Paul S. Herrnson, et al, Brookings Institution Press, 2008.

Counting op-scan votes is not so easy

Real ballot from an election in CA:



One of these votes was counted correctly by the op-scan equipment, the other wasn't.

Note: this does not mean voting on paper ballots is bad, just (1) manual audits should be mandatory, and (2) more research is needed.

“Improving California’s 1% Manual Tally Procedure,” Joseph Lorenzo Hall, UC Berkeley School of Information, EVT Workshop 2008.

Fast forward to November 2008

While useful, neither of these alternatives is completely satisfying. What we would like to have is actual ballots from a real election. Even better, the ballots would be from an important election where the voter markings present serious pattern recognition challenges.



Extremely close U.S. Senate race in State of Minnesota: six days after election, unofficial results showed Republican Norm Coleman leading Democratic challenger Al Franken by 206 votes out of nearly 3 million cast, a difference of less than 0.01%.



Fortunate series of events

- Minnesota uses op-scan ballots.
- Closeness of election triggers a manual recount.
- Both sides are allowed to challenge validity of “questionable” ballots.
- Openness laws make challenged ballots a matter of public record.
- Ballot images made available on MN public radio website.
- PDF files contain 300 dpi TIF images!



http://minnesota.publicradio.org/features/2008/11/19_challenged_ballots/

Minnesota Statutes

Remember that the guiding principle is *voter intent*. Here are a few key points to keep in mind when interpreting ballot markings:

- “A ballot shall not be rejected for a technical error that does not make it impossible to determine the voter's intent.”
- “If a mark (X) is made out of its proper place, but so near a name or space as to indicate clearly the voter's intent, the vote shall be counted.”
- “Misspelling or abbreviations of the names of write-in candidates shall be disregarded if the individual for whom the vote was intended can be clearly ascertained from the ballot.”

<https://www.revisor.mn.gov/statutes/?id=204C.22>

Minnesota Statutes

... and ...

- “If a voter uniformly uses a mark other than (X) which clearly indicates an intent to mark a name or to mark yes or no on a question, and the voter does not use (X) anywhere else on the ballot, a vote shall be counted for each candidate or response to a question marked.

If a voter uses two or more distinct marks, such as (X) and some other mark, a vote shall be counted for each candidate or response to a question marked, unless the ballot is marked by distinguishing characteristics that make the entire ballot defective ...”

<https://www.revisor.mn.gov/statutes/?id=204C.22>

Minnesota Statutes

... and ...

- “If the names of two candidates have been marked, and an attempt has been made to erase or obliterate one of the marks, a vote shall be counted for the remaining marked candidate.”
- “A ballot shall not be rejected merely because it is slightly soiled or defaced.”
- “If a ballot is marked by distinguishing characteristics in a manner making it evident that the voter intended to identify the ballot, the entire ballot is defective.”

Goal here is to prevent coercion or vote selling.

<https://www.revisor.mn.gov/statutes/?id=204C.22>

Challenged ballots: you be the judge

Challenged Ballots: You be the Judge | Campaign 2008 | Minnesota Pub...

File Edit View History Bookmarks Tools Help

http://minnesota.p

Most Visited Getting Started Latest Headlines

Challenged Ballots: You be the Judge ...

Ballot #1: The Jellyfish
[View the whole ballot \(PDF opens in new window\)](#)

The Franken campaign challenged this Stearns County ballot due to "distinguishing marks." Marks from the reverse side of the ballot appear to have bled through and the voter appears to have attempted to rectify that by scribbling over the marks. (Secretary of State's Office)

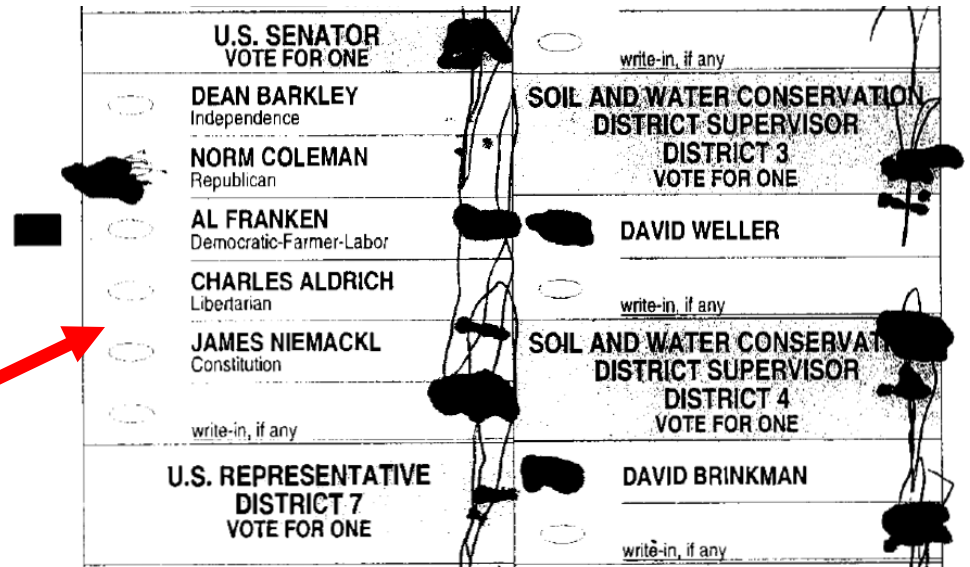
U.S. SENATOR VOTE FOR ONE	write-in, if any
DEAN BARKLEY Independence	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 3 VOTE FOR ONE
NORM COLEMAN Republican	DAVID WELLER
AL FRANKEN Democratic-Farmer-Labor	write-in, if any
CHARLES ALDRICH Libertarian	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 4 VOTE FOR ONE
JAMES NIEMACKL Constitution	write-in, if any
write-in, if any	U.S. REPRESENTATIVE DISTRICT 7 VOTE FOR ONE
U.S. REPRESENTATIVE DISTRICT 7 VOTE FOR ONE	DAVID BRINKMAN
write-in, if any	write-in, if any

Who gets the vote?

Norm Coleman
 Al Franken
 Nobody. Reject the ballot.

View Results

Done



Who gets vote? Public opinion:

- Norm Coleman: 63% (7,626 votes)
- Al Franken: 4% (474 votes)
- Nobody: 33% (4,050 votes)

Challenged ballots: you be the judge

Challenged Ballots: You be the Judge | Campaign 2008 | Minnesota Pub...

File Edit View History Bookmarks Tools Help

http://minnesota.p

Challenged Ballots: You be the Judge ...

Ballot #2: The Just Because
View the whole ballot (PDF opens in new window)

The Coleman campaign challenged this ballot from Hennepin County, saying the voter's editorial comments constitute a distinguishing mark on the ballot. (Secretary of State's Office)

write-in, if any

KARL

write-in

DEAN BARKLEY
Independence

NORM COLEMAN
Republican

AL FRANKEN
Democratic-Farmer-Labor

CHARLES ALDRICH
Libertarian

JAMES NIEMACKL
Constitution

write-in, if any

Does Al Franken get the vote?

Yes, but "just because he is a Democrat."

No. The ballot is invalid.

View Results

vote

Done

write-in

DEAN BARKLEY
Independence

NORM COLEMAN
Republican

AL FRANKEN
Democratic-Farmer-Labor

CHARLES ALDRICH
Libertarian

JAMES NIEMACKL
Constitution

write-in, if any

Just because he is on democratic ticket

Vote for Franken? Public opinion:

- Yes: 92% (11,069 votes)
- No: 8% (1,012 votes)

Challenged ballots: you be the judge

Challenged Ballots: You be the Judge | Campaign 2008 | Minnesota Public Radio NewsQ - Mozilla F...

File Edit View History Bookmarks Tools Help

http://minnesota.publicradio.org/feature

Most Visited Getting Started Latest Headlines

Challenged Ballots: You be the Judge ...

Ballot #5: The Yes
View the whole ballot (PDF opens in new window)
The Coleman campaign challenged this Benton County ballot because of "unusual marks." The voter appears to have written the word 'yes' inside the oval next to Al Franken's name. (Secretary of State's Office)

U.S. SENATOR VOTE FOR ONE		
<input type="radio"/>	DEAN BARKLEY Independence	SOIL AND DISTRICT
<input type="radio"/>	NORM COLEMAN Republican	
<input checked="" type="radio"/>	AL FRANKEN Democratic-Farmer-Labor	WAC
<input type="radio"/>	CHARLES ALDRICH Libertarian	write-in
<input type="radio"/>	JAMES NIEMACKL Constitution	SOIL AND DISTRICT
<input type="radio"/>	write-in, if any	

Does Al Franken get the vote?

Yes.
 No.

View Results vote

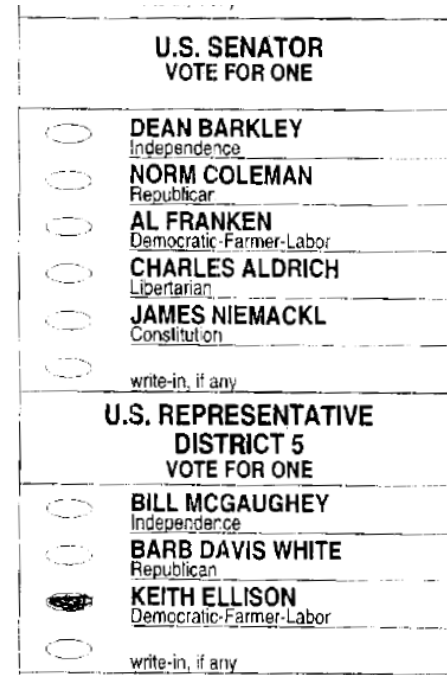
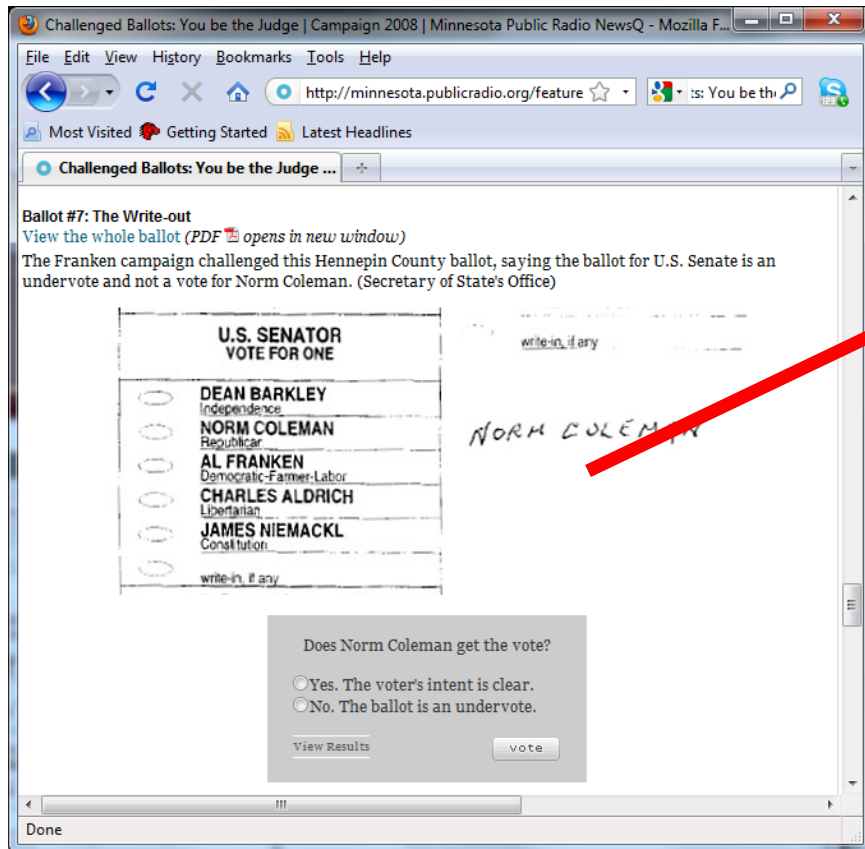
U.S. SENATOR VOTE FOR ONE		
<input type="radio"/>	DEAN BARKLEY Independence	SOIL AND DISTRICT
<input type="radio"/>	NORM COLEMAN Republican	
<input checked="" type="radio"/>	AL FRANKEN Democratic-Farmer-Labor	WAC
<input type="radio"/>	CHARLES ALDRICH Libertarian	write-in
<input type="radio"/>	JAMES NIEMACKL Constitution	SOIL AND DISTRICT
<input type="radio"/>	write-in, if any	

U.S. REPRESENTATIVE		
<input checked="" type="radio"/>		BERI

Vote for Franken? Public opinion:

- Yes: 96% (11,250 votes)
- No: 4% (452 votes)

Challenged ballots: you be the judge



Vote for Coleman? Public opinion:

- Yes: 54% (6,080 votes)
- No: 46% (5,203 votes)

MN Challenged Ballot Collection

How the ballot collection was generated and harvested:

- Ballots photocopied and originals stored in a secure location.
- Copies scanned to PDF using auto-feeder flatbed scanner.
- Ballot was two-sided, with both sides scanned simultaneously.
- We wrote a simple web “crawler” that automatically downloaded all the files and extracted TIF images from PDF.
- A total of 6,737 ballots in the set.
- Examination of the TIF suggests that ballots were scanned at 300 dpi bitonal, and that lossy compression was never used.
- Hence, they form an ideal dataset for research purposes.

Minnesota ballot front and back

OFFICIAL BALLOT

ATKIN COUNTY STATE OF MINNESOTA NOVEMBER 4, 2008

STATE GENERAL ELECTION BALLOT
INSTRUCTIONS TO VOTERS
To vote, completely fill in the oval(s) next to your choice(s) like this: ●

FEDERAL OFFICES	STATE OFFICES	COUNTY OFFICES
PRESIDENT AND VICE PRESIDENT VOTE FOR ONE TEAM	STATE REPRESENTATIVE DISTRICT 3B VOTE FOR ONE	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 5 VOTE FOR ONE
JOHN MCCAIN AND SARAH PALIN Republican	CAROLYN MCELFRATK Republican	DONNA RAE ASP write-in, if any
BARACK OBAMA AND JOE BIDEN Democratic-Farmer-Labor	LOREN A. SOLBERG Democratic-Farmer-Labor	TOWN OFFICES
CYNTHIA MCKINNEY AND ROSA CLEMENTE Green	CONSTITUTIONAL AMENDMENT	TOWN SUPERVISOR SEAT B TOWN OF NORDLAND VOTE FOR ONE
ROGER GALERO AND ALYSON KENNEDY Social Workers	Failure to vote on a constitutional amendment will have the same effect as voting "no" for the amendment.	RUTH ANN NELSON write-in, if any
RALPH NADER AND MATT GONZALEZ Independent	To vote for a proposed constitutional amendment, completely fill in the oval next to the word "YES" for that question. To vote against a proposed constitutional amendment, completely fill in the oval next to the word "NO" for that question.	JOHN STEEBER write-in, if any
BOB BARR AND WAYNE A. ROOT Libertarian	CLEAN WATER, WILDLIFE, CULTURAL HERITAGE AND NATURAL AREAS	WAYNE DAVIS write-in, if any
CHUCK BALOWIN AND DARRELL CASTLE Conservative	Shall the Minnesota Constitution be amended to dedicate land to protect our drinking water sources, to protect, enhance, and restore our wetlands, riparian forests, and fish, game, and wildlife habitat, to preserve our arts and cultural heritage, to support our parks and trails, and to protect, enhance, and restore our lakes, rivers, streams, and riparian wetlands by increasing the three-eighths of one percent on tobacco sales until the year 2034?	TOWN SUPERVISOR SEAT C TOWN OF NORDLAND VOTE FOR ONE
U.S. SENATOR VOTE FOR ONE	YES	STANLEY W. NIX write-in, if any
DEAN BARKLEY Independent	NO	TOWN TREASURER TOWN OF NORDLAND VOTE FOR ONE
NORM COLEMAN Republican	COUNTY OFFICES	JUDY PEYSAR write-in, if any
AL FRANKEN Democratic-Farmer-Labor	COUNTY COMMISSIONER DISTRICT 2 VOTE FOR ONE	SCHOOL DISTRICT OFFICES
CHARLES ALDRICH Libertarian	DALE K. LUECK write-in, if any	SCHOOL BOARD MEMBER INDEPENDENT SCHOOL DISTRICT NO. 1 (ATKIN) VOTE FOR UP TO THREE
JAMES NIEMACKL Conservative	LAURIE A. WESTERLUND write-in, if any	PETER A. WELSHONS write-in, if any
U.S. REPRESENTATIVE DISTRICT 8 VOTE FOR ONE	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 2 VOTE FOR ONE	DENNIS HASSKAMP write-in, if any
MICHAEL CUMMINS Republican	FRANKLIN TURNOCK write-in, if any	JOHN CHUTE write-in, if any
JAMES L. OBERSTAR Democratic-Farmer-Labor	SOIL AND WATER CONSERVATION DISTRICT SUPERVISOR DISTRICT 4 VOTE FOR ONE	CHARLES WIKELIUS write-in, if any
0145 TOWN OF NORDLAND	BOB JANZEN write-in, if any	WILLIAM E. STIMAC write-in, if any

VOTE FRONT AND BACK OF BALLOT

STATE GENERAL ELECTION BALLOT

ATKIN COUNTY STATE OF MINNESOTA NOVEMBER 4, 2008

INSTRUCTIONS TO VOTERS
To vote, completely fill in the oval(s) next to your choice(s) like this: ●

JUDICIAL OFFICES	9TH DISTRICT COURT
SUPREME COURT	JUDGE 4 VOTE FOR ONE
ASSOCIATE JUSTICE 3	DAVID F. HARRINGTON Incumbent
TIM TINGELSTAD write-in, if any	JUDGE 6 VOTE FOR ONE
PAUL H. ANDERSON Incumbent	CHARLES H. (CHAD) LEDUC Incumbent
ASSOCIATE JUSTICE 4	JUDGE 8 VOTE FOR ONE
DEBORAH HEDLUND Incumbent	DONALD J. AANDAL Incumbent
LORIE SKJERVEN GILDEA Incumbent	JUDGE 11 VOTE FOR ONE
COURT OF APPEALS	MICHAEL J. KRAKER Incumbent
JUDGE 16 VOTE FOR ONE	JUDGE 12 VOTE FOR ONE
TERRI J. STONEBURNER Incumbent	LOIS J. LANG Incumbent
DAN GRIFFITH Incumbent	JUDGE 14 VOTE FOR ONE
JUDGE 1 VOTE FOR ONE	ROBERT D. TIFFANY Incumbent
EDWARD TOUSSAINT, JR. Incumbent	JUDGE 15 VOTE FOR ONE
JUDGE 8 VOTE FOR ONE	TAMARA L. YON Incumbent
THOMAS J. KALITOWSKI Incumbent	JUDGE 18 VOTE FOR ONE
JUDGE 9 VOTE FOR ONE	JEFFREY S. REMICK Incumbent
ROGER M. KLAPHAKE Incumbent	JUDGE 21 VOTE FOR ONE
JUDGE 10 VOTE FOR ONE	DAVID J. TEN EYCK Incumbent
HARRIET LANSING Incumbent	JUDGE 22 VOTE FOR ONE
JUDGE 15 VOTE FOR ONE	KURT J. MARBEN Incumbent
KEVIN D. ROSS Incumbent	9TH DISTRICT COURT
JUDGE 3 VOTE FOR ONE	JOHN R. SOLIEN Incumbent
JOHN R. SOLIEN Incumbent	

VOTE FRONT AND BACK OF BALLOT

Handwritten notes:
- "Nader" with a checkmark next to Ralph Nader and Matt Gonzalez.
- "Nader" with a checkmark next to the "NO" option for the Clean Water, Wildlife, Cultural Heritage and Natural Areas amendment.
- "Nader" with a checkmark next to the "NO" option for the U.S. Senator vote.

More about the collection

Reason for challenge is recorded in stamp added to each ballot:

U.S. Senator

Precinct: *Shamrock*

Challenged ballot #: *1*

Challenged by COLEMAN

Challenge reason: *Red stray mark on front of ballot*

- Challenges as a result of manual recount – not machine rejects.
- Ballot is challenged for one race – others may be “normal.”
- Challenges are extremely aggressive (both sides want to win).

Franken ultimately declared winner by 312 votes: machine-reading got the results of the election wrong.

Ground-truthing protocol

Guiding principles:

- “Ground-truthing” can refer to identifying raw markings on ballot and/or interpreting their meaning (“vote” / “no vote”).
- We have built a GUI tool that captures truth at both levels.
- Ideally, a system built for reading op-scan ballots should replicate same understanding of voter intent possessed by a knowledgeable human judge.
- Legitimate differences of opinion exist, so “truth” is relative.
- Users provided with 15-page guideline, as well as MN statutes.

What here generalizes to other document analysis applications?

BallotTool GUI

The screenshot displays the BallotTool GUI interface. The main window shows an 'OFFICIAL BALLOT' for Aitkin County, State of Minnesota. The ballot is titled 'STATE GENERAL ELECTION BALLOT' and includes 'INSTRUCTIONS TO VOTERS'. The ballot is divided into three columns: 'FEDERAL OFFICES', 'STATE OFFICES', and 'COUNTY OFFICES'. The 'FEDERAL OFFICES' column lists candidates for President and Vice President: John McCain and Sarah Palin (Republican), Barack Obama and Joe Biden (Democratic-Farmer-Labor), Cynthia McKinney and Rosa Clemente (Green), and Roger Calero and Alyson Kennedy (Socialists/Workers). The 'STATE OFFICES' column lists candidates for State Representative District 3B: Carolyn McElPatrick (Republican) and Loren A. Solberg (Democratic-Farmer-Labor). The 'COUNTY OFFICES' column lists candidates for Soil and Water District: Donna (name partially obscured) and Wayne Davis. A 'MAGNIFIED VIEW' window is open, showing a close-up of a handwritten mark on the ballot, which appears to be a circle with a dot inside, indicating a vote for Barack Obama and Joe Biden. The 'Annotations' window is also open, showing the user ID 'dpi', the last edit by 'dpi', and the annotation 'Aitkin_Norland_challenged_ballot'. The 'Annotations' window also shows the page image path and the 'Legal Vote' status for each candidate.

FEDERAL OFFICES	STATE OFFICES	COUNTY OFFICES
PRESIDENT AND VICE PRESIDENT VOTE FOR ONE TEAM	STATE REPRESENTATIVE DISTRICT 3B VOTE FOR ONE	SOIL AND WATER DISTRICT VOTE FOR ONE
JOHN MCCAIN AND SARAH PALIN Republican	CAROLYN MCELPATRICK Republican	DONNA write-in, if any
BARACK OBAMA AND JOE BIDEN Democratic-Farmer-Labor	LOREN A. SOLBERG Democratic-Farmer-Labor	TOWN TOWN SUPERVISOR VOTE FOR ONE
CYNTHIA MCKINNEY AND ROSA CLEMENTE Green	CONSTITUTIONAL AMENDMENT Failure to vote on a constitutional amendment, will have the same effect as voting no for the amendment. To vote for a proposed constitutional amendment, completely fill in the oval next to the word "YES" for that question. To vote against a proposed constitutional amendment, completely fill in the oval next to the word "NO" for that question.	RUTH ANN NELSON
ROGER CALERO AND ALYSON KENNEDY Socialists/Workers		JOHN STEEBER
RALPH NADER AND MATT GONZALEZ Independent		WAYNE DAVIS write-in, if any

Ground-truth

Physical level:

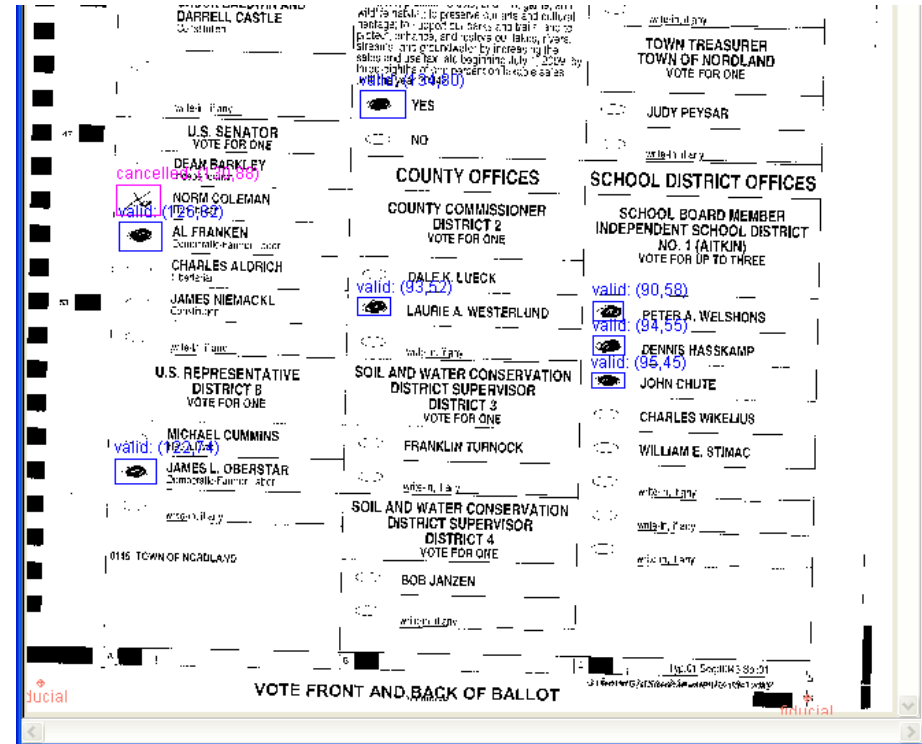
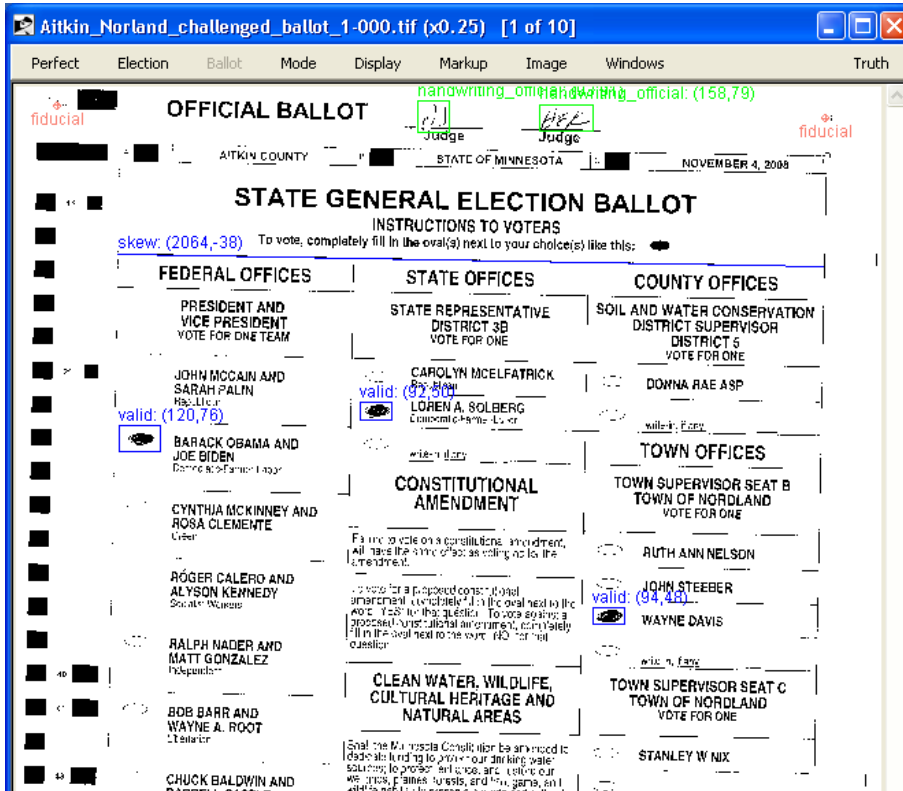
- Each target annotated with bounding box as **valid mark**, stray mark, cancelled vote, or no vote.
- Marking style is recorded as filled oval, partially filled oval, ex (X), or check mark.
- Other marks on ballot face annotated (challenge stamp, bleed-through, voter or official handwriting, fiducial, skew line, etc.).

Logical level:

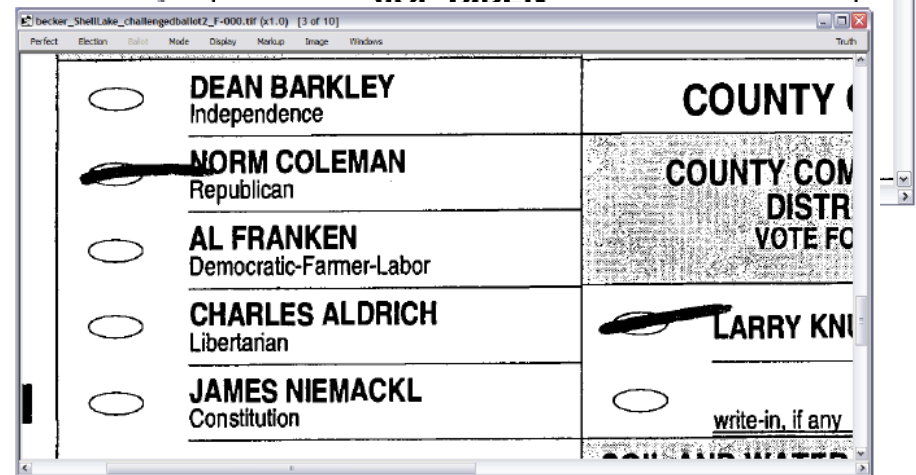
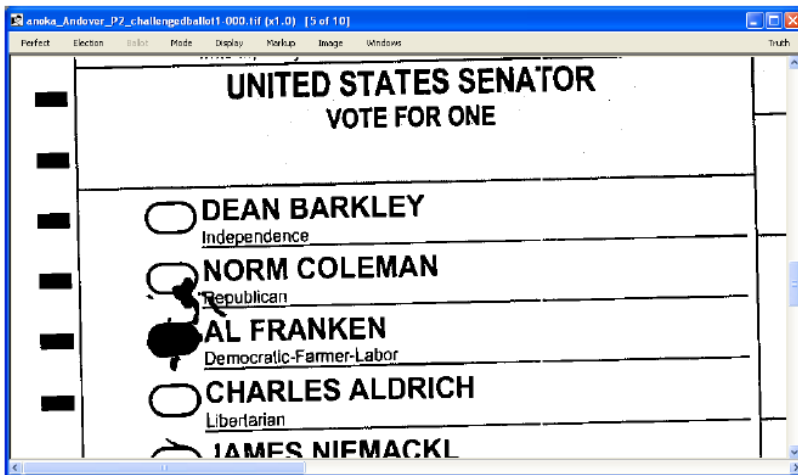
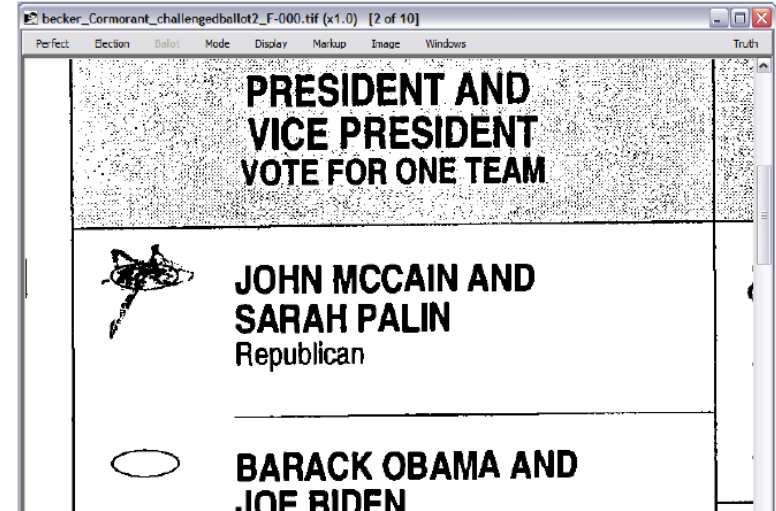
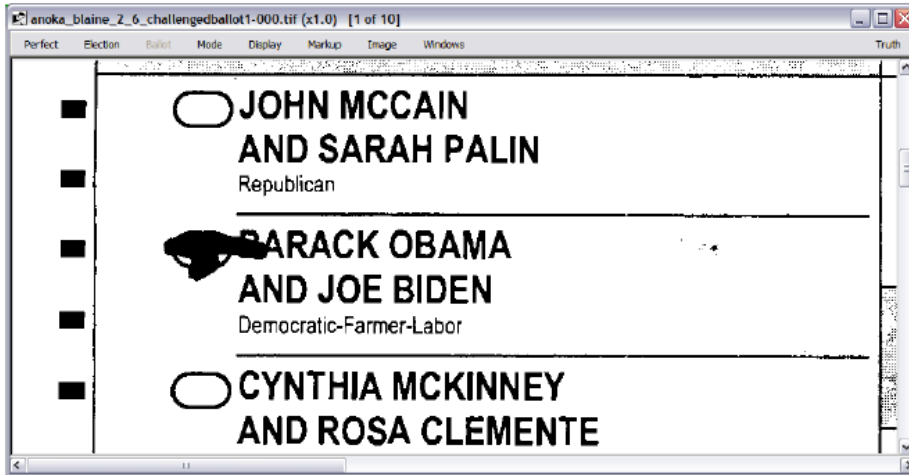
- User specifies who gets **legal vote(s)** in each race (i.e., intent).

Note two are not equivalent.

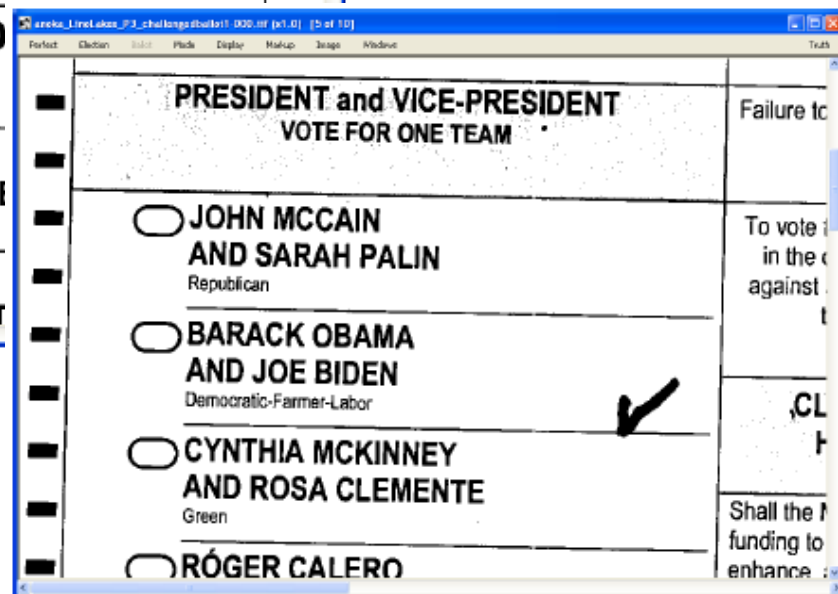
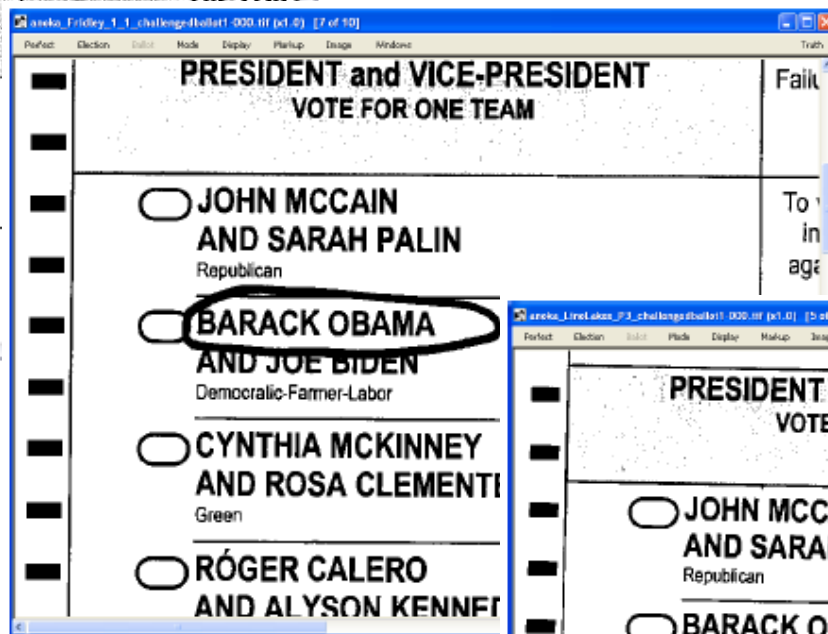
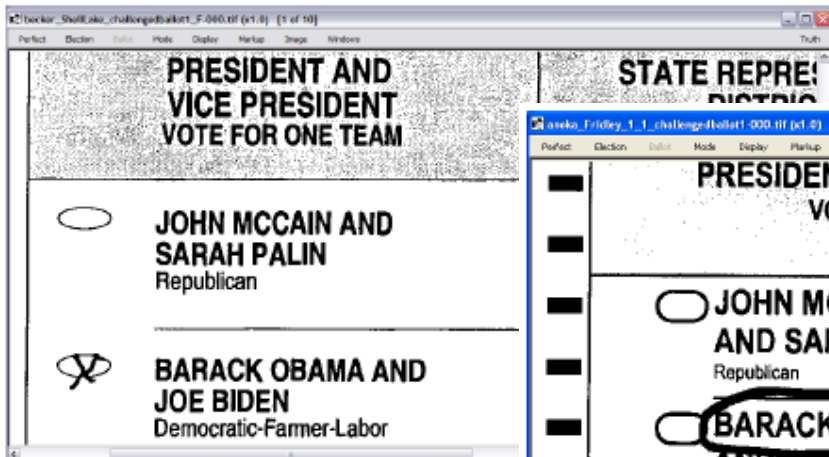
Example of a Fully Annotated Ballot



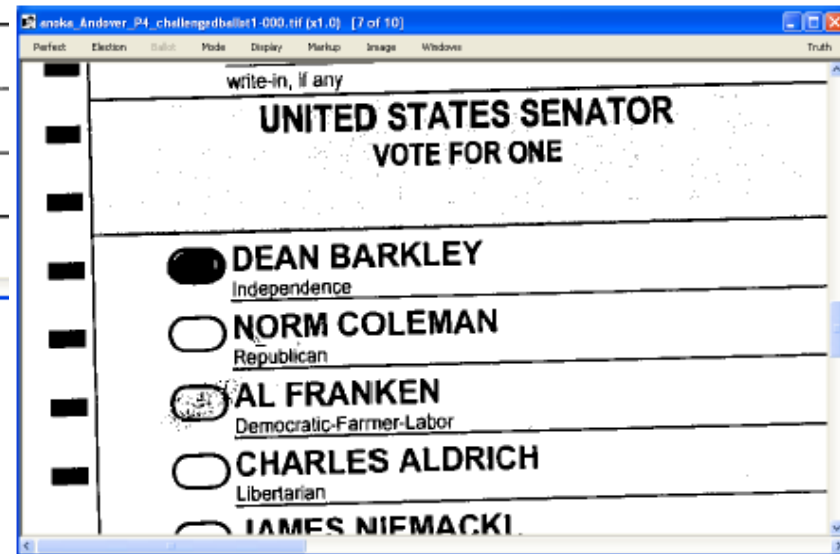
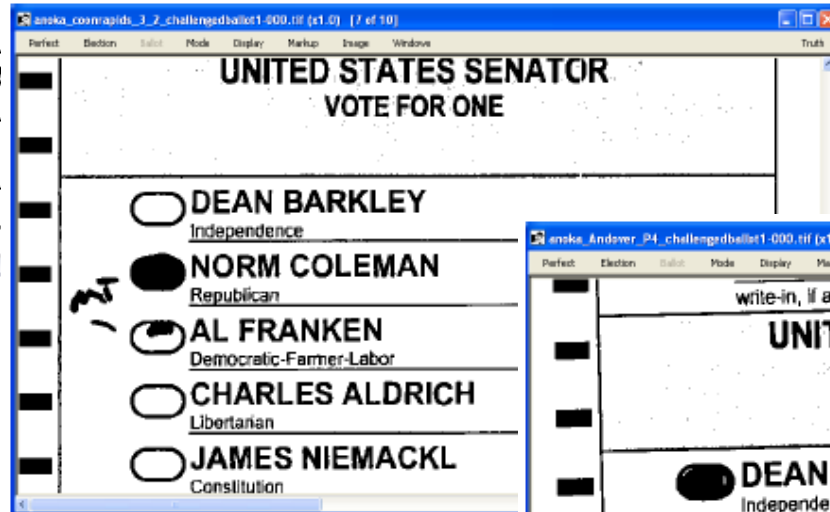
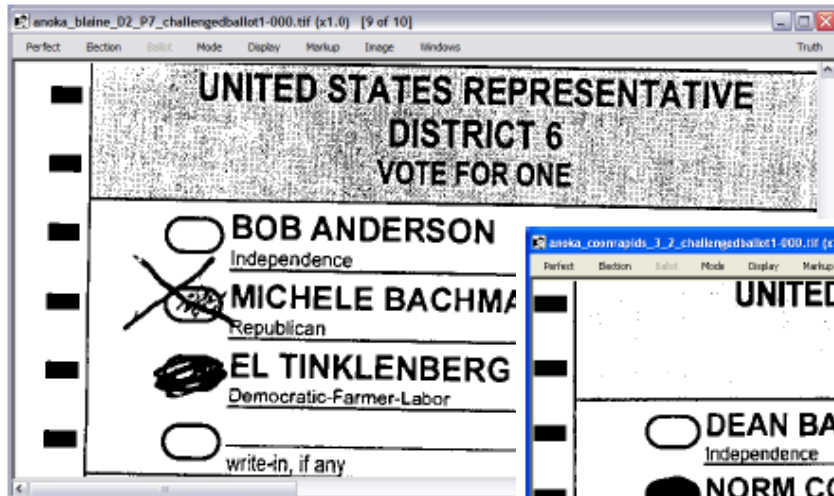
Sloppy-but-valid marks



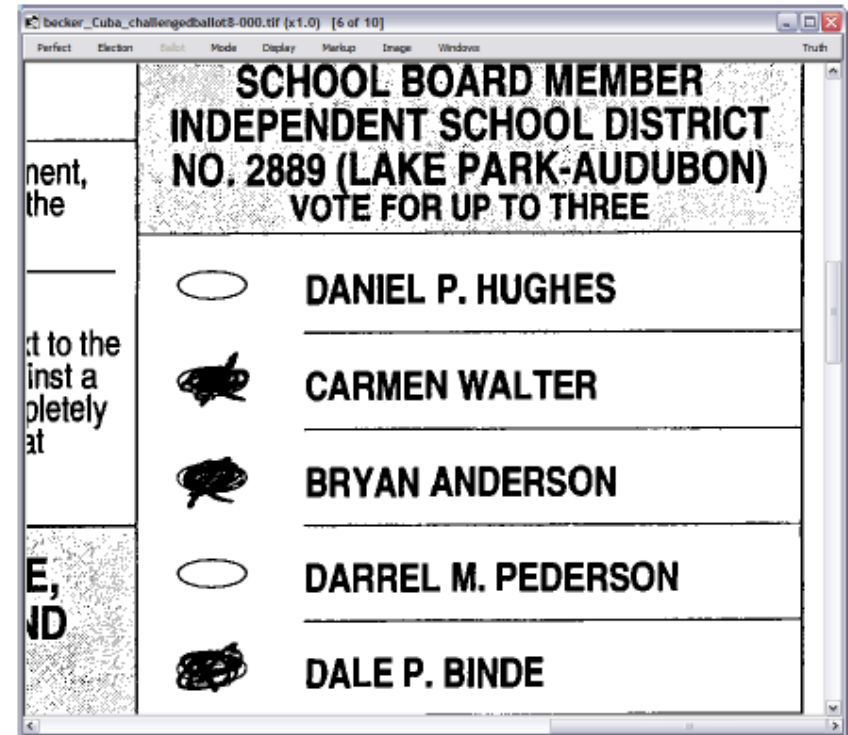
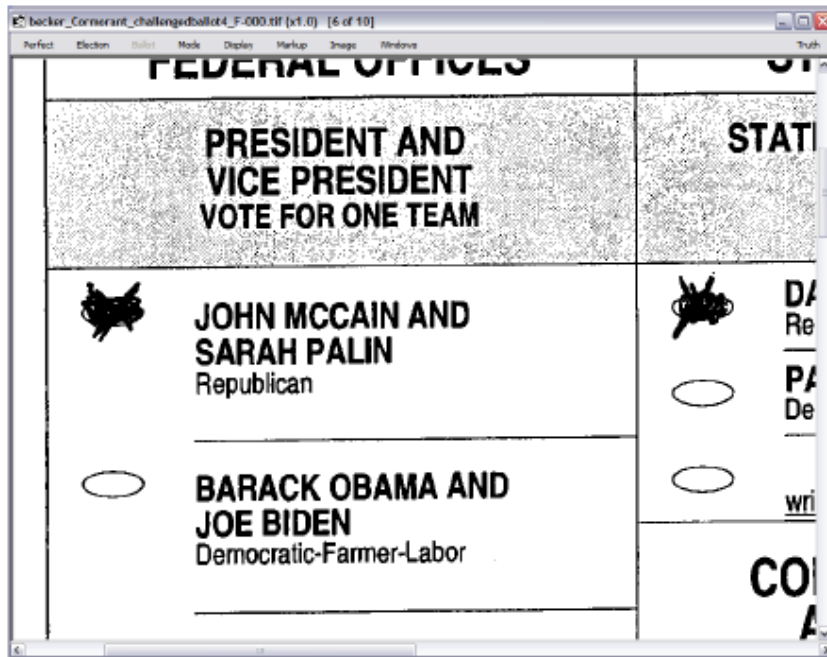
Non-confirming marking styles



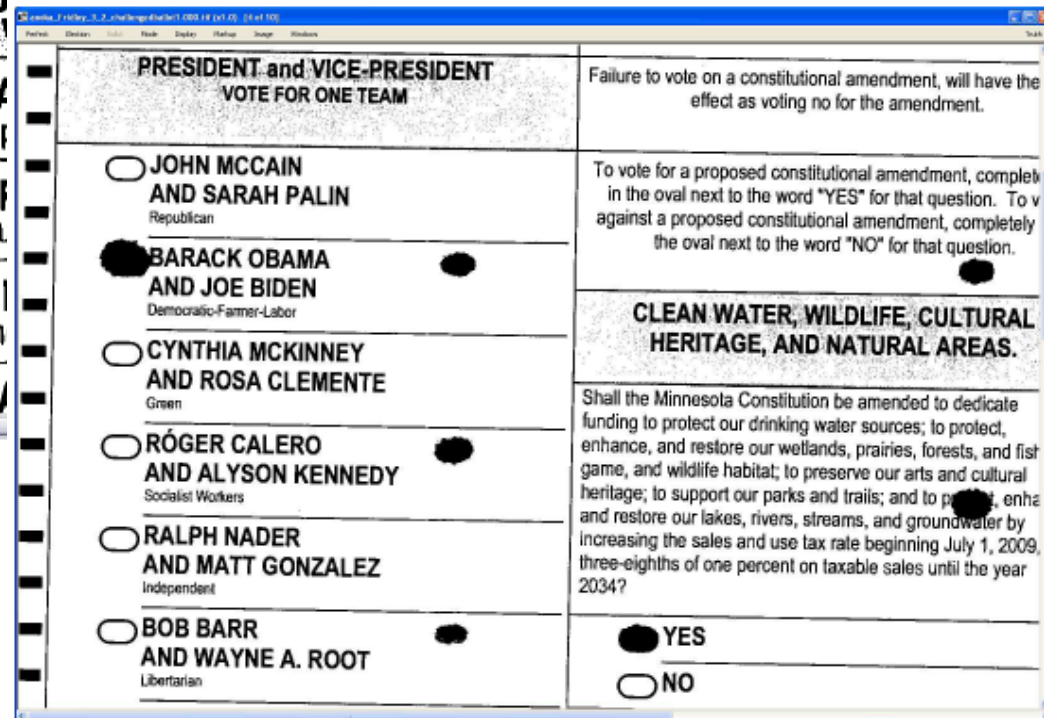
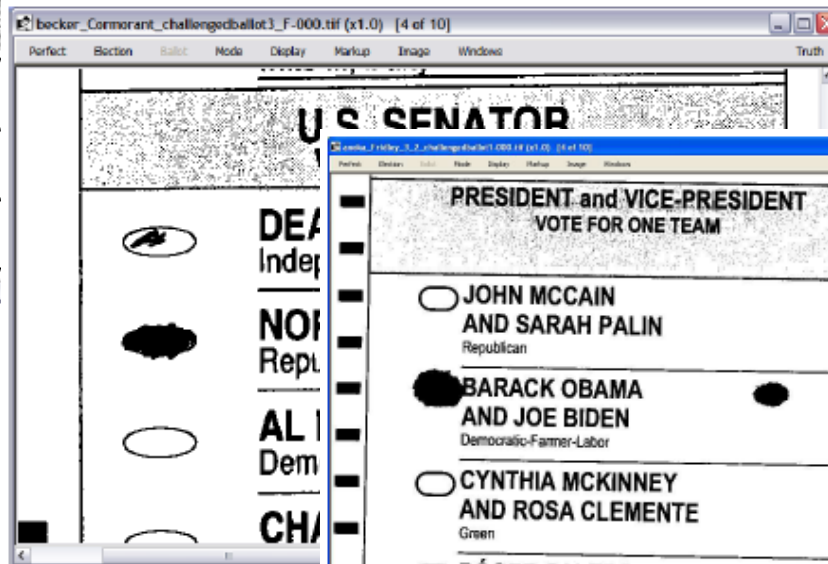
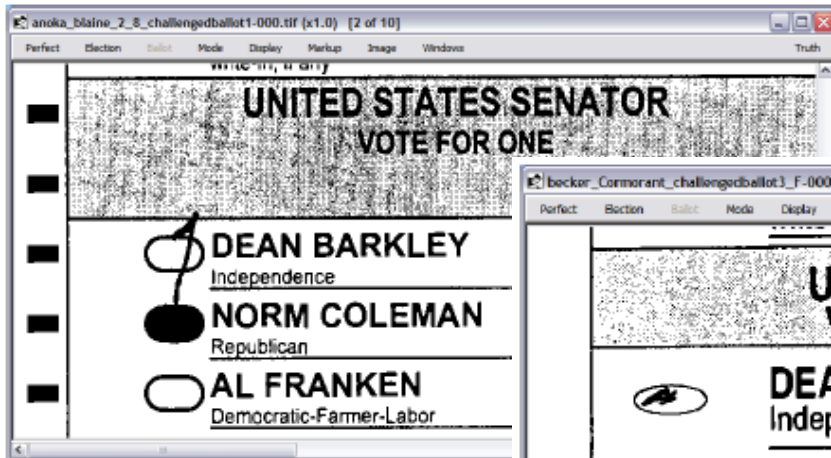
Attempts to cancel a vote



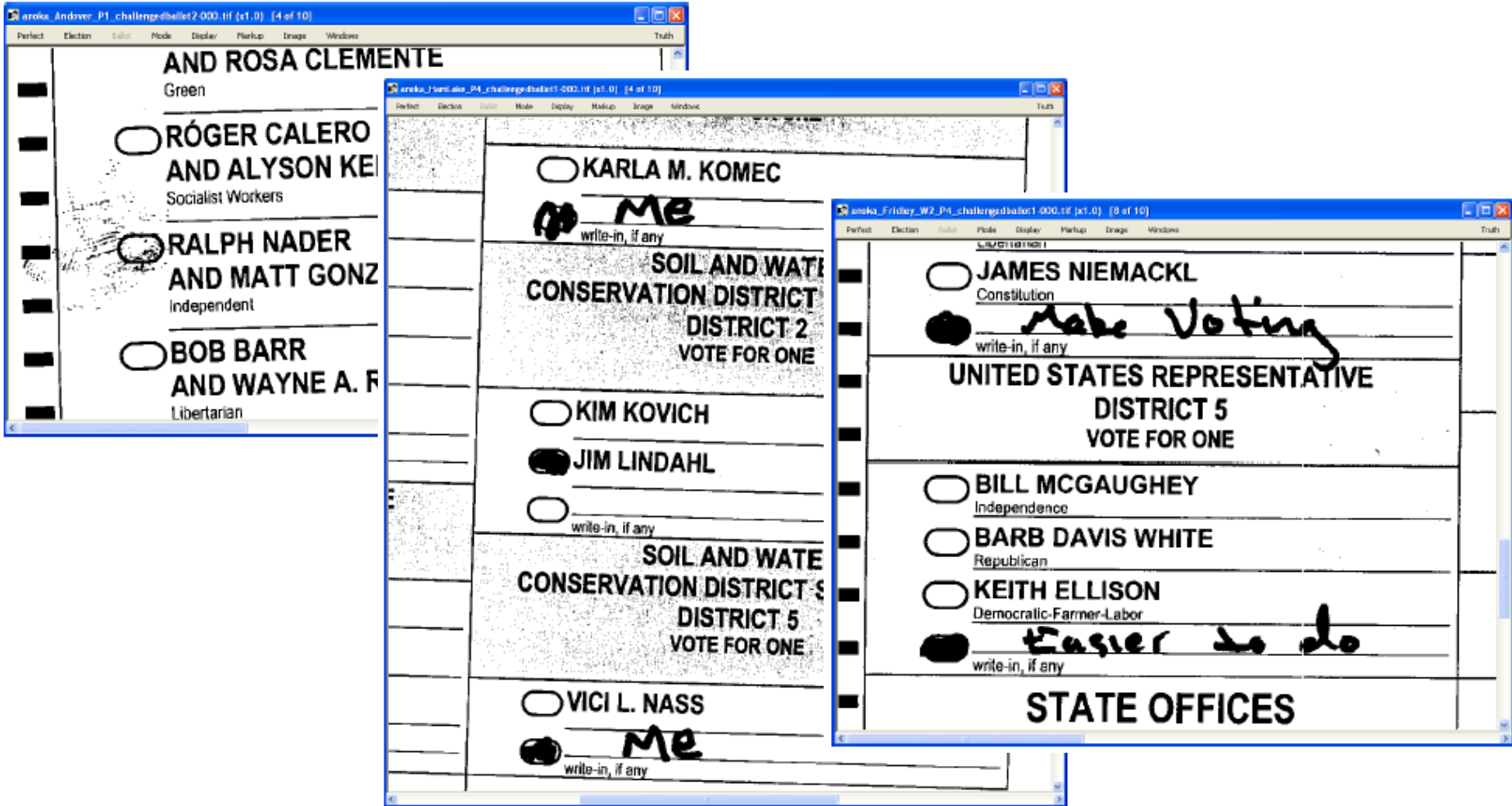
Intended votes that look cancelled



Stray marks and bleedthrough



Invalidating markings



Why isn't this an easy problem?

After all, ballots are just a simple type of form. We must read the votes correctly, but we aren't expected to recognize write-in names. Can't we just push up reject rate until the accuracy reaches 100%?

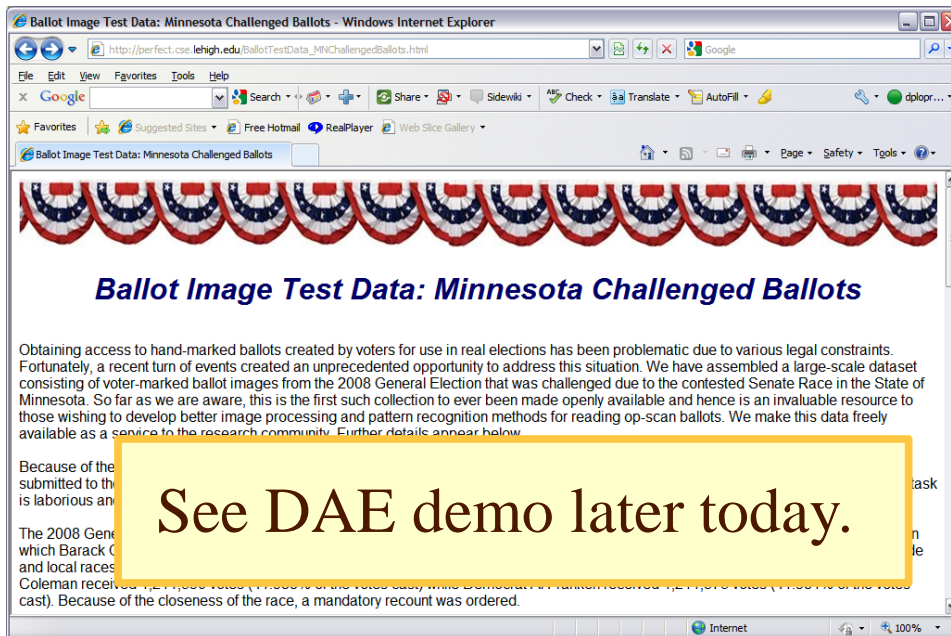
Remember, we can't change rules in ways that violate the law. VOTER INTENT is the definition we must always follow.

To do this right, we must be prepared to:

- Reject any ballot that may contain “identifying marks.”
- Recognize intent when mark is atypical and/or far from target.
- Accurately identify when a vote has been cancelled.

Status

- All 6,737 ballots now online at:
http://perfect.cse.lehigh.edu/BallotTestData_MNChallengedBallots.html
- Ground truth collected from 8 test subjects, 980 ballot sides.



Coming soon:

- Add to TC-11 website.
- Ground-truthing continues – to be made available online.