Appendix A

ELFT-EFS [Evaluation #2]
NIST Evaluation of Latent Fingerprint Technologies: Extended Feature Sets

Additional Results

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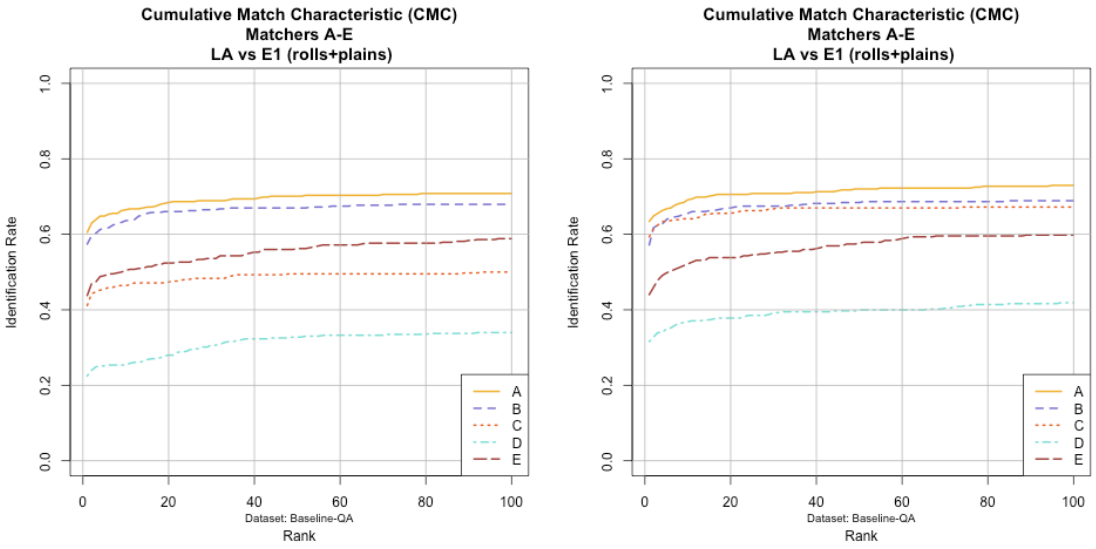
A-1 Additional Rank-based results

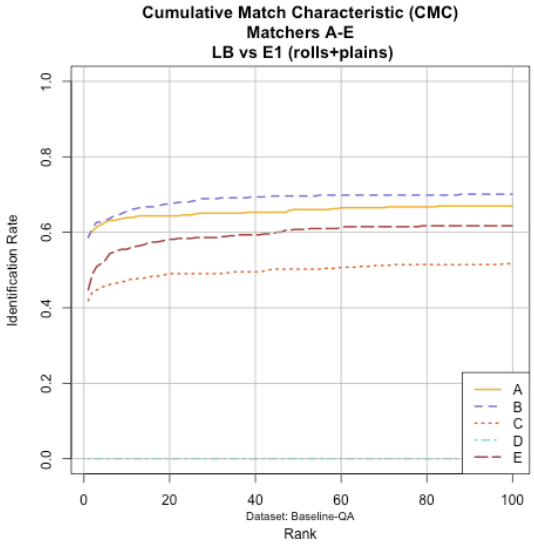
These are additional results not presented in the main report.

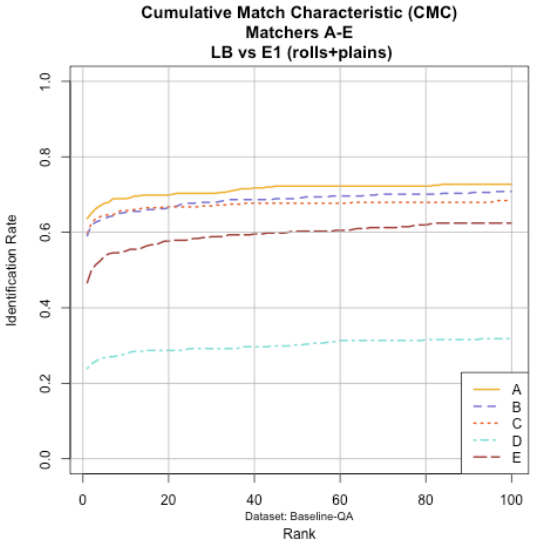
Note: in this section and throughout the report, results from Evaluation #1 differ slightly from those reported in NISTIR 7775, because these are based on the revised Baseline and Baseline-QA datasets. In general, the Evaluation #1 results reported here are about 1 percentage point higher than those reported in NISTIR 7775.

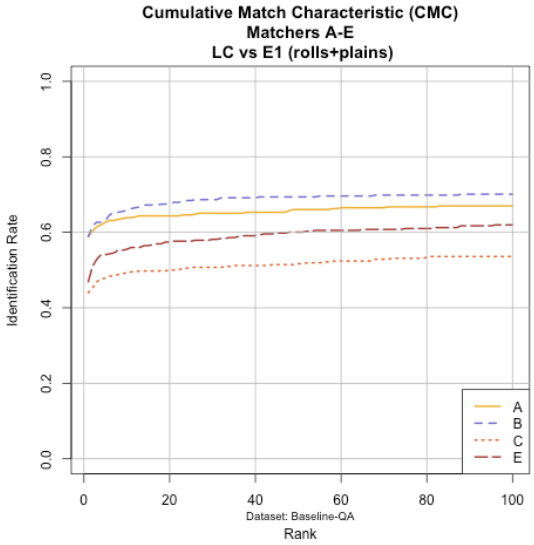
A-1.1 CMCs for Baseline-QA dataset

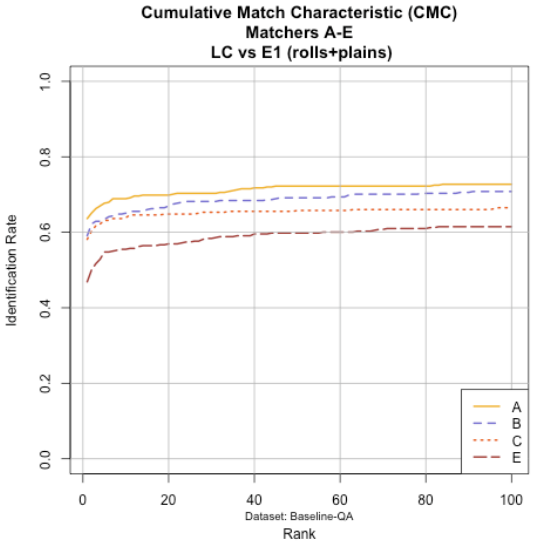
The following CMCs compare the performance of the individual matchers for each latent feature subset for the Baseline-QA dataset. In each case, the results for Evaluation #1 are on the left, and the results for Evaluation #2 are on the right.

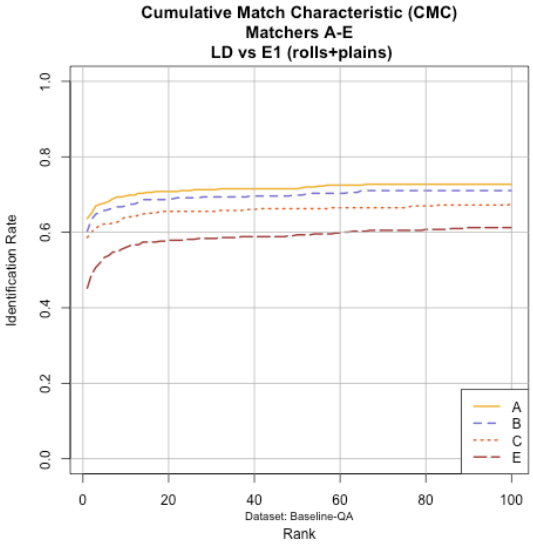


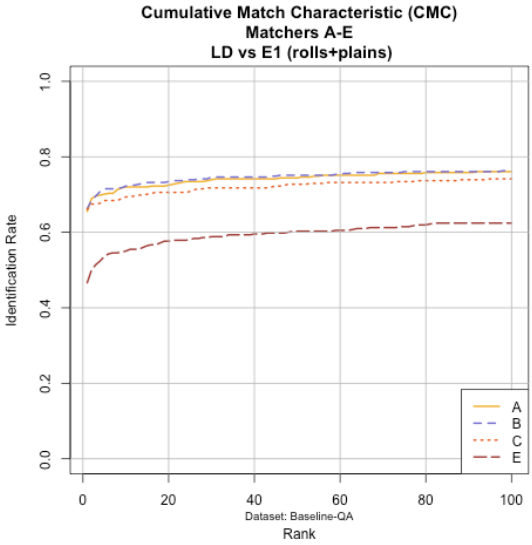

Cumulative Match Characteristic (CMC)
Matchers A-E
LB vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
D
E

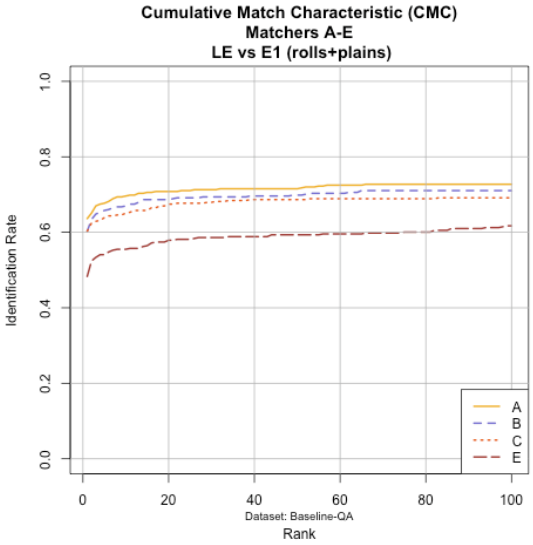

Cumulative Match Characteristic (CMC)
Matchers A-E
LB vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
D
E

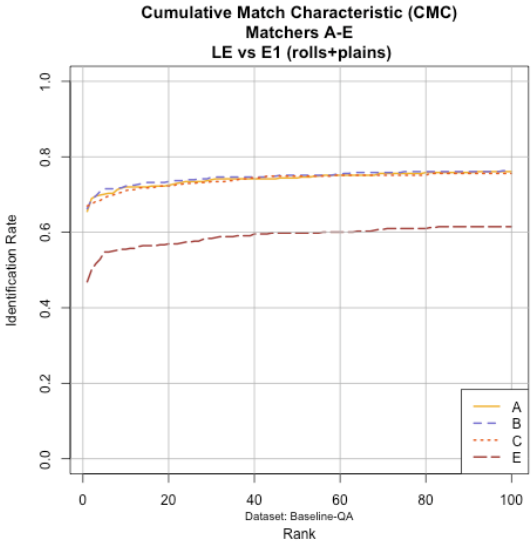

Cumulative Match Characteristic (CMC)
Matchers A-E
LC vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
E

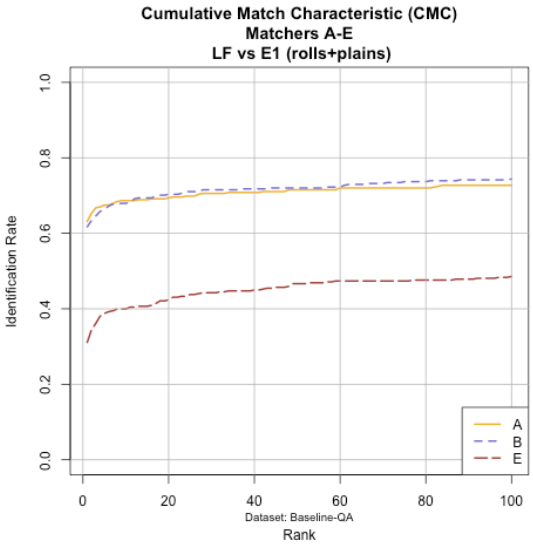

Cumulative Match Characteristic (CMC)
Matchers A-E
LC vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
E

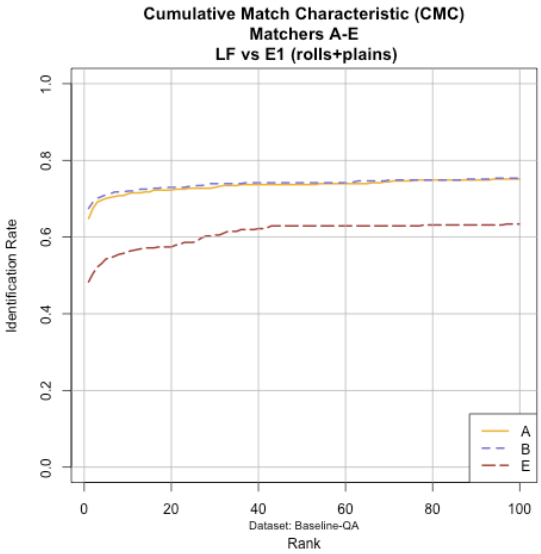

Cumulative Match Characteristic (CMC)
Matchers A-E
LD vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
C
E

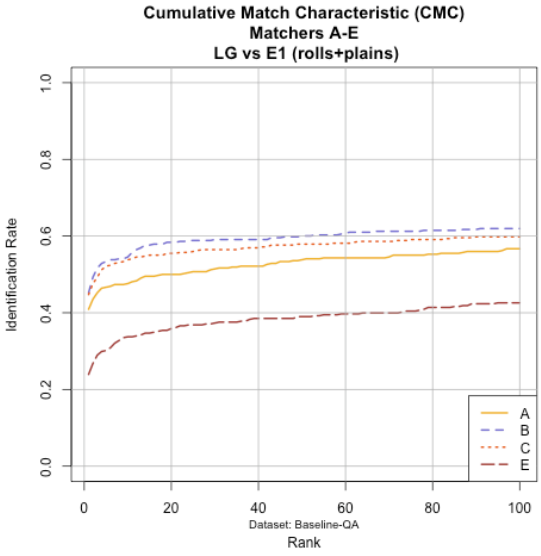

Cumulative Match Characteristic (CMC)
Matchers A-E
LD vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
C
E

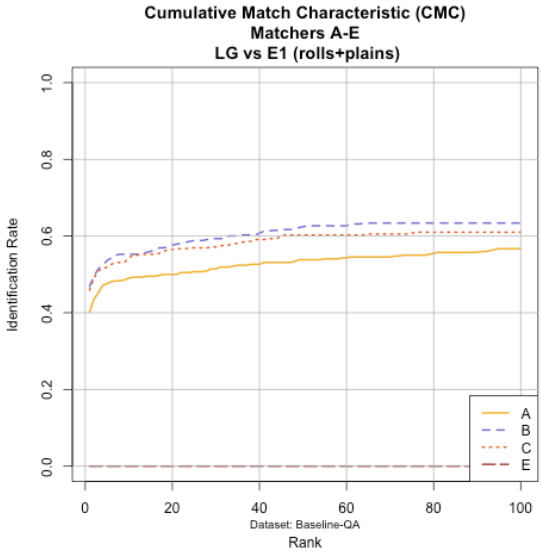

Cumulative Match Characteristic (CMC)
Matchers A-E
LE vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
C
E


Cumulative Match Characteristic (CMC)
Matchers A-E
LE vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
C
E


Cumulative Match Characteristic (CMC)
Matchers A-E
LF vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
E

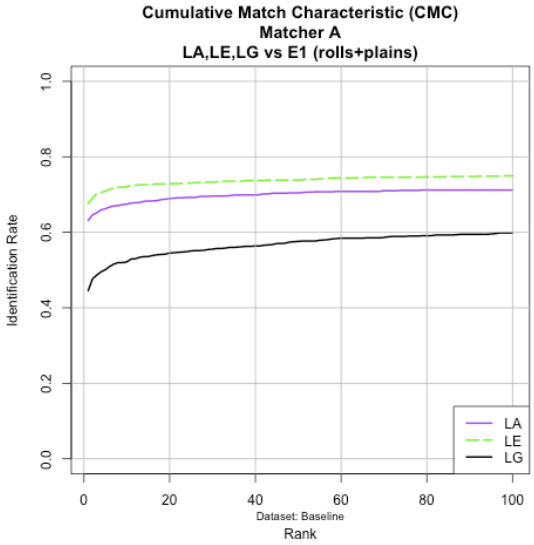

Cumulative Match Characteristic (CMC)
Matchers A-E
LF vs E1 (rolls+plains)
Identification Rate
Dataset: Baseline-QA
Rank
A
B
E

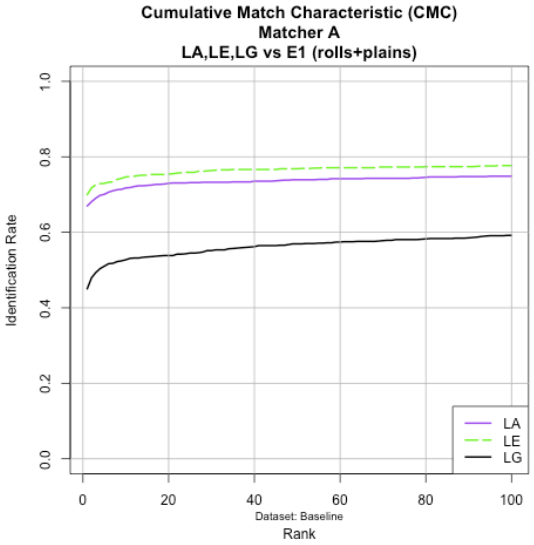

Cumulative Match Characteristic (CMC)
Matchers A-E
LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
E

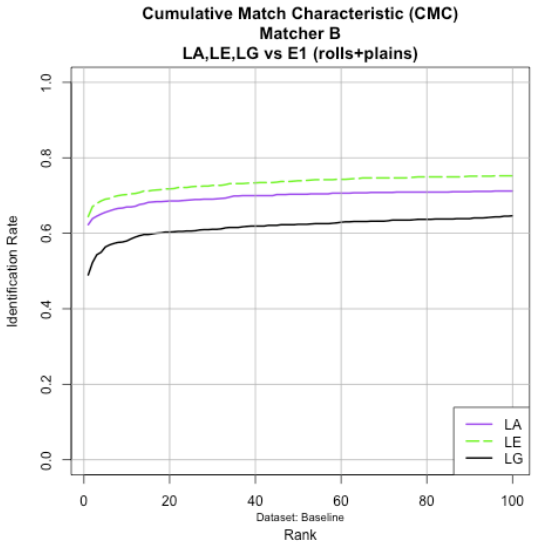

Cumulative Match Characteristic (CMC)
Matchers A-E
LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline-QA
Rank
A
B
C
E

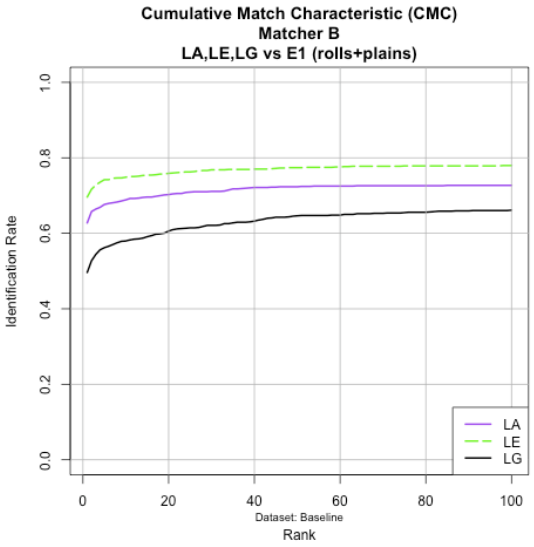
A-1.2 CMCs for Baseline Dataset

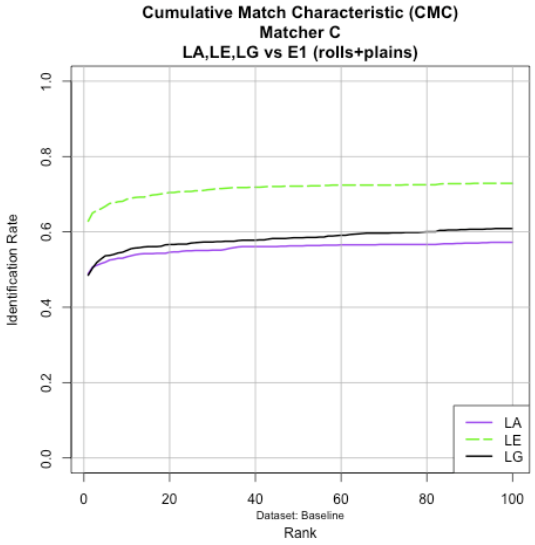
The following CMCs compare the performance of individual latent feature subsets for each matcher on the Baseline dataset. In each case, the results for Evaluation #1 are on the left, and the results for Evaluation #2 are on the right.

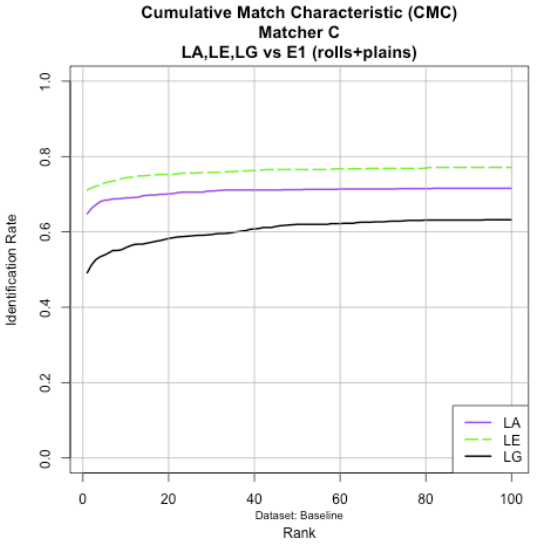


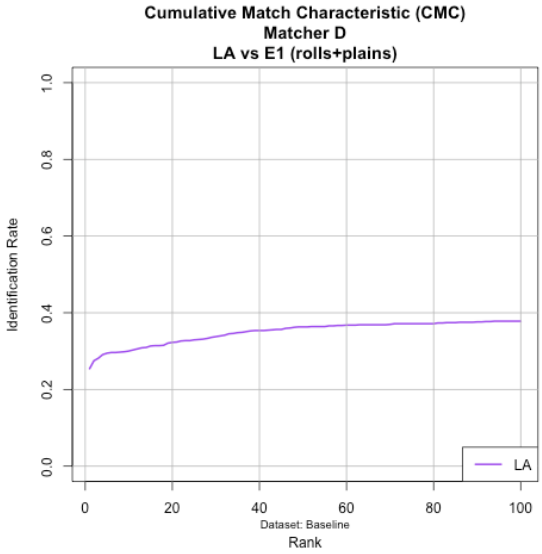


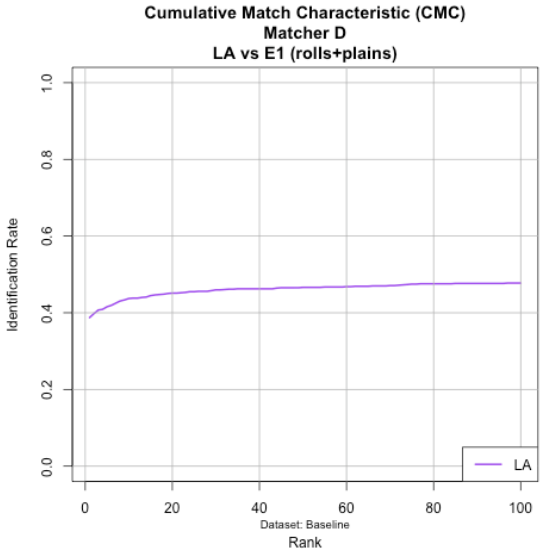


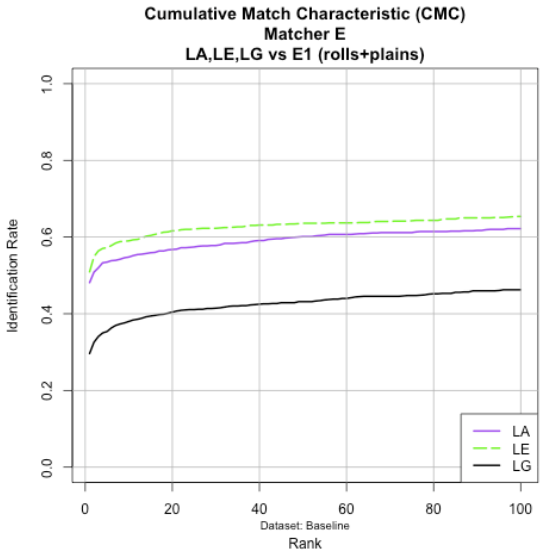


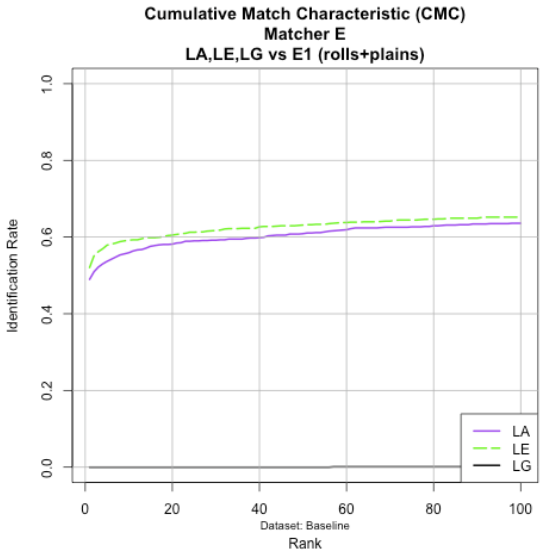

Cumulative Match Characteristic (CMC)
Matcher C
LA,LE,LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA
LE
LG


Cumulative Match Characteristic (CMC)
Matcher C
LA,LE,LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA
LE
LG


Cumulative Match Characteristic (CMC)
Matcher D
LA vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA


Cumulative Match Characteristic (CMC)
Matcher D
LA vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA


Cumulative Match Characteristic (CMC)
Matcher E
LA,LE,LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA
LE
LG


Cumulative Match Characteristic (CMC)
Matcher E
LA,LE,LG vs E1 (rolls+plains)
Identification Rate
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
Dataset: Baseline
Rank
LA
LE
LG

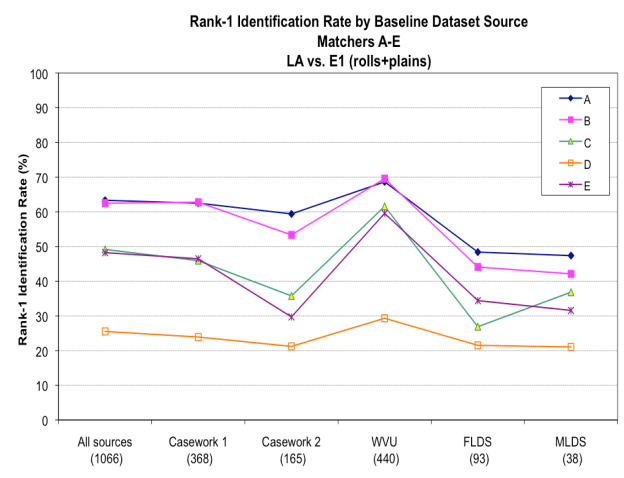
A-1.3 Rank-1 identification rates for MLDS dataset

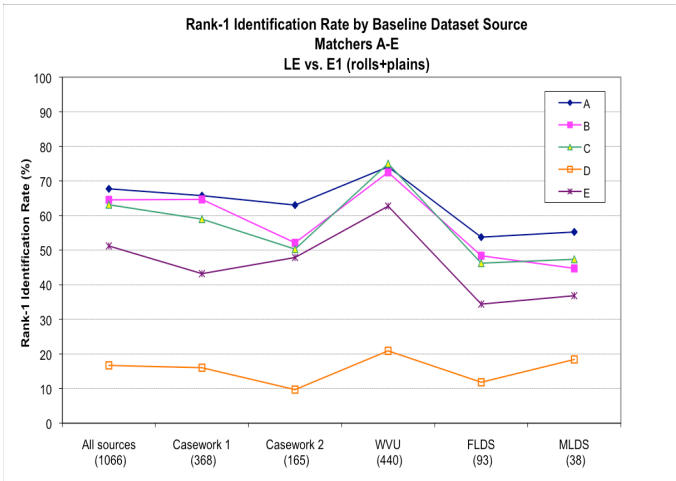
Evaluation #1		Latent Feature Subset						
		LA	LB	LC	LD	LE	LF	LG
Matcher	A	47.4	50.0	50.0	**55.3**	55.3	55.3	36.8
	B	42.1	42.1	42.1	44.7	44.7	**47.4**	36.8
	C	36.8	39.5	36.8	47.4	47.4	**55.3**	36.8
	D	21.1	*n/a*	*n/a*	18.4	*n/a*	**15.8**	21.1
	E	31.6	**42.1**	42.1	39.5	36.8	26.3	28.9

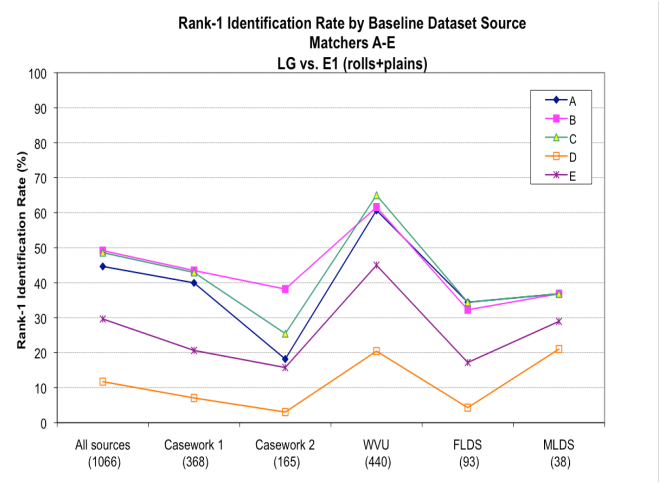
Evaluation #2		Latent Feature Subset						
		LA	LB	LC	LD	LE	LF	LG
Matcher	A	52.6	52.6	52.6	55.3	55.3	**57.9**	36.8
	B	47.4	55.3	55.3	55.3	55.3	**60.5**	31.6
	C	52.6	52.6	50.0	52.6	**55.3**	*n/a*	39.5
	D	23.7	13.2	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
	E	34.2	**36.8**	36.8	36.8	36.8	36.8	0.0

A-1.4 Rank-1 Identification Rate by Baseline Dataset Source

The following charts show, for the matchers tested in Evaluation #1 with respect to the Baseline dataset used in Evaluation #2, the difference in the rank-1 identification rate between the latents of differing sources.

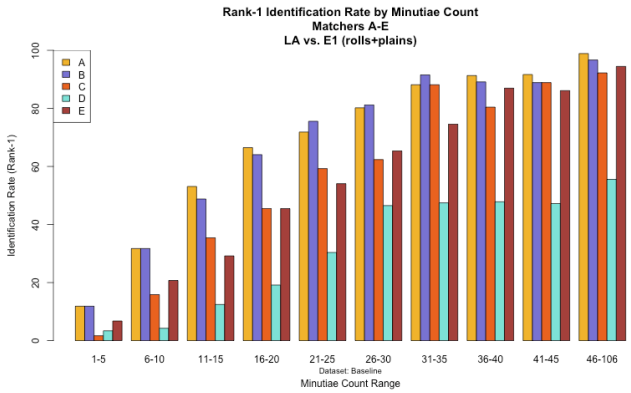


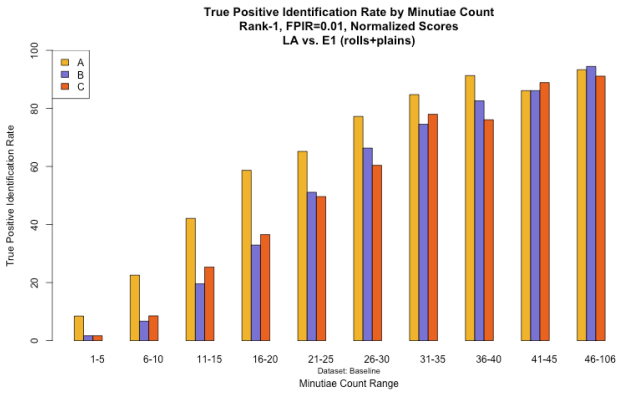


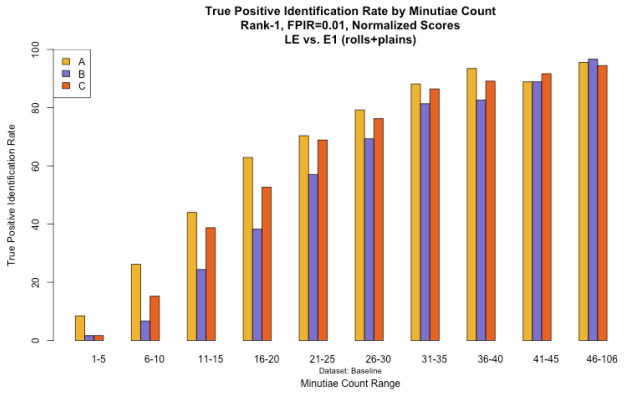

Rank-1 Identification Rate by Baseline Dataset Source
Matchers A-E
LG vs. E1 (rolls+plains)
Rank-1 Identification Rate (%)
100
90
80
70
60
50
40
30
20
10
0
A
B
C
D
E
All sources (1066)
Casework 1 (368)
Casework 2 (165)
WVU (440)
FLDS (93)
MLDS (38)

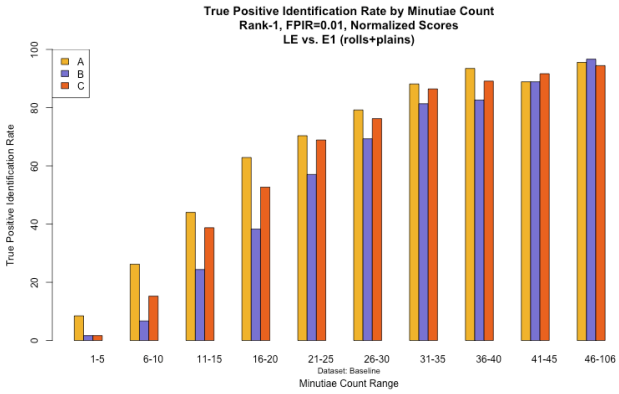
A-1.5 Rank-1 Identification Rate by Minutiae Count

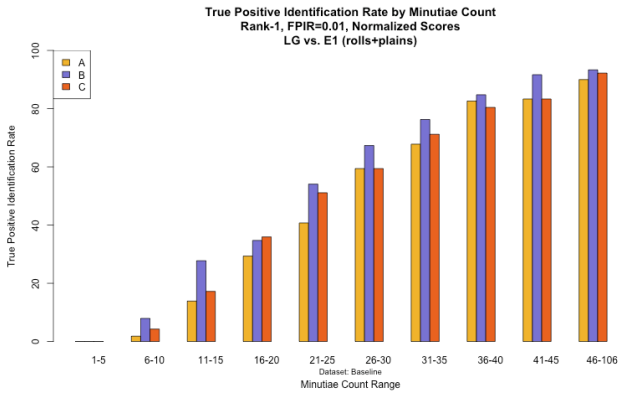
The following charts show, for the matchers tested in Evaluation #1 with respect to the Baseline dataset used in Evaluation #2, the rank-1 identification rate for different ranges of minutiae count.

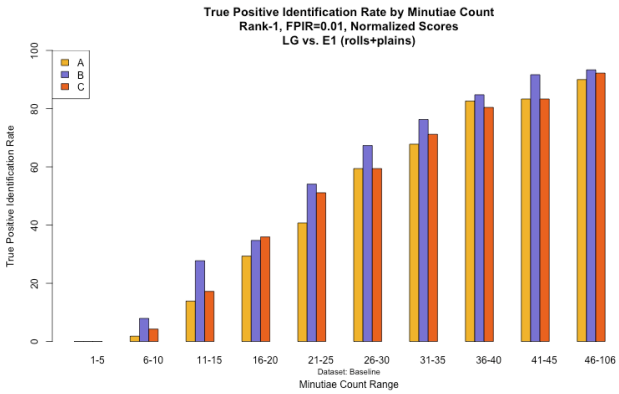






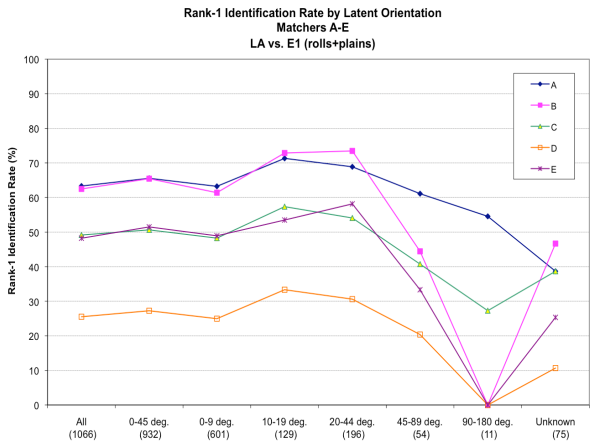


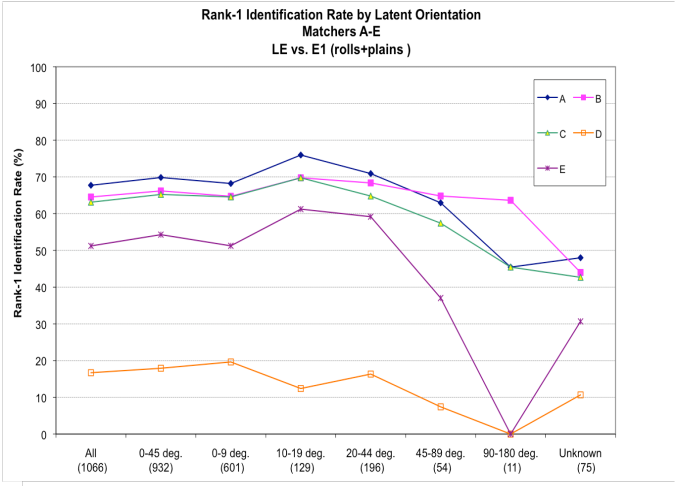


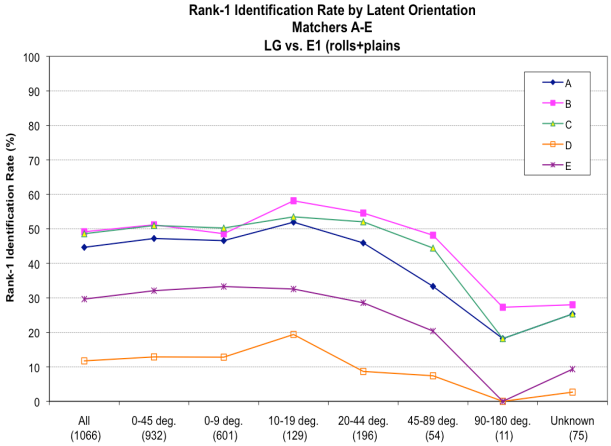


A-1.6 Rank-1 Identification Rate by Latent Orientation

The following charts show, for the matchers tested in Evaluation #1 with respect to the Baseline dataset used in Evaluation #2, the rank-1 identification rate for different ranges of latent orientation.


Rank-1 Identification Rate by Latent Orientation
Matchers A-E
LA vs. E1 (rolls+plains)
Rank-1 Identification Rate (%)
A
B
C
D
E
All (1066)
0-45 deg. (932)
0-9 deg. (601)
10-19 deg. (129)
20-44 deg. (196)
45-89 deg. (54)
90-180 deg. (11)
Unknown (75)


Rank-1 Identification Rate by Latent Orientation
Matchers A-E
LE vs. E1 (rolls+plains)
Rank-1 Identification Rate (%)
A
B
C
D
E
All (1066)
0-45 deg. (932)
0-9 deg. (601)
10-19 deg. (129)
20-44 deg. (196)
45-89 deg. (54)
90-180 deg. (11)
Unknown (75)


Rank-1 Identification Rate by Latent Orientation
Matchers A-E
LG vs. E1 (rolls+plains
Rank-1 Identification Rate (%)
A
B
C
D
E
All (1066)
0-45 deg. (932)
0-9 deg. (601)
10-19 deg. (129)
20-44 deg. (196)
45-89 deg. (54)
90-180 deg. (11)
Unknown (75)

A-1.7 Rank-1 Identification Rate by Latent Value Determination

The following charts show, for the matchers tested in Evaluation #1 with respect to the Baseline dataset used in Evaluation #2, the rank-1 identification rate for different examiner-assigned Value, Limited Value, and No Value determinations.

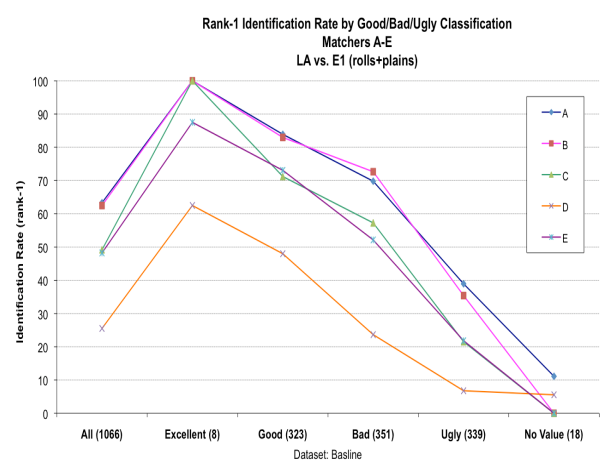
		All	No Value	Limited Value	Value
Count		1066*	25	113	917
LA	A	63.3%	20.0%	27.4%	68.9%
	B	62.5%	4.0%	19.5%	69.3%
	C	49.2%	0.0%	14.2%	54.9%
	D	25.5%	0.0%	2.7%	29.1%
	E	48.2%	0.0%	14.2%	53.5%
LE	A	67.7%	20.0%	31.0%	73.6%
	B	64.5%	8.0%	21.2%	71.4%
	C	63.1%	8.0%	19.5%	69.9%
	D	16.7%	0.0%	2.7%	19.0%
	E	51.2%	8.0%	12.4%	57.3%
LG	A	44.7%	0.0%	5.3%	50.6%
	B	49.2%	4.0%	2.7%	56.2%
	C	48.6%	4.0%	7.1%	54.9%
	D	11.7%	0.0%	0.9%	13.4%
	E	29.6%	0.0%	1.8%	34.0%

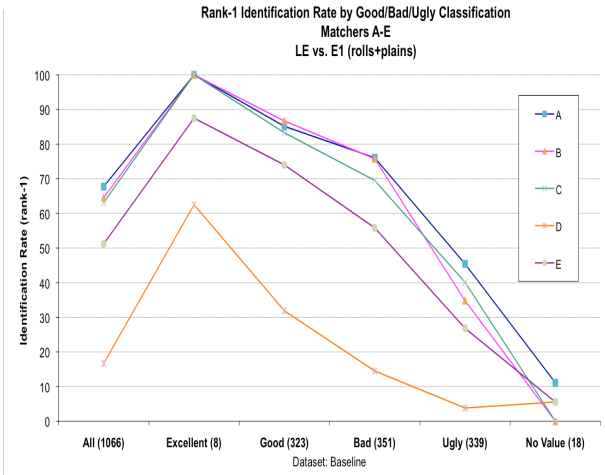
		All	No Value	Limited Value	Value
Count		1066	25	113	917
LA	A	56.4%	8.0%	21.2%	63.6%
	B	43.4%	4.0%	5.3%	50.4%
	C	42.4%	0.0%	9.7%	48.8%
	D	18.0%	0.0%	0.9%	11.5%
	E	-	-	-	-
LE	A	59.4%	8.0%	25.7%	66.9%
	B	47.1%	0.0%	8.0%	54.9%
	C	53.0%	4.0%	13.3%	60.2%
	D	-	-	-	-
	E	-	-	-	-
LG	A	36.1%	0.0%	0.9%	43.4%
	B	34.3%	0.0%	1.8%	39.6%
	C	38.8%	0.0%	2.7%	45.4%
	D	-	-	-	-
	E	-	-	-	-

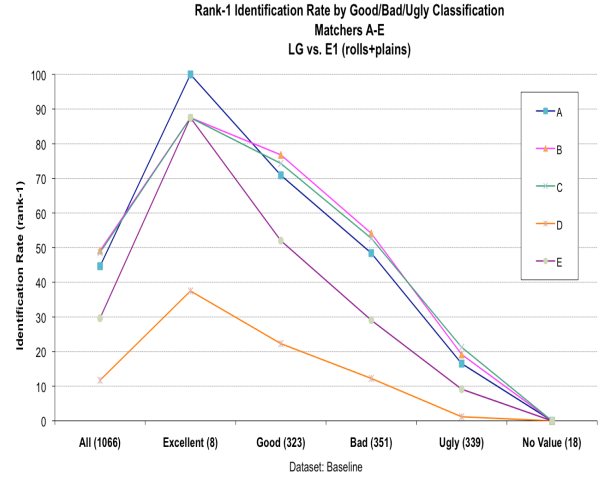
* *Note: 11 latents (out of 1066) in Baseline, and 5 latents (out of 418) in Baseline-QA did not have value determinations.*

A-1.8 Rank-1 Identification Rate by Good / Bad / Ugly Quality Classifications

The following charts show, for the matchers tested in Evaluation #1 with respect to the Baseline dataset used in Evaluation #2, the rank-1 identification rate for different examiner-assigned Excellent, Good, Bad, Ugly, and No Value quality determinations.







A-2 Proportion of hits at rank 1

The following tables show, for Evaluation #2, the proportion of the total hits made by a matcher at any rank (rank ≤ 100) that were rank 1.[*]

Table 1 Proportion of hits at rank 1 for the Baseline-QA dataset (418 latents, subset of Baseline)

	Latent Subset						
	LA	**LB**	**LC**	**LD**	**LE**	**LF**	**LG**
	Image only	Image + ROI	Image + ROI + Pattern Class + Qual map	Image + Minutiae	Image + EFS	Image + EFS + Skeleton	Minutiae only
A	89%	91%	91%	90%	90%	89%	80%
B	85%	89%	88%	88%	90%	92%	82%
C	91%	90%	90%	90%	92%	NA	82%
D	84%	82%	NA	NA	NA	NA	NA
E	82%	81%	83%	81%	83%	83%	0%

Table 2: Proportion of hits at rank 1 for the Baseline dataset (1066 latents)

	Latent Subset		
	LA	**LE**	**LG**
	Image only	Image + EFS	Minutiae only
A	92%	93%	83%
B	90%	91%	81%
C	92%	94%	84%
D	87%	NA	NA
E	84%	86%	0%

[*] *This is sometimes known as the "Ray Moore statistic". AFIS pioneer Ray Moore observed that this tended to be about 83% at the time.*