

# ARAPAHOE COUNTY SHERIFF'S OFFICE (ACSO) ACCOUNTABILITY REPORT FOR FACIAL RECOGNITION SERVICE

**Facial Recognition Service (FRS) Name:** Lumen

**Vendor:** Lexis-Nexis, using an algorithm supplied by Rank One Computing Corporation

**Version:** ROC SDK version 2.2.1

**Description of general capabilities and limitations:** Lumen's facial recognition service may be used as an investigative aid to provide possible leads to help identify potential suspects by comparing a single probe image of an unknown suspect to a collection of candidate facial images provided by the Colorado Information Sharing Consortium (CISC). Lumen provides multiple results, each with a given accuracy score generated by the ROC SDK's facial recognition algorithms. The accuracy score is designed to indicate the likelihood of the probe image matching a given result. The core facial recognition algorithms depend primarily on the image quality of the probe image and candidate images and on the robustness of the algorithm development process. The primary factors of image quality are capture conditions, including camera sensor quality, field of focus, glare, blur, low light, high contrast, variable lighting, height of the camera, pose of the subject and occlusions between the camera and the subject face. Algorithms are developed by processing training data through machine learning architectures and iteratively testing accuracy on data that represents real-world conditions. Accuracy of a match score may be impacted by poor image quality of the probe image and/or candidate image or to the extent that operational data is fundamentally dissimilar to training data and/or testing data selected in the research and development process.

## I. DATA INPUT AND GENERATION

**Type of data inputs used:** The Lumen facial recognition service accepts images as data inputs.

**How the data is generated, collected and processed:** Candidate facial image data is collected by the Colorado Information Sharing Consortium (CISC) from member agencies who elect to share images. CISC contributing member agencies provide booking photos, and those facial images from CISC are processed into Lumen's facial recognition service. The probe image, which will be compared against the candidate facial images, is collected in the course of an investigation and typically consist of stills from surveillance footage, body worn camera footage or other personal images and/or video footage.

**Type of data reasonably likely to be generated:** The ROC SDK generates a template of each facial image, which is a mathematical model of the unique subject and which may be compared to templates generated from other images to produce a match score. For each facial image, the ROC SDK also generates metadata including pitch, yaw, image quality estimations and facial analytics like age, gender, geographic origin, emotion, facial hair, glasses and mask estimations.

## II. DESCRIPTION OF PURPOSE AND PROPOSED USE

**Proposed use / purpose for use of the FRS:** When provided a probe image to search against a collection of candidate images, Lumen returns multiple results, sorted by the highest match score generated by the ROC SDK's facial recognition algorithms. Once Lumen provides a list of results, a human investigator must review the results before making any determination of a possible match. A possible match determination may be used as an investigative lead that is treated in a similar manner as an anonymous tip. In particular, the investigative lead does not supply adequate probable cause to make an arrest without additional evidence. The intended benefit of using the Lumen facial recognition service is to generate investigative leads for further investigation with the hope of solving crimes that would otherwise go unsolved.

**Decision(s) to be made or supported by FRS:** Match determinations may be used to provide investigators with possible leads to develop independent probable cause to solve criminal cases and support arrests/case filings. Match determinations will be subject to meaningful human review in accordance with ACSO policies and will not be the sole basis for making decisions that produce legal effects concerning individuals or similarly significant effects concerning individuals. In particular, match determinations will not serve as the sole basis to establish probable cause in a criminal investigation.

**Intended benefits of use, including any data or research demonstrating such benefits:** Lumen is intended to benefit ACSO by serving as an investigative aid to provide possible leads to help identify potential suspects. In comparable use by the New York City Police Department (NYPD) since 2011, the NYPD has successfully used facial recognition to identify suspects whose images were captured by cameras at robberies, burglaries, assaults, shootings, and other crimes. In 2019 alone, the Facial Identification Section received 9,850 requests for comparison and identified 2,510 possible matches, including possible matches in 68 murders, 66 rapes, 277 felony assaults, 386 robberies, and 525 grand larcenies with no known instance in which a person was falsely arrested on the basis of a facial recognition match. See <https://www.nyc.gov/site/nypd/about/about-nypd/equipment-tech/facial-recognition.page>.

## III. USE AND DATA MANAGEMENT POLICY

**Use and data management policy:** ACSO's Facial Recognition Service Use and Data Management Policy, ADM \_\_\_\_\_, is attached as Exhibit 1.

## IV. TESTING INFORMATION

Description of operational testing performed on FRS: Rank One Computing submits the ROC SDK for testing in the following series of the National Institute of Standards and Technology (NIST) Face Recognition Vendor Test (FRVT) Ongoing:

1:1 Verification (<https://pages.nist.gov/frvt/html/frvt11.html>),

1:N Identification (<https://pages.nist.gov/frvt/html/frvt1N.html>),

Quality Assessment ([https://pages.nist.gov/frvt/html/frvt\\_quality.html](https://pages.nist.gov/frvt/html/frvt_quality.html)),

Demographic Effects ([https://pages.nist.gov/frvt/html/frvt\\_demographics.html](https://pages.nist.gov/frvt/html/frvt_demographics.html)),  
 Paperless Travel ([https://pages.nist.gov/frvt/html/frvt\\_paperless\\_travel.html](https://pages.nist.gov/frvt/html/frvt_paperless_travel.html)) and  
 Presentation Attack Detection ([https://pages.nist.gov/frvt/html/frvt\\_pad.html](https://pages.nist.gov/frvt/html/frvt_pad.html)).

**Description of any additional ACSO testing performed:** ACSO has not yet implemented the Lumen facial recognition service.

## V. INFORMATION REGARDING FALSE MATCHES

**Rate of false matches:** On the NIST 1:1 leaderboard (available at <https://pages.nist.gov/frvt/html/frvt11.html>), the latest version of the ROC SDK, version 2.4, is currently listed as the #10 algorithm out of 478 total entries (top 2%), placing Rank One Computing in the top 7 among vendors overall. Three of the vendors producing algorithms ahead of Rank One are produced by Chinese companies who are prohibited from doing business in the United States due to human rights violations (CloudWalk, SenseTime and Megvii):

FALSE NON-MATCH RATE (FNMR)

Algorithm	Constrained, Cooperative						Unconstrained, Non-Coop		
	FMR	= 0.000001	= 0.00001	= 0.00001	= 0.000001	= 0.000001	= 0.000001	= 0.00001	= 0.00001
Submission Date	VISA	MUGSHOT	MUGSHOT AT≥12 YRS	VISABORDER	VISABORDER Yaw≥45°	BORDER	WILD	KIOSK Photos	
<a href="#">cloudwalk-mt-006</a>	2022-10-20	0.0006 <sup>(41)</sup>	0.0023 <sup>(12)</sup>	0.0019 <sup>(1)</sup>	0.0016 <sup>(1)</sup>	0.0031 <sup>(1)</sup>	0.0032 <sup>(1)</sup>	0.0305 <sup>(80)</sup>	0.0399 <sup>(2)</sup>
<a href="#">cloudwalk-mt-005</a>	2022-03-29	0.0009 <sup>(3)</sup>	0.0025 <sup>(36)</sup>	0.0022 <sup>(9)</sup>	0.0017 <sup>(2)</sup>	0.0065 <sup>(5)</sup>	0.9286 <sup>(404)</sup>	0.0305 <sup>(84)</sup>	0.8895 <sup>(248)</sup>
<a href="#">sensetime-007</a>	2022-06-17	0.0022 <sup>(23)</sup>	0.0021 <sup>(5)</sup>	0.0020 <sup>(3)</sup>	0.0018 <sup>(3)</sup>	0.0055 <sup>(4)</sup>	0.0034 <sup>(2)</sup>	0.0300 <sup>(24)</sup>	0.0423 <sup>(4)</sup>
<a href="#">sensetime-008</a>	2023-01-04	0.0014 <sup>(4)</sup>	0.0021 <sup>(2)</sup>	0.0020 <sup>(2)</sup>	0.0018 <sup>(4)</sup>	0.0039 <sup>(3)</sup>	0.0036 <sup>(3)</sup>	0.0302 <sup>(47)</sup>	0.0477 <sup>(10)</sup>
<a href="#">megvii-005</a>	2022-03-28	0.0015 <sup>(7)</sup>	0.0026 <sup>(51)</sup>	0.0031 <sup>(61)</sup>	0.0019 <sup>(5)</sup>	0.0081 <sup>(8)</sup>	0.0500 <sup>(251)</sup>	0.0313 <sup>(134)</sup>	0.0663 <sup>(60)</sup>
<a href="#">intema-001</a>	2023-01-11	0.0014 <sup>(6)</sup>	0.0021 <sup>(3)</sup>	0.0020 <sup>(5)</sup>	0.0019 <sup>(6)</sup>	0.0084 <sup>(9)</sup>	0.0037 <sup>(4)</sup>	0.0305 <sup>(81)</sup>	0.0394 <sup>(1)</sup>
<a href="#">samsungsds-002</a>	2022-09-16	0.0027 <sup>(38)</sup>	0.0023 <sup>(11)</sup>	0.0022 <sup>(8)</sup>	0.0021 <sup>(7)</sup>	0.0073 <sup>(6)</sup>	0.0043 <sup>(6)</sup>	0.0303 <sup>(56)</sup>	0.0489 <sup>(13)</sup>
<a href="#">kakao-008</a>	2022-05-12	0.0018 <sup>(14)</sup>	0.0023 <sup>(9)</sup>	0.0023 <sup>(12)</sup>	0.0021 <sup>(8)</sup>	0.0080 <sup>(7)</sup>	0.0041 <sup>(5)</sup>	0.0447 <sup>(299)</sup>	0.0417 <sup>(3)</sup>
<a href="#">intema-000</a>	2022-07-15	0.0017 <sup>(11)</sup>	0.0023 <sup>(8)</sup>	0.0022 <sup>(10)</sup>	0.0022 <sup>(9)</sup>	-	0.0172 <sup>(150)</sup>	0.0302 <sup>(44)</sup>	0.0567 <sup>(39)</sup>
<a href="#">rankone-014</a>	2022-12-21	0.0021 <sup>(21)</sup>	0.0024 <sup>(17)</sup>	0.0027 <sup>(30)</sup>	0.0022 <sup>(10)</sup>	0.0167 <sup>(29)</sup>	0.0047 <sup>(9)</sup>	0.0311 <sup>(128)</sup>	0.0479 <sup>(11)</sup>

Results also continue to be available for the earlier submitted versions ROC SDK v2.2, listed as rankone-013 and ROC SDK v2.0, listed as rankone-012:

FALSE NON-MATCH RATE (FNMR)									
Algorithm	Constrained, Cooperative						Unconstrained, Non-Coop		
	FMR	= 0.000001	= 0.00001	= 0.00001	= 0.000001	= 0.000001	= 0.000001	= 0.00001	= 0.00001
Submission Date	VISA	MUGSHOT	MUGSHOT AT≥12 YRS	VISABORDER	VISABORDER Yaw≥45°	BORDER	WILD	KIOSK Photos	
rankone-014	2022-12-21	0.0021 <sup>(21)</sup>	0.0024 <sup>(17)</sup>	0.0027 <sup>(30)</sup>	0.0022 <sup>(10)</sup>	0.0167 <sup>(29)</sup>	0.0047 <sup>(9)</sup>	0.0311 <sup>(128)</sup>	0.0479 <sup>(11)</sup>
rankone-013	2022-07-21	0.0041 <sup>(81)</sup>	0.0026 <sup>(48)</sup>	0.0033 <sup>(70)</sup>	0.0028 <sup>(31)</sup>	0.0304 <sup>(49)</sup>	0.0055 <sup>(22)</sup>	0.0310 <sup>(123)</sup>	0.0543 <sup>(32)</sup>
rankone-012	2021-12-27	0.0058 <sup>(135)</sup>	0.0031 <sup>(110)</sup>	0.0038 <sup>(98)</sup>	0.0047 <sup>(111)</sup>	-	0.0081 <sup>(62)</sup>	0.0380 <sup>(259)</sup>	0.0656 <sup>(58)</sup>

For the ROC SDK v2.2, listed as rankone-013, the overall false match rates (FMR) range from 0.001% (1 in 100,000) to 0.0001% (1 in 1,000,000) with the equivalent false non-match rates (FNMR) shown above, ranging from 0.26% to 5.43%. The direct impact of an erroneously high match score from the ROC SDK is that a candidate would rank higher on the list of results returned by Lumen for human investigator review. The human investigator would then apply his or her skills, training and experience in facial examination to closely review the unique facial characteristics of each of the candidates on the list. The human investigator may select one of the candidates from the list of results and make a possible match determination on the basis of similarity of facial characteristics between the candidate and suspect image, or instead may determine that none of the candidates from the list of results are a possible match. If the false match eluded both the ROC SDK and the human investigator, it could become an investigative lead, which may trigger additional investigation into the relevant candidate. In the absence of additional evidence, erroneous investigative leads do not result in a false arrest. As shown by the NYPD statistics, facial recognition is used tens of thousands of times each year by a single agency without a known instance of false arrest. See <https://www.nyc.gov/site/nypd/about/about-nypd/equipment-tech/facial-recognition.page>). Across the nation, automated facial recognition has been used on the order of millions of times by law enforcement agencies, and there are only three known false arrests involving automated facial recognition. Each of these false arrests is attributable to violation of applicable policies and procedures, particularly the requirement to develop independent evidence to support probable cause prior to making an arrest.

Algorithm	Submission Date	FNMR Overall	FMR Min	FMR Max	FMR Max/Min	FMR Max/Mean	FMR Max/GeoMean	FMR Vary GeoMean	FM Var Gini
<a href="#">cloudwalk_mt_006</a>	2022-10-20	0.0015 <sup>[1]</sup>	0.00014 E.Europe M (20-35]	0.00917 W.Africa F (65-99]	65 <sup>(9)</sup>	8.58 <sup>(61)</sup>	13.62 <sup>(20)</sup>	0.31 <sup>(5)</sup>	0.52
<a href="#">cloudwalk_mt_005</a>	2022-03-29	0.0015 <sup>[2]</sup>	0.00013 E.Europe M (20-35]	0.01997 W.Africa F (65-99]	150 <sup>(26)</sup>	10.08 <sup>(154)</sup>	20.67 <sup>(100)</sup>	0.41 <sup>(39)</sup>	0.62 <sup>[</sup>
<a href="#">sunsetime_007</a>	2022-06-17	0.0015 <sup>[3]</sup>	0.00004 E.Europe M (20-35]	0.01565 W.Africa F (65-99]	402 <sup>(164)</sup>	13.84 <sup>(332)</sup>	34.43 <sup>(306)</sup>	0.46 <sup>(175)</sup>	0.67 <sup>[</sup>
<a href="#">intema_001</a>	2023-01-11	0.0015 <sup>[4]</sup>	0.00005 E.Europe M (20-35]	0.02071 W.Africa F (65-99]	399 <sup>(158)</sup>	13.12 <sup>(314)</sup>	29.85 <sup>(272)</sup>	0.43 <sup>(84)</sup>	0.64 <sup>[</sup>
<a href="#">sunsetime_008</a>	2023-01-04	0.0017 <sup>[5]</sup>	0.00005 E.Europe M (35-50]	0.01709 W.Africa F (65-99]	327 <sup>(98)</sup>	16.48 <sup>(382)</sup>	38.65 <sup>(329)</sup>	0.40 <sup>(37)</sup>	0.67 <sup>[</sup>
<a href="#">cybercore_003</a>	2022-08-31	0.0017 <sup>[6]</sup>	0.00003 E.Europe M (35-50]	0.00947 W.Africa F (65-99]	338 <sup>(104)</sup>	11.09 <sup>(203)</sup>	23.03 <sup>(150)</sup>	0.42 <sup>(57)</sup>	0.60 <sup>[</sup>
<a href="#">rankone_014</a>	2022-12-21	0.0018 <sup>[7]</sup>	0.00008 E.Asia M (20-35]	0.01871 W.Africa F (65-99]	236 <sup>(57)</sup>	13.47 <sup>(325)</sup>	39.45 <sup>(333)</sup>	0.49 <sup>(245)</sup>	0.73 <sup>[</sup>

Algorithm	Submission Date	FNMR Overall	FMR Min	FMR Max	FMR Max/Min	FMR Max/Mean	FMR Max/GeoMean	FMR Vary GeoMean	FMR Vary Gini	FMR_Ratio W/Africa E/Europe	FMR_Rat E/Asia E/Europe
<a href="#">rankone_014</a>	2022-12-21	0.0018 <sup>[7]</sup>	0.00008 E.Asia M (20-35]	0.01871 W.Africa F (65-99]	236 <sup>(57)</sup>	13.47 <sup>(325)</sup>	39.45 <sup>(333)</sup>	0.49 <sup>(245)</sup>	0.73 <sup>(354)</sup>	2.64 <sup>(7)</sup>	1.94 <sup>(55)</sup>
<a href="#">rankone_013</a>	2022-07-21	0.0021 <sup>[21]</sup>	0.00010 E.Europe F (12-20]	0.03608 W.Africa F (65-99]	357 <sup>(129)</sup>	15.31 <sup>(360)</sup>	52.14 <sup>(366)</sup>	0.52 <sup>(324)</sup>	0.76 <sup>(375)</sup>	5.08 <sup>(30)</sup>	3.46 <sup>(101)</sup>
<a href="#">rankone_012</a>	2021-12-27	0.0036 <sup>(110)</sup>	0.00009 E.Europe M (20-35]	0.03107 W.Africa F (65-99]	345 <sup>(112)</sup>	14.41 <sup>(347)</sup>	48.16 <sup>(359)</sup>	0.52 <sup>(313)</sup>	0.75 <sup>(372)</sup>	5.39 <sup>(38)</sup>	2.91 <sup>(89)</sup>

**Potential impacts on protected subpopulations:** In the NIST Demographic Effects series (available here: [https://pages.nist.gov/frvt/html/frvt\\_demographics.html](https://pages.nist.gov/frvt/html/frvt_demographics.html)), the ROC SDK shows less than a 4% FMR, with less than a 0.2% FNMR across all 70 sub-populations of the NIST test data, with the lowest scoring demographic being West African females aged 65-99 years old. The potential impact of a false match, including on protected subpopulations, is mitigated by the human investigator review requirement and the requirement to develop additional evidence prior to making an arrest as well as the prohibition on relying solely on match determinations to establish probable cause for an arrest.

**ACSO procedures for addressing error rates in excess of one percent (1%):** ACSO's policy provides for substantial secondary human review of match results as well as additional review by an investigations supervisor in the event of any conflict between reviewers relating to the results.

## **VI. ASSESSMENT OF POTENTIAL IMPACTS**

**Potential impacts of FRS on civil rights and liberties:** The potential impacts of ACSO's use of Lumen on civil rights and liberties are minimal. To begin with, law enforcement use is limited by statute to minimize those impacts. For example, under C.R.S. § 24-18-307, law enforcement agencies are prohibited from applying a facial recognition service to individuals based on their religious, political or social views or activities; based on their participation in non-criminal organizations or lawful events; based on their actual or perceived race, ethnicity, citizenship, place of origin, immigration status, age, disability, gender, gender expression, gender identity, sexual orientation or other protected characteristics; or for purposes of creating a record depicting an individual's exercise of their First Amendment rights. Similarly, Fourth Amendment violations are minimized by the statutory prohibitions on using match determinations as the sole basis for establishing probable cause in a criminal investigation and limitations on the use of a facial recognition service to engage in ongoing surveillance, conduct real-time or near real-time identification or conduct persistent tracking. In addition, ACSO's policy requires that match determinations be used only as investigative leads to aid in the development and collection of additional evidence.

**Potential impacts to privacy:** ACSO's use of Lumen as an investigative aid will have minimal impacts on individual privacy rights because the collection of candidate images is limited to booking photos and not DMV photos, social media photos or related images. Because the candidate images are limited to photos procured of individuals who have had law enforcement contact, the use of this facial recognition service poses minimal risk of infringing on the privacy rights of law-abiding citizens.

**Potential disparate impacts on marginalized communities:** The NIST data regarding false matches shows a limited disparate impact on Western African females of 2%. However, the NIST data derives its photo images from Visa applications. Research using U.S. booking photos as the candidate images shows the highest error rates are for white males, suggesting that the use of Lumen, which relies exclusively on booking photos, poses even less risk of potential disparate impact on marginalized communities.

**Specific steps ACSO will take to mitigate foregoing potential impacts:** As discussed above, the nature of the photos included in Lumen's candidate images, and the specific intended use for the Lumen facial recognition service significantly limit any potential impacts on individual rights and privacy interests. In addition, ACSO conducts annual anti-bias training and has implemented an anti-bias policy to make its members aware of potential biases and limit the impact of bias in practice. ACSO's policy governing use of a facial recognition service also requires meaningful human review of all results and mandates secondary human review and requires further human

review in the event of any disputes before an arrest is made, further minimizing the potential that the facial recognition service could disparately impact marginalized communities.

## **VII. FEEDBACK PROCEDURES**

**ACSO procedures and channels for receiving feedback from individuals affected by FRS:** ACSO will publish notice of and conduct three community meetings to obtain feedback on its facial recognition policy and the Lumen product specifically. In addition, this Accountability Report and its policy will be posted on its website for public review. ACSO also has well-established channels for taking and evaluating public complaints through its Internal Affairs unit. Information on how to submit complaints to Internal Affairs is publicly available on its website.

**ACSO procedures and channels for receiving feedback from community at large:** In addition to the procedures described above for accepting complaints, ACSO maintains open lines of communication with the public through a variety means including all of its social media platforms such as Facebook, Twitter, Instagram and Nextdoor. These social media sites are maintained by ACSO's Public Information Office and are monitored daily. The Sheriff also offers the public the opportunity for direct communication during periodic Facebook Live programs. In addition, emails can be sent to [ACSOInfo@arapahoegov.com](mailto:ACSOInfo@arapahoegov.com), a public email address designed specifically for questions, comments and feedback. All members also have a phone number on their business cards where members of the public can provide feedback.

**ACSO procedures in place for responding to feedback:** ACSO's procedures for responding to feedback are oriented to the type of feedback and the manner in which it was received. When complaints are received, individual sections may respond to specific concerns relating to their areas of expertise or the Internal Affairs unit may respond to update citizens on the status and/or results of the agency's investigation into a complaint. ACSO also conducts satisfaction surveys that are sent to members of the community and individuals who have had a contact with one its members. ACSO engages in various community outreach programs, including, for example, National Night Out and Coffee with a Cop, to engage with citizens and respond to feedback.