



Face Recognition Prize Challenge (FRPC 2017) - Rules and Regulations

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1 Background

Face recognition has been deployed in governmental and private sector applications for nearly twenty years. It has been the subject of academic research for even longer. Substantial gains in capability have been achieved in that time. The amount of research in academia and commercial research and development laboratories is likely as large as it has ever been due to the availability of large ground-truthed image sets¹. These images are referred to as “wild”, in that they were mostly collected in settings not designed to support face recognition and from subjects who are not specifically cooperating with a camera. While the main source of revenue for commercial developers remains in applications where photographs are collected from cooperative subjects (passports, for example), the possibility to accurately identify faces in unconstrained images is of interest to IARPA and many other users. While several benchmarks have been defined in recent years, none so far have included measurements of open-universe identification accuracy where score thresholds are applied to reduce false positive outcomes. This Challenge is defined to promote improved recognition of unconstrained faces.

2 Roles

The FRPC proceeds with the involvement of four parties:

1. **IARPA** – The owner of the FRPC
2. **NIST** – IARPA has appointed the National Institute of Standards and Technology (NIST) as the test laboratory for the FRPC. NIST is an independent agency of the United States government.
3. **JUDGES** – IARPA will appoint three judges to determine prize winners
4. **PARTICIPANTS** – The FRPC is open to a worldwide audience of developers of face recognition algorithms. IARPA particularly encourages universities, corporations and individual developers to apply.

¹ More completely, research has increased with: the availability of inexpensive digital cameras (from c. 2002); the advent of mass broadband internet as infrastructure for sharing large photographs (from c. 1995); the ubiquitous practice of uploading photographs to social media (from c. 2008); the ability to automatically find and download (“scrape”) images; the development of convolutional neural networks (c. 1997), deep learning paradigms (c. 2010); the availability of open-source software for such; and the ability to expedite operations using GPUs.



3 Documents

The following documents and websites contain all public FRPC documentation.

1. [IARPA-FRPC] This document.
2. [IARPA-WEB] The FRPC homepage located at:
<https://www.challenge.gov/challenge/face-recognition-prize-challenge/>
3. [NIST-API] The NIST Concept of operations and API specification
4. [NIST-ENTRY] The NIST Participation Agreement
5. [NIST-WEB] NIST's FRPC homepage located at:
<https://www.nist.gov/programs-projects/face-recognition-prize-challenge/>

4 Overview

The IARPA Face Recognition Prize Challenge (FRPC) seeks to identify which algorithms are most accurate at recognizing faces in images collected in an unconstrained manner. It also seeks to assess the limits of recognition and to understand when algorithms fail. The term unconstrained refers to images for which there is weak control of the photographic conditions and the behavior of the human subject. Unconstrained face images are characterized by: variable head pose relative to the position of the camera; variable head position in the scene; variable head size; variable and non-uniform ambient illumination; varying degrees of facial expression, with and without open mouth; occlusion of the face by hair, arms or other objects.

Approach: With these goals in mind the Challenge is staged as follows.

1. **Participants send documentation to NIST:** As specified in the NIST FRPC specifications, participants must send a completed and signed Participation Agreement to NIST.
2. **Participants send software to NIST:** As specified in the NIST FRPC specifications, participants must send algorithms to the National Institute of Standards and Technology (NIST) as a compiled library. Source code and other intellectual property must not be submitted to NIST.
3. **Software is run on sequestered images:** NIST runs the algorithm on images that are not made available to developers. This creates a repeatable and fair test. It impedes gaming strategies. NIST will link submitted libraries to their test harness which is used in three steps:
 - Validation: NIST confirms it can reproduce participant-provided outputs on a small common set of images, provided by NIST.
 - Timing: NIST confirms that the implementation meets limits on computation duration.
 - Evaluation: NIST runs the algorithm on the test images sequestered at NIST.
4. **NIST computes performance:** Performance refers to accuracy and speed, and their dependence on quantities such as enrolled population size, image properties, and subject demographics.
5. **NIST delivers performance report to IARPA and judging commences.**

Training imagery: Neither IARPA nor NIST will provide training data to prospective or registered participants. Algorithms are expected to run in a turnkey manner, without tuning, training or other in-the-field specialization. While this approach differs from many academic studies, in which training is an integral part of the study, it reflects typical operational off-the-shelf deployment. Of course, developers may train their algorithms on external data, before submission to NIST. As specified in [NIST-API], the outputs of such training, for example models or representations, may be sent to NIST and used to initialize the algorithm.

Software readiness: Participants are expected to provide an algorithm with sufficient software engineering robustness that it can be invoked by NIST millions of times, simultaneously running in many possibly forked



processes on one or many computers. The software must implement a simple C++ testing API specified by [NIST-API]

5 Timeline

The FRPC will be conducted with the following schedule.

1. 2017-04-21 Publication of the FRPC on challenge.gov [IARPA-WEB]
2. 2017-04-21 Publication of [NIST-ENTRY]
3. 2017-04-21 Publication of [NIST-API]
4. Developers prepare algorithms
5. **2017-06-15; 14:00 EDT** **Deadline for submission of participation agreements and algorithms to NIST**
6. 2017-08-25 NIST provides participation and performance report to IARPA
7. 2017-09 Judges meet to determine prize winners
8. 2017-10 IARPA expects to complete prize award
9. 2017-10 NIST expects to publish one or more performance reports

6 Challenges and Prizes

There are two challenges within FRPC, named “Challenge IDENT” and “Challenge VERIF”. Respectively, these are intended to attract the most accurate one-to-many identification and one-to-one verification face recognition algorithms. Participants may submit zero, one or two (0 – 2) algorithms to Challenge IDENT. Participants may enter zero or one (0 – 1) algorithms to Challenge VERIF.

6.1 Identification

Name: Challenge IDENT

Primary Prize Amount: \$25,000

Primary Prize Goal: To determine the most accurate search algorithm.

Secondary Prize Amount: \$5000

Second Prize Goal: To determine the fastest accurate search algorithm.

Method: The algorithm will be invoked in four phases, as follows.

1. To produce N enrollment templates from N input images. This will be achieved by NIST’s test harness calling the implementation’s template generation function a total of N times, spreading the work over separate processes running on separate machines. We anticipate that N will be $O(10^6)$. The software must operate for all values of $N > 100$. We anticipate enrolling one and only one image per person.
2. To produce a searchable data structure from the N templates. This process is described in the NIST API and is termed finalization. Once computed the data structure is read-only.
3. To produce M search templates from M search input images. Again, this is achieved by separate template generation function calls.
4. To execute M searches against the searchable data structure. Some fraction of these searches will be mate searches, the remainder will be non-mate. Each search must return a list of candidate identities and similarity scores.
5. The duration of searches will be measured using high resolution operating system timers.

Input Images: The algorithm will be invoked with two categories of images, as follows.

1. The enrollment dataset will be populated with portrait images that were acquired with some cooperation of the subject. These images are in most cases in good conformance to the image quality specifications



associated with Full Frontal image type of the ISO/IEC 19794-5 face standard. Exactly one face appears in these images.

2. The search images will be taken from multiple sources including: a) frames from surveillance video; b) frames from access control videos; c) selfies; d) non-frontal cooperative stills; e) cooperative stills; f) the web, including social media, news sites, and blogs. These images will be cropped, with dimensions and aspect ratios varying widely. Faces will not necessarily be centered, and may be partially or slightly cropped. Most images will contain exactly one face. In a small fraction of the images other, smaller, faces will appear in the background. Algorithms should detect one foreground face in each image and produce one template.

Input Metadata: The algorithm will not be given any metadata. Particularly, the algorithm will not be provided with face location, face landmark points, subject IDs, nor any demographic information.

Computational constraints: The algorithms must execute within certain time limits.

1. *Template generation:* When invoked with a 640x480 color image, the template generation function must execute within 2000 milliseconds. This limit is a 90-th percentile. It will be estimated from at least 1000 separate invocations of the template generation function. The template generation function may use a single GPU or a single CPU core or both, the specifications of which appear in the NIST API document.
2. *Search:* The duration of the search must not exceed 25 seconds when 100,000 templates are enrolled. This limit is a 90-th percentile. It will be estimated from at least 1000 separate invocations of the search function.

Prize eligibility: A developer is ineligible to win prizes if any of the following occur:

1. The algorithm cannot be linked, validated or executed.
2. The algorithm crashes, or refuses to process the input.
3. The algorithm violates any of the environmental constraints listed in [NIST API]
4. The algorithm violates the timing limits. Note that IARPA and NIST, at their option, may evaluate implementations that process inputs too slowly.

Primary Prize award: The Primary Prize winner will be declared by considering measurements of identification accuracy. This will be stated as the False Negative Identification Rate (FNIR)² measured at the lowest scalar threshold that gives a fixed False Positive Identification Rate (FPIR) no higher than 10^{-3} .

- FNIR will be measured over many mate searches. FNIR is defined as the proportion of mate searches for which a correct mate is not returned above a threshold, T . Mate searches are those for which the person in the search image has a face image in the enrolled dataset.
- FPIR will be measured over many non-mate searches. FPIR is defined as the proportion of non-mate searches that yield one or more non-mates³ at or above threshold, T . Non-mate searches are those which the person in the search image does not have a face image in the enrolled dataset.

The conduct of both mate and non-mate searches defines an open-set, or open-universe, problem.

In the case of a tie in identification accuracy between two participants, the algorithm with the lowest median search duration will be declared the Primary Prize winner.

Second Prize award: The Secondary Prize will be awarded to the algorithm that a) has FNIR no larger than twice that of the Primary Prize award winner, and b) executes one-to-many template searches with the shortest

² The ISO/IEC 19795 standard *Biometrics Performance Testing and Reporting – Part 1: Principles and Framework* reserves the terms FNIR and FPIR for one-to-many searches. The standard reserves analogous but different terms, FNMR and FMR, for one-to-one verification comparisons.

³ This definition does not count the number of non-mates returned above threshold in a given search – the term selectivity is reserved for that. Instead FPIR counts whether *any* false positives are at or above threshold – a false positive is counted if the highest score – the extreme value – is at or above threshold.



duration. If the Primary Prize winner's algorithm is the fastest, the both prizes will be awarded to the same participant.

Reported metrics: NIST will produce a test report that is likely to include the following information. These will be published with attribution to the organization that submitted the algorithm.

1. Statistics on the duration of enrollment template generation.
2. Statistics on the duration of search template generation.
3. Statistics on the duration of search.
4. FNIR at each of a set of possible operating thresholds.
5. FPIR at the same set of thresholds.

These, and other technical information, may appear on NIST web pages, at conferences, workshops, seminars and other briefings, or in academic proceedings or journal articles.

6.2 Verification

Name: Challenge VERIF

Prize amount: \$20,000.

Goal: To determine the most accurate verification algorithm.

Method: The algorithm will be invoked in four phases, as follows.

1. To produce N enrollment templates from N input images. This will be achieved by NIST's test harness calling the implementation's template generation function a total of N times, spreading the work over separate processes running on separate machines.
2. To produce M verification templates from M input images. This will be achieved by NIST's test harness calling the implementation's template generation function a total of M times, spreading the work over separate processes running on separate machines.
3. To execute $K \leq MN$ template comparisons, some fraction of which will be mate (genuine) comparisons, the remainder will be non-mate (impostor).

Input Images: The algorithm will be invoked with images from multiple sources, including: a) frames from surveillance video; b) frames from access control videos; c) selfies; d) non-frontal cooperative stills; e) cooperative stills; f) the web, including social media, news sites, and blogs.

Input Metadata: The algorithm will not be given any metadata. Particularly, the algorithm will not be provided with face location, face landmark points, subject IDs, nor any demographic information.

Computational constraints: The algorithms must execute within certain time limits.

1. *Template generation:* When invoked with a 640x480 color image, the template generation function must execute within 2000 milliseconds. This limit is a 90-th percentile. It will be estimated from at least 1000 separate invocations of the template generation function. The template generation function may use a single GPU or a single CPU core or both, the specifications of which appear in [NIST API].
2. *Comparison:* The duration of the template comparison function must not exceed 1000 microseconds.

Prize eligibility: A developer is ineligible to win the prize if any of the following occur:

1. The algorithm cannot be linked, validated or executed.
2. The algorithm crashes, or refuses to process the input.
3. The algorithm violates any of the environmental constraints listed in the [NIST API] document.
4. The algorithm violates the timing limits. Note that IARPA and NIST, at their option, may evaluate implementations that process inputs too slowly.



Prize award: The winner will be declared by considering measurements of verification accuracy. This will be stated as the False Non-Match Rate (FNMR)⁴ measured at the lowest scalar threshold that gives a fixed False Match Rate (FMR) no higher than 10^{-3} .

- FNMR will be measured over many genuine comparison. FNMR is defined as the proportion of genuine comparisons that yield a similarity score below a threshold, T.
- FMR will be measured over many impostor comparisons. FMR is defined as the proportion of impostor comparisons that yield a similarity score at or above threshold, T.

In the case of a tie in verification accuracy between two participants, the algorithm with the lowest median template generation duration will be declared the winner.

Reported metrics: NIST will produce a test report that is likely to include the following information. These will be published with attribution to the organization that submitted the algorithm.

1. Statistics on the duration of enrollment template generation.
2. Statistics on the duration of verification template generation.
3. Statistics on the duration of comparison.
4. FNMR at each of a set of possible operating thresholds.
5. FMR at the same set of thresholds.

These, and other technical information, may appear on NIST web pages, at conferences, workshops, seminars and other briefings, or in academic proceedings or journal articles.

7 Judging

The submissions will be judged by a 3 person United States Government (USG) team. The judges will award funds based on the NIST performance report. The judges expect to award the prize funds to the most accurate algorithms as identified in the NIST report. The Judges may update or modify the rules within the spirit of the competition if needed. The judges may, however, award prizes to other algorithms if a submission is assessed to have violated the FRPC rules or the provisions of the NIST FRPC participation agreement or the specifications in [NIST API].

8 Rules

- **Delivery of Algorithms:** Participants will need to make the software algorithm(s) available to the NIST FRPC POC at the location specified below. NIST requires that all software submitted by participants be signed and encrypted. The algorithm(s) must be encrypted per [NIST-API] and should be made available through electronic online means. Physical delivery of a DVD, flash drive, or hard drive is allowed also. Cost for shipment or transport of the electronic media to and from the site is the responsibility of the participant.
 - **NIST FRPC POC:**
Image Group, Stop 8940
Attn: Face Recognition Prize Challenge
National Institute of Standards and Technology
100 Bureau Dr.
Gaithersburg, MD 20899-8940
frpc@nist.gov
- **Payment Terms:** Participants need to submit a W-9 tax form, or a W8-BEN form to receive payment. Participants are responsible for all taxes incurred from the acceptance of Prize funds.

⁴ The ISO/IEC 19795 standard Biometrics Performance Testing and Reporting – Part 1: Principles and Framework reserves the terms FNIR and FPIR for one-to-many searches. Analogous but different terms, FNMR and FMR, are reserved for one-to-one verification comparisons.



9 Intellectual Property

Participants will retain the rights to their Intellectual Property for their algorithms and accompanying data. As algorithms are provided to NIST as compiled libraries, participants should not provide any intellectual property to IARPA or NIST. If participants' implementations emit error messages, warning, debug symbols, crash logs that expose the use of certain algorithms, techniques or approaches, neither NIST nor IARPA expect to share such information.

However, IARPA does request that each provider submit a short description of the technologies in use. This step is optional. A developer might disclose, for example, the use of ResNets. This information must be submitted through the challenge and application process. IARPA will use this to better understand the technology.

- IARPA and NIST will have the rights to utilize algorithms provided for USG testing purposes.
- Challenge participant names, titles, general technology descriptions, photographs, and abstracts for their submissions may be utilized in challenge-related media and promotional materials or for other internal government uses. No sensitive intellectual property information will be shared in this manner.

10 Participation Eligibility

To be eligible to win a prize under this competition, an individual or entity:

1. Must have visited the challenge website [IARPA-WEB];
2. Must have read the FRPC rules [IARPA-FRPC];
3. Must have completed and submitted a participation agreement form from [NIST-WEB];
4. Must have complied with all the requirements under these rules; and
5. Must be (1) an individual or team member each of whose members are 18 years of age and over, or (2) an entity incorporated.

The following are ineligible to participate

1. May not be a federal entity or federal employee acting within the scope of their employment. An individual or entity shall not be deemed ineligible because the individual or entity used federal facilities or consulted with federal employees during a competition if the facilities and employees are made available to all individuals and entities participating in the competition on an equitable basis.
2. Employees of IARPA, NIST, their affiliates, and/or any other individual or entity associated with the development, evaluation, or administration of the competition as well as members of such persons' immediate families (spouses, children, siblings, parents), and persons living in the same household as such persons, whether or not related, are not eligible to participate in the competition.
3. Foreign Nationals & International Developers: All Developers can participate with this exception: residents of, Iran, Cuba, North Korea, Crimea Region of Ukraine, Sudan or Syria or other countries prohibited on the U.S. State Department's State Sponsors of Terrorism list. In addition, Developers are not eligible to participate if they are on the Specially Designated National list promulgated and amended, from time to time, by the United States Department of the Treasury. It is the responsibility of the Developer to ensure that they are allowed to export their technology solution to the United States for the Live Test. Additionally, it is the responsibility of participants to ensure that no US law export control restrictions would prevent them from participating when foreign nationals are involved. If there are US export control concerns, please contact IARPA and we will attempt to make reasonable accommodations if possible. IARPA will not be held responsible for devices shipped or transported to the U.S. that are confiscated by local authorities or that violate local export laws.

In addition:



1. Federal grantees may not use federal funds to develop challenge applications unless consistent with the purpose of their grant award. Federal contractors may not use federal funds from a contract to develop challenge applications or to fund efforts in support of a challenge submission without written approval of both IARPA and their Federal government sponsor. Entities affiliated with the IARPA Janus program are ineligible to participate.
2. Entrants must agree to assume any and all risks and waive claims against the federal government and its related entities, except in the case of willful misconduct, for any injury, death, damage, or loss of property, revenue, or profits, whether direct, indirect, or consequential, arising from their participation in a competition, whether the injury, death, damage, or loss arises through negligence or otherwise.
3. Entrants must also agree to indemnify the federal government against third-party claims for damages arising from or related to competition activities. Entrants are not required to obtain liability insurance or demonstrate financial responsibility in order to participate in the competition.
4. By participating in the competition, each entrant agrees to comply with and abide by these rules and the decisions of IARPA, NIST and/or the individual judges, which shall be final and binding in all respects.
5. By participating in the competition, each entrant agrees to follow all applicable local, state, federal and country of residence laws and regulations.

11 General Liability Release

By participating in the competition, each entrant hereby agrees that:

1. IARPA shall not be responsible or liable for any losses, damages, or injuries of any kind (including death) resulting from participation in the competition or any competition-related activity, or from entrants' acceptance, receipt, possession, use, or misuse of any prize; and
2. Entrants will indemnify, defend, and hold harmless IARPA, NIST, and ODNI from and against all third party claims, actions, or proceedings of any kind and from any and all damages, liabilities, costs, and expenses relating to or arising from entrant's participation in the competition.

Without limiting the generality of the foregoing, IARPA is not responsible for incomplete, illegible, misdirected, misprinted, late, lost, postage-due, damaged, or stolen entries or prize notifications; or for lost, interrupted, inaccessible, or unavailable networks, servers, satellites, Internet Service Providers, websites, or other connections; or for miscommunications, failed, jumbled, scrambled, delayed, or misdirected computer, telephone, cable transmissions or other communications; or for any technical malfunctions, failures, difficulties, or other errors of any kind or nature; or for the incorrect or inaccurate capture of information, or the failure to capture any information. These rules cannot be modified except by IARPA. All decisions by IARPA regarding adherence to these rules are final. The invalidity or unenforceability of any provision of these rules shall not affect the validity or enforceability of any other provision. In the event that any provision is determined to be invalid or otherwise unenforceable or illegal, these rules shall otherwise remain in effect and shall be construed in accordance with their terms as if the invalid or illegal provision were not contained herein.

12 Warranties / Indemnification

By participating in the competition, each entrant represents, warrants, and covenants as follows:

1. The entrant – whether an individual, team or entity – is the sole author, creator, and owner of the submission or has secured usage rights to include as part of the software submission;
2. The submission is not the subject of any actual or threatened litigation or claim;
3. The submission does not and will not violate or infringe upon the intellectual property rights, privacy rights, publicity rights, or other legal rights of any third party;



4. The submission does not and will not contain any known harmful equipment that can cause injury or long term risks of exposure in humans; and
5. The Submission, and entrants' use of the Submission, does not and will not violate any applicable laws or regulations, including, without limitation, applicable export control laws and regulations of the U.S. and other jurisdictions.

If the Submission includes any third party works (such as third party content, equipment, or open source code), entrant must be able to provide, upon the request of IARPA, documentation of all appropriate licenses and releases for such third party works. If entrant cannot provide documentation of all required licenses and releases, IARPA reserves the right to disqualify the applicable Submission, or seek to secure the licenses and releases for the benefit of IARPA, and allow the applicable Submission to remain in the Competition. IARPA also reserves all rights with respect to claims based on any damages caused by participant's failure to obtain such licenses and releases.

Entrants – whether an individual, a team or an entity – will indemnify, defend, and hold IARPA, NIST, and ODNI from and against all third party claims, actions, or proceedings of any kind and from any and all damages, liabilities, costs, and expenses relating to or arising from entrant's Submission or any breach or alleged breach of any of the representations, warranties, and covenants of entrant hereunder.

IARPA reserves the right to disqualify any Submission that IARPA, in its discretion, deems to violate these Rules. IARPA also reserves the right to amend these rules throughout the duration of the contest should extenuating circumstances arise.