Face Recognition Performance + Measurement

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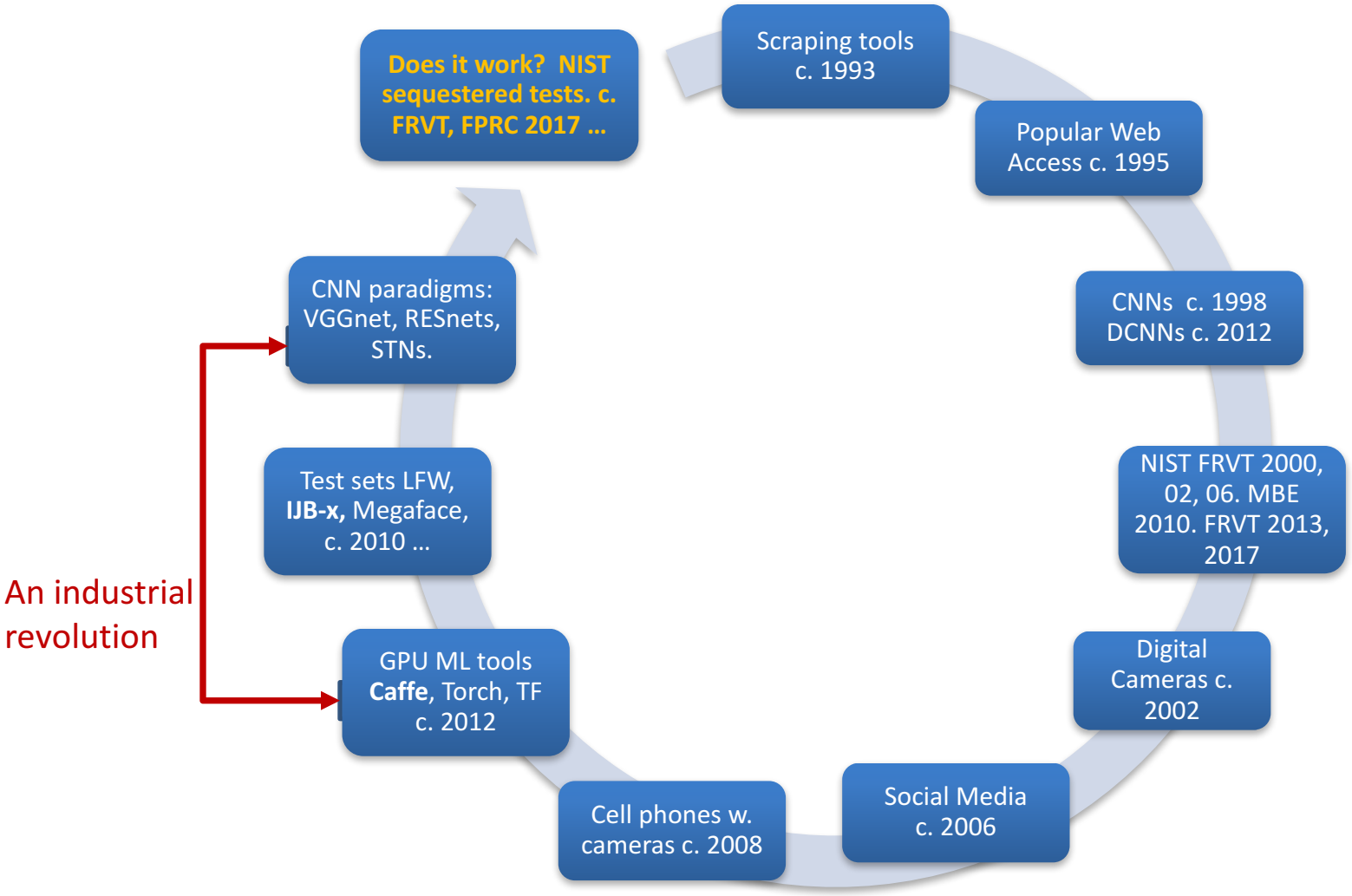
Enablers of Better Face Recognition



Face recognition trends, evolution, revolution

Marketplace, organizational

- » Many more developers
- » More large programs
  - US Exit. EES (2022)
- » Capture envelope
  - Constrained → Unconstrained
- » Bigger better benchmarks
- » New applications
- » New tasks
  - Clustering
- » Larger databases, ↑N

Sensors

- Better VSS cameras
  - ↑ resolution
  - ↓ lower frame rate
  - H265
- Face-aware cameras
  - Detection
  - Quality
- PAD
- Resurrection of 3D
  - Face action

Algorithms

- » Revolution under the hood: CNNs
  - Better accuracy
  - Smaller templates
  - Better pose invariance
- » Faster processing
  - Faster template generation
  - Sublinear search
- » Processors
  - GPU for training
  - CPU very much alive

Gaps

- Quality infrastructure
- Quality standardization

- PAD, Morph detection
- Demographic neutrality

Partial List of FR companies

- Cognitec
- Idemia (Morpho)
- Gemalto-Cogent
- NEC
- Toshiba
- Neurotechnology
- HP / Virage
- IBM
- Camvi
- Rankone
- Noblis
- Cyberextruder
- Decatur

- Dalian U. of Technology
- Surrey U.
- Tsinghua U.
- Beijing Ivsign
- Chinese Academy of Sciences
- Fudan U.
- U. of Maryland
- USC ISI
- Itmo

- Ayonix
- Dermalog
- Digitalbarriers
- FST
- HB Innovation
- Herta
- Id3
- Innovatrics
- Isityou
- Vision Labs
- NtechLab
- 3divi
- STR, Oxford U.

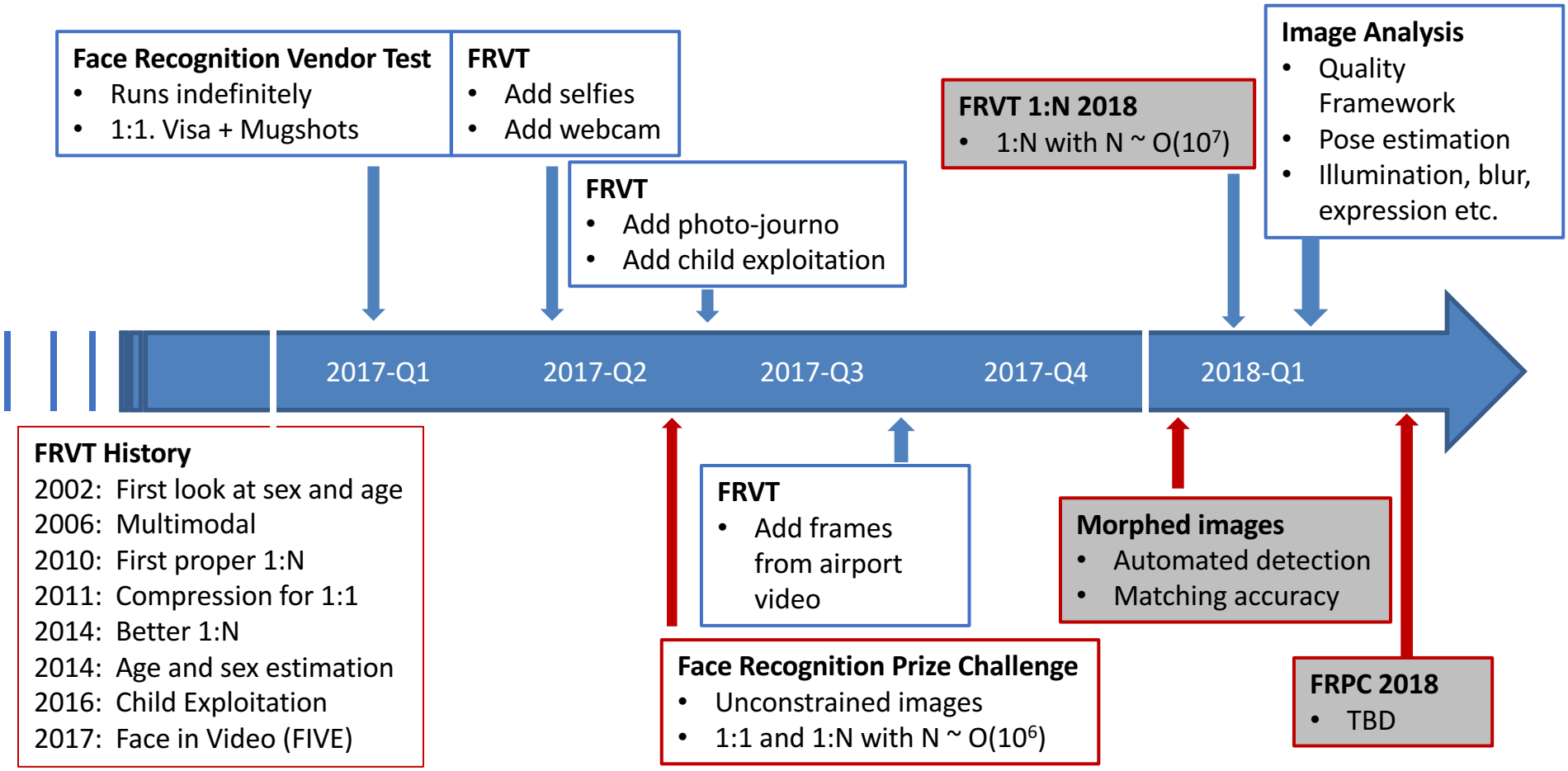
- Non-Biometrics
  - Apple
  - Google
  - Facebook
  - Microsoft
  - Amazon
  - Kairos
  - Affectiva
  - OpenCV

- Betaface
- Panasonic
- Progeny
- Samtech
- Tongyi Trans.
- Vcognition
- Yitu
- Intellivision
- Ping An
- Zhuhai Yisheng
- JunYi

- SeeQuestor
- AnyVision
- Megvii, Face++
- FaceFirst
- Videmo

AND THE LIST is GROWING rapidly…

Face Recognition Tests at NIST



Upcoming FRVT 1:N 2018 Test

- Cooperative, still images
- Metrics: 1:N
  - 1:N False positive / negative
  - Speed, template size
  - Demographic effects

FRVT
FACE RECOGNITION VENDOR TEST

Large-scale 1:N evaluation

- Cooperative, still images
- Gallery N ~ O(10^7)
- Subject-based vs. event-based gallery composition
- Gallery maintenance

FRVT 2018: Important Dates

2017-Oct-26 - Nov-15: Draft API publication and public comments period
2017-Nov-16: Final API published
2018-Jan-22: First day algorithms can be sent to NIST
2018-Feb-16: Phase 1 submission deadline
2018-Jun-21: Phase 2 submission deadline
2018-Oct-19: Phase 3 submission deadline

FRVT 1:N 2018: Intended main outcomes

Accuracy

- Absolute accuracy
  - Hit rates, rank 1, 2, …
  - Hit rates, threshold-based
  - Dependence on gallery size, N
- Relative FR accuracy 2010 ⟶ 2013 ⟶ 2018
- Comparative accuracy of 2018 FR algorithms
- Accuracy dependence on
  - Subject-specific factors: Race, age, gender, skin tone
  - Image-specific factors: Pose, compression, camera
- Effect of gallery composition
  - Subject-based (consolidated)
  - Event-based

Computational resources

- Template
  - Size
  - Generation duration
- Search duration
  - Dependence on gallery size, N
  - Dependence on candidate list size
- Gallery maintenance
  - Finalization
  - Subject insert/delete
- Memory

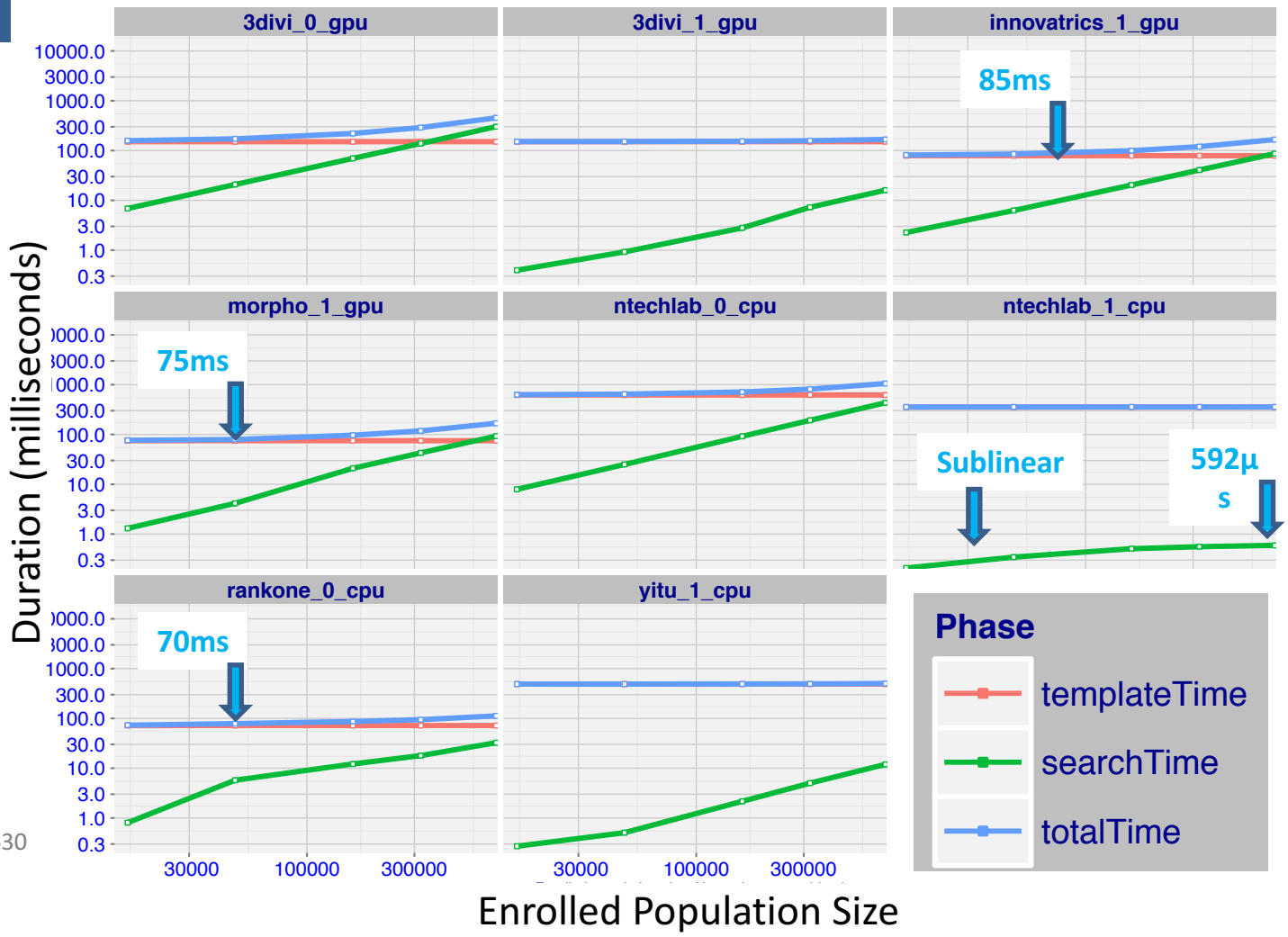
Demographic effects

- Phase 1. Measurement of effects of age, race, sex
  - Type I + II errors
- Phase 2
  - Mitigate via turnkey training on operational data
  - Multimodal face + iris

Durations

Algorithm	Template	
	Size	Time
	Bytes	msec
Innovatri 1	276	85
3divi 0	4224	150
3divi 1	4096	150
Morpho	404	75
Ntech 0	5784	630
Ntech 1	987	360
Rankone	144	70
Yitu	2260	440
Neurotec	4780	1400

All times on single Intel Xeon core E5-2630 2.2GHz, or NVIDIA Kepler K40m



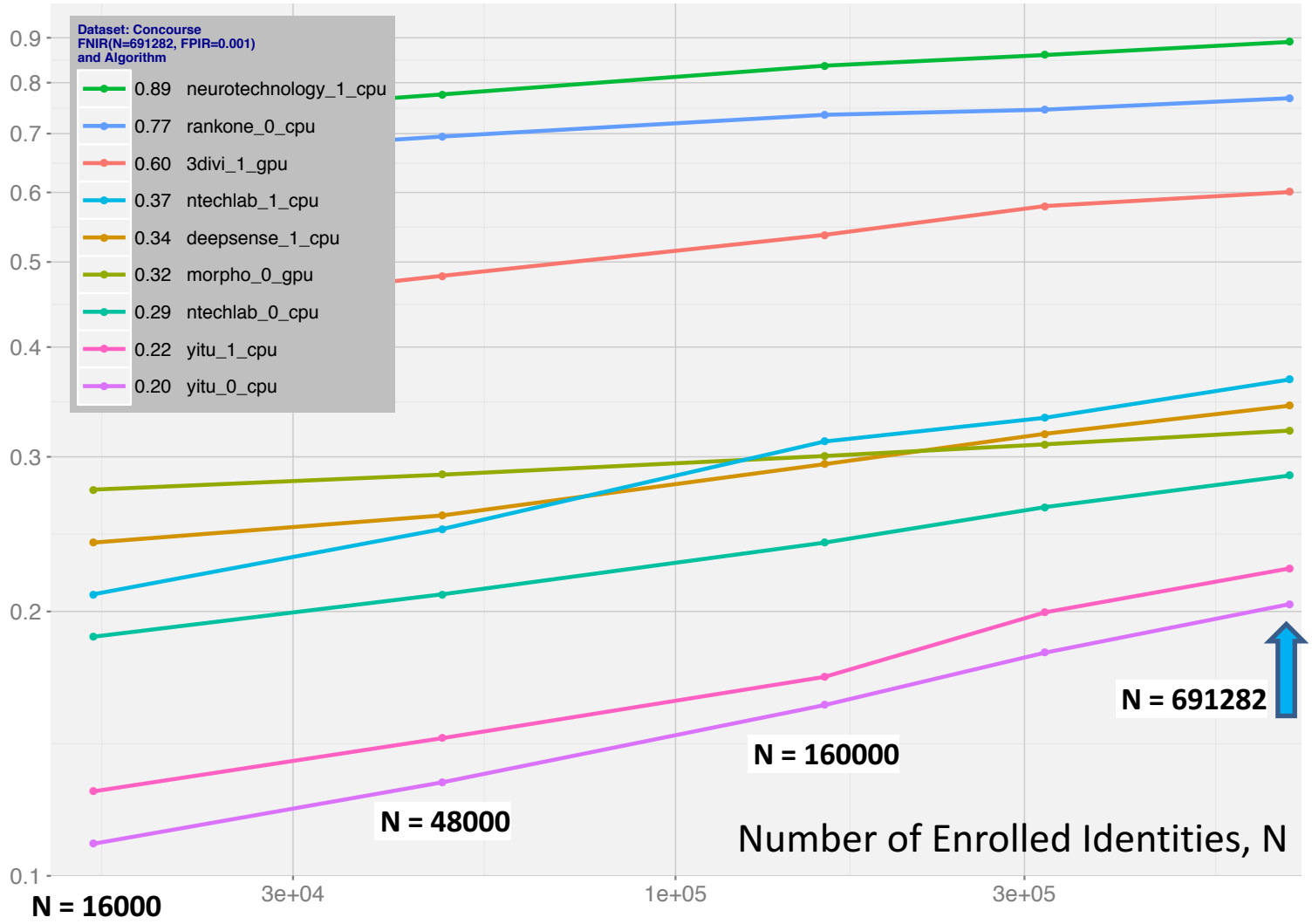
[1] H. Jégou, M. Douze and C. Schmid, "Product quantization for nearest neighbor search", PAMI 33(1), 2011

[2] K. Chatfield, R. Arandjelović, O. M. Parkhi, A. Zisserman "On-the-fly learning for visual search of large-scale image and video datasets", International Journal of Multimedia Information Retrieval, 2015

[4] Masato Ishii, Hitoshi Imaoka, and Atsushi Sato. Fast k-nearest neighbor search for face identification using bounds of residual score. In *2017 12th IEEE International Conference on Automatic Face & Gesture Recognition (FG 2017)*, pages 194–199, Los Alamitos, CA, USA, May 2017. IEEE Computer Society.

[5] Jeff Johnson, Matthijs Douze, and Hervé Jégou. Billion-scale similarity search with gpus. *CoRR*, abs/1702.08734, 2017

Miss rates grow with increased population, N

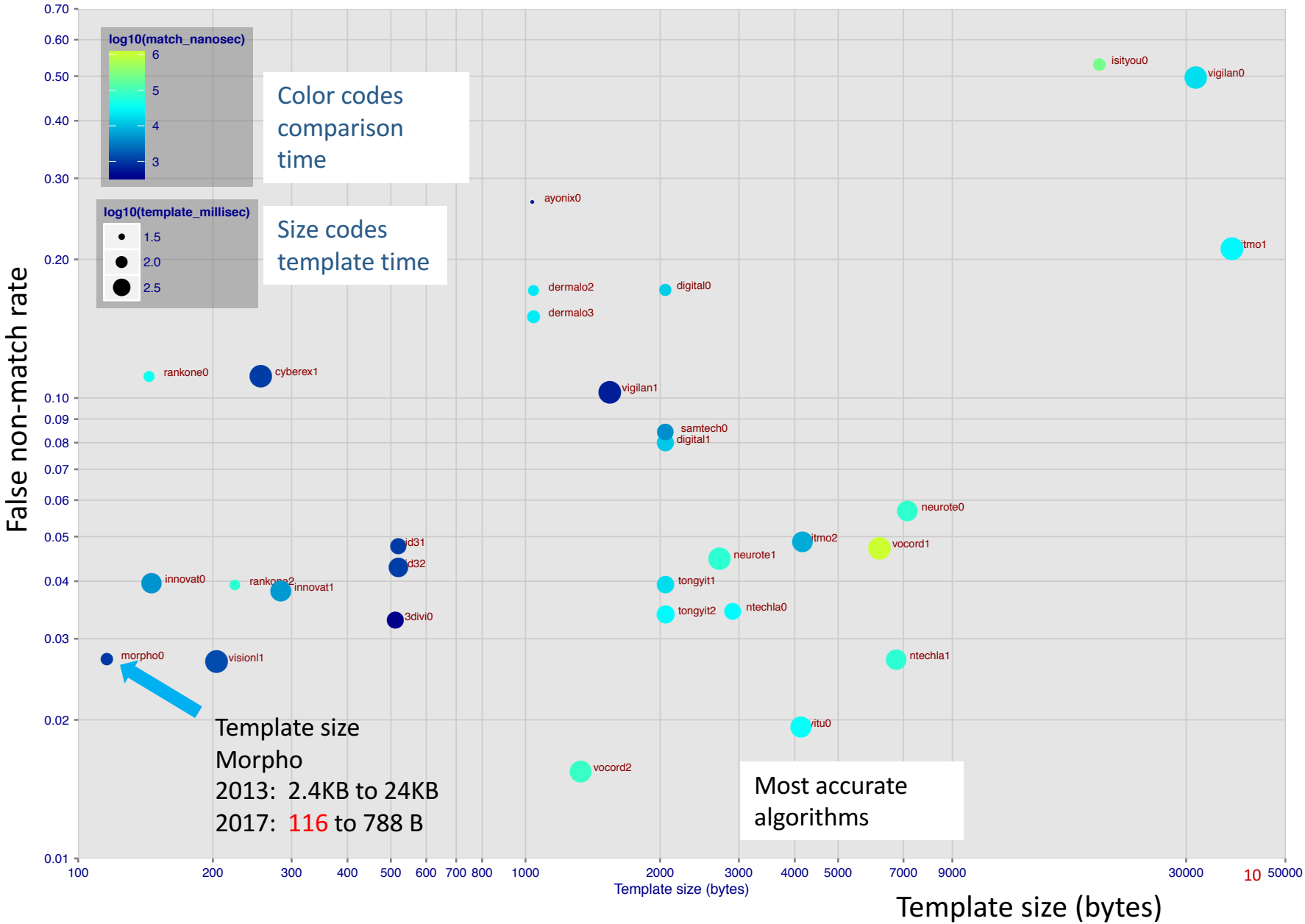


Threshold set so that only 1 in 1000 searches produces a false positive

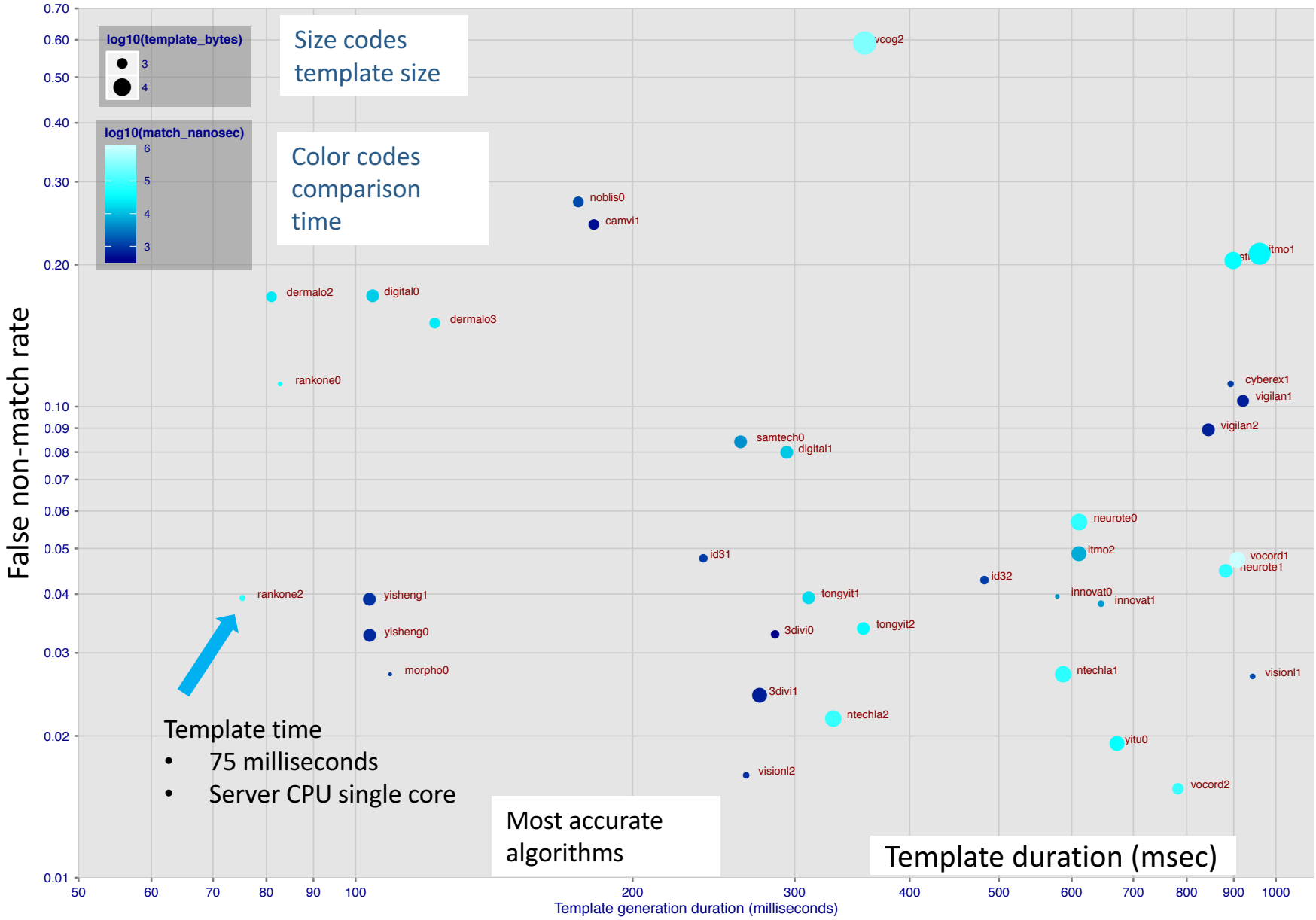
FPIR = 0.001

Source: https://www.nist.gov/programs-projects/face-recognition-prize-challenge

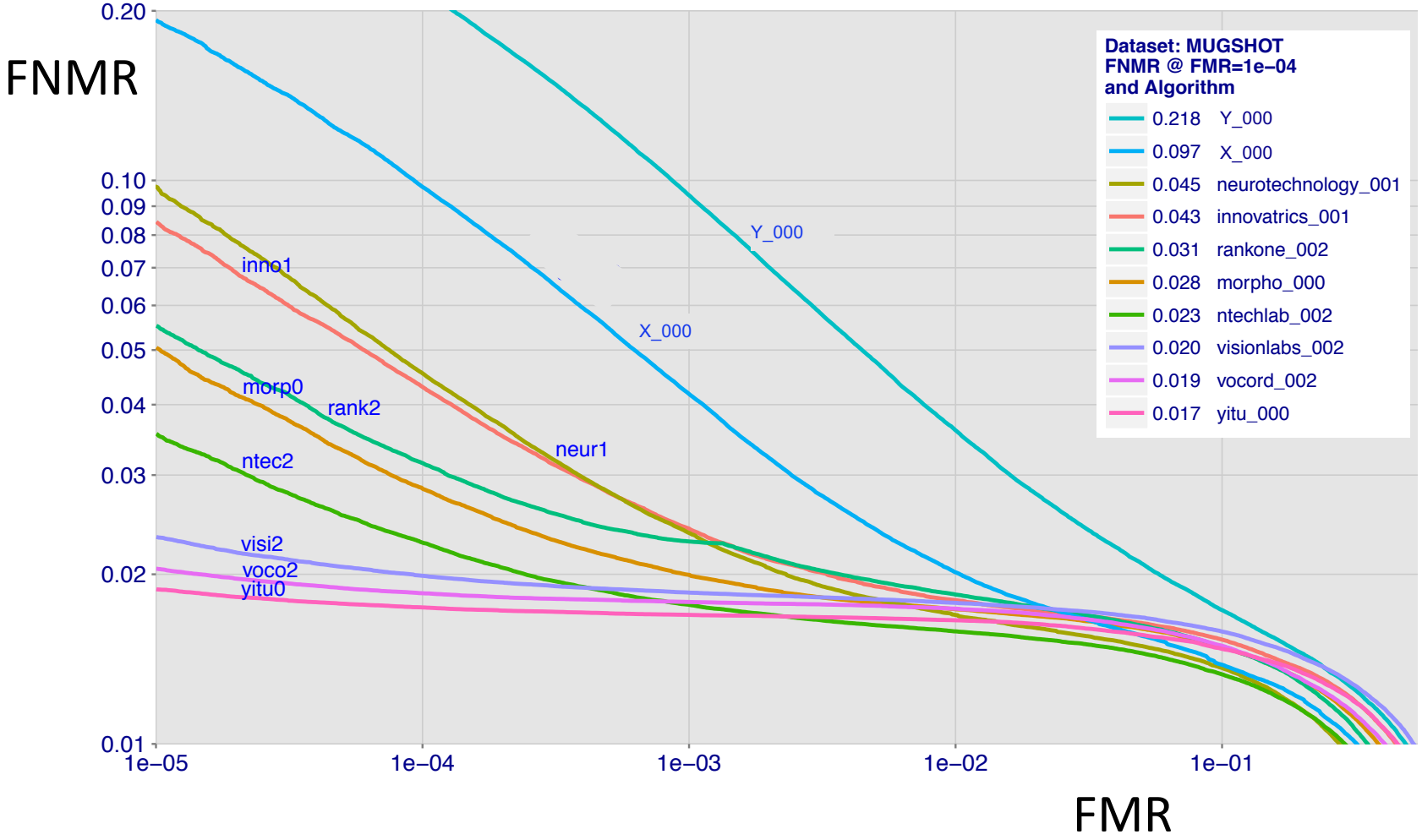
FR: Smaller, faster, more accurate



Performance: Accuracy + Speed

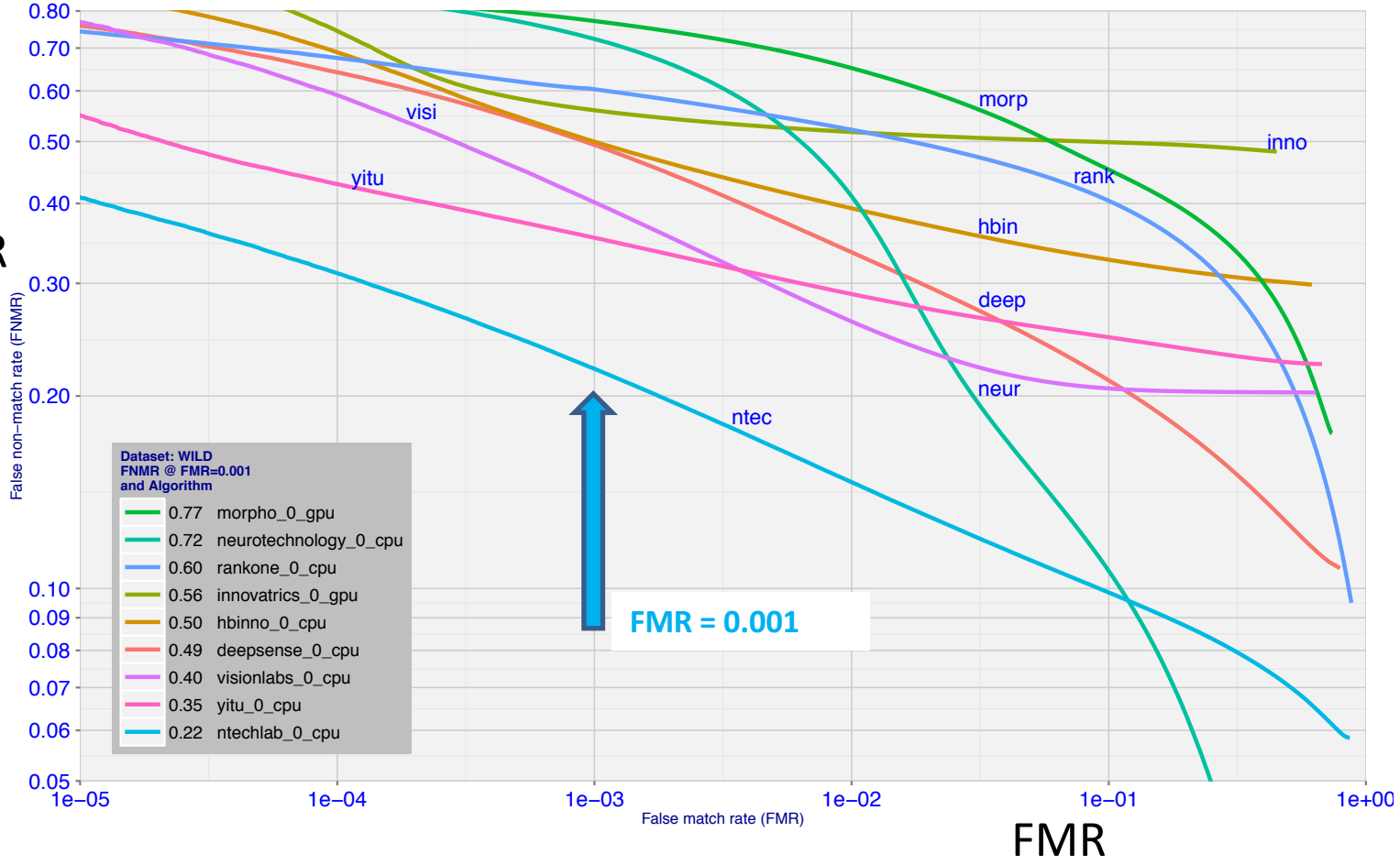


Mugshot-to-mugshot comparisons



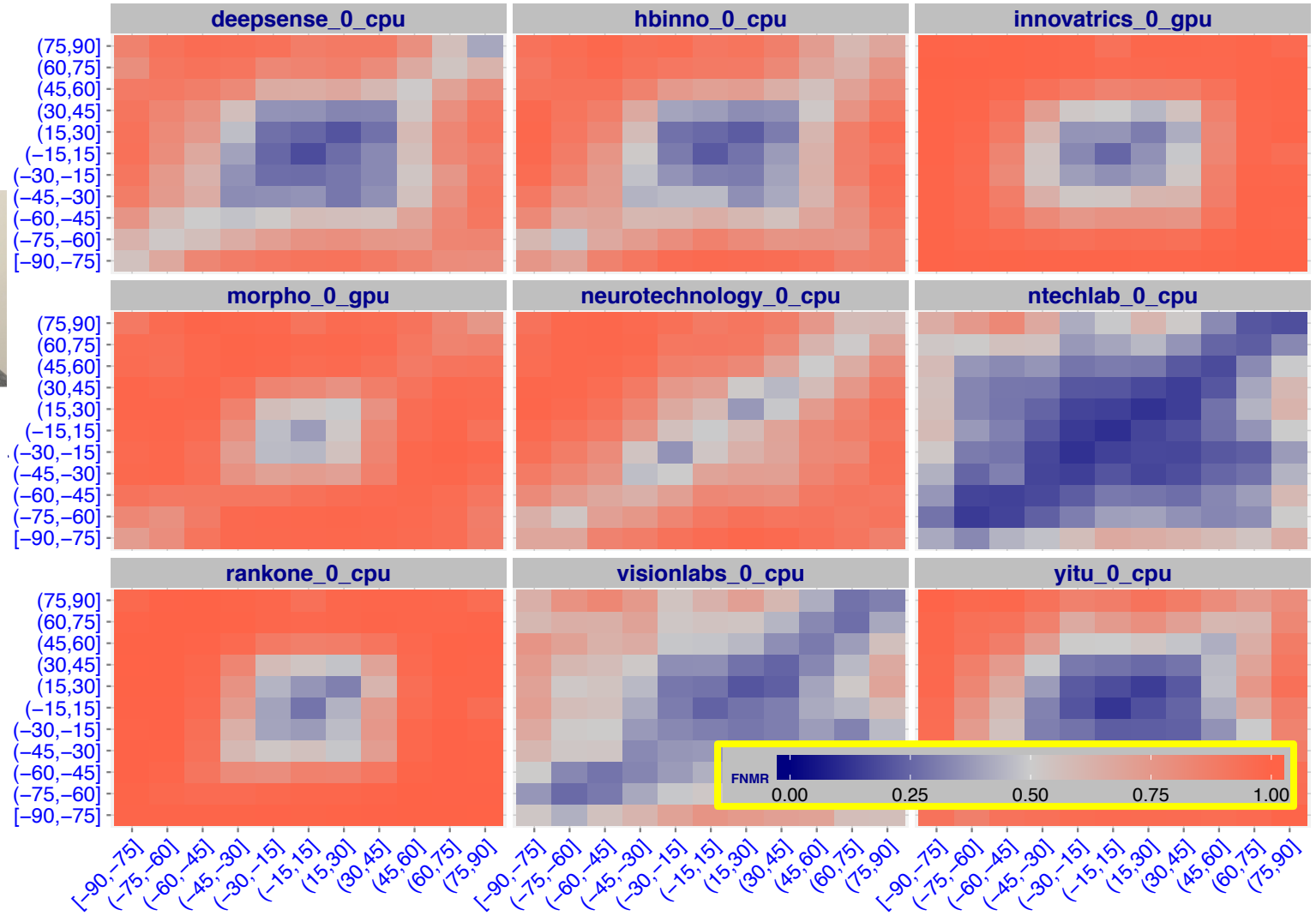
Wild-to-wild comparisons

FNMR



FMR

Verification FNMR(T, θ_E, θ_V) Wild Images



YAW_{VERIF}

THRESHOLD FIXED TO GIVE FMR = 0.001 on NEAR FRONTAL IMAGES

YAW_{ENROL}

Thanks

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