UNIVERSITÄT SALZBURG

Evaluation of the IRISSEG datasets

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Technical Report Series

Technical Report
Appendix for the *paper*
titled "A Ground Truth
for Iris Segmentation"
(**IRISSEG)**

Technical Report: IRISSEG–2013–12

Evaluation of the IRISSEG datasets

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This is an appendix to the paper

Heinz Hofbauer, Fernando Alonso-Fernandez, Peter Wild, Josef Bigun, and Andreas Uhl. A ground truth for iris segmentation. In *Proceedings of the 22th International Conference on Pattern Recognition (ICPR'14)*, page 6pp., Stockholm, Sweden, 2014

Contents

Introduction

Evaluation Method

The goal of an segmentation algorithm is to retrieve the iris region, or iris pixels, from an image. In order to evaluate the performance of the algorithm we will utilize the precision ($\mathcal{P}$), recall ($\mathcal{R}$) and F-measure ($\mathcal{F}$), which are well known measures from the field of information retrieval. We can split the mask produced by an algorithm into four result groups: true positives (*tp*), the number of iris pixels which were correctly marked; false positives (*fp*), the number of non-iris pixels which were marked; false negative (*fn*), the number of unmarked iris pixels; and true negative (*tn*), the number of unmarked non-iris pixel.

The precision defined as

$$\mathcal{P} = \frac{\mathrm{tp}}{\mathrm{tp} + \mathrm{fp}},$$

gives the percentage of retrieved iris pixels which are correct. The recall

$$\mathcal{R} = \frac{\mathrm{tp}}{\mathrm{tp} + \mathrm{fn}},$$

gives the percentage of iris pixels in the ground truth which were correctly retrieved. Since the target is to optimize both recall and precision these two scores are combined by the F-measure, which is the harmonic mean of $\mathcal{P}$ and $\mathcal{R}$,

$$\mathcal{F} = \frac{2\mathcal{R}\mathcal{P}}{\mathcal{R} + \mathcal{P}}$$

The recall, precision and f-measure can concisely describe the segmentation performance of a given algorithm based on ground truth. The measures are good when comparing algorithms. From the equations we can see that recall is a measure for the original iris content retrieved by an algorithm, it can also be maximized by overestimating the iris. Precision on the other hand can be optimized by underestimating the iris and is a measure of the non-iris content of the retrieved iris mask. The f-score combines the two measures in a way that will prevent optimization of results by over fitting or under fitting the iris.

While the overall performance over a database is a good performance measure, it is often more useful to know border cases when developing an algorithm. Iris images which are especially good or especially bad show faults and strength of an algorithm better than the overall performance. Especially during development this information can be utilized to further improve and algorithm. In order to find outlier we suggest the following methods.

Precision, recall and the F-measure is calculated for every image I in a given database $\mathcal{D}$. In order to find outliers we calculate the z-score for a given measure $m \in \{\mathcal{R}, \mathcal{P}, \mathcal{F}\}$ as

$$z_I(D) = \frac{m(I) - \mu(m_{i \in \mathcal{D}}(i))}{\sigma(m_{i \in \mathcal{D}}(i))}.$$

A given mask is defined as an outlier if $|z| > 3$. This can not only be done for individual iris images but also for users, i.e. find users which overall exhibit interesting properties regarding an algorithm. To do this we partition $\mathcal{D}$ into groups $\mathcal{G}$, where each group contains all iris images of one user. Another possibility is to partition the groups by user and eye id, either left or right. In this case we can also calculate the group outliers with

$$z_{\mathfrak{g}}(D) = \frac{\mu(m_{i \in \mathfrak{g}}(i)) - \mu(\mu_{g \in \mathcal{G}}(m_{i \in g}(i)))}{\sigma(\mu_{g \in \mathcal{G}}(m_{i \in g}(i)))},$$

for $\mathfrak{g} \in \mathcal{G}$.

Note: The file id of the iris image identifies the user, sometimes the left or right eye, distance, angle and so on. We used the file id to perform the grouping to user id, mostly we also split left and right eye into a separate group. In each case the regular expression used for the grouping is given in the section line of the grouped results. The labels in the graphs also reflect the file id for non-grouped results or the group id obtained from the file id via the given regular expression.

Databases

CC Dataset

BioSec Baseline database[1]
The BioSec (*biosec*) database has 3,200 iris images of 640×480 pixels from 200 subjects acquired with a LG IrisAccess EOU3000 close-up infrared iris camera. Here,

[1] `http://atvs.ii.uam.es/databases.jsp`

we use a subset comprising data from 75 subjects (totalling 1,200 iris images), for which iris and eyelids segmentation groundtruth is available. Segmentation was done by one operator. The remaining 125 subjects only contain iris segmentation groundtruth, and therefore they are not used in our experiments (this data, however, is also available in the distribution).

Literature:

- J. Fierrez, J. Ortega-Garcia, D. Torre-Toledano, and J. Gonzalez-Rodriguez. BioSec baseline corpus: A multimodal biometric database. *Pattern Recognition*, 40(4):1389–1392, 2007

CASIA Iris Image Database version 3.0[2]

The CASIA-Iris-Interval (*casia3i*) subset of the CASIA v3.0 database, containing 2655 iris images of 320×280 pixels from 249 subjects, was fully segmented. Images were acquired with a close-up infrared iris camera in an indoor environment, having images with very clear iris texture details thanks to a circular NIR LED array. The segmentation of iris images was performed by one operator.

MobBIO Database[3]

The iris (*mobbio*) training subset of the MobBIO database, containing 800 images of 240×200 pixels from 100 subjects, was fully segmented by one operator. Images were captured with the Asus Eee Pad Transformer TE300T Tablet (webcam in visible light) in two different lightning conditions, with variable eye orientations and occlusion levels, resulting in a large variability of acquisition conditions. Distance to the camera was kept constant, however.

Literature:

- J. C. Monteiro, H. P. Oliveira, A. Rebelo, and A. F. Sequeira. Mobbio 2013: 1st biometric recognition with portable devices competition, 2013

EP Dataset

CASIA Iris Image Database version 4.0[4]

The CASIA-Iris-Interval (*casia4i*) subset of the CASIA v4.0 database, containing 2639 iris images of 249 subjects, was fully segmented. The segmentation of iris images was performed by two separate operators. Consequently two sets of ground truth are available for the iris images in the casia4i.

IIT Delhi Iris Database version 1.0[5]

The IIT Delhi iris database (*iitd*), containing 2240 iris images of 224 subjects, was fully segmented by one operator.

Literature:

- Ajay Kumar and Arun Passi. Comparison and combination of iris matchers for reliable personal identification. In *Proceedings of the CVPR 2008*, pages 21–27, 2008
- Ajay Kumar and Arun Passi. Comparison and combination of iris matchers for reliable personal authentication. *Pattern Recognition*, 43(3):1016–1026, 2010

ND-IRIS-0405 Database[6]

The acquisition of ground truth for the ND-IRIS-0405 (*notredame*) database was not completed. Of the 64980 iris image contained in notredame only 837, from 30 different subjects, were segmented. The ground truth of one operator is available.

Literature:

- P. Jonathon Phillips, W. Todd Scruggs, Alice J. O'Toole, Patrick J. Flynn, Kevin W. Bowyer, Cathy L. Schott, and Matthew Sharpe. FRVT 2006 and ICE 2006 large-scale experimental results. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 32(5):1–1, 2010

UBIRIS.v2 Database[7]

The segmentation of the UBIRIS.v2 database (*ubiris*) was not completed. Of the 11101 iris images contained in ubiris only 2250 iris images, from 50 different subjects, were segmented by one operator.

Literature:

- H. Proenca, S. Filipe, R. Santos, J. Oliveira, and L.A. Alexandre. The UBIRIS.v2: A database of visible wavelength images captured on-the-move and at-a-distance. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 32(8):1529–1535, 2010

Segmentation Algorithms

CAHT

Christian Rathgeb, Andreas Uhl, and Peter Wild. *Iris Recognition: From Segmentation to Template Security*, volume 59 of *Advances in Information Security*. Springer Verlag, 2013

WAHET

Andreas Uhl and Peter Wild. Weighted adaptive hough and ellipsopolar transforms for real-time iris segmentation. In *Proceedings of the 5th IAPR/IEEE International Conference on Biometrics (ICB'12)*, pages 1–8, 2012

Osiris

[2] http://biometrics.idealtest.org
[3] http://paginas.fe.up.pt/ mobbio2013
[4] http://biometrics.idealtest.org
[5] http://www4.comp.polyu.edu.hk/ csajaykr/IITD/Database_Iris.htm
[6] http://www3.nd.edu/ cvrl/CVRL/Data_Sets.html
[7] http://iris.di.ubi.pt/ubiris2.html

Dijana Petrovska and Aurélien Mayoue. Description and documentation of the biosecure software library. Deliverable, Project No IST-2002-507634 - BioSecure, 2007

IFFP

Andreas Uhl and Peter Wild. Multi-stage visible wavelength and near infrared iris segmentation framework. In *Proceedings of the International Conference on Image Analysis and Recognition (ICIAR'12)*, LNCS, pages 1–10, 2012

GST

F. Alonso-Fernandez and J. Bigun. Iris boundaries segmentation using the generalized structure tensor. an study on the effects of image degradation. In *Proceedings of the IEEE Conference on Biometrics: Theory, Applications and Systems (BTAS)*, 2012

Part I

CC Dataset

Chapter 1

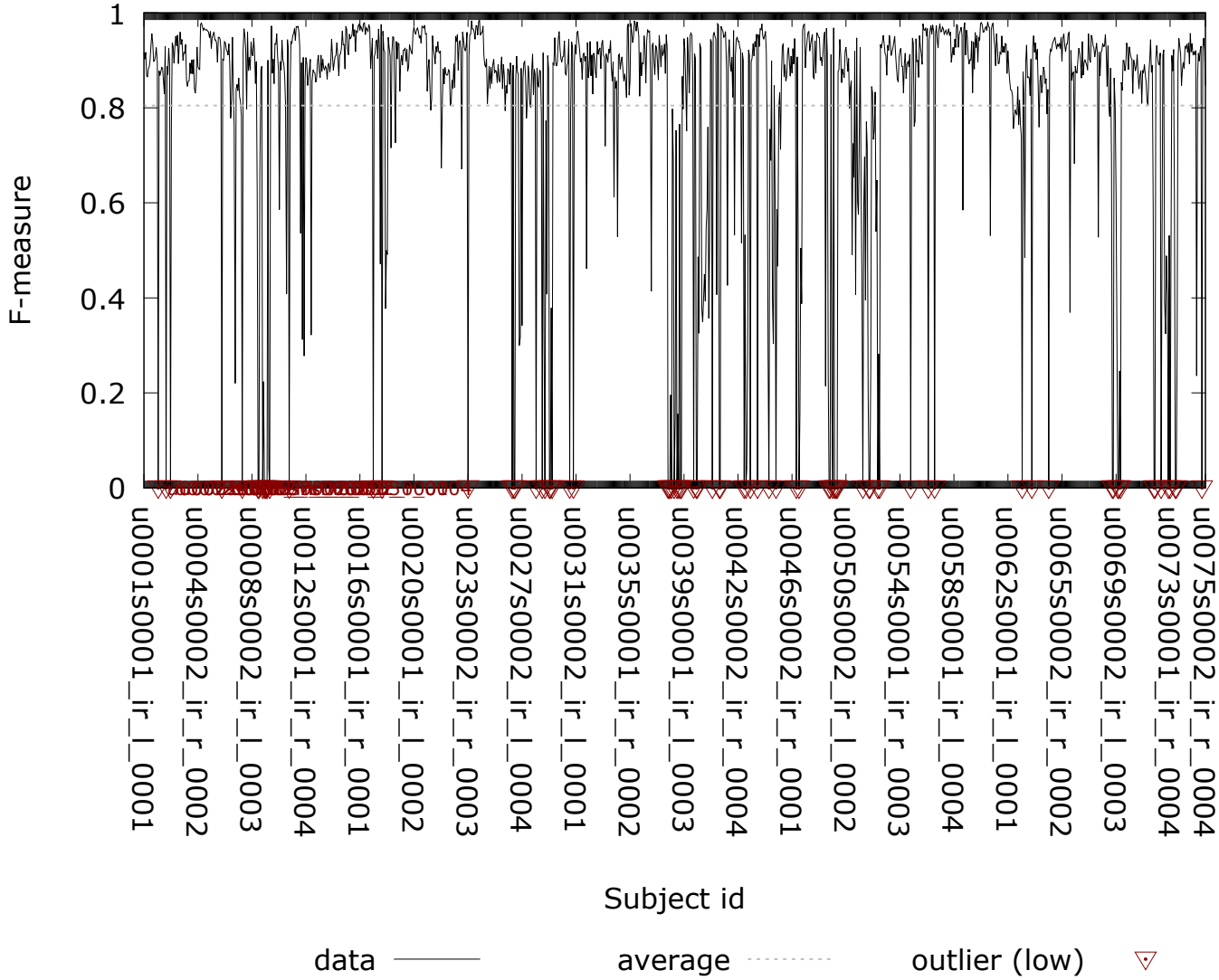
biosec – Operator C

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator C on *biosec*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	86.60%	25.45%	77.47%	27.18%	80.49%	26.15%
gst	92.62%	8.96%	90.03%	7.10%	91.01%	7.07%
iffp	91.26%	13.68%	80.68%	15.32%	85.17%	14.37%
osiris	89.30%	6.26%	94.62%	4.19%	91.73%	4.18%
wahet	94.28%	9.27%	84.47%	10.96%	88.79%	9.55%

1.1 caht

1.1.1 Per Iris Evaluation



Low point outlier

- u0002s0001_ir_l_0001
- u0002s0002_ir_l_0002
- u0002s0002_ir_r_0003
- u0006s0002_ir_l_0001
- u0007s0002_ir_r_0004
- u0009s0001_ir_l_0002
- u0009s0001_ir_l_0003
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- u0072s0001_ir_r_0003

- u0072s0002_ir_r_0002
- u0073s0001_ir_r_0002
- u0073s0001_ir_r_0004
- u0073s0002_ir_r_0002
- u0073s0002_ir_r_0003
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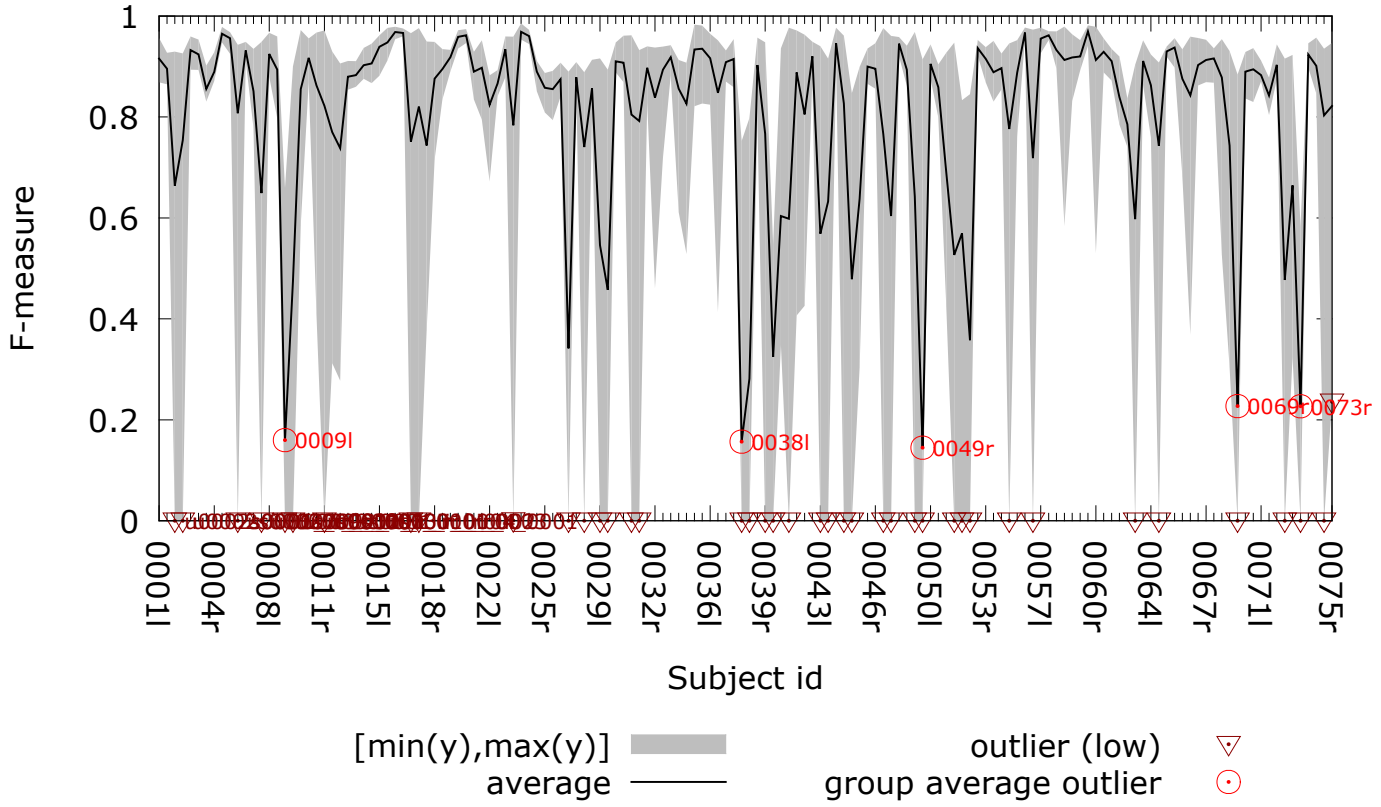
1.1.2 Grouped Evaluation – `u(\d{4})s\d{4}_ir_([lr])`



Group average outlier

- 0009l
- 0038l
- 0049r
- 0069r
- 0073r

Low outlier per group

- u0002s0001_ir_l_0001
- u0002s0002_ir_r_0003
- u0006s0002_ir_l_0001
- u0007s0002_ir_r_0004
- u0009s0001_ir_l_0002
- u0009s0001_ir_r_0003
- u0011s0001_ir_r_0001
- u0017s0001_ir_l_0004
- u0017s0002_ir_r_0002
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- u0038s0001_ir_r_0001
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- u0047s0001_ir_l_0002
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- u0049s0002_ir_l_0003
- u0049s0001_ir_r_0003
- u0051s0002_ir_r_0001
- u0052s0001_ir_l_0004
- u0052s0001_ir_r_0001
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- u0056s0001_ir_r_0003
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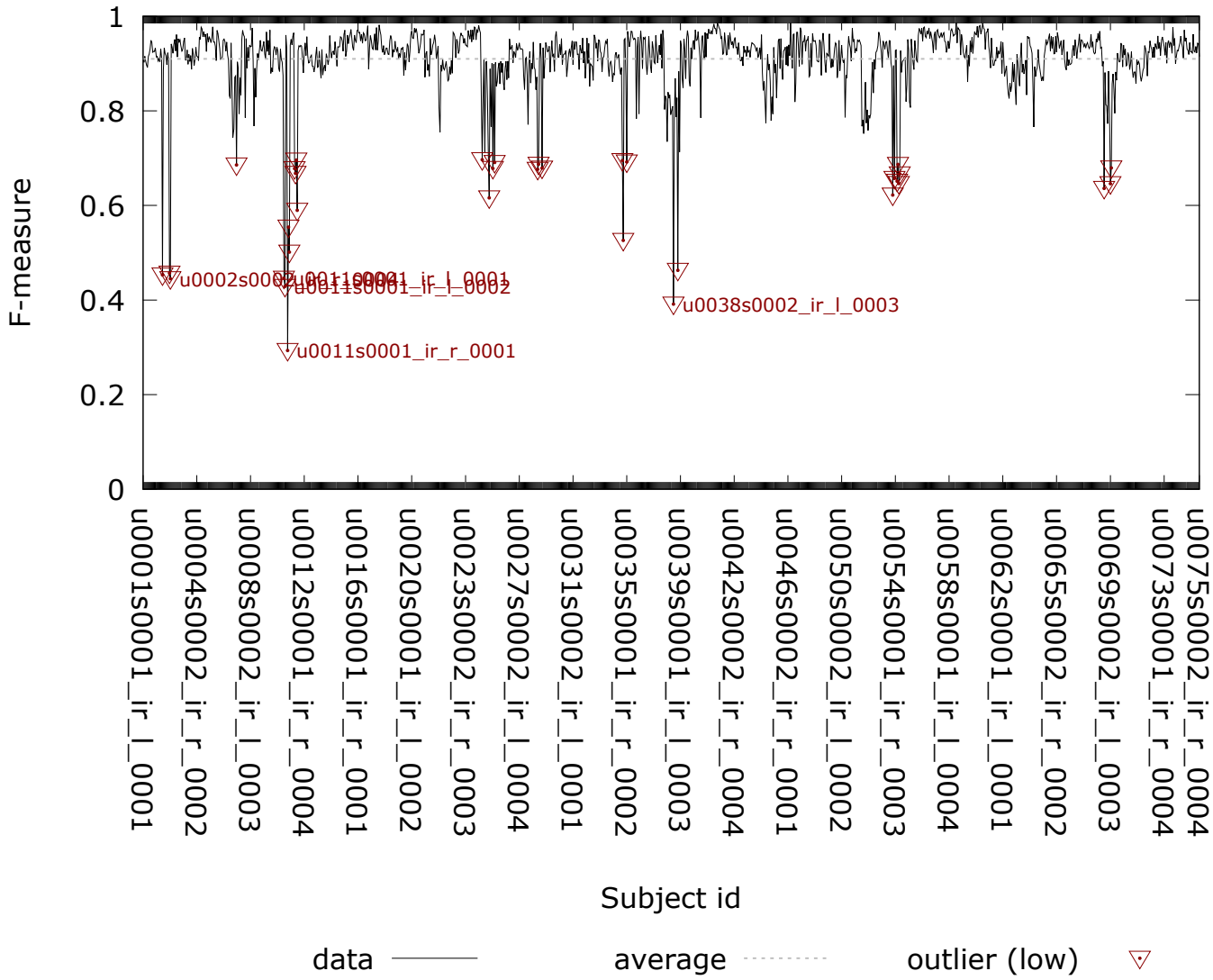
- u0064s0002_ir_r_0003
- u0069s0001_ir_r_0003
- u0072s0001_ir_r_0002
- u0073s0001_ir_r_0002
- u0075s0002_ir_l_0004
- u0075s0001_ir_r_0002

1.2 gst

1.2.1 Per Iris Evaluation



Low point outlier

- u0002s0001_ir_r_0003
- u0002s0002_ir_r_0003
- u0002s0002_ir_r_0004
- u0007s0002_ir_l_0003
- u0011s0001_ir_l_0001
- u0011s0001_ir_l_0002
- u0011s0001_ir_r_0001
- u0011s0001_ir_r_0002
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- u0054s0001_ir_r_0002
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- u0054s0002_ir_l_0003
- u0054s0002_ir_l_0004
- u0069s0001_ir_l_0004
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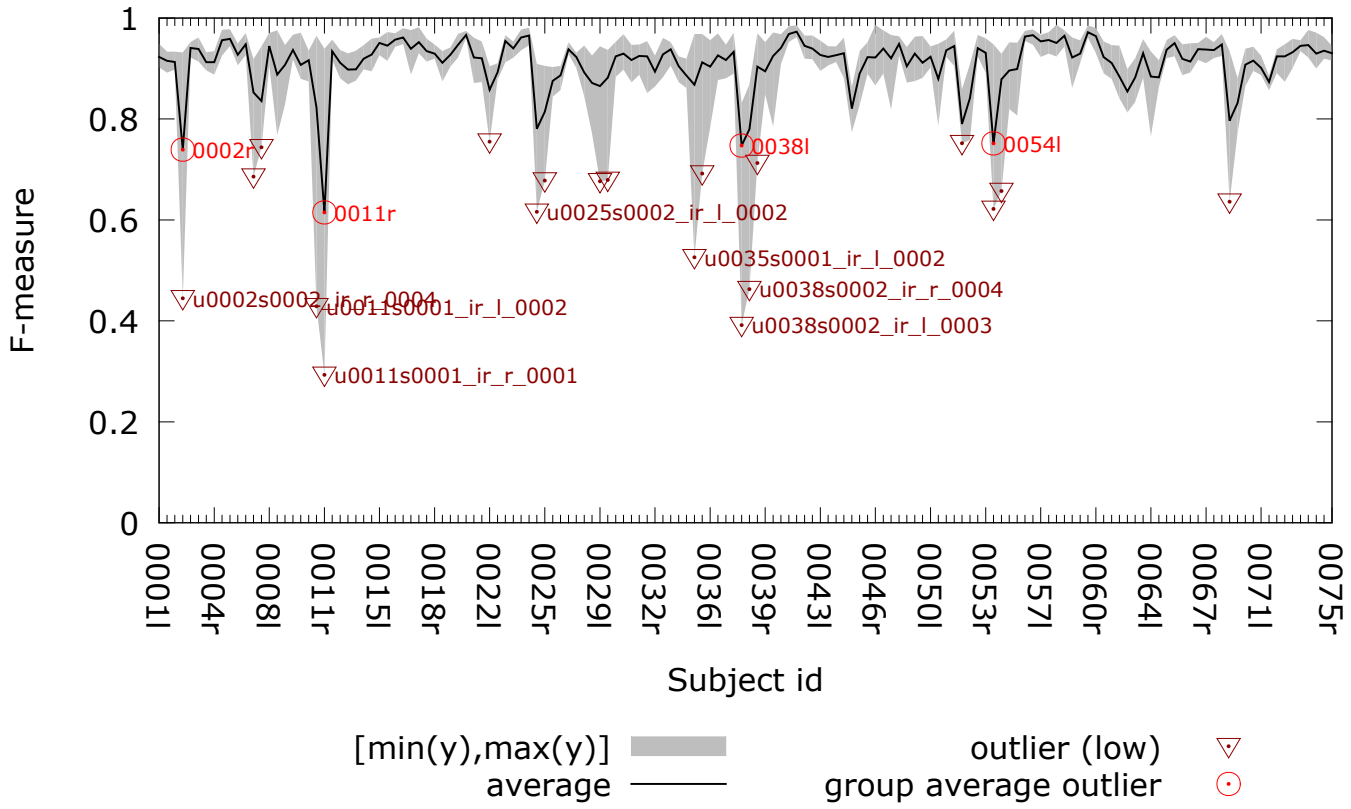
- u0069s0002_ir_l_0004

1.2.2 Grouped Evaluation – `u(\d{4})s\d{4}_ir_([lr])`



Group average outlier

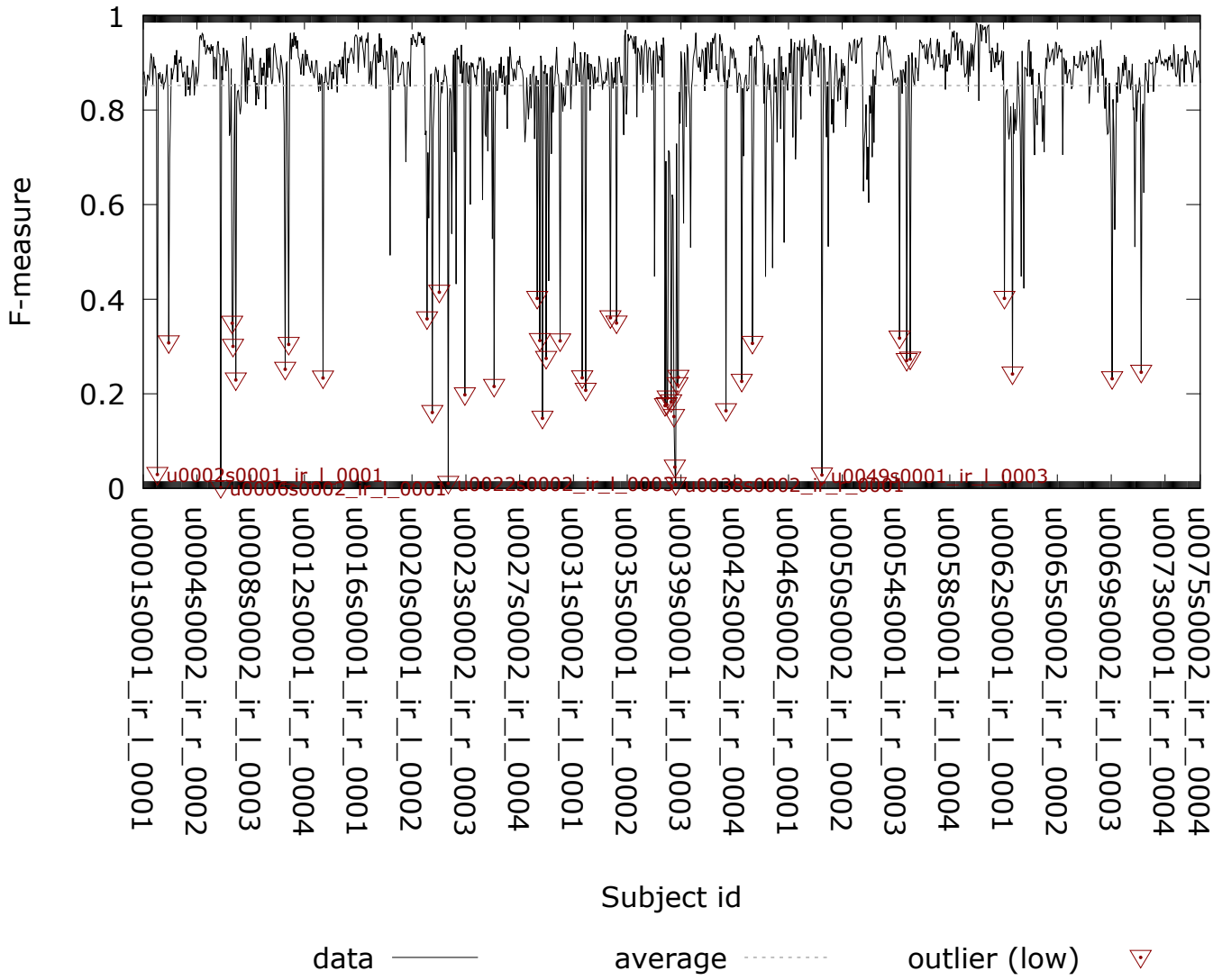
- 0002r
- 0011r
- 0038l
- 0054l

Low outlier per group

- u0002s0002_ir_r_0004
- u0007s0002_ir_l_0003
- u0007s0001_ir_r_0003
- u0011s0001_ir_l_0002
- u0011s0001_ir_r_0001
- u0022s0001_ir_l_0002
- u0025s0002_ir_l_0002
- u0025s0002_ir_r_0002
- u0029s0001_ir_l_0001
- u0029s0001_ir_r_0002
- u0035s0001_ir_l_0002
- u0035s0001_ir_r_0002
- u0038s0002_ir_l_0003
- u0038s0002_ir_r_0004
- u0039s0001_ir_l_0002
- u0052s0001_ir_l_0003
- u0054s0001_ir_l_0004
- u0054s0001_ir_r_0002
- u0069s0001_ir_l_0004

1.3 iffp

1.3.1 Per Iris Evaluation



Low point outlier

- u0002s0001_ir_l_0001
- u0002s0002_ir_r_0002
- u0006s0002_ir_l_0001
- u0007s0001_ir_r_0002
- u0007s0001_ir_r_0003
- u0007s0002_ir_l_0002
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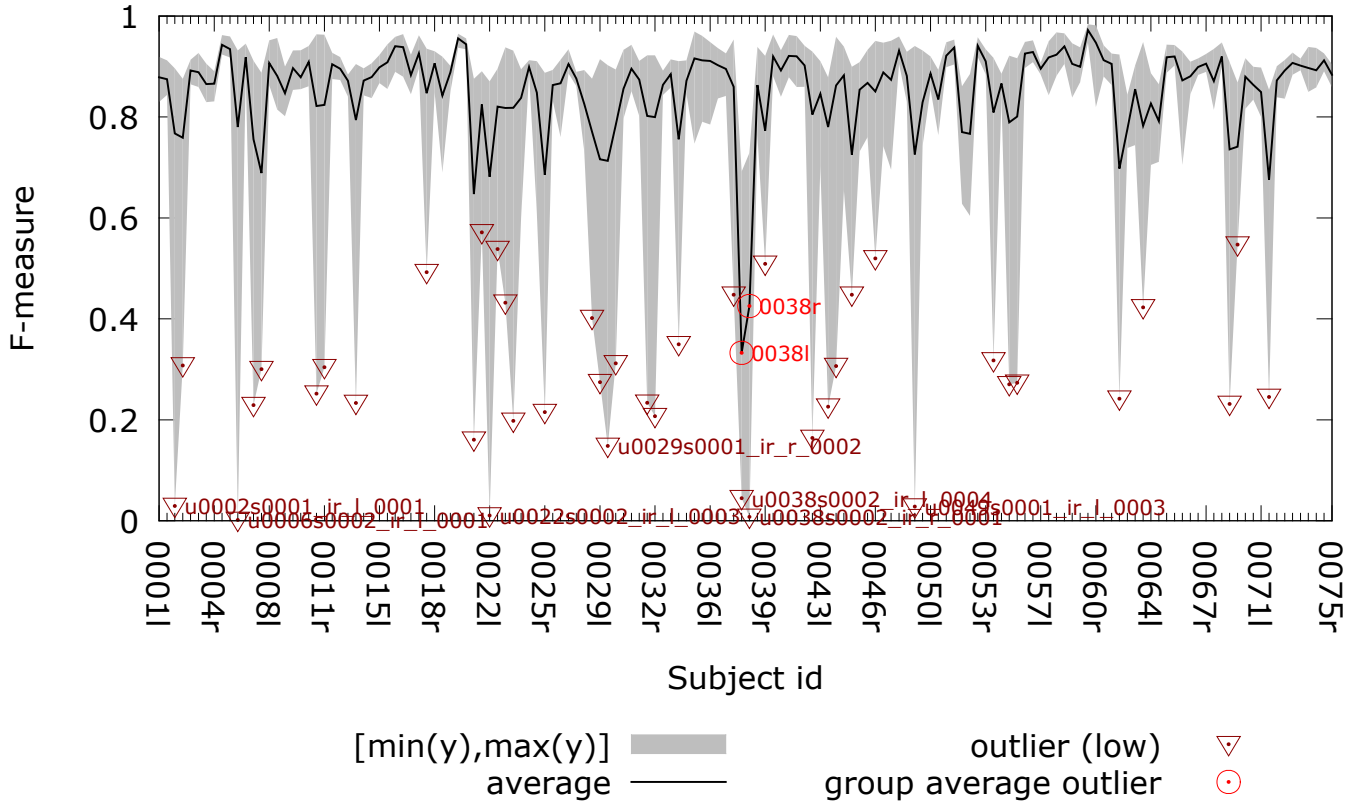
- u0055s0001_ir_r_0003
- u0062s0001_ir_l_0002
- u0062s0002_ir_l_0003
- u0069s0002_ir_l_0004
- u0071s0002_ir_r_0001

1.3.2 Grouped Evaluation – `u(\d{4})s\d{4}_ir_([lr])`



Group average outlier

- 0038l
- 0038r

Low outlier per group

- u0002s0001_ir_l_0001
- u0002s0002_ir_r_0002
- u0006s0002_ir_l_0001
- u0007s0002_ir_l_0002
- u0007s0001_ir_r_0003
- u0011s0001_ir_l_0002
- u0011s0001_ir_r_0002
- u0013s0002_ir_r_0001
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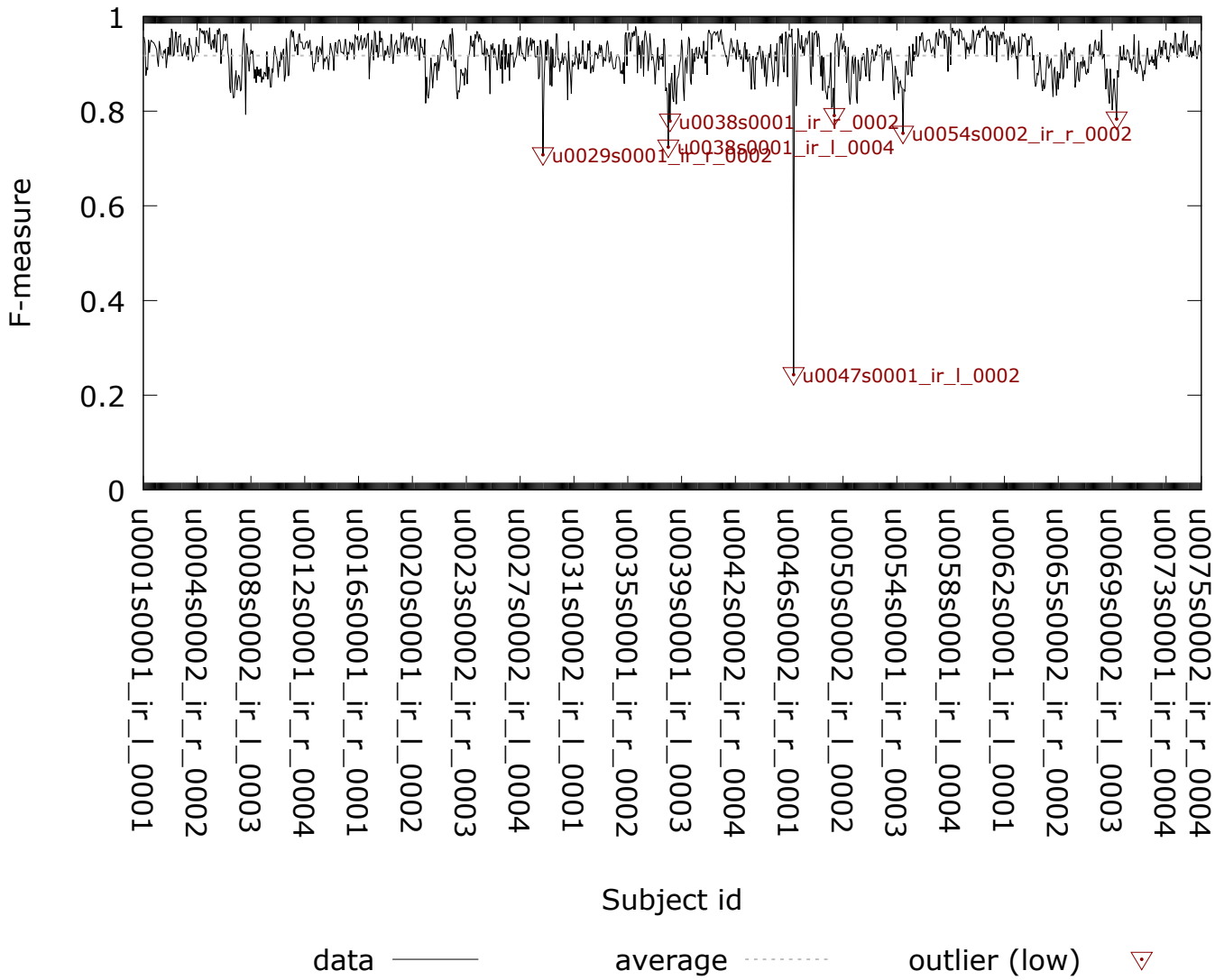
1.4 osiris

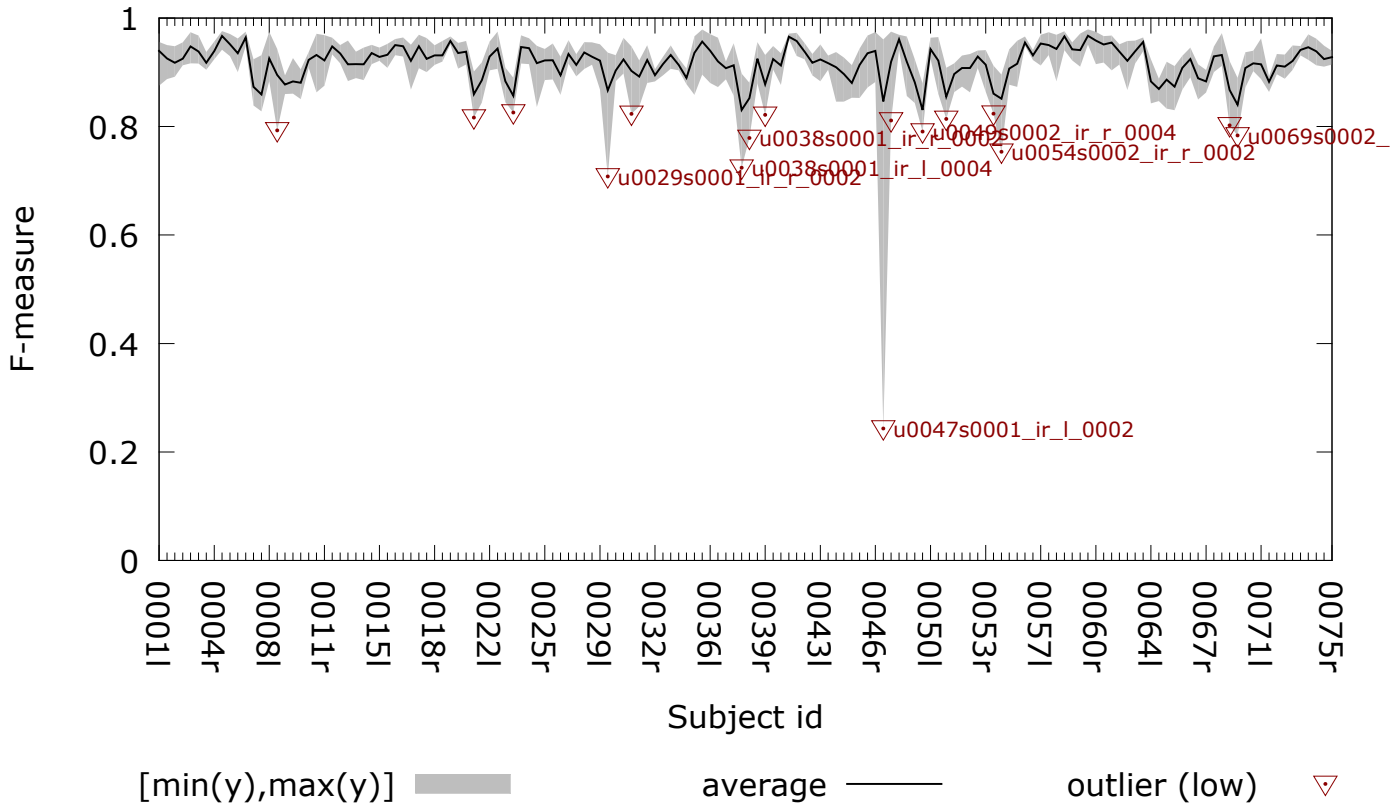
1.4.1 Per Iris Evaluation



Low point outlier

- u0029s0001_ir_r_0002
- u0038s0001_ir_l_0004
- u0038s0001_ir_r_0002
- u0047s0001_ir_l_0002
- u0049s0002_ir_r_0004
- u0054s0002_ir_r_0002
- u0069s0002_ir_r_0004

1.4.2 Grouped Evaluation – `u(\d{4})s\d{4}_ir_([lr])`



Low outlier per group

- u0008s0001_ir_r_0001
- u0021s0001_ir_l_0001
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- u0031s0001_ir_l_0002
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- u0054s0002_ir_r_0002
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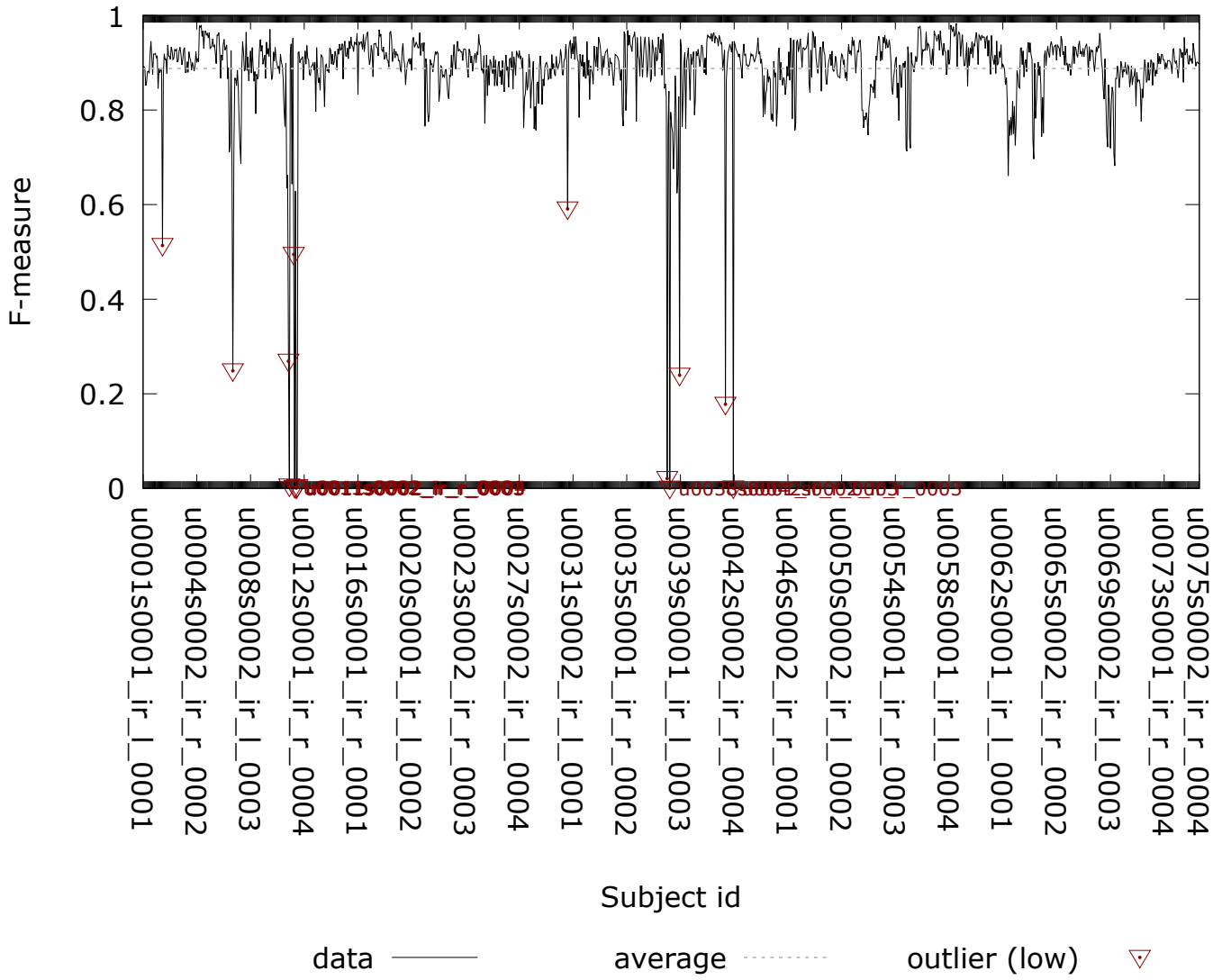
- u0069s0002_ir_r_0004

1.5 wahet

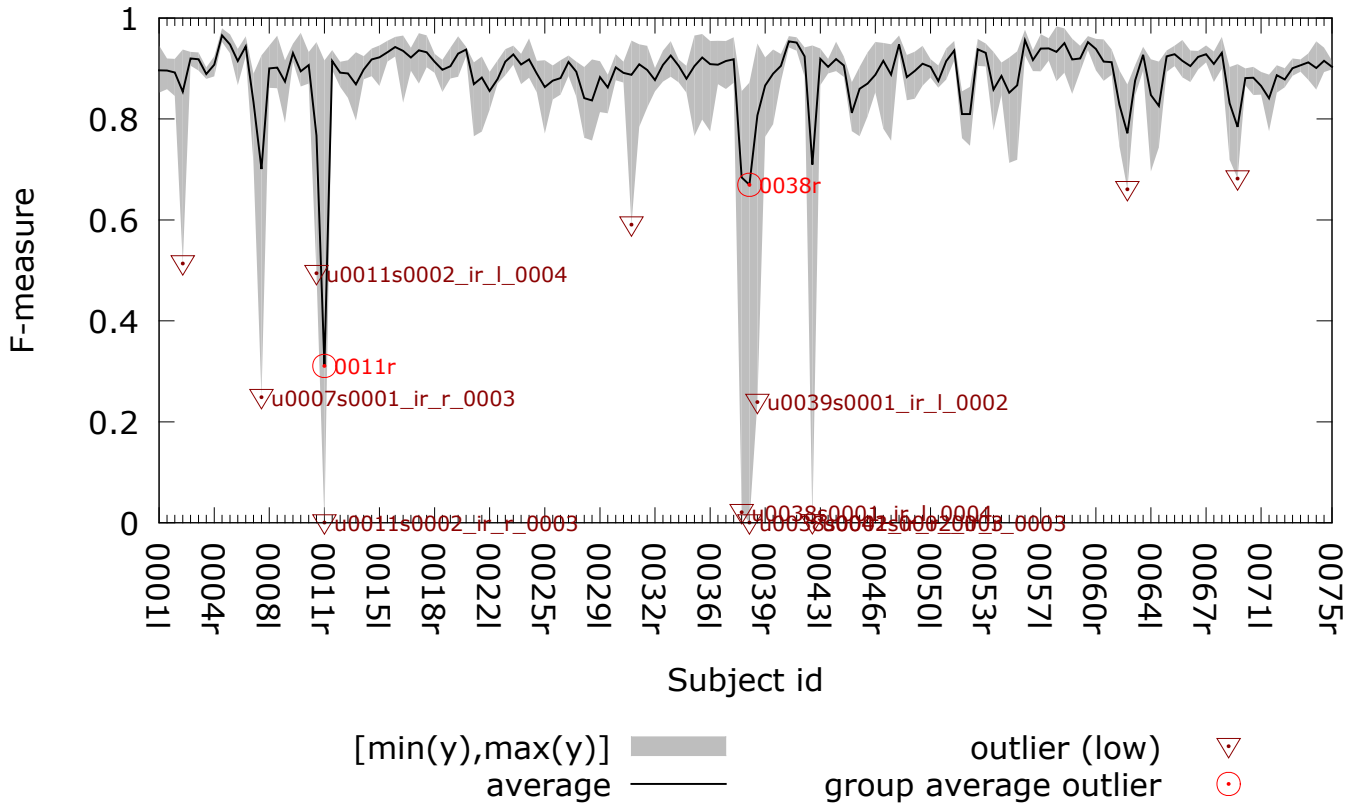
1.5.1 Per Iris Evaluation



Low point outlier

- u0002s0001_ir_r_0003
- u0007s0001_ir_r_0003
- u0011s0001_ir_r_0002
- u0011s0001_ir_r_0003
- u0011s0002_ir_l_0004
- u0011s0002_ir_r_0001
- u0011s0002_ir_r_0003
- u0011s0002_ir_r_0004
- u0031s0001_ir_l_0003
- u0038s0001_ir_l_0004
- u0038s0001_ir_r_0003
- u0039s0001_ir_l_0002
- u0042s0001_ir_r_0002
- u0042s0002_ir_r_0003

1.5.2 Grouped Evaluation – `u(\d{4})s\d{4}_ir_([lr])`



Group average outlier

- 0011r
- 0038r

Low outlier per group

- u0002s0001_ir_r_0003
- u0007s0001_ir_r_0003
- u0011s0002_ir_l_0004
- u0011s0002_ir_r_0003
- u0031s0001_ir_l_0003
- u0038s0001_ir_l_0004
- u0038s0001_ir_r_0003
- u0039s0001_ir_l_0002
- u0042s0002_ir_r_0003
- u0062s0001_ir_r_0003
- u0069s0002_ir_r_0004

Chapter 2

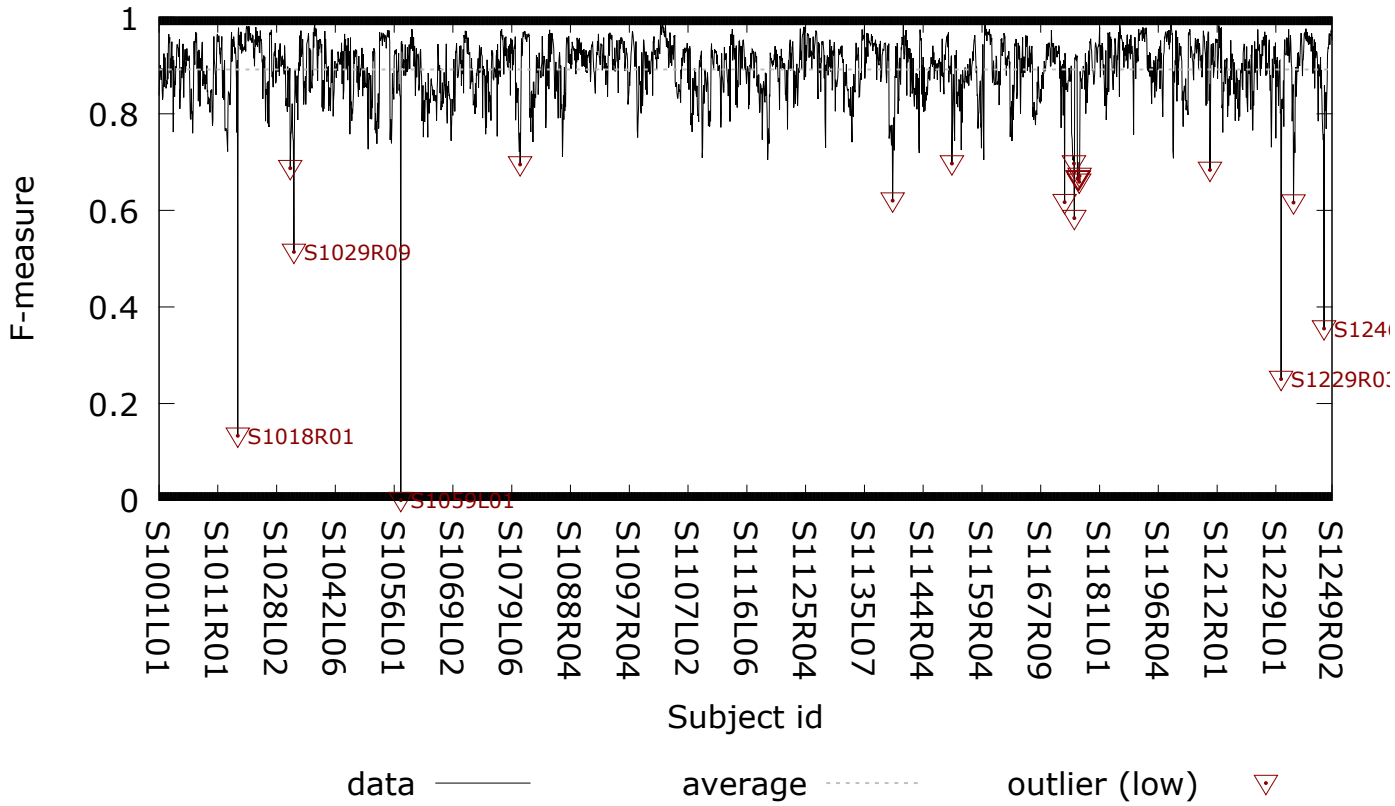
casia3i – Operator C

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator C on *casia3i*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	97.05%	4.41%	83.07%	9.47%	89.16%	6.48%
gst	84.81%	18.48%	91.13%	7.30%	86.44%	12.06%
iffp	91.30%	14.49%	83.90%	13.69%	86.89%	13.00%
osiris	86.16%	8.27%	92.61%	5.00%	89.02%	5.70%
wahet	94.09%	8.84%	85.66%	9.21%	89.03%	8.20%

2.1 caht

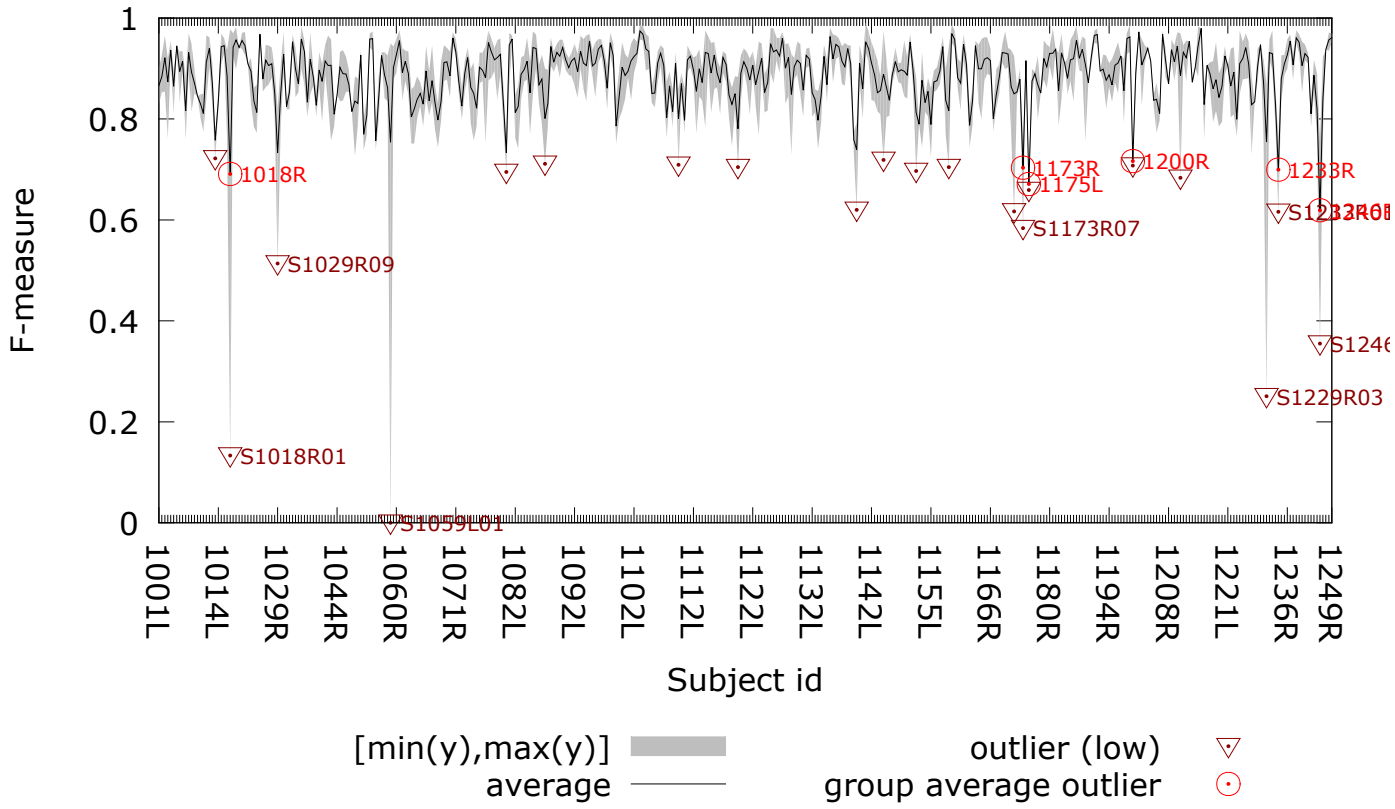
2.1.1 Per Iris Evaluation



Low point outlier

- S1018R01
- S1029R01
- S1029R09
- S1059L01
- S1080R04
- S1139R03
- S1150L01
- S1170R05
- S1173R06
- S1173R07
- S1175L01
- S1175L03
- S1175L04
- S1175L05
- S1175L06
- S1211L10
- S1229R03
- S1233R01
- S1246R03

2.1.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

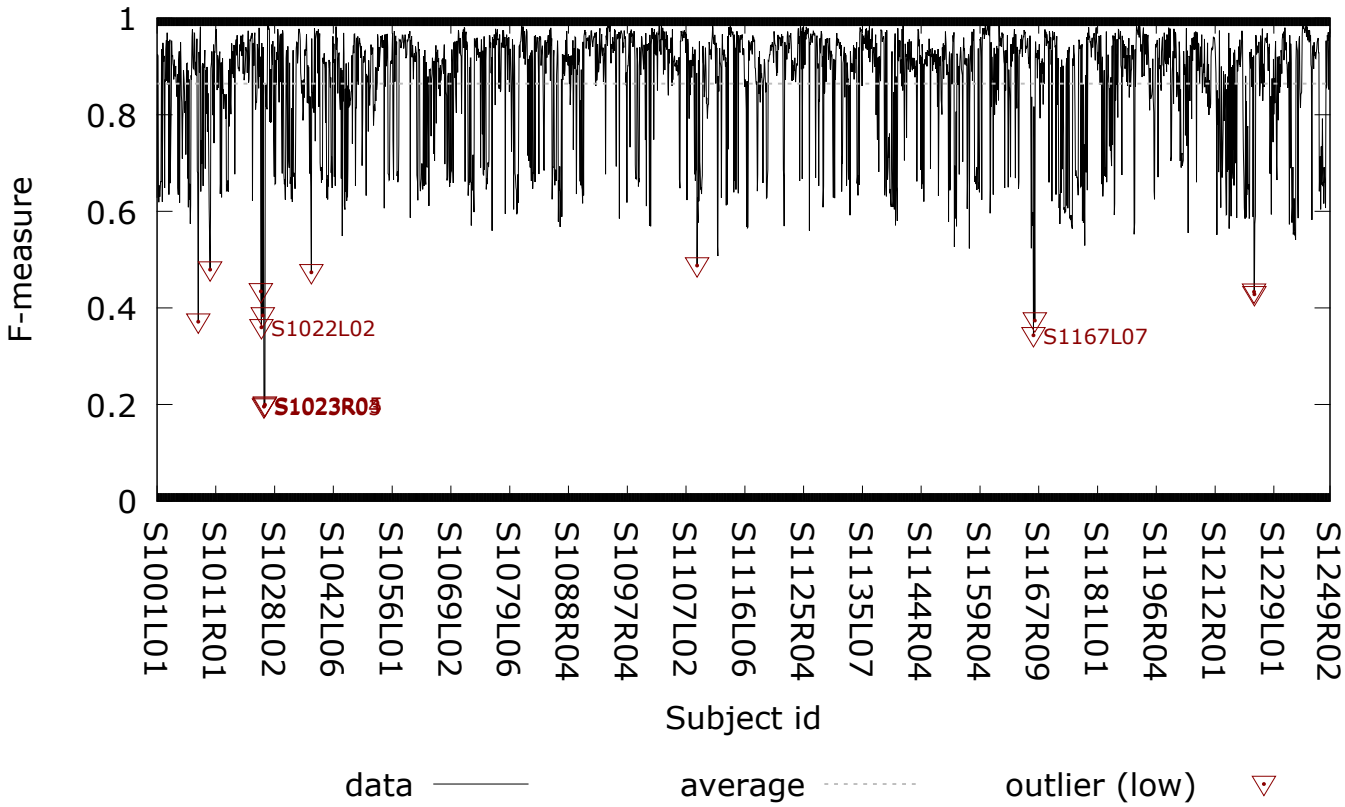
- 1018R
- 1173R
- 1175L
- 1200R
- 1233R
- 1246R

Low outlier per group

- S1013L07
- S1018R01
- S1029R09
- S1059L01
- S1080R04
- S1087L06
- S1109R02
- S1119R04
- S1139R03
- S1144L02
- S1150L01
- S1159R08
- S1170R05
- S1173R07
- S1175L05
- S1200R02
- S1211L10
- S1229R03
- S1233R01
- S1246R03

2.2 gst

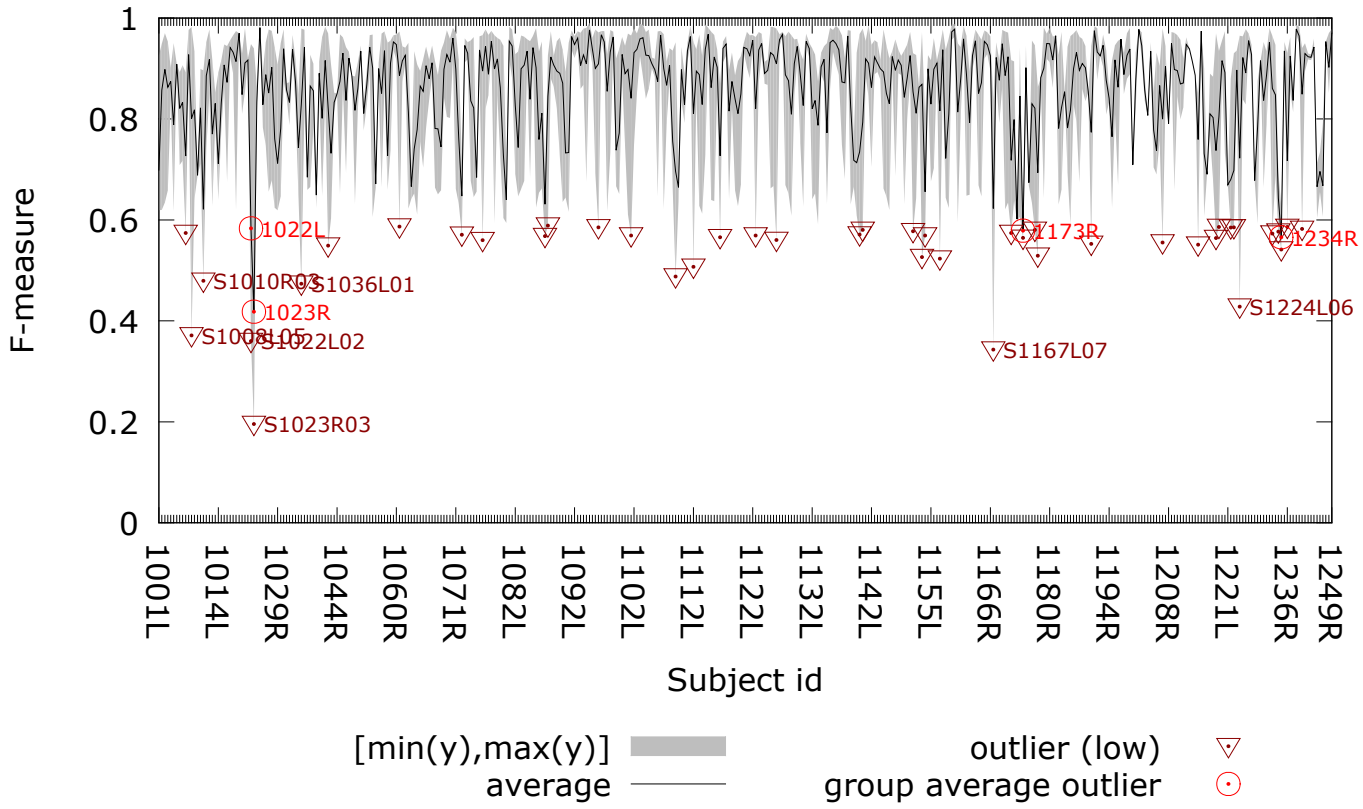
2.2.1 Per Iris Evaluation



Low point outlier

- S1008L05
- S1010R03
- S1022L01
- S1022L02
- S1022L05
- S1023R03
- S1023R04
- S1023R05
- S1036L01
- S1109L01
- S1167L07
- S1167L10
- S1224L05
- S1224L06

2.2.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

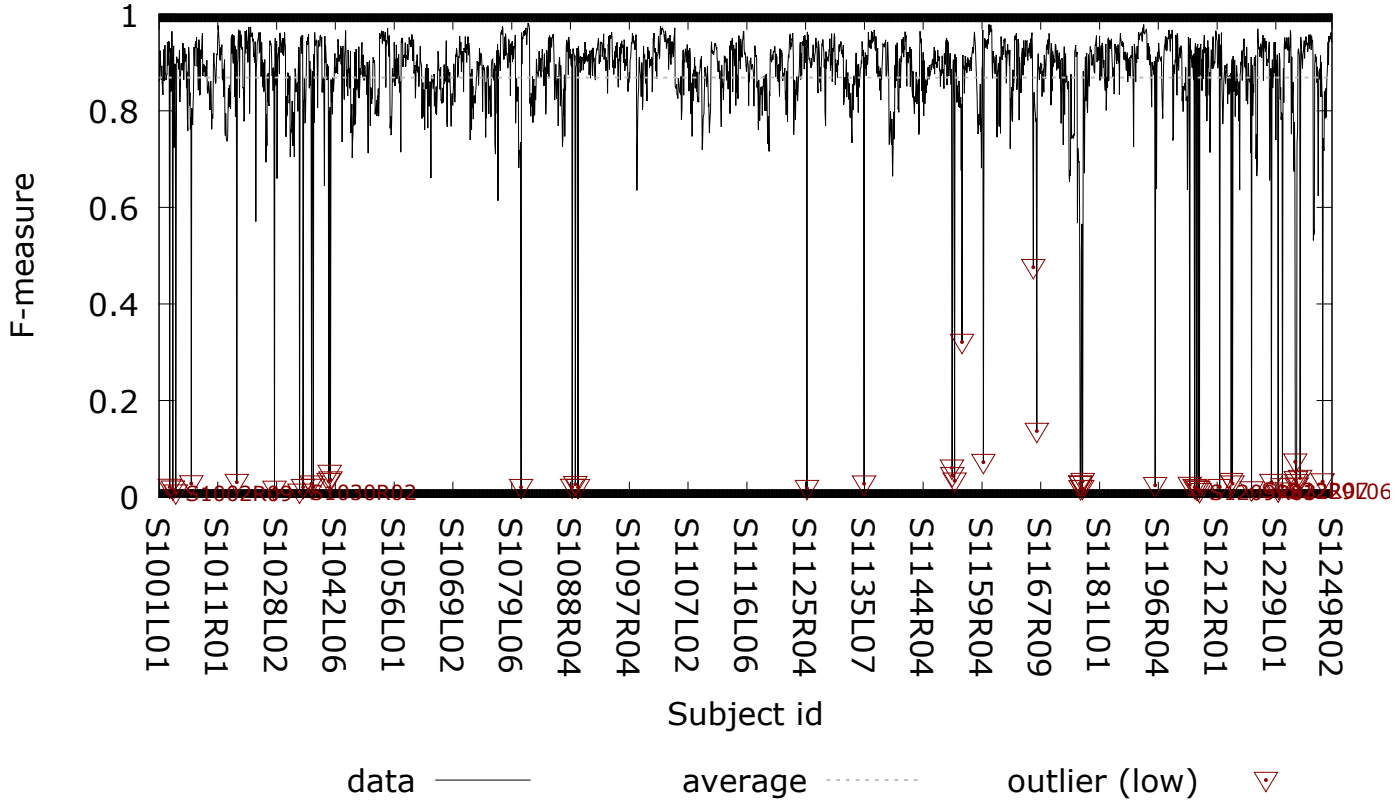
- 1022L
- 1023R
- 1173R
- 1234R

Low outlier per group

- S1007L07
- S1008L05
- S1010R03
- S1022L02
- S1023R03
- S1036L01
- S1043L06
- S1061R02
- S1072R01
- S1076L01
- S1087L05
- S1087R02
- S1096L07
- S1101R05
- S1109L01
- S1112L07
- S1116R05
- S1122R05
- S1126L07
- S1140L07
- S1140R04
- S1149R05
- S1152L05
- S1153L05
- S1157R06
- S1167L07
- S1170L07
- S1173R07
- S1177R03
- S1178L05
- S1190L01
- S1207R05
- S1214L02
- S1218R08
- S1219L10
- S1221R03
- S1222R06
- S1224L06
- S1231L07
- S1233R02
- S1234R06
- S1236R02
- S1240L03

2.3 iffp

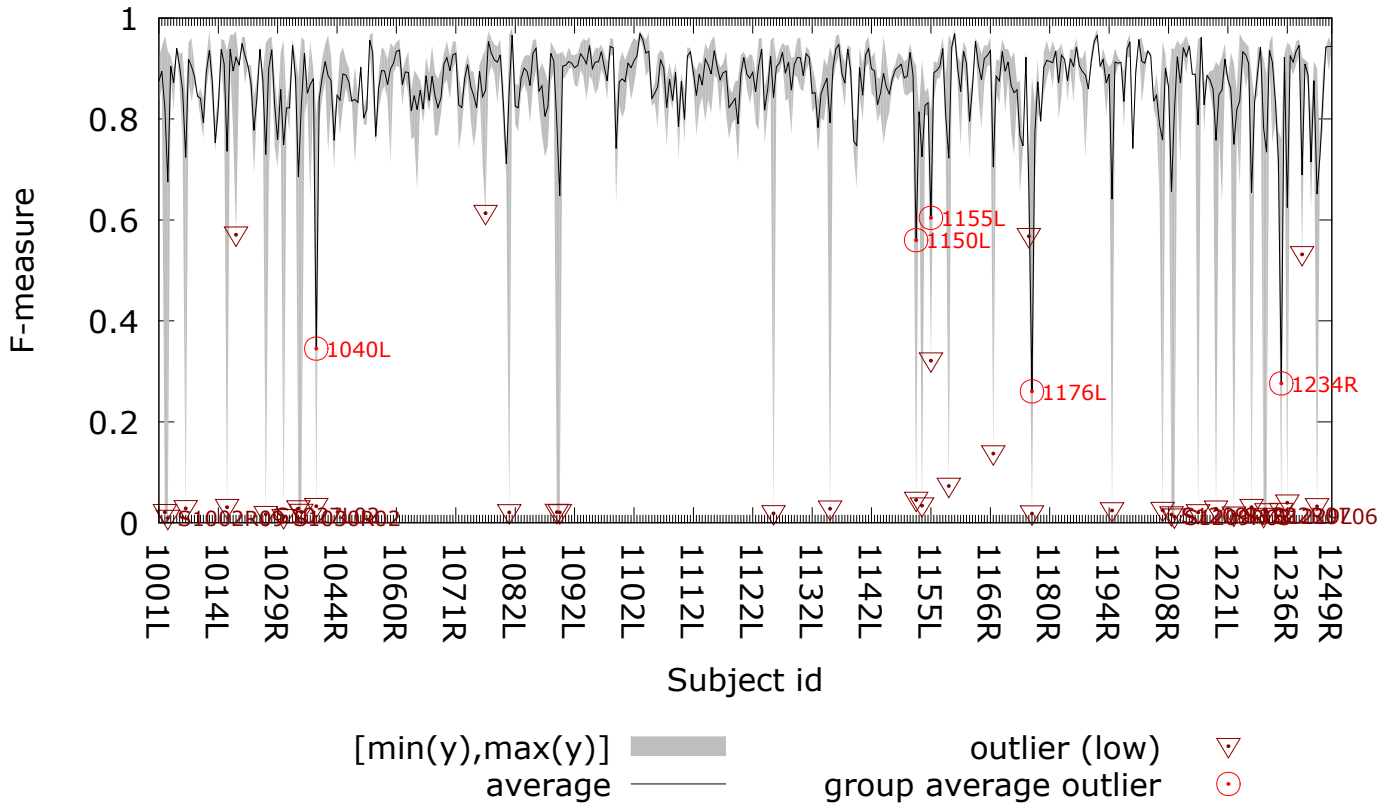
2.3.1 Per Iris Evaluation



Low point outlier

- S1002L05
- S1002R02
- S1002R09
- S1007L05
- S1017R05
- S1027L02
- S1030R02
- S1030R10
- S1035L02
- S1036L01
- S1040L01
- S1040L03
- S1040L05
- S1081L01
- S1089L01
- S1089R01
- S1089R07
- S1125R07
- S1135L06
- S1150L01
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L02
- S1167L10
- S1176L01
- S1176L02
- S1176L03
- S1176L06
- S1176L07
- S1195R02
- S1207R04
- S1209L02
- S1209L06
- S1209L10
- S1209R03
- S1214L04
- S1218R08
- S1218R11
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R01
- S1234R02
- S1234R03
- S1234R04
- S1236R02
- S1245R04

2.3.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

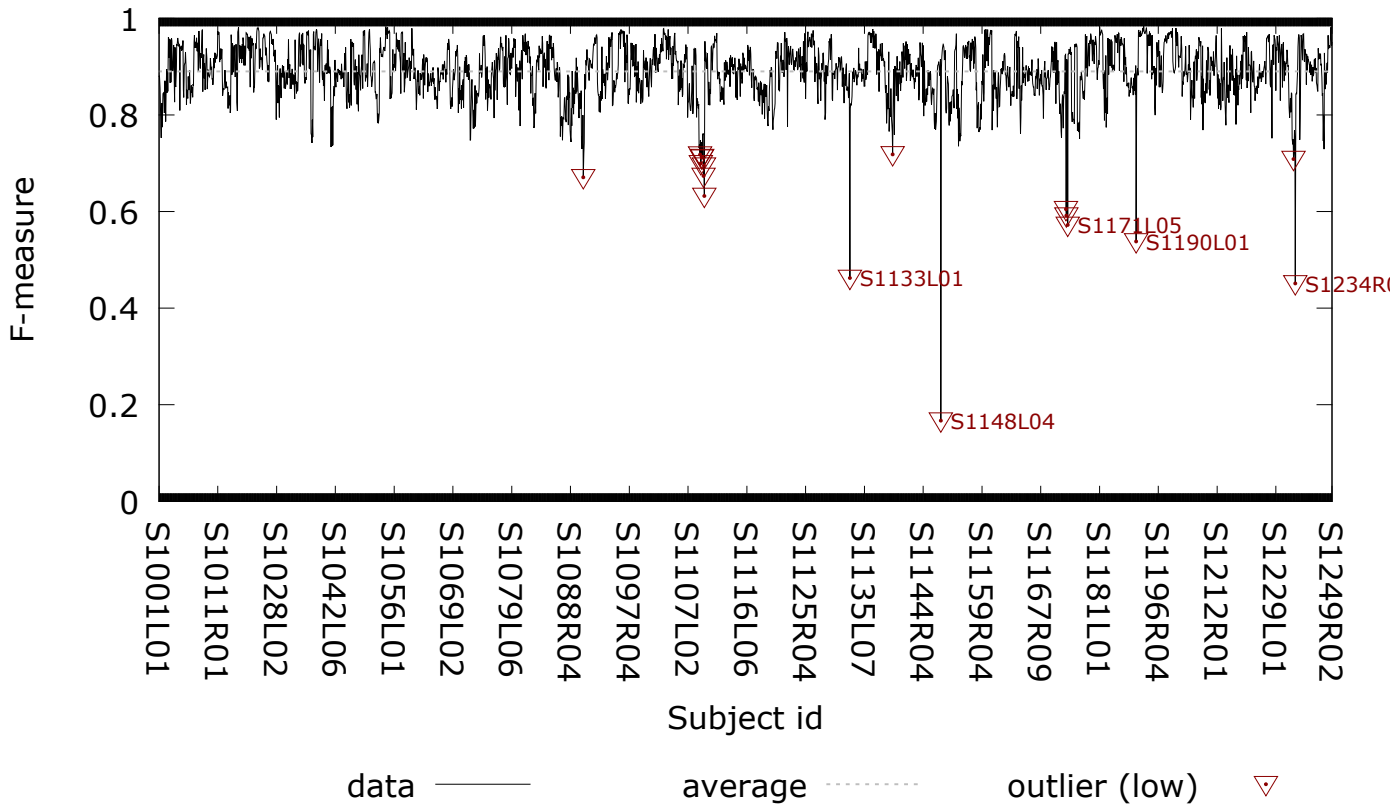
- 1040L
- 1150L
- 1155L
- 1176L
- 1234R

Low outlier per group

- S1002L05
- S1002R09
- S1007L05
- S1017R05
- S1019R25
- S1027L02
- S1030R02
- S1035L02
- S1036L01
- S1040L01
- S1076R03
- S1081L01
- S1089L01
- S1089R07
- S1125R07
- S1135L06
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L10
- S1175L01
- S1176L02
- S1195R02
- S1207R04
- S1209L10
- S1209R03
- S1214L04
- S1218R11
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R04
- S1236R02
- S1240L02
- S1245R04

2.4 osiris

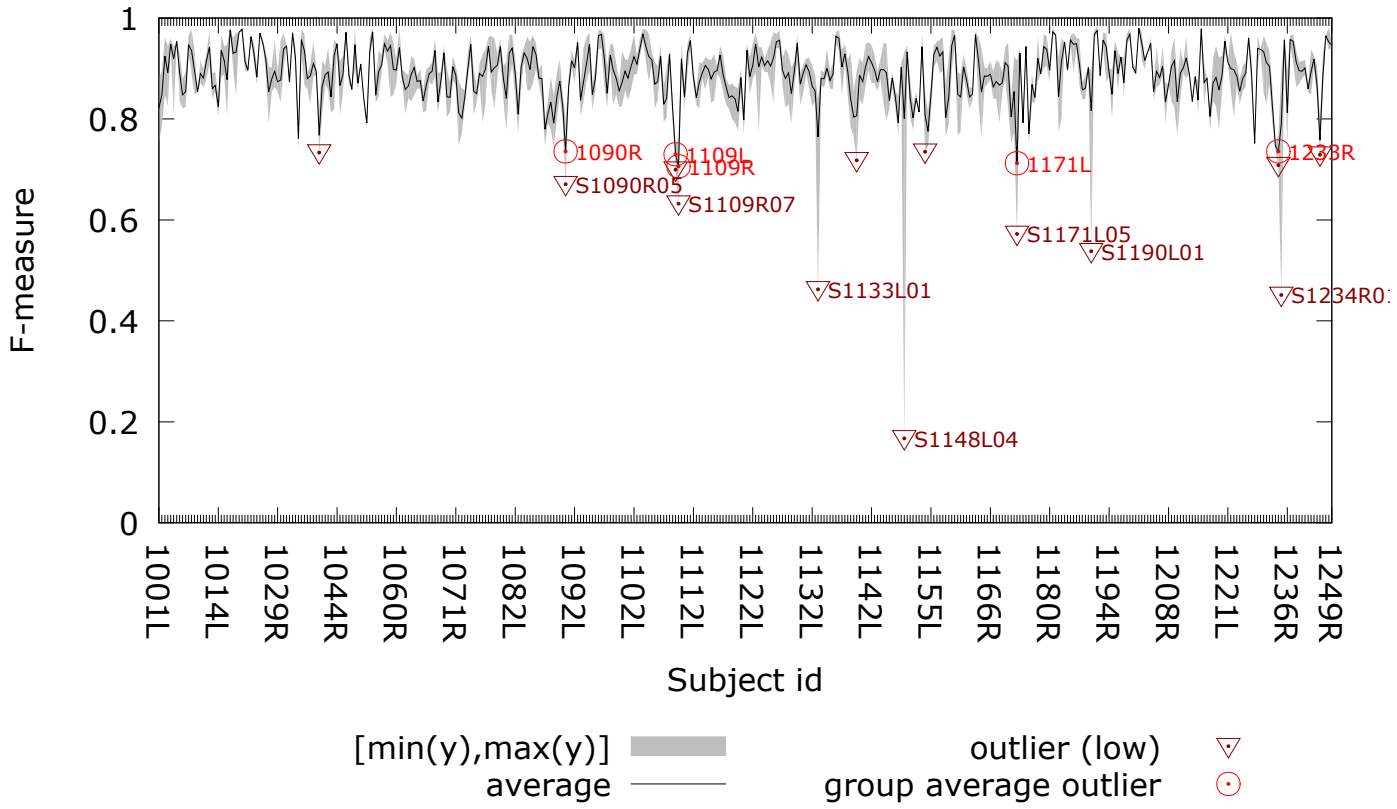
2.4.1 Per Iris Evaluation



Low point outlier

- S1090R05
- S1109L03
- S1109L05
- S1109R01
- S1109R02
- S1109R05
- S1109R06
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1171L01
- S1171L02
- S1171L05
- S1190L01
- S1233R01
- S1234R01

2.4.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

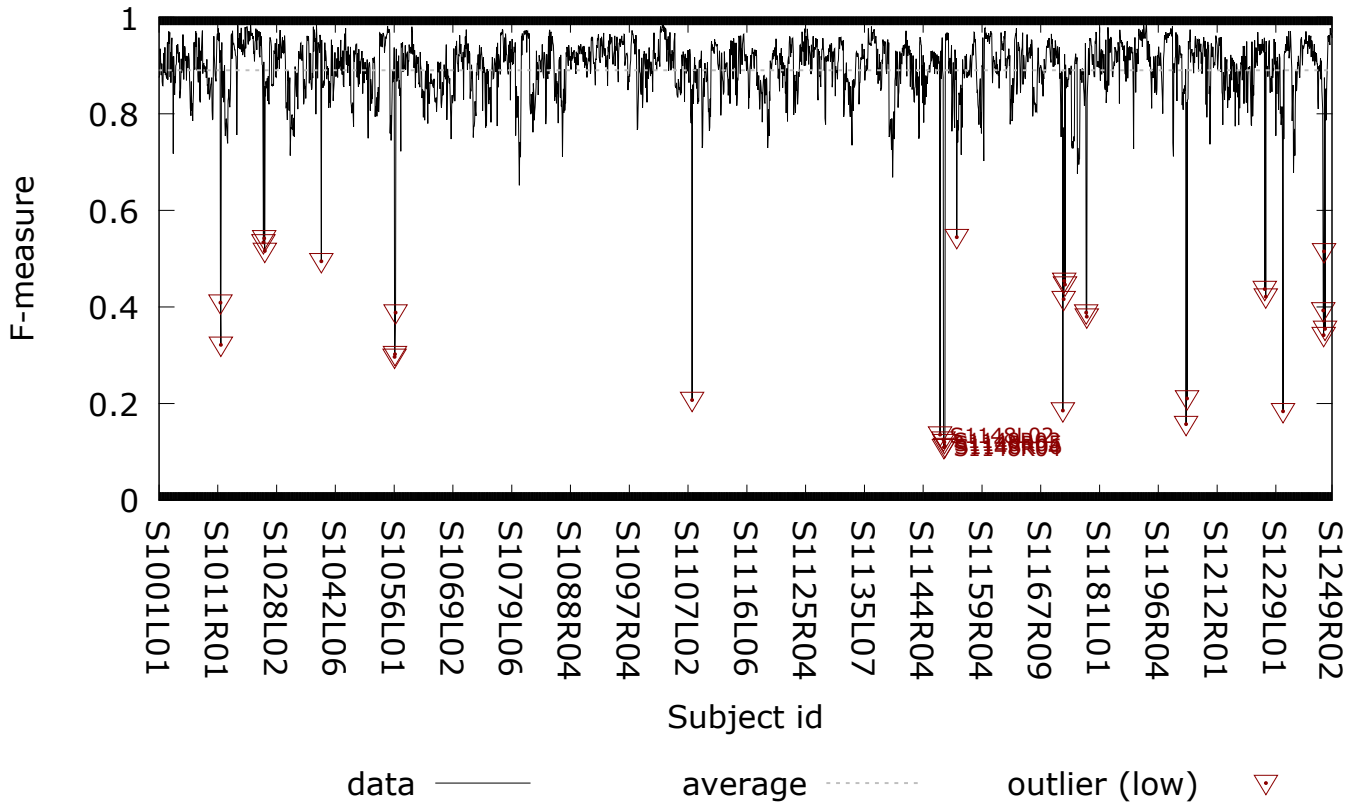
- 1090R
- 1109L
- 1109R
- 1171L
- 1233R

Low outlier per group

- S1041L01
- S1090R05
- S1109L05
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1153L05
- S1171L05
- S1190L01
- S1233R01
- S1234R01
- S1246R03

2.5 wahet

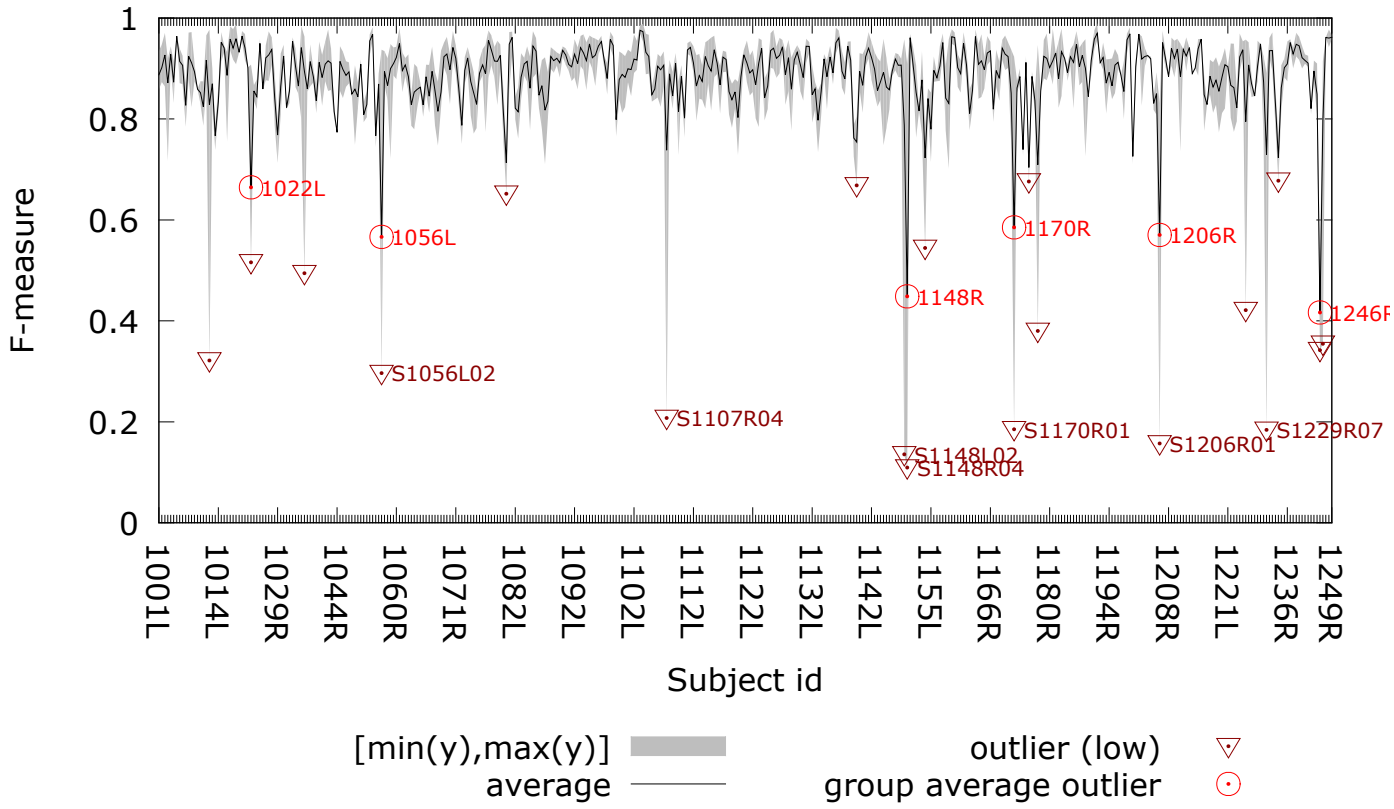
2.5.1 Per Iris Evaluation



Low point outlier

- S1011R07
- S1011R08
- S1022L02
- S1022L04
- S1022L05
- S1036R09
- S1056L02
- S1056L03
- S1056L04
- S1107R04
- S1148L02
- S1148R03
- S1148R04
- S1148R05
- S1148R06
- S1153L01
- S1170R01
- S1170R03
- S1170R04
- S1170R06
- S1178L04
- S1178L05
- S1206R01
- S1206R03
- S1225L04
- S1225L06
- S1229R07
- S1246R01
- S1246R02
- S1246R03
- S1247R02

2.5.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

- 1022L
- 1056L
- 1148R
- 1170R
- 1206R
- 1246R

Low outlier per group

- S1011R08
- S1022L05
- S1036R09
- S1056L02
- S1080R02
- S1107R04
- S1139R03
- S1148L02
- S1148R04
- S1153L01
- S1170R01
- S1175L01
- S1178L05
- S1206R01
- S1225L06
- S1229R07
- S1233R01
- S1246R02
- S1247R02

Chapter 3

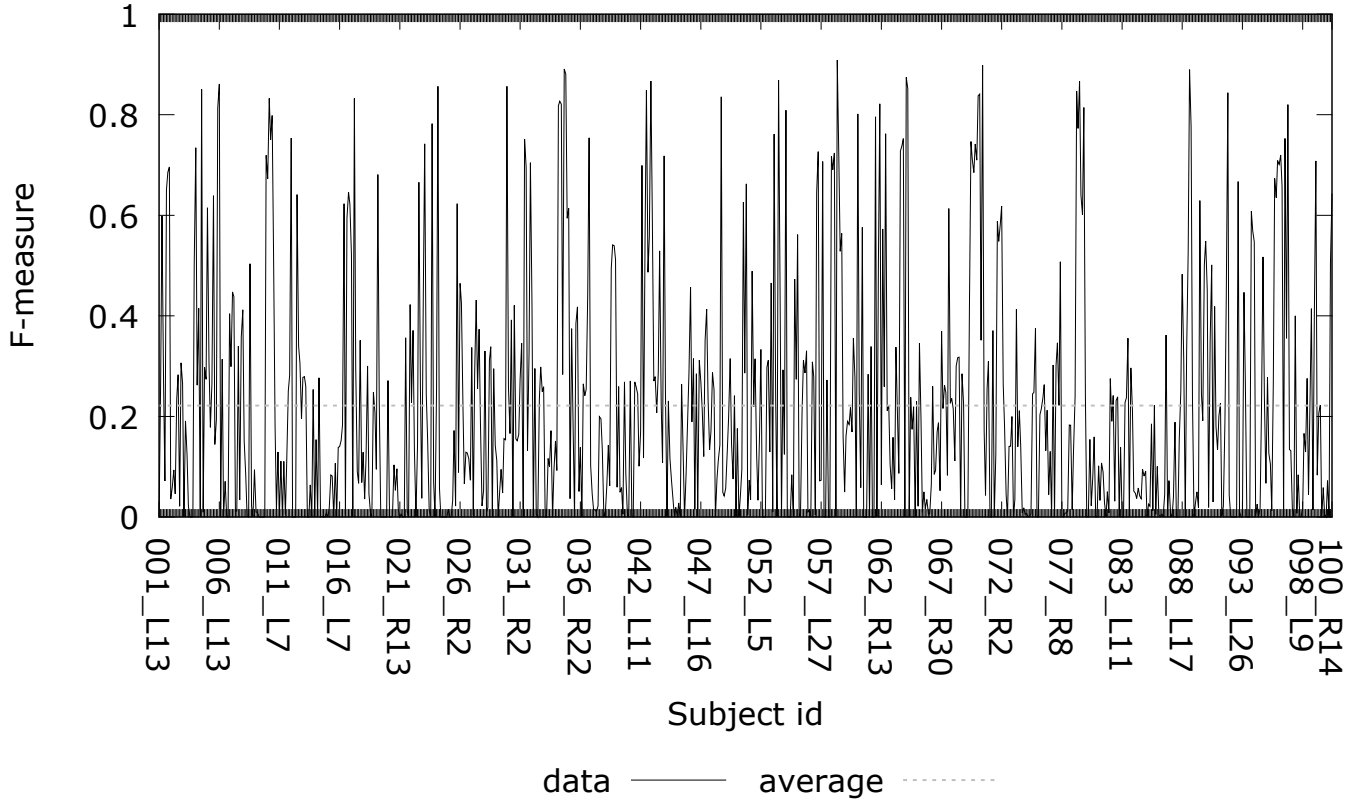
mobbio – Operator C

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator C on *mobbio*.

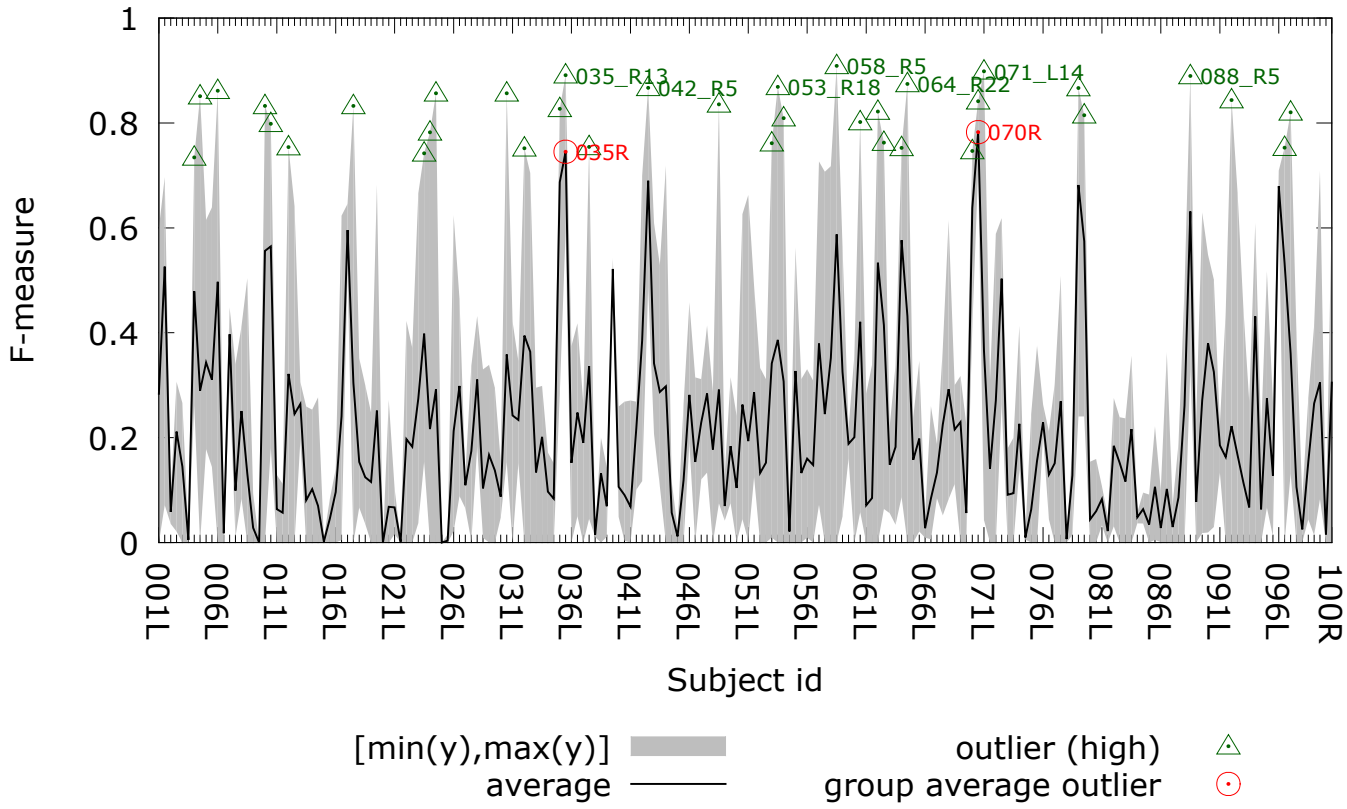
algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	28.37%	26.84%	20.96%	25.14%	22.15%	24.39%
gst	42.21%	35.31%	45.79%	31.49%	42.09%	31.57%
iffp	50.58%	39.31%	32.50%	32.28%	37.76%	35.10%
osiris	20.08%	22.34%	5.67%	10.52%	8.26%	12.85%
wahet	44.27%	37.99%	38.52%	34.46%	39.94%	35.60%

3.1 caht

3.1.1 Per Iris Evaluation



3.1.2 Grouped Evaluation – `(\d{3})_([LR])`



Group average outlier

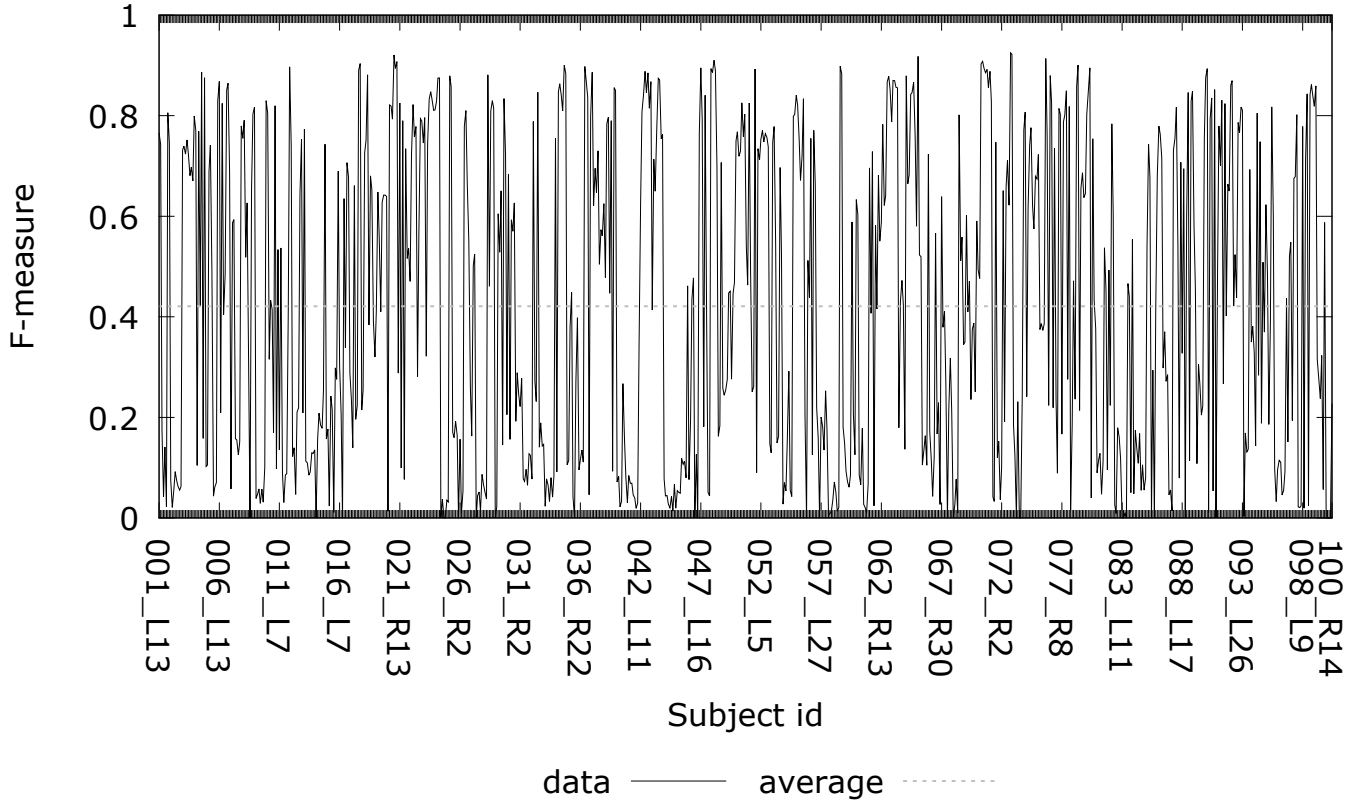
- 035R
- 070R

High outlier per group

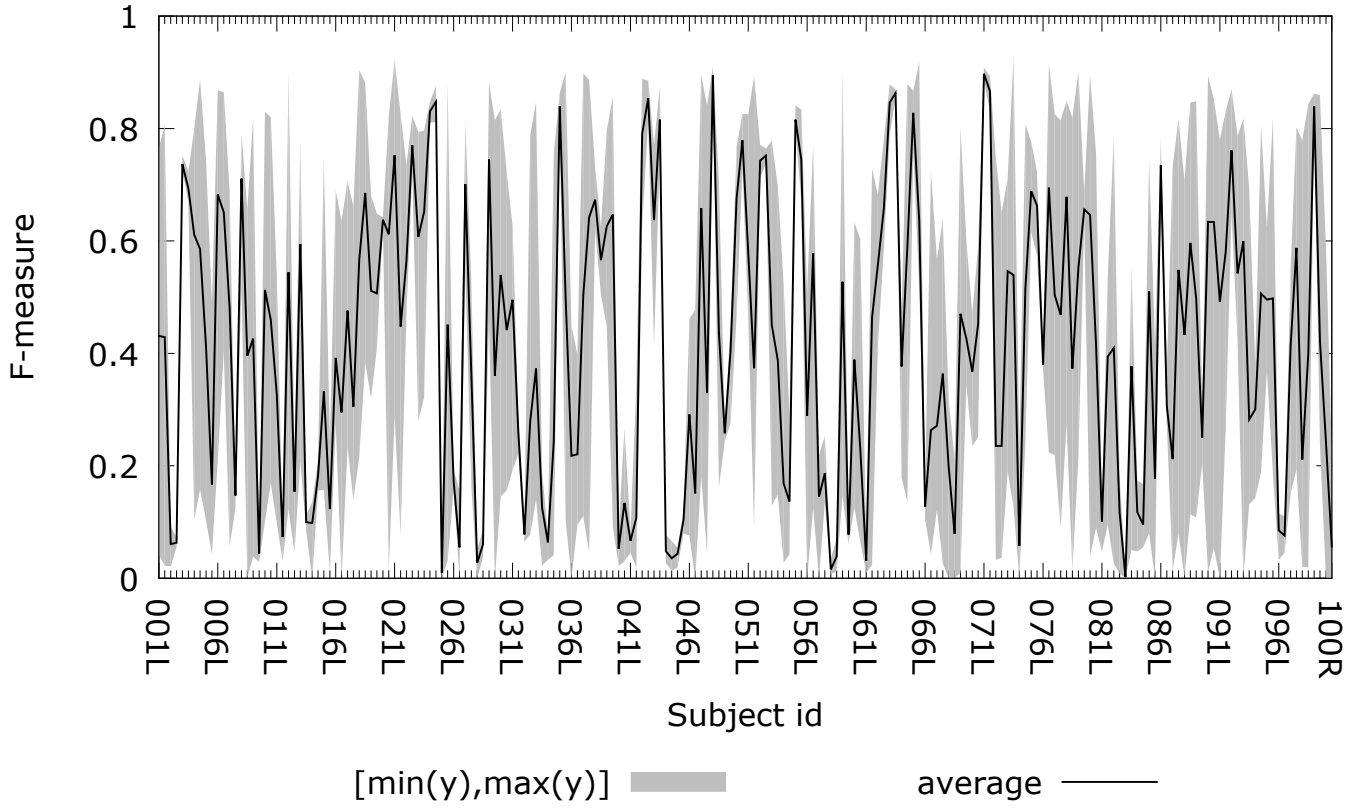
- 004_L14
- 004_R13
- 006_L13
- 010_L9
- 010_R13
- 012_L3
- 017_R15
- 023_R22
- 024_L22
- 024_R22
- 030_R14
- 032_L15
- 035_L18
- 035_R13
- 037_R18
- 042_R5
- 048_R9
- 053_L9
- 053_R18
- 054_L9
- 058_R5
- 060_R1
- 062_L9
- 062_R9
- 064_L22
- 064_R22
- 070_L24
- 070_R24
- 071_L14
- 079_L8
- 079_R2
- 088_R5
- 092_L17
- 096_R23
- 097_L22

3.2 gst

3.2.1 Per Iris Evaluation

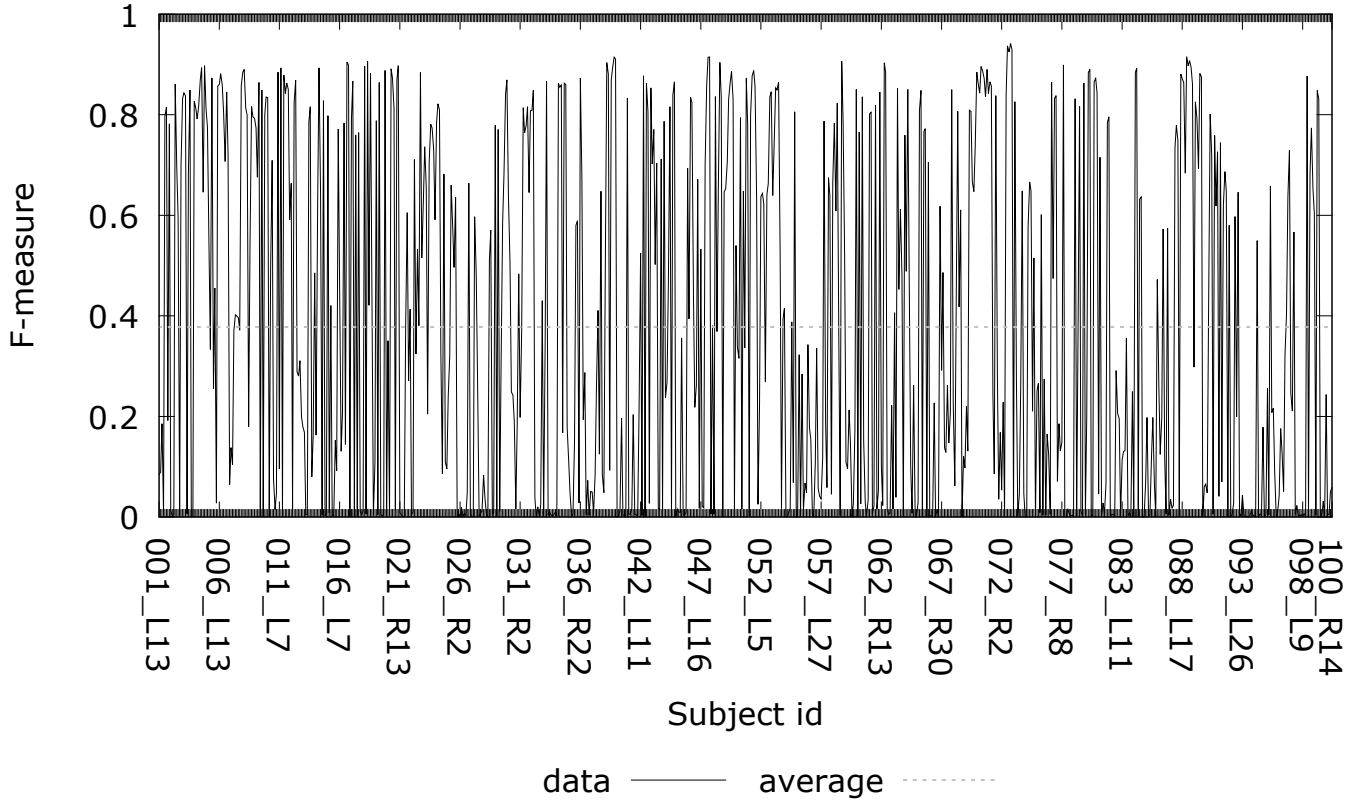


3.2.2 Grouped Evaluation – `(\d{3})_([LR])`

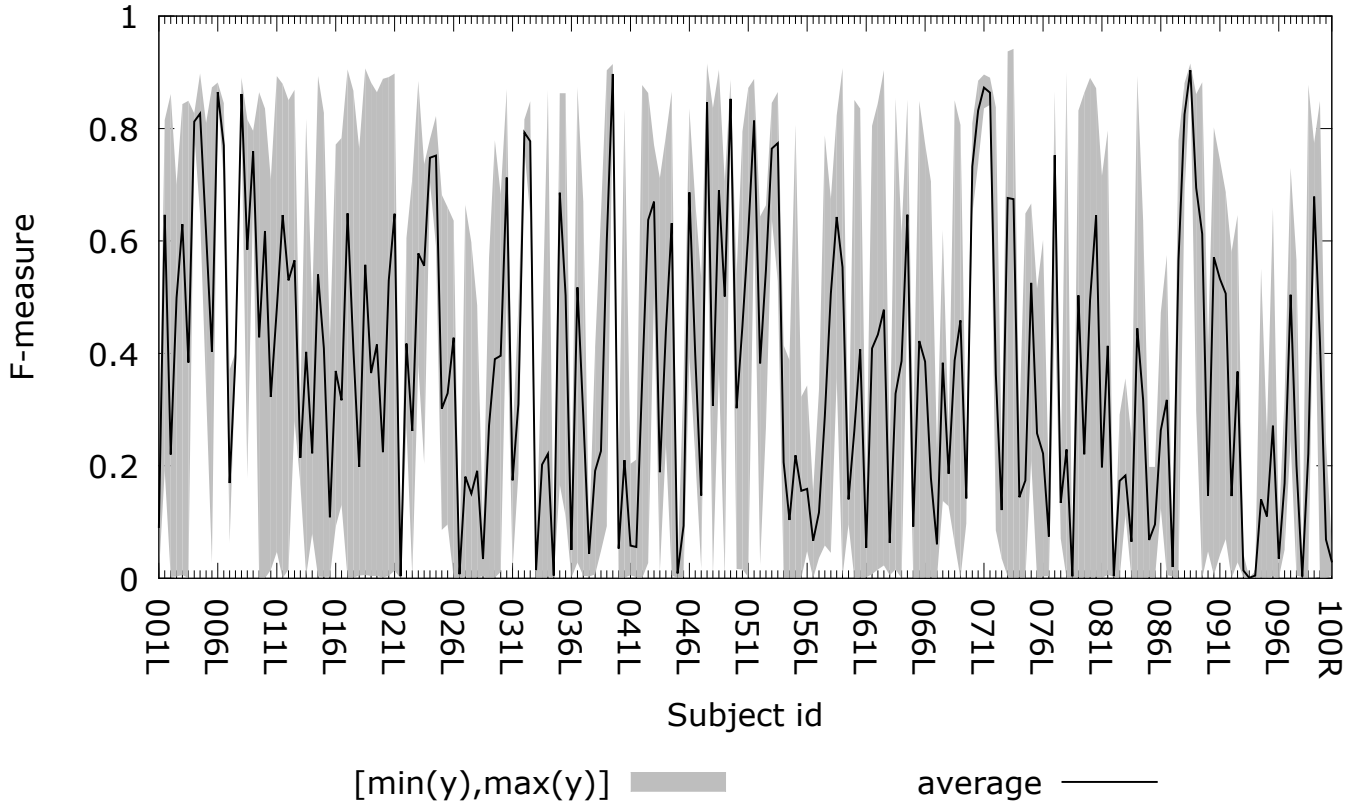


3.3 iffp

3.3.1 Per Iris Evaluation

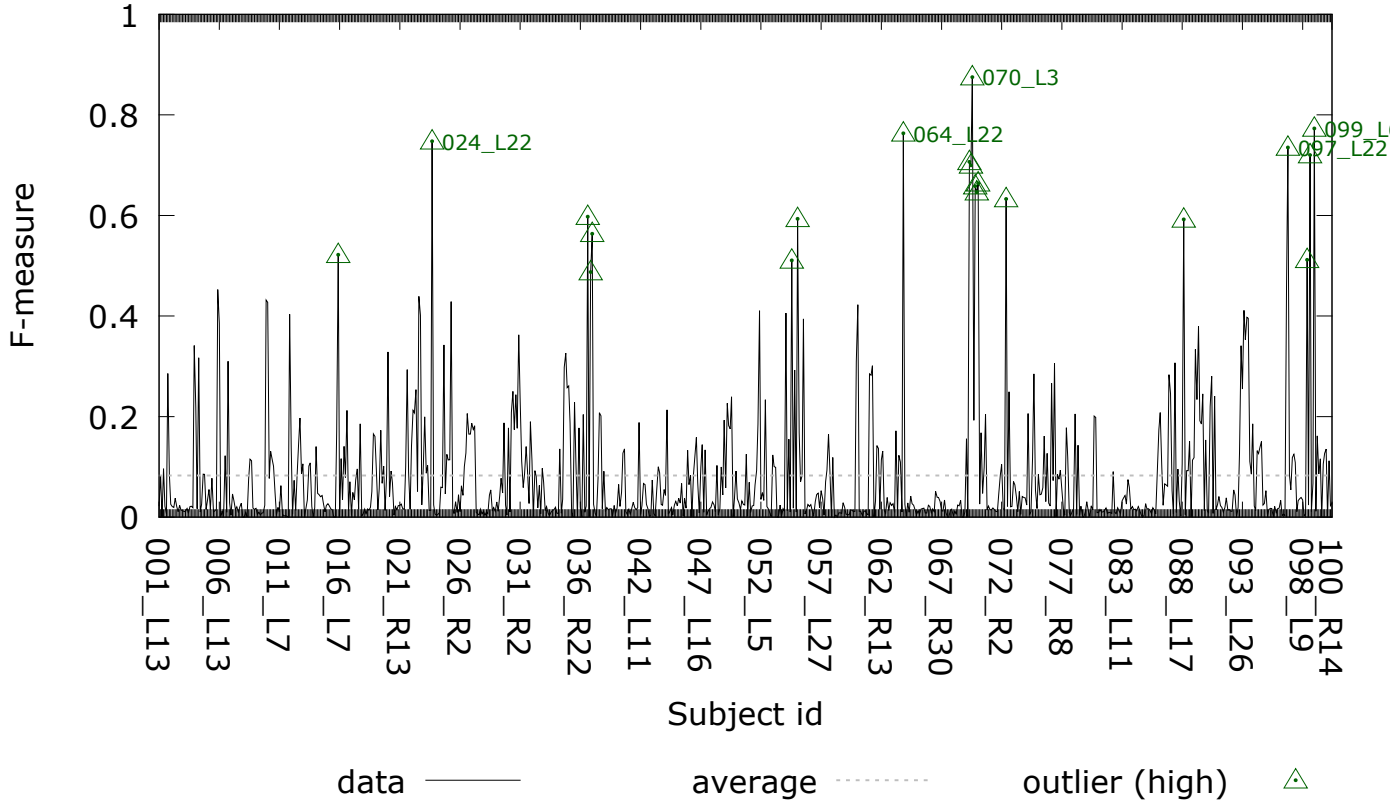


3.3.2 Grouped Evaluation – `(\d{3})_([LR])`



3.4 osiris

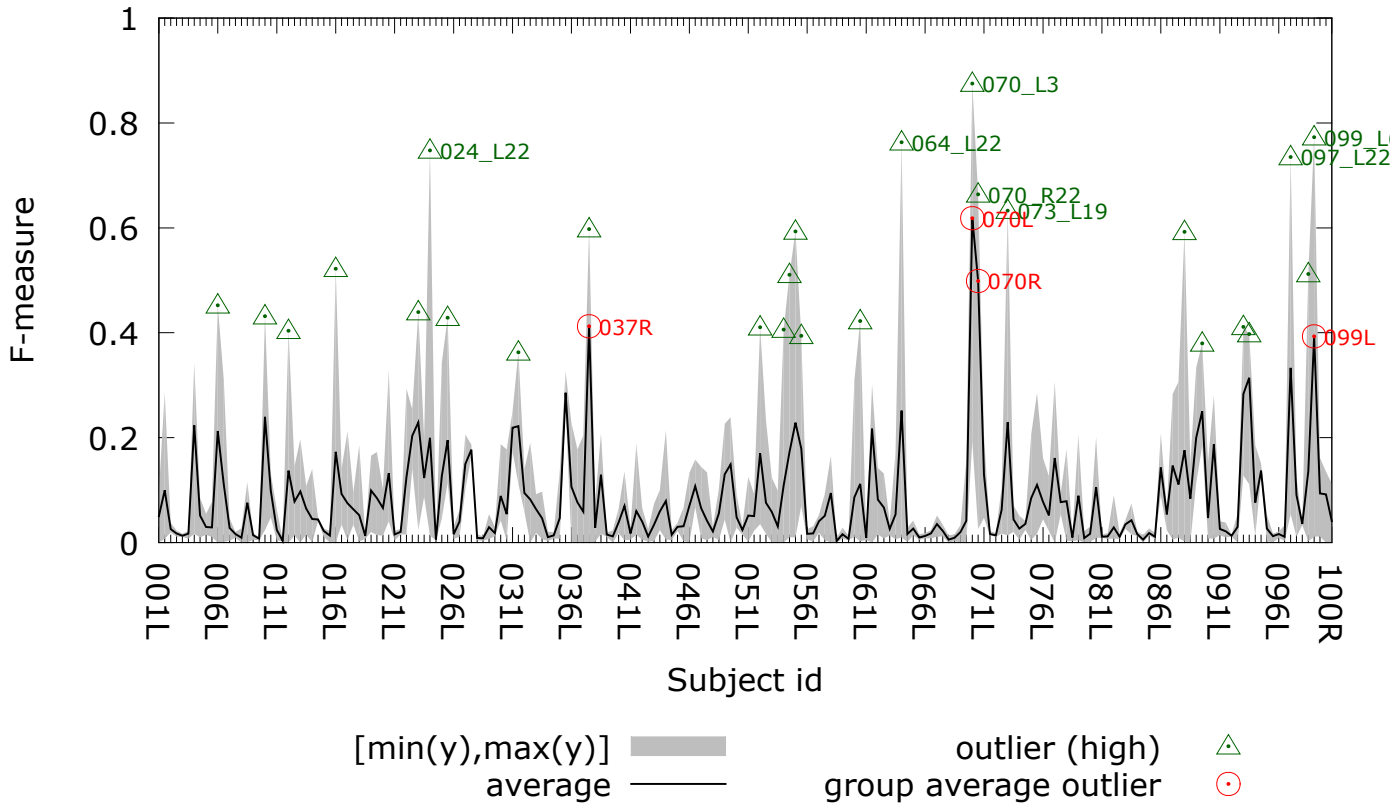
3.4.1 Per Iris Evaluation



High point outlier

- 016_L18
- 024_L22
- 037_R10
- 037_R2
- 037_R5
- 054_R3
- 055_L7
- 064_L22
- 070_L19
- 070_L24
- 070_L3
- 070_R17
- 070_R21
- 070_R22
- 073_L19
- 088_L6
- 097_L22
- 098_R12
- 099_L10
- 099_L6

3.4.2 Grouped Evaluation – `(\d{3})_([LR])`



Group average outlier

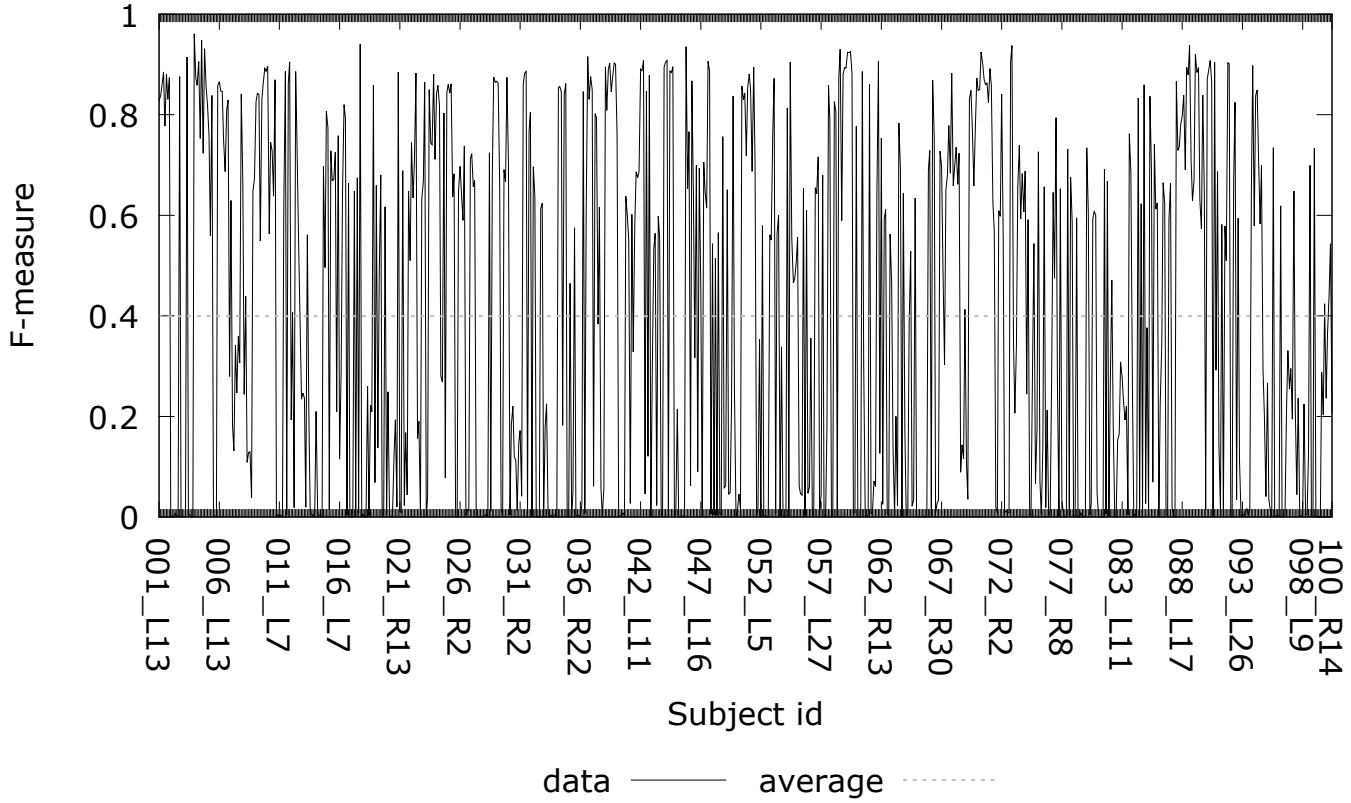
- 037R
- 070L
- 070R
- 099L

High outlier per group

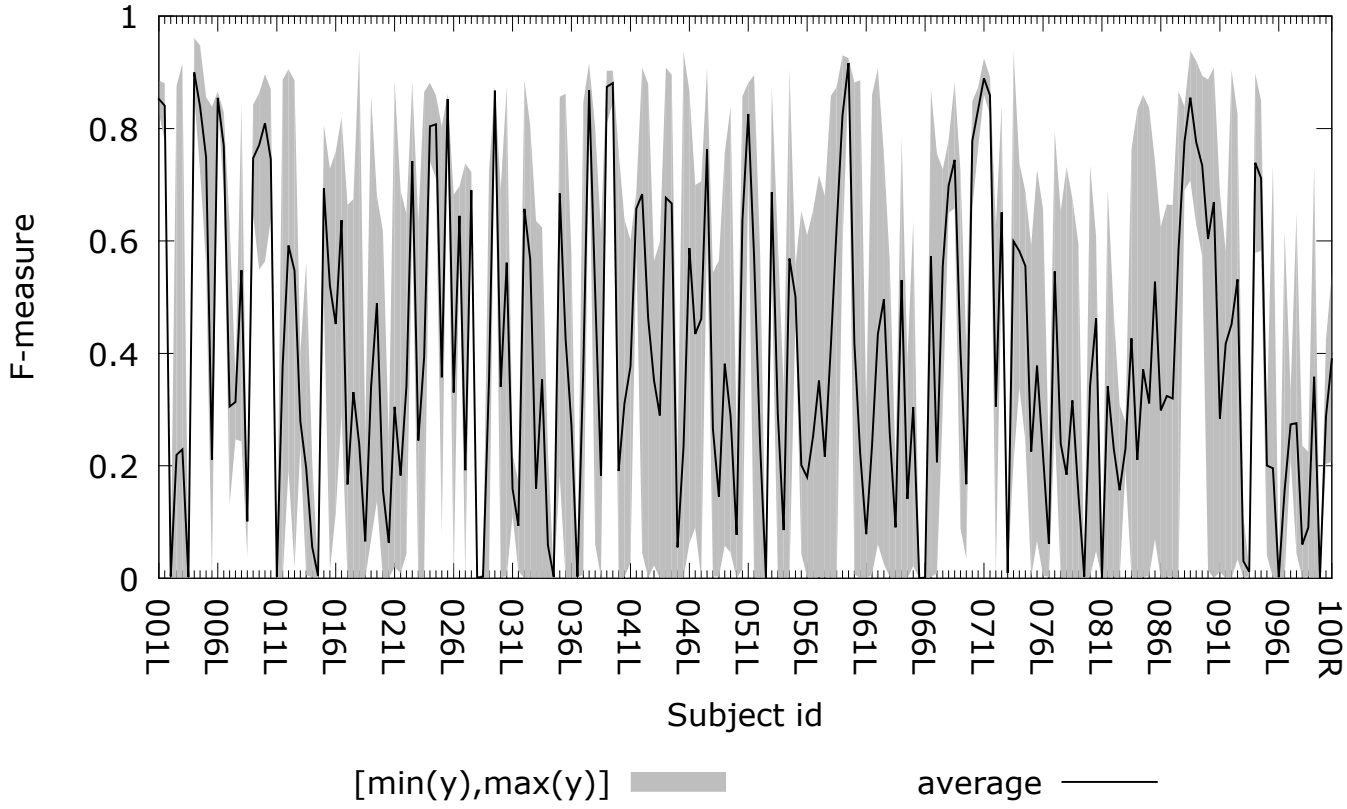
- 006_L10
- 010_L4
- 012_L13
- 016_L18
- 023_L18
- 024_L22
- 025_R9
- 031_R10
- 037_R10
- 052_L15
- 054_L9
- 054_R3
- 055_L7
- 055_R5
- 060_R1
- 064_L22
- 070_L3
- 070_R22
- 073_L19
- 088_L6
- 089_R11
- 093_L31
- 093_R26
- 097_L22
- 098_R12
- 099_L6

3.5 wahet

3.5.1 Per Iris Evaluation



3.5.2 Grouped Evaluation – `(\d{3})_([LR])`



Part II

EP Dataset

Chapter 4

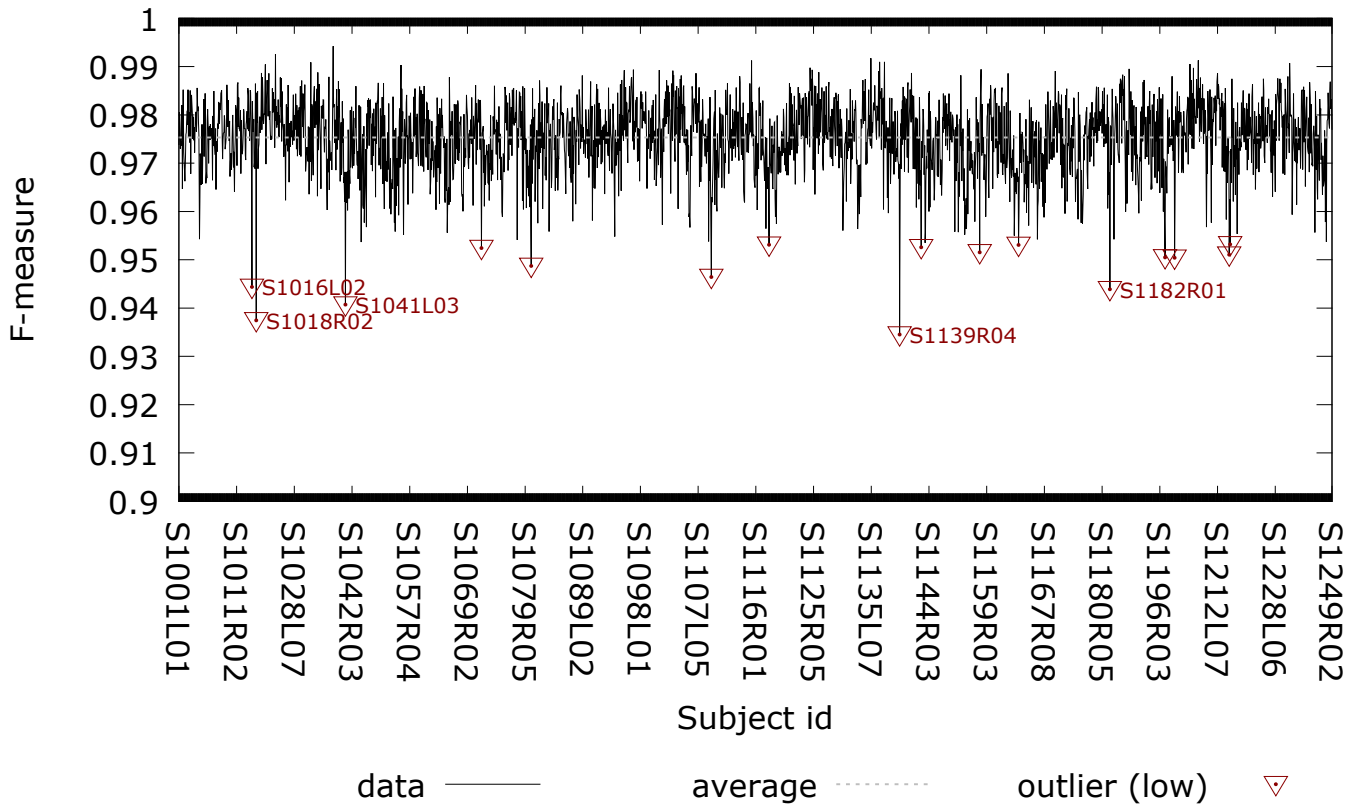
casia4i – Operator A

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator A on *casia4i*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
OperatorB	98.66%	1.06%	96.45%	1.55%	97.53%	0.73%
caht	97.68%	4.56%	82.89%	9.95%	89.27%	6.67%
gst	85.19%	18.00%	89.91%	7.37%	86.16%	11.53%
iffp	91.74%	14.74%	83.50%	14.26%	86.86%	13.27%
osiris	87.32%	7.93%	93.03%	4.95%	89.85%	5.47%
wahet	94.72%	9.01%	85.44%	9.67%	89.13%	8.39%

4.1 OperatorB

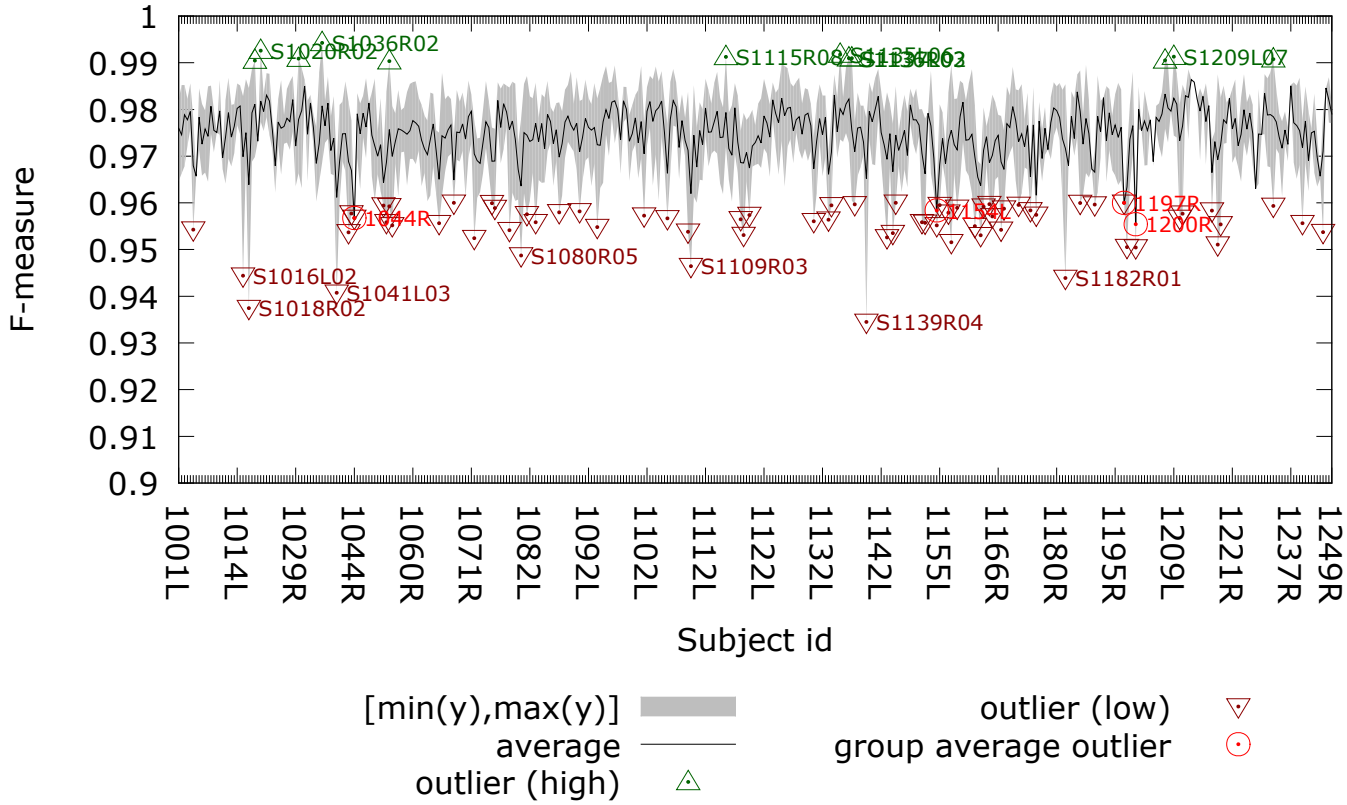
4.1.1 Per Iris Evaluation



Low point outlier

- S1016L02
- S1018R02
- S1041L03
- S1072L01
- S1080R05
- S1109R03
- S1118R03
- S1139R04
- S1143L06
- S1158R02
- S1163R04
- S1182R01
- S1198L04
- S1200R01
- S1218R01
- S1218R03

4.1.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

- 1044R
- 1154L
- 1197R
- 1200R

High outlier per group

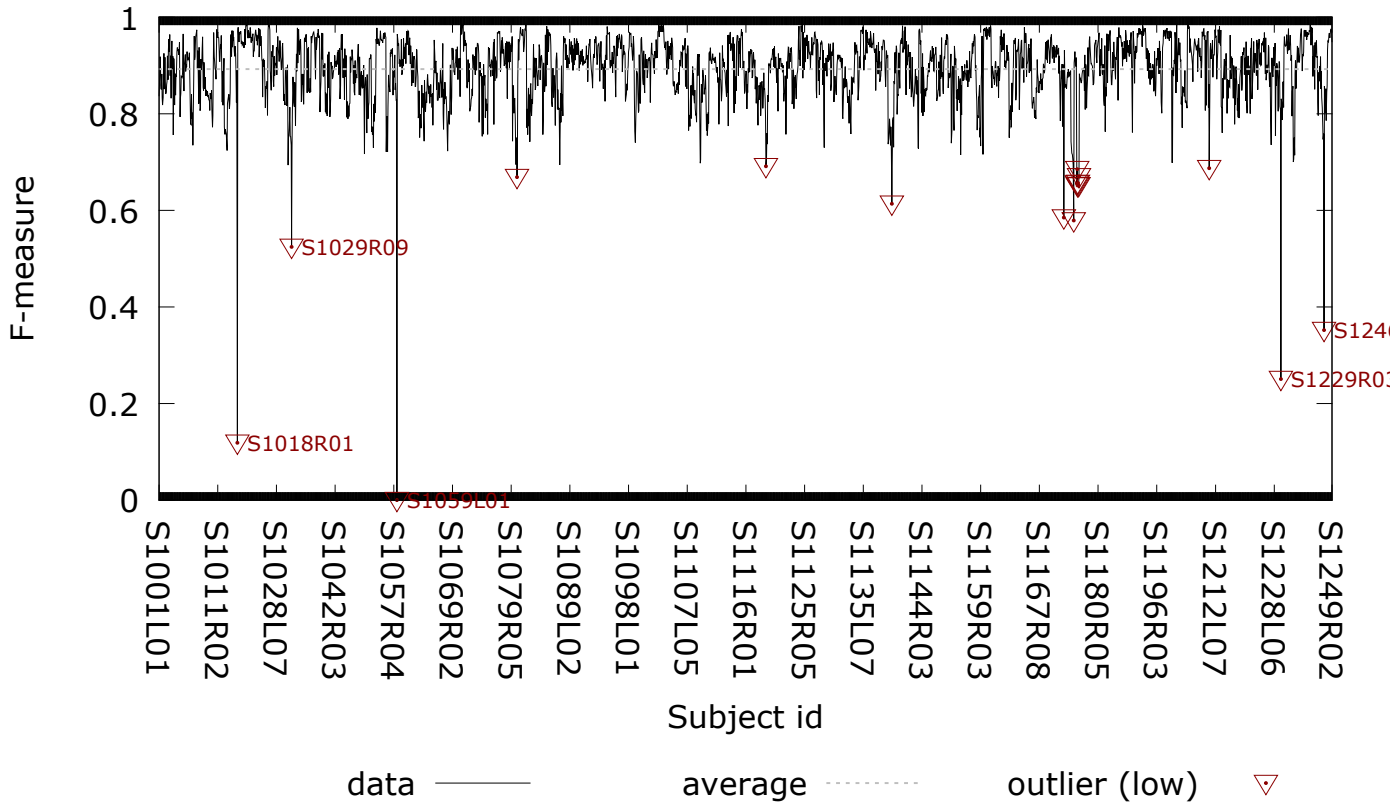
- S1019R06
- S1020R02
- S1030L03
- S1036R02
- S1053R08
- S1115R08
- S1135L06
- S1136R02
- S1137L03
- S1207R01
- S1209L07
- S1231L02

Low outlier per group

- S1004R01
- S1016L02
- S1018R02
- S1041L03
- S1043R04
- S1044L02
- S1044R01
- S1052L03
- S1053L08
- S1053R03
- S1054L04
- S1066L04
- S1068R05
- S1072L01
- S1075L06
- S1075R01
- S1078R01
- S1080R05
- S1081R05
- S1083L07
- S1087L06
- S1090R03
- S1093R08
- S1101R06
- S1105R07
- S1109L03
- S1109R03
- S1118L03
- S1118R03
- S1119R06
- S1130R02
- S1133L03
- S1133R01
- S1137R05
- S1139R04
- S1143L06
- S1144L01
- S1144R03
- S1149R01
- S1150L02
- S1154L01
- S1155L03
- S1157R01
- S1158R02
- S1159R01
- S1162R10
- S1163R04
- S1164L01
- S1165L08
- S1165R04
- S1167L02
- S1167R07
- S1170L05
- S1173R07
- S1175L04
- S1182R01
- S1186L09
- S1190L02
- S1197R01
- S1198L04
- S1200R01
- S1210L06
- S1211L10
- S1217L01
- S1218R01
- S1219L04
- S1231L08
- S1240L05
- S1247R05

4.2 caht

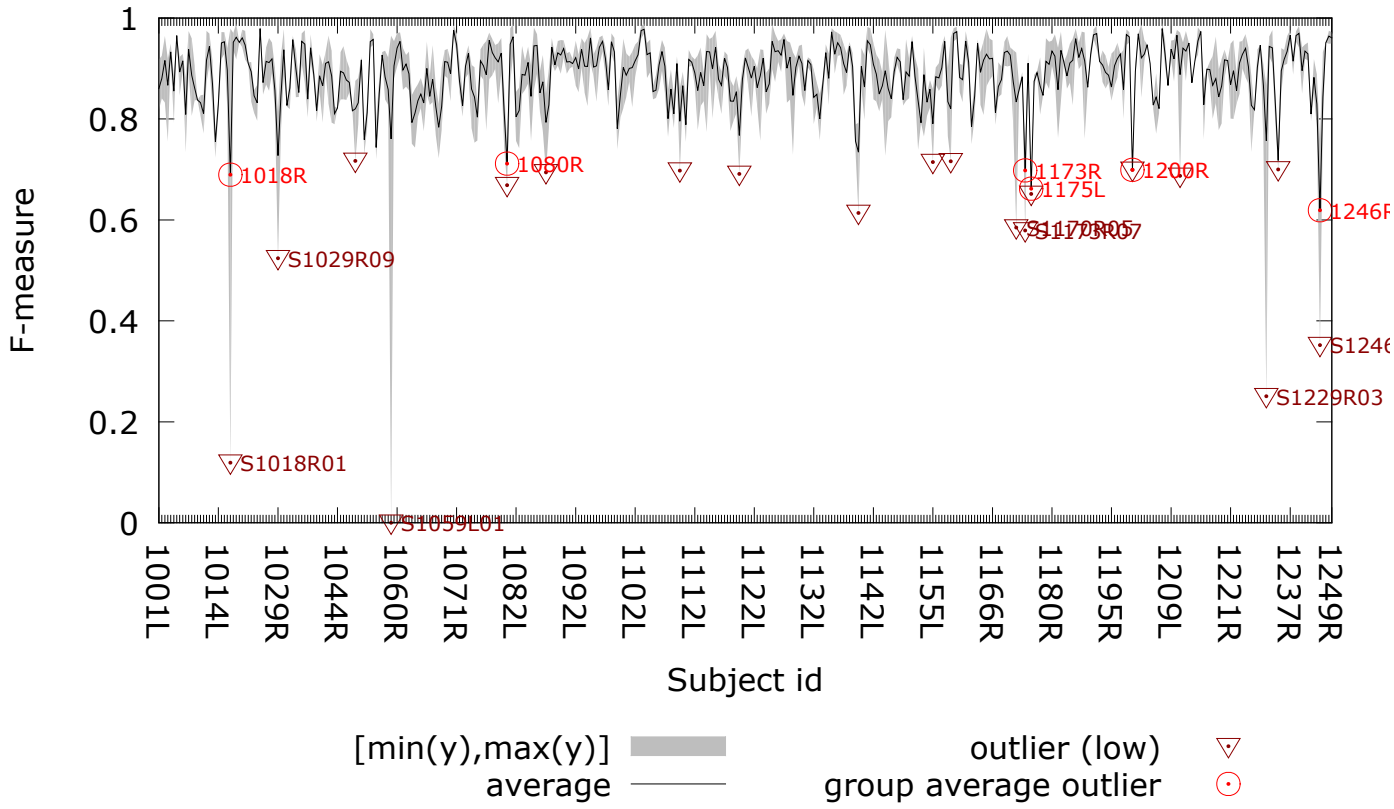
4.2.1 Per Iris Evaluation



Low point outlier

- S1018R01
- S1029R09
- S1059L01
- S1080R04
- S1119R04
- S1139R03
- S1170R05
- S1173R07
- S1175L01
- S1175L02
- S1175L03
- S1175L04
- S1175L05
- S1175L06
- S1211L10
- S1229R03
- S1246R03

4.2.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

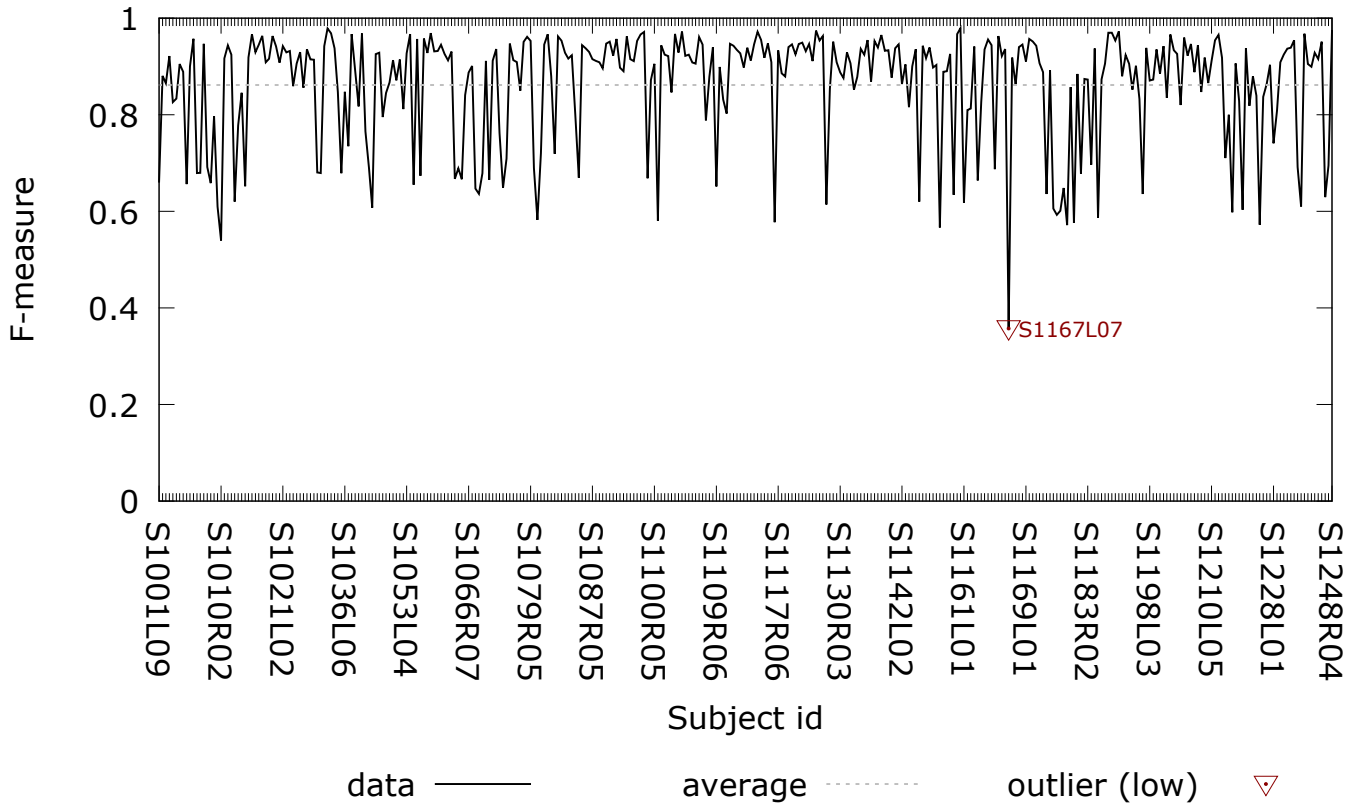
- 1018R
- 1080R
- 1173R
- 1175L
- 1200R
- 1246R

Low outlier per group

- S1018R01
- S1029R09
- S1048R01
- S1059L01
- S1080R04
- S1087L06
- S1109R02
- S1119R04
- S1139R03
- S1155L01
- S1159R08
- S1170R05
- S1173R07
- S1175L03
- S1200R02
- S1211L10
- S1229R03
- S1233R01
- S1246R03

4.3 gst

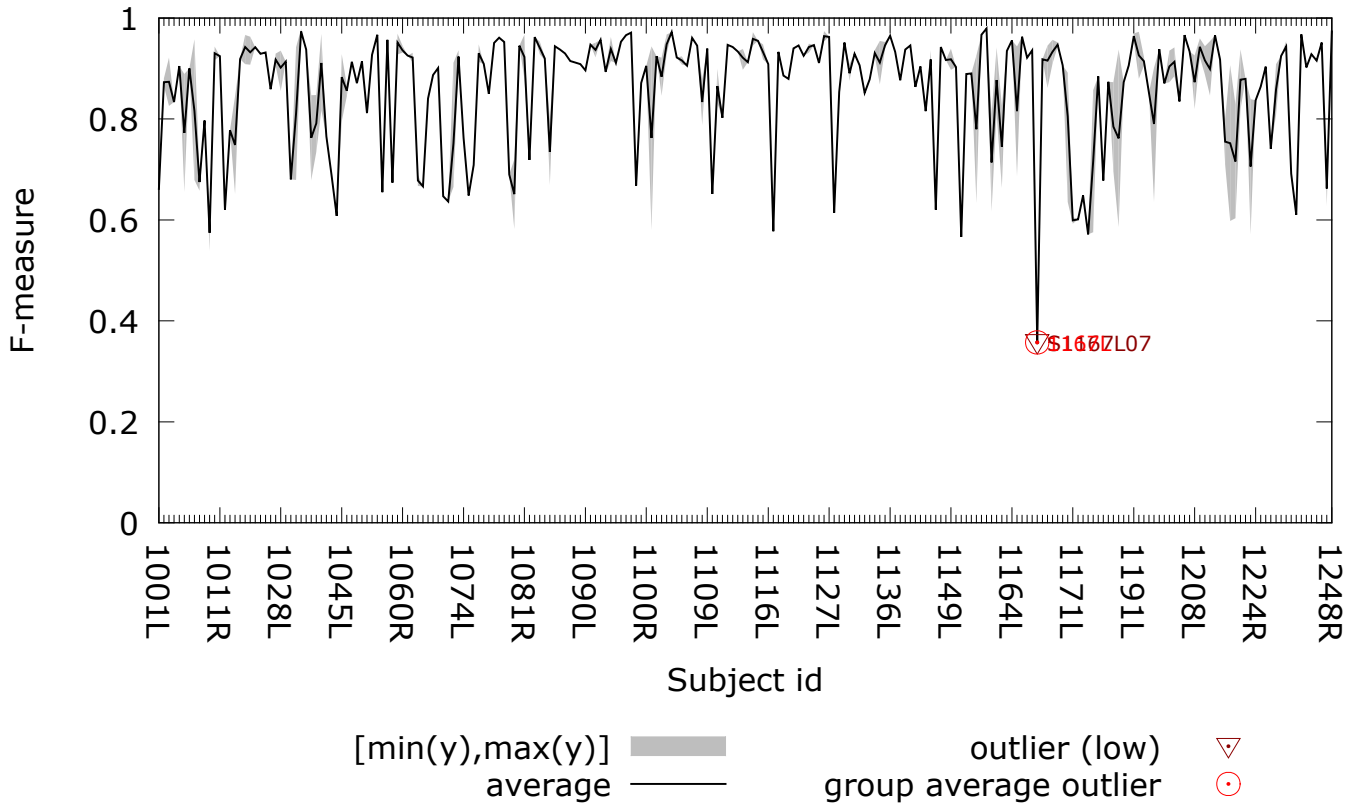
4.3.1 Per Iris Evaluation



Low point outlier

- S1167L07

4.3.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

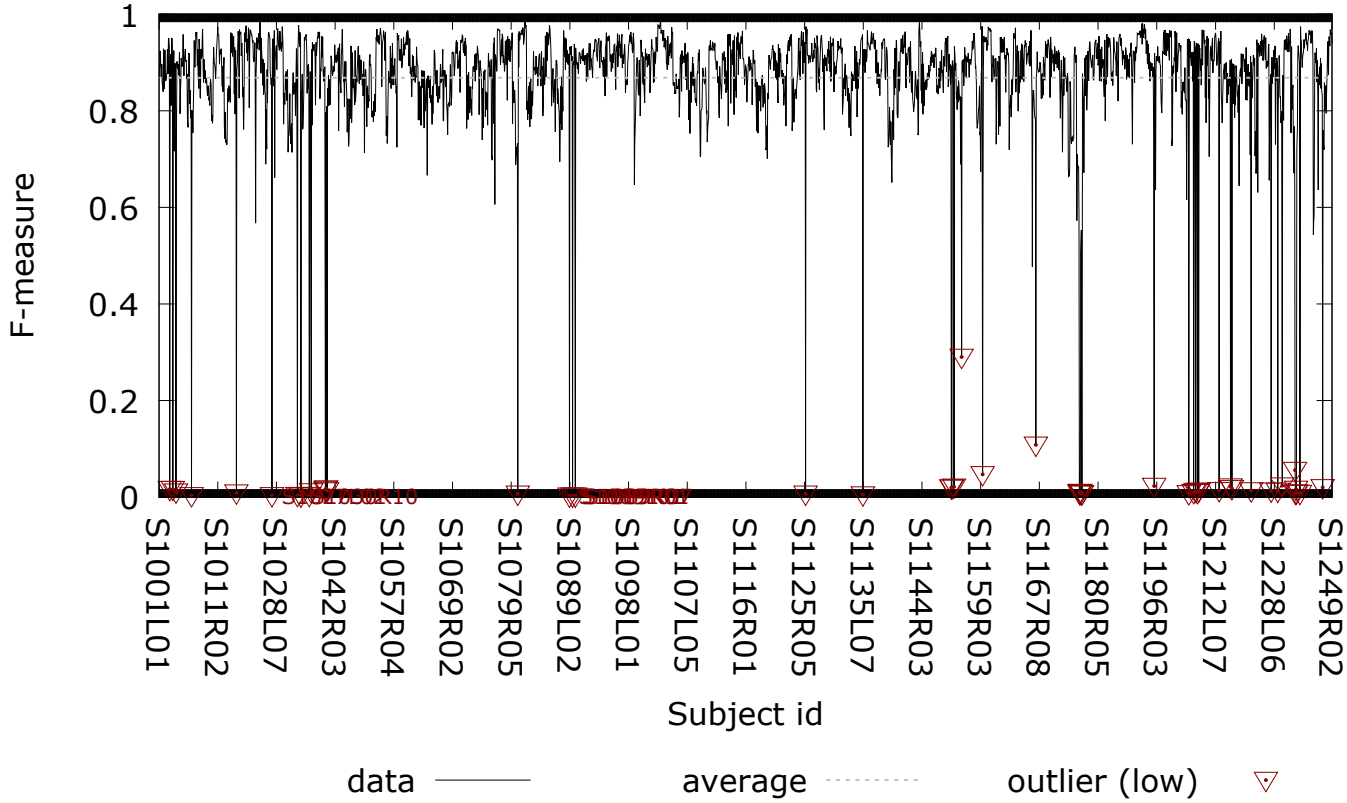
- 1167L

Low outlier per group

- S1167L07

4.4 iffp

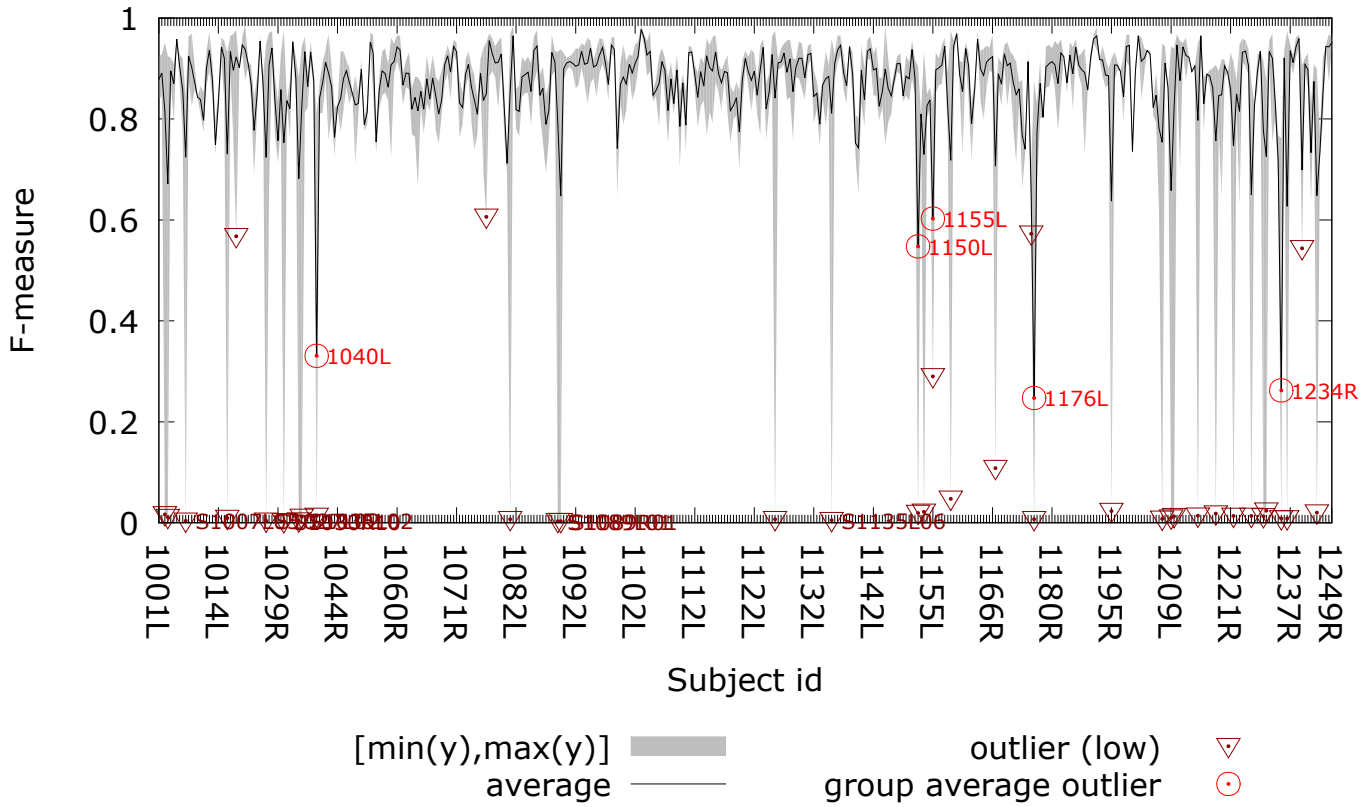
4.4.1 Per Iris Evaluation



Low point outlier

- S1002L05
- S1002R02
- S1002R09
- S1007L05
- S1017R05
- S1027L02
- S1030R02
- S1030R10
- S1035L02
- S1036L01
- S1040L01
- S1040L03
- S1040L05
- S1081L01
- S1089L01
- S1089R01
- S1089R07
- S1125R07
- S1135L06
- S1150L01
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L10
- S1176L01
- S1176L02
- S1176L03
- S1176L06
- S1176L07
- S1195R02
- S1207R04
- S1209L02
- S1209L06
- S1209L10
- S1209R03
- S1214L04
- S1218R08
- S1218R11
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R01
- S1234R02
- S1234R03
- S1234R04
- S1236R02
- S1245R04

4.4.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

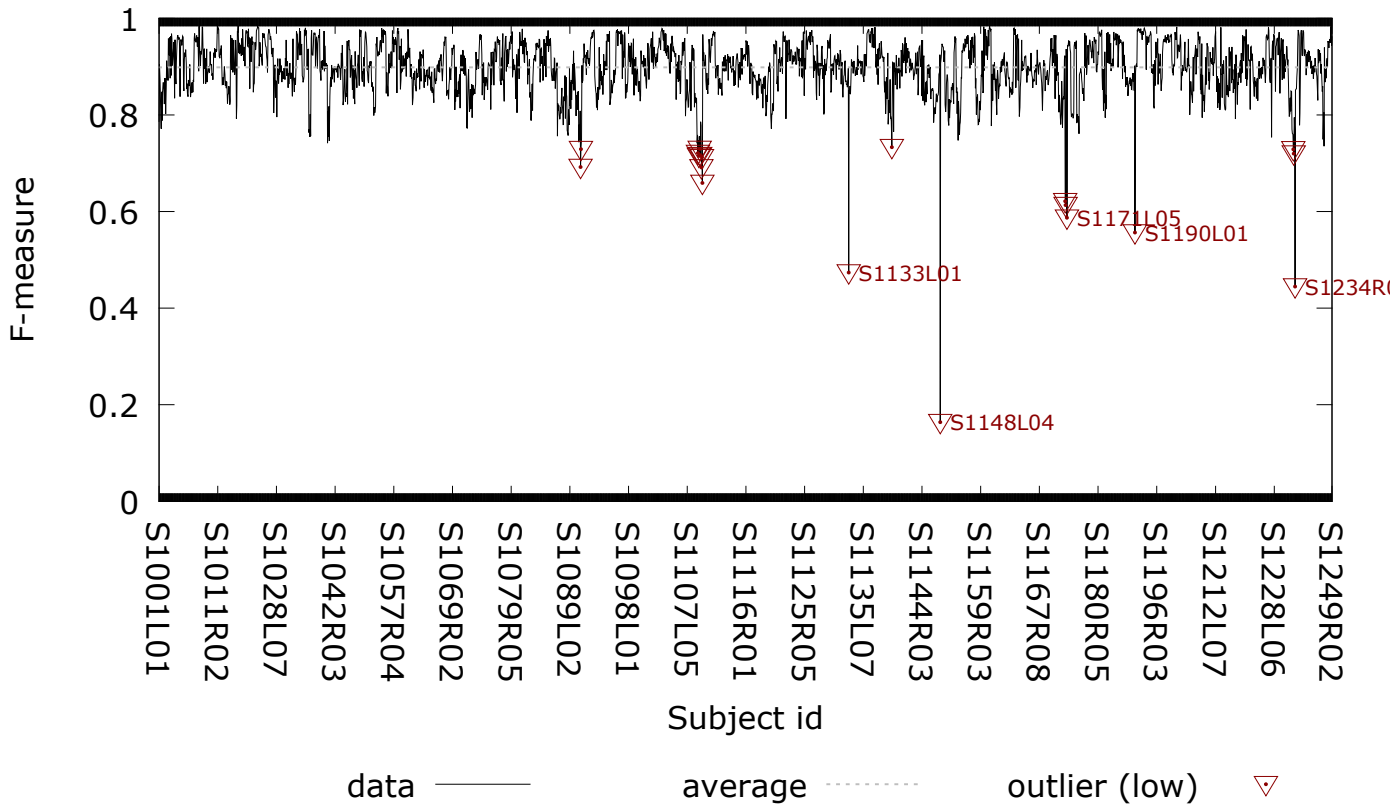
- 1040L
- 1150L
- 1155L
- 1176L
- 1234R

Low outlier per group

- S1002L05
- S1002R09
- S1007L05
- S1017R05
- S1019R25
- S1027L02
- S1030R10
- S1035L02
- S1036L01
- S1040L05
- S1076R03
- S1081L01
- S1089L01
- S1089R01
- S1125R07
- S1135L06
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L10
- S1175L01
- S1176L02
- S1195R02
- S1207R04
- S1209L10
- S1209R03
- S1214L04
- S1218R11
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R02
- S1236R02
- S1240L02
- S1245R04

4.5 osiris

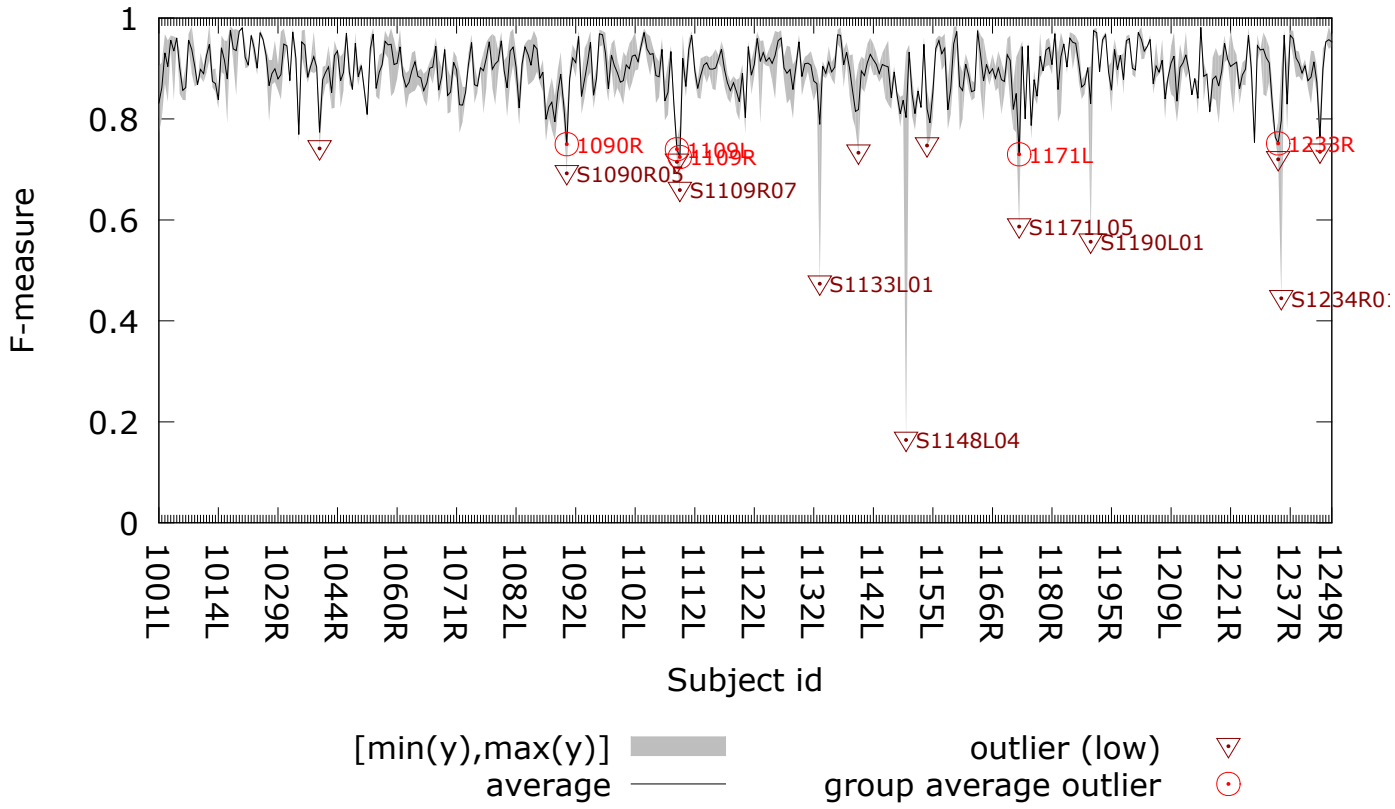
4.5.1 Per Iris Evaluation



Low point outlier

- S1090R05
- S1090R06
- S1109L03
- S1109L05
- S1109R01
- S1109R02
- S1109R05
- S1109R06
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1171L01
- S1171L02
- S1171L05
- S1190L01
- S1233R01
- S1233R02
- S1234R01

4.5.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

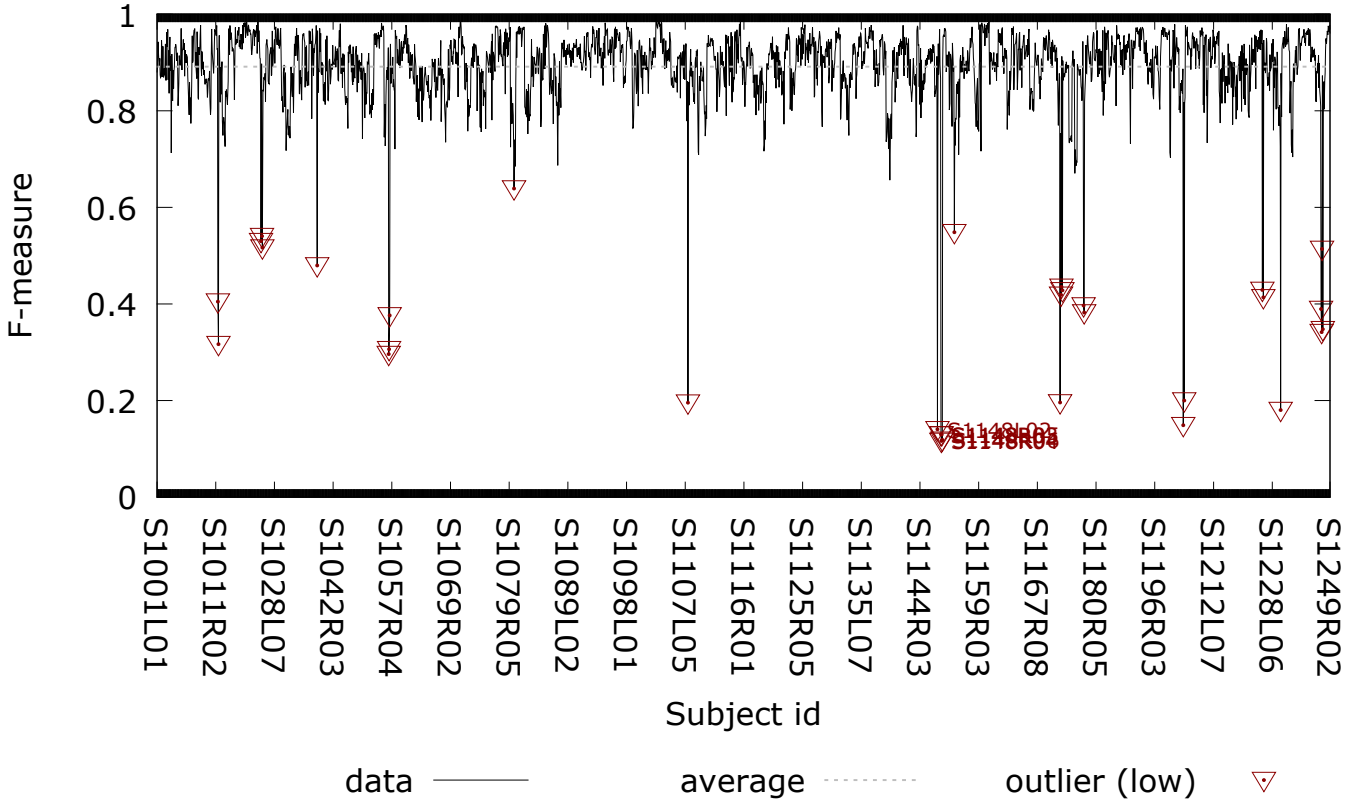
- 1090R
- 1109L
- 1109R
- 1171L
- 1233R

Low outlier per group

- S1041L01
- S1090R05
- S1109L05
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1153L05
- S1171L05
- S1190L01
- S1233R02
- S1234R01
- S1246R03

4.6 wahet

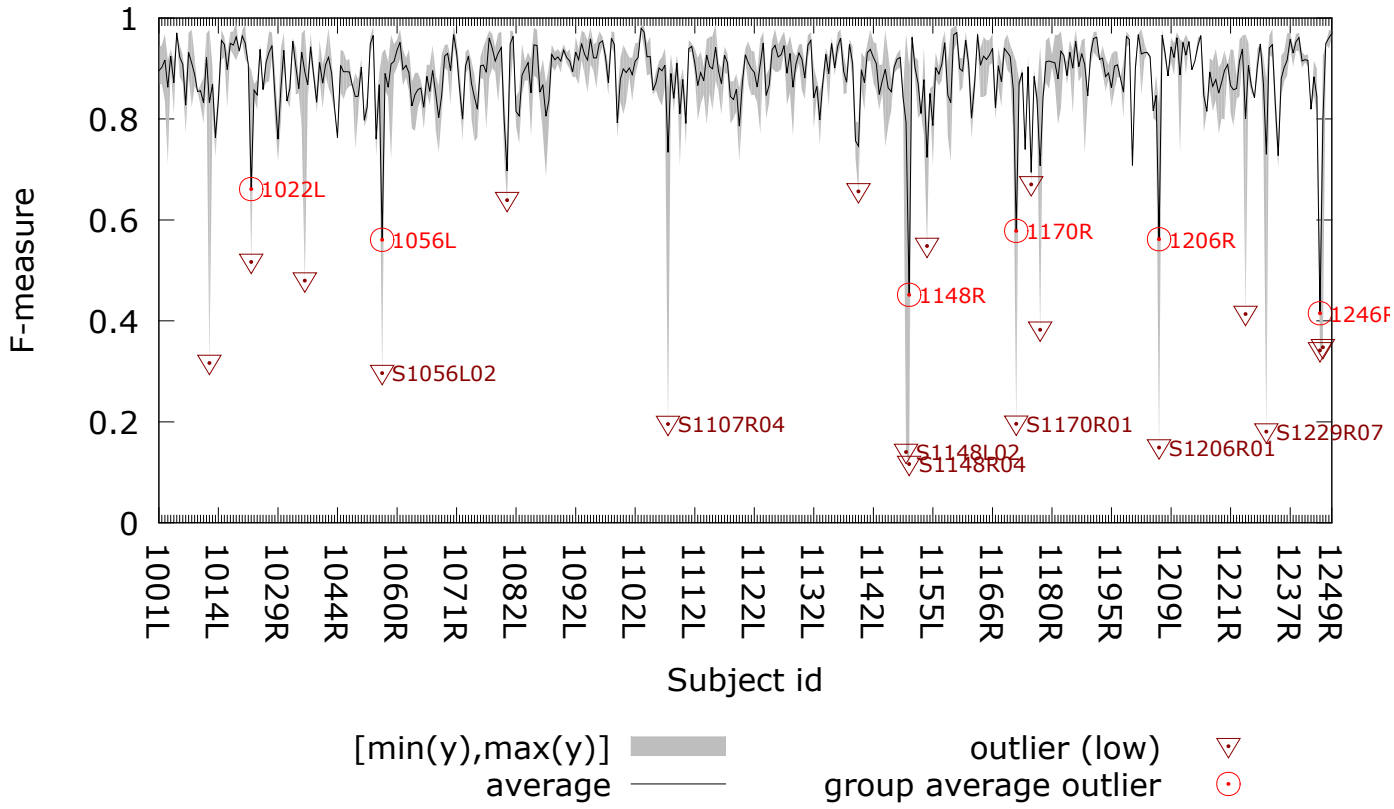
4.6.1 Per Iris Evaluation



Low point outlier

- S1011R07
- S1011R08
- S1022L02
- S1022L04
- S1022L05
- S1036R09
- S1056L02
- S1056L03
- S1056L04
- S1080R02
- S1107R04
- S1148L02
- S1148R03
- S1148R04
- S1148R05
- S1148R06
- S1153L01
- S1170R01
- S1170R03
- S1170R04
- S1170R06
- S1178L04
- S1178L05
- S1206R01
- S1206R03
- S1225L04
- S1225L06
- S1229R07
- S1246R01
- S1246R02
- S1246R03
- S1247R02

4.6.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

- 1022L
- 1056L
- 1148R
- 1170R
- 1206R
- 1246R

Low outlier per group

- S1011R08
- S1022L05
- S1036R09
- S1056L02
- S1080R02
- S1107R04
- S1139R03
- S1148L02
- S1148R04
- S1153L01
- S1170R01
- S1175L01
- S1178L05
- S1206R01
- S1225L06
- S1229R07
- S1246R02
- S1247R02

Chapter 5

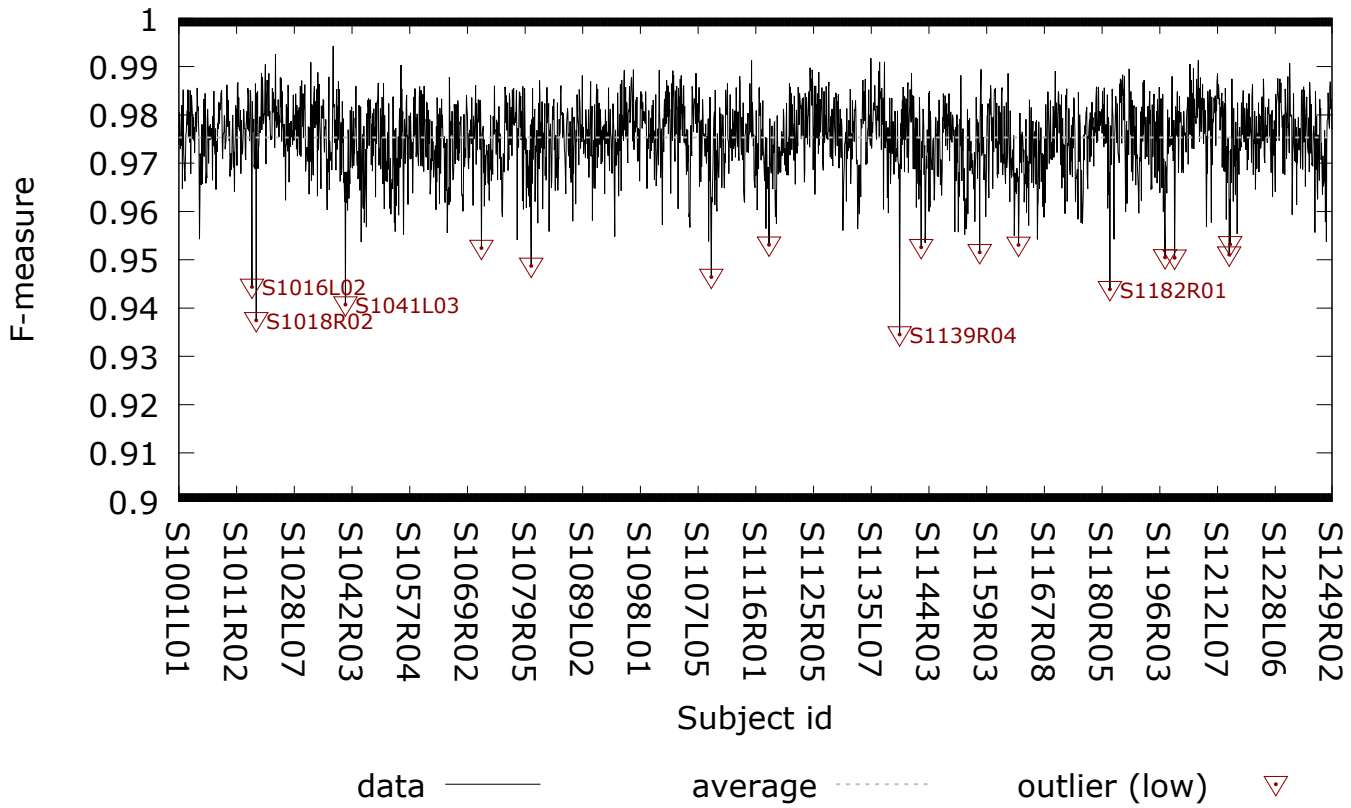
casia4i – Operator B

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator B on *casia4i*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
OperatorA	96.45%	1.55%	98.66%	1.06%	97.53%	0.73%
caht	97.34%	4.60%	84.43%	9.52%	90.05%	6.34%
gst	81.48%	19.04%	91.67%	7.51%	84.88%	12.70%
iffp	91.21%	14.73%	84.86%	14.16%	87.37%	13.24%
osiris	86.13%	8.08%	93.84%	4.87%	89.58%	5.59%
wahet	94.07%	9.01%	86.72%	9.17%	89.58%	8.19%

5.1 OperatorA

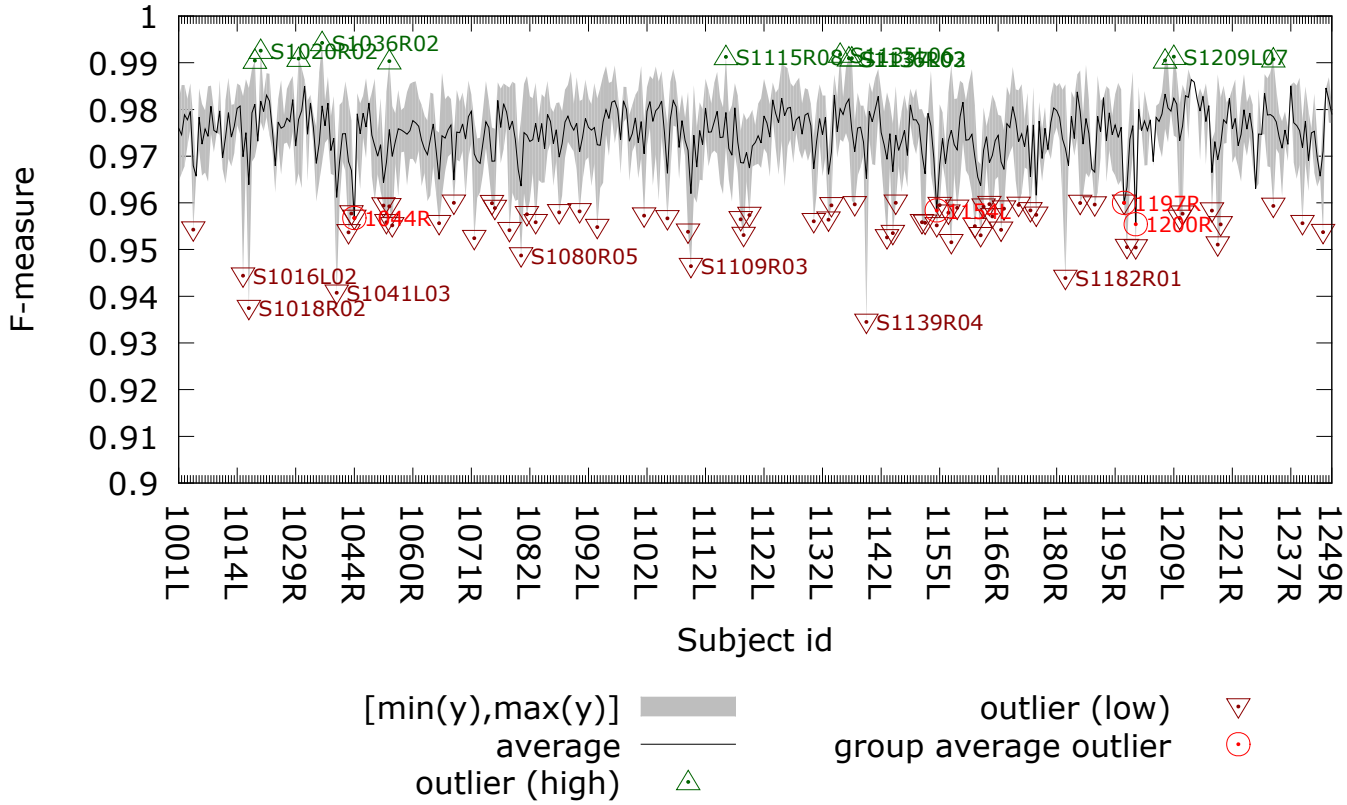
5.1.1 Per Iris Evaluation



Low point outlier

- S1016L02
- S1018R02
- S1041L03
- S1072L01
- S1080R05
- S1109R03
- S1118R03
- S1139R04
- S1143L06
- S1158R02
- S1163R04
- S1182R01
- S1198L04
- S1200R01
- S1218R01
- S1218R03

5.1.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

- 1044R
- 1154L
- 1197R
- 1200R

High outlier per group

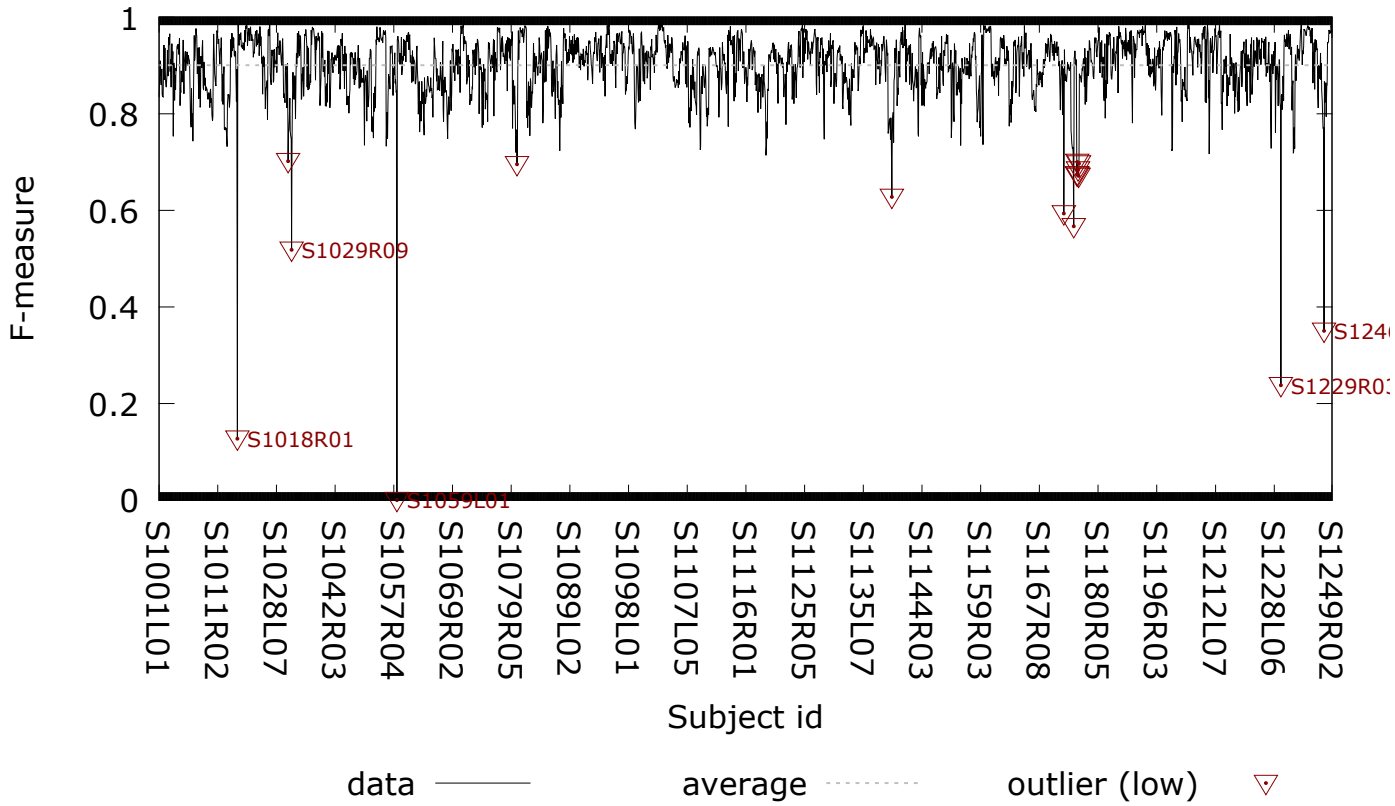
- S1019R06
- S1020R02
- S1030L03
- S1036R02
- S1053R08
- S1115R08
- S1135L06
- S1136R02
- S1137L03
- S1207R01
- S1209L07
- S1231L02

Low outlier per group

- S1004R01
- S1016L02
- S1018R02
- S1041L03
- S1043R04
- S1044L02
- S1044R01
- S1052L03
- S1053L08
- S1053R03
- S1054L04
- S1066L04
- S1068R05
- S1072L01
- S1075L06
- S1075R01
- S1078R01
- S1080R05
- S1081R05
- S1083L07
- S1087L06
- S1090R03
- S1093R08
- S1101R06
- S1105R07
- S1109L03
- S1109R03
- S1118L03
- S1118R03
- S1119R06
- S1130R02
- S1133L03
- S1133R01
- S1137R05
- S1139R04
- S1143L06
- S1144L01
- S1144R03
- S1149R01
- S1150L02
- S1154L01
- S1155L03
- S1157R01
- S1158R02
- S1159R01
- S1162R10
- S1163R04
- S1164L01
- S1165L08
- S1165R04
- S1167L02
- S1167R07
- S1170L05
- S1173R07
- S1175L04
- S1182R01
- S1186L09
- S1190L02
- S1197R01
- S1198L04
- S1200R01
- S1210L06
- S1211L10
- S1217L01
- S1218R01
- S1219L04
- S1231L08
- S1240L05
- S1247R05

5.2 caht

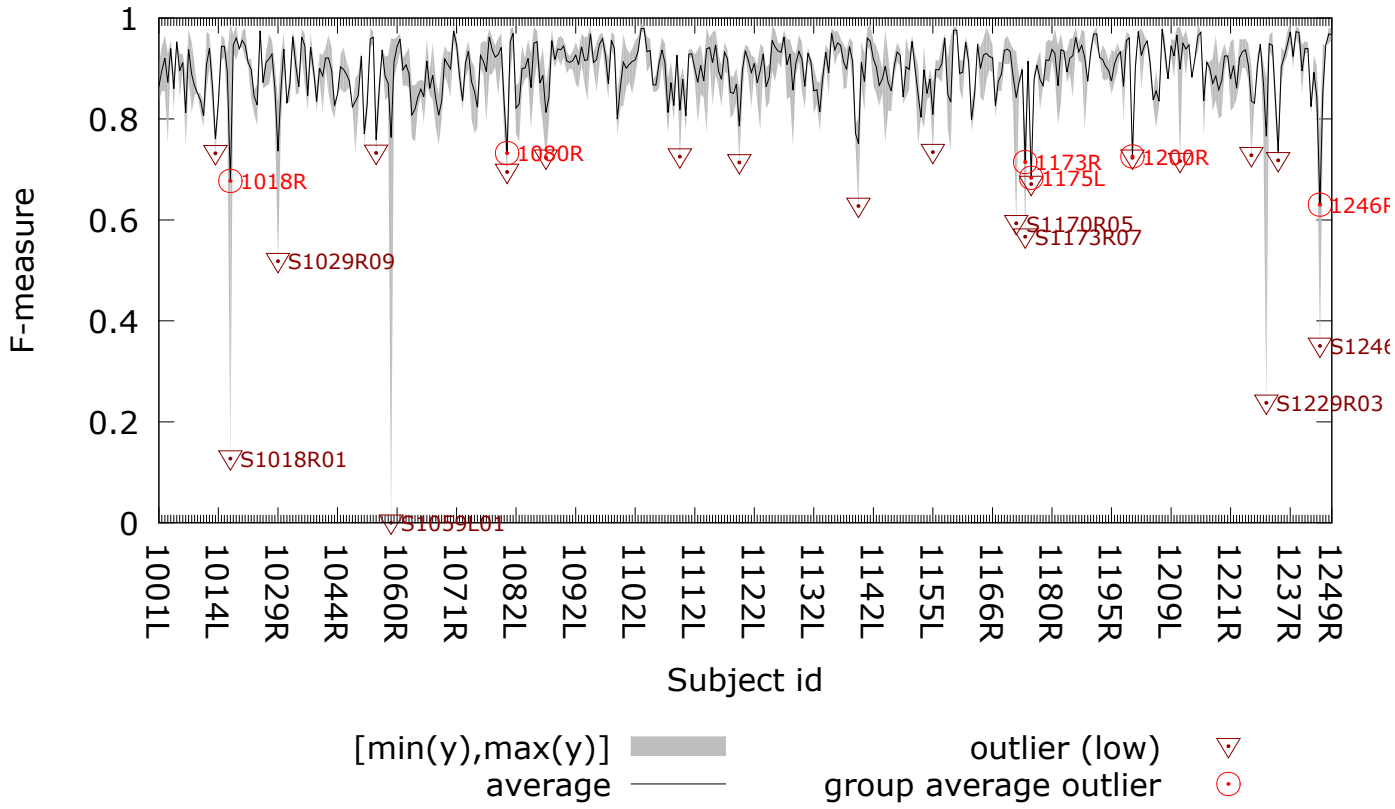
5.2.1 Per Iris Evaluation



Low point outlier

- S1018R01
- S1029R01
- S1029R09
- S1059L01
- S1080R04
- S1139R03
- S1170R05
- S1173R07
- S1175L01
- S1175L02
- S1175L03
- S1175L04
- S1175L05
- S1175L06
- S1229R03
- S1246R03

5.2.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

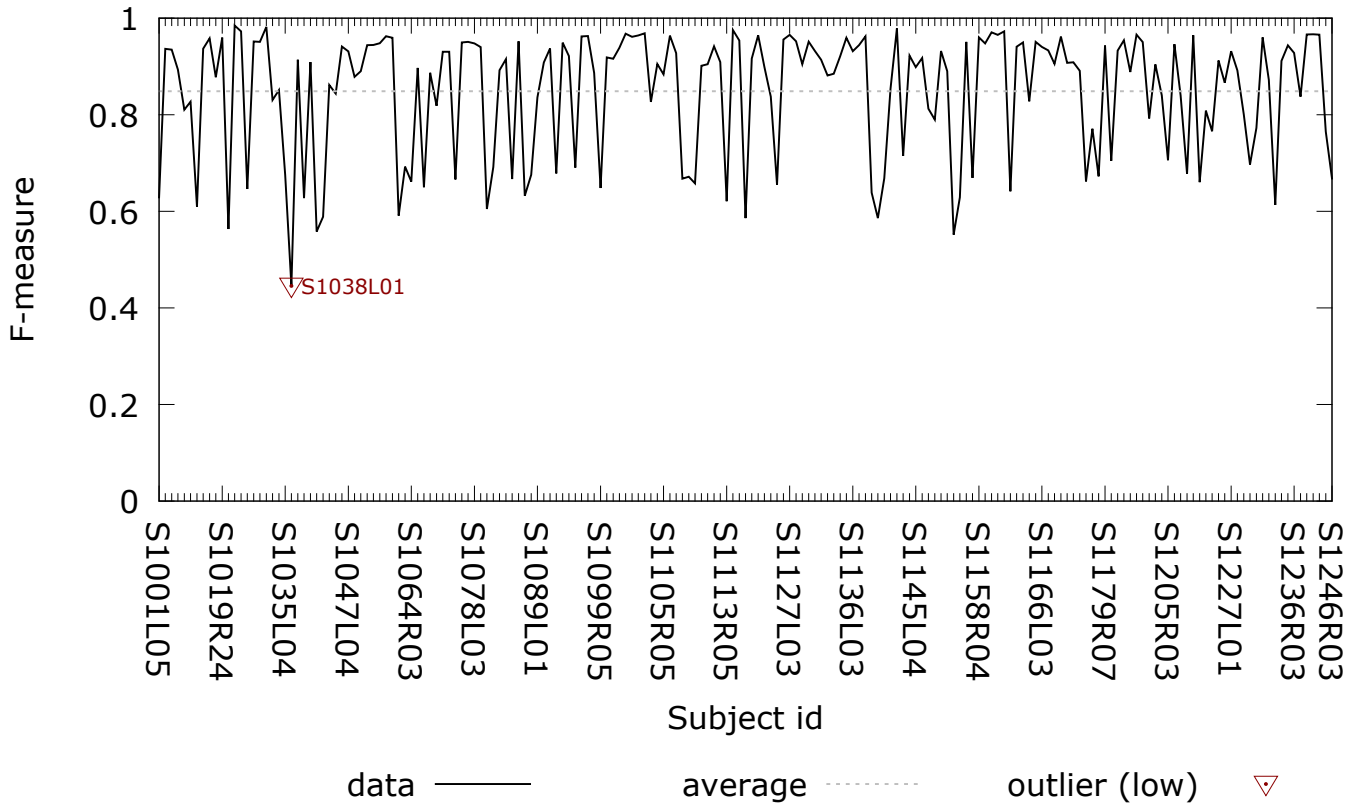
- 1018R
- 1080R
- 1173R
- 1175L
- 1200R
- 1246R

Low outlier per group

- S1013L07
- S1018R01
- S1029R09
- S1054L01
- S1059L01
- S1080R04
- S1087L06
- S1109R02
- S1119R04
- S1139R03
- S1155L01
- S1170R05
- S1173R07
- S1175L05
- S1200R01
- S1211L10
- S1227L05
- S1229R03
- S1233R01
- S1246R03

5.3 gst

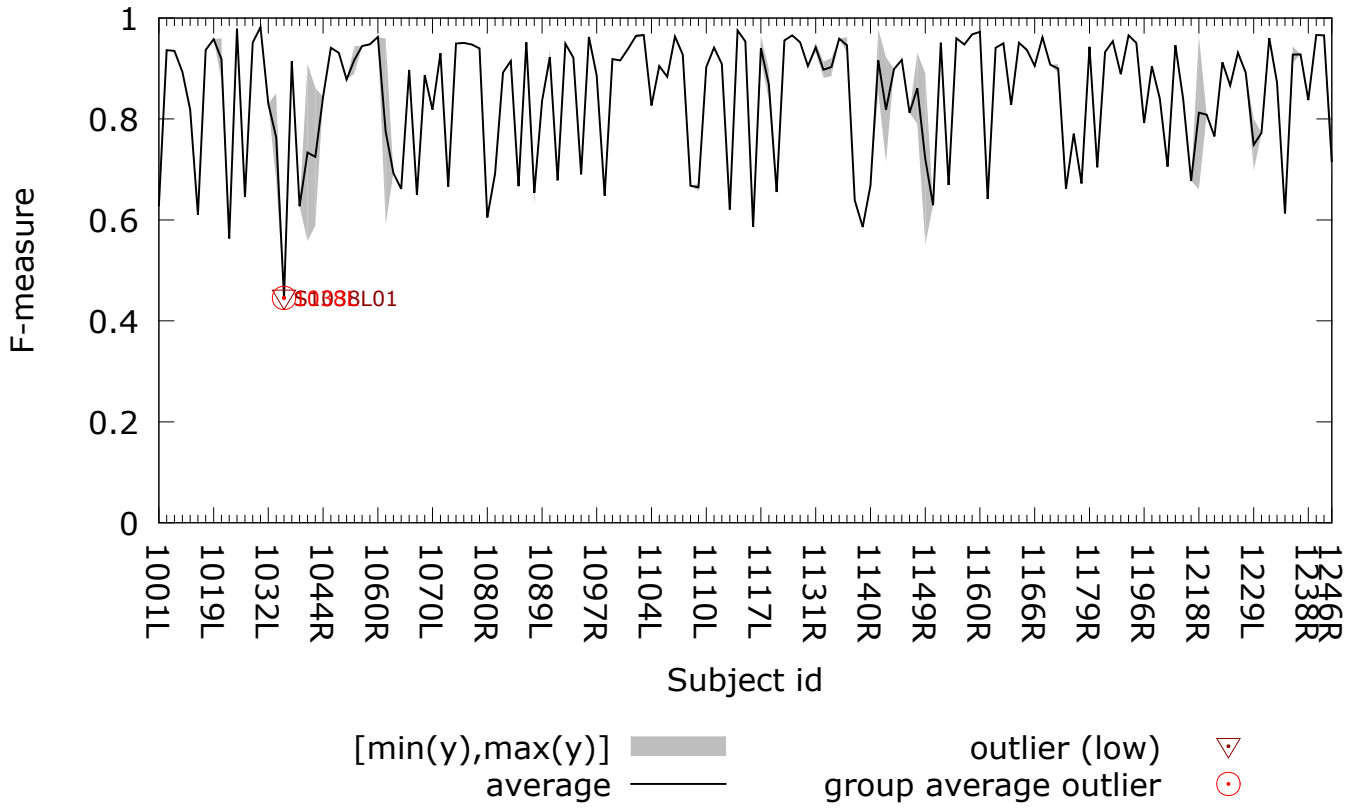
5.3.1 Per Iris Evaluation



Low point outlier

- S1038L01

5.3.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

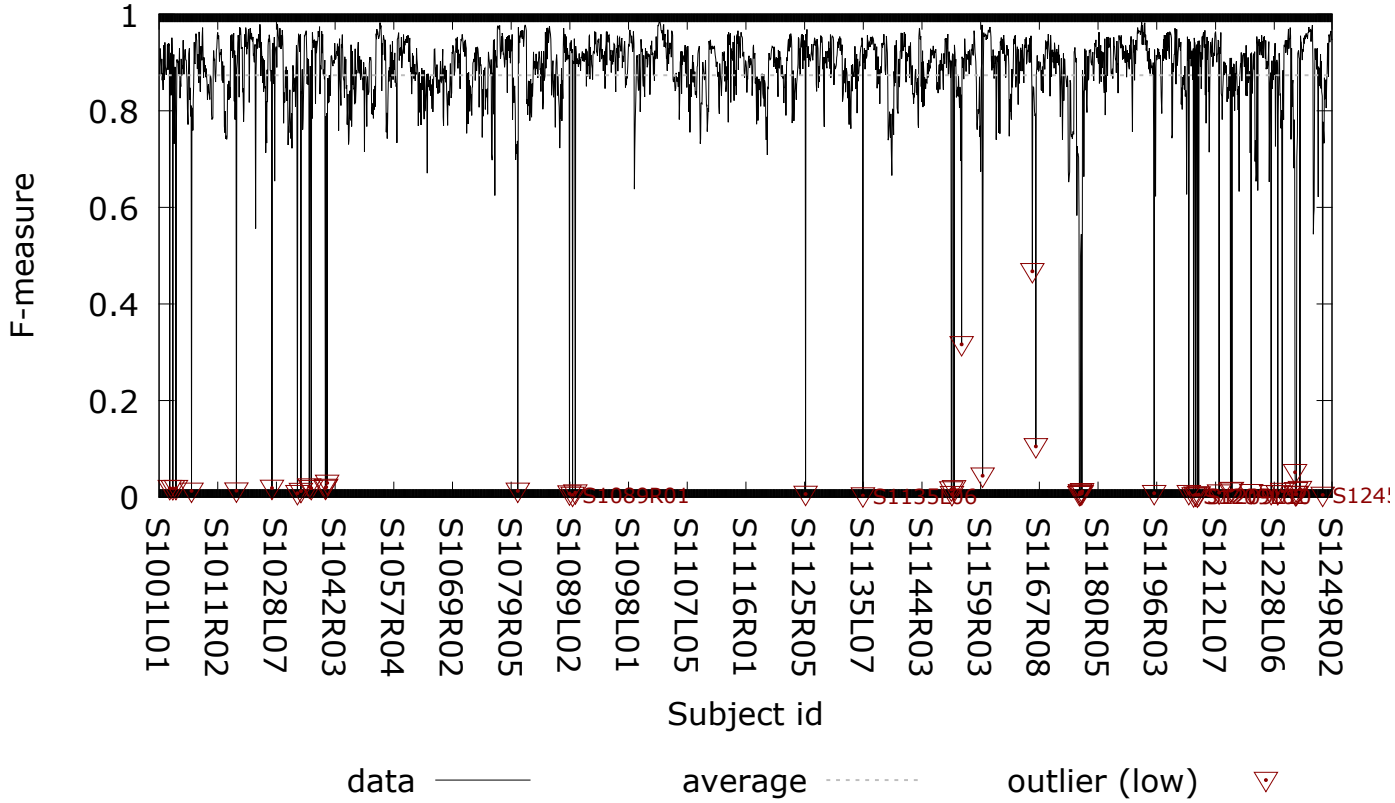
- 1038L

Low outlier per group

- S1038L01

5.4 iffp

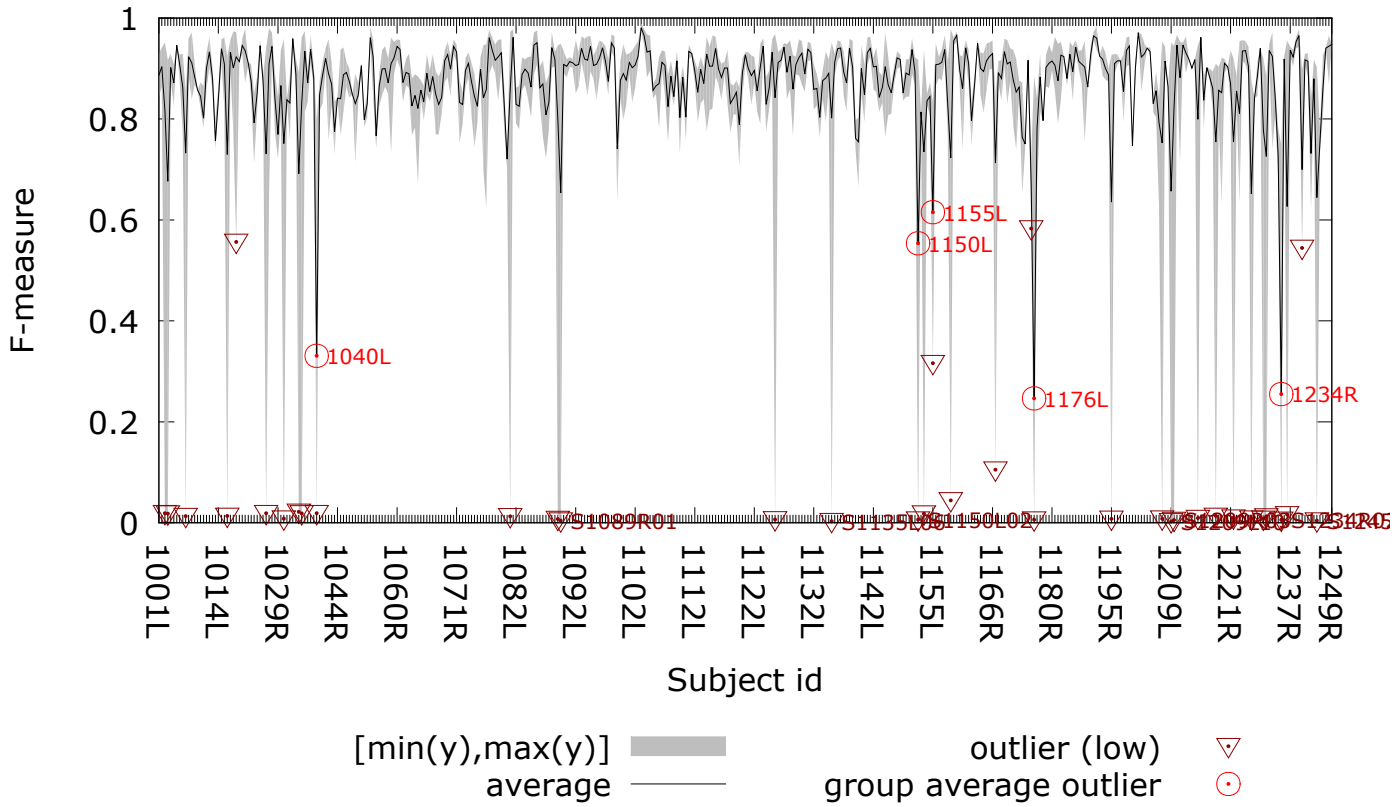
5.4.1 Per Iris Evaluation



Low point outlier

- S1002L05
- S1002R02
- S1002R09
- S1007L05
- S1017R05
- S1027L02
- S1030R02
- S1030R10
- S1035L02
- S1036L01
- S1040L01
- S1040L03
- S1040L05
- S1081L01
- S1089L01
- S1089R01
- S1089R07
- S1125R07
- S1135L06
- S1150L01
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L02
- S1167L10
- S1176L01
- S1176L02
- S1176L03
- S1176L06
- S1176L07
- S1195R02
- S1207R04
- S1209L02
- S1209L06
- S1209L10
- S1209R03
- S1214L04
- S1218R08
- S1218R11
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R01
- S1234R02
- S1234R03
- S1234R04
- S1236R02
- S1245R04

5.4.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

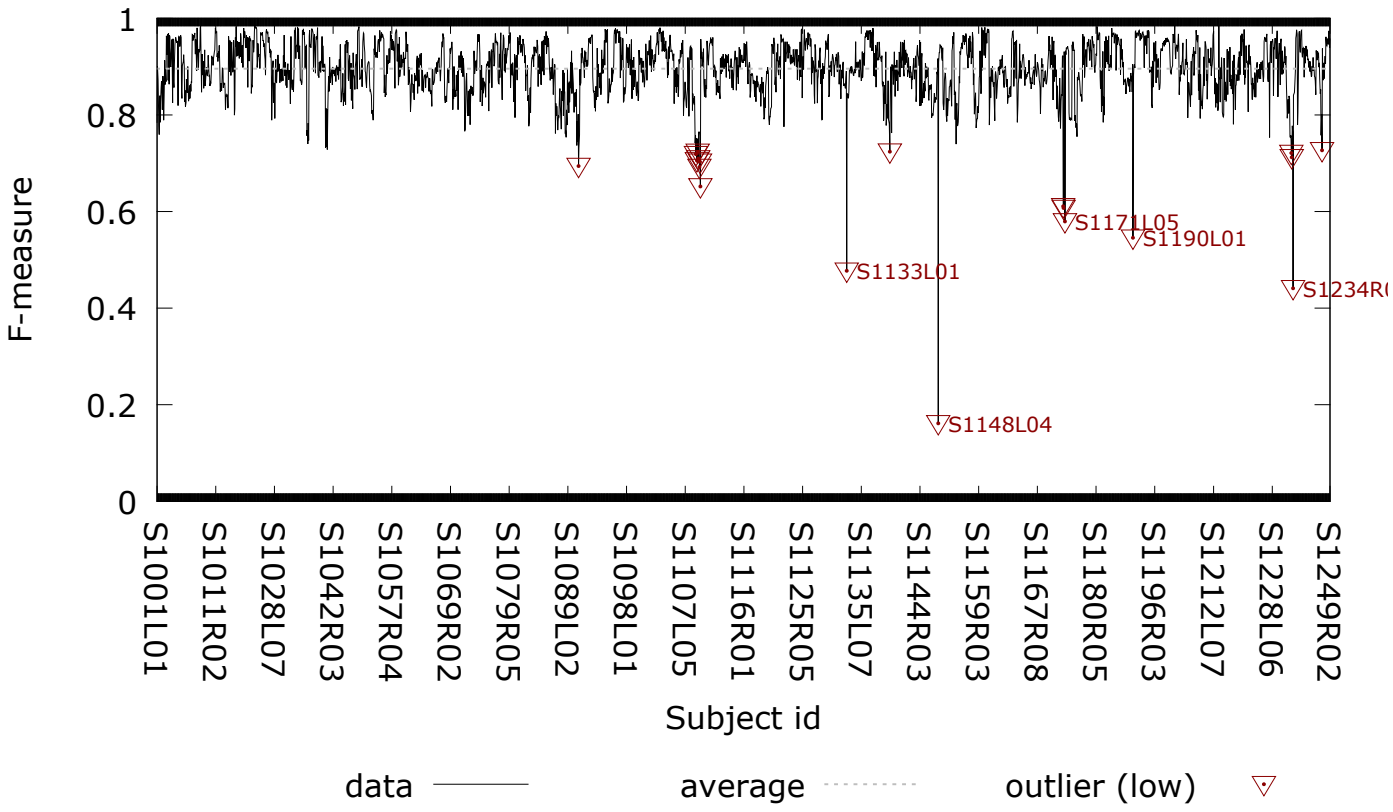
- 1040L
- 1150L
- 1155L
- 1176L
- 1234R

Low outlier per group

- S1002L05
- S1002R02
- S1007L05
- S1017R05
- S1019R25
- S1027L02
- S1030R02
- S1035L02
- S1036L01
- S1040L01
- S1081L01
- S1089L01
- S1089R01
- S1125R07
- S1135L06
- S1150L02
- S1152L01
- S1155L03
- S1159R07
- S1167L10
- S1175L01
- S1176L01
- S1195R02
- S1207R04
- S1209L10
- S1209R03
- S1214L04
- S1218R08
- S1222R07
- S1227L05
- S1229L06
- S1229R06
- S1234R02
- S1236R02
- S1240L02
- S1245R04

5.5 osiris

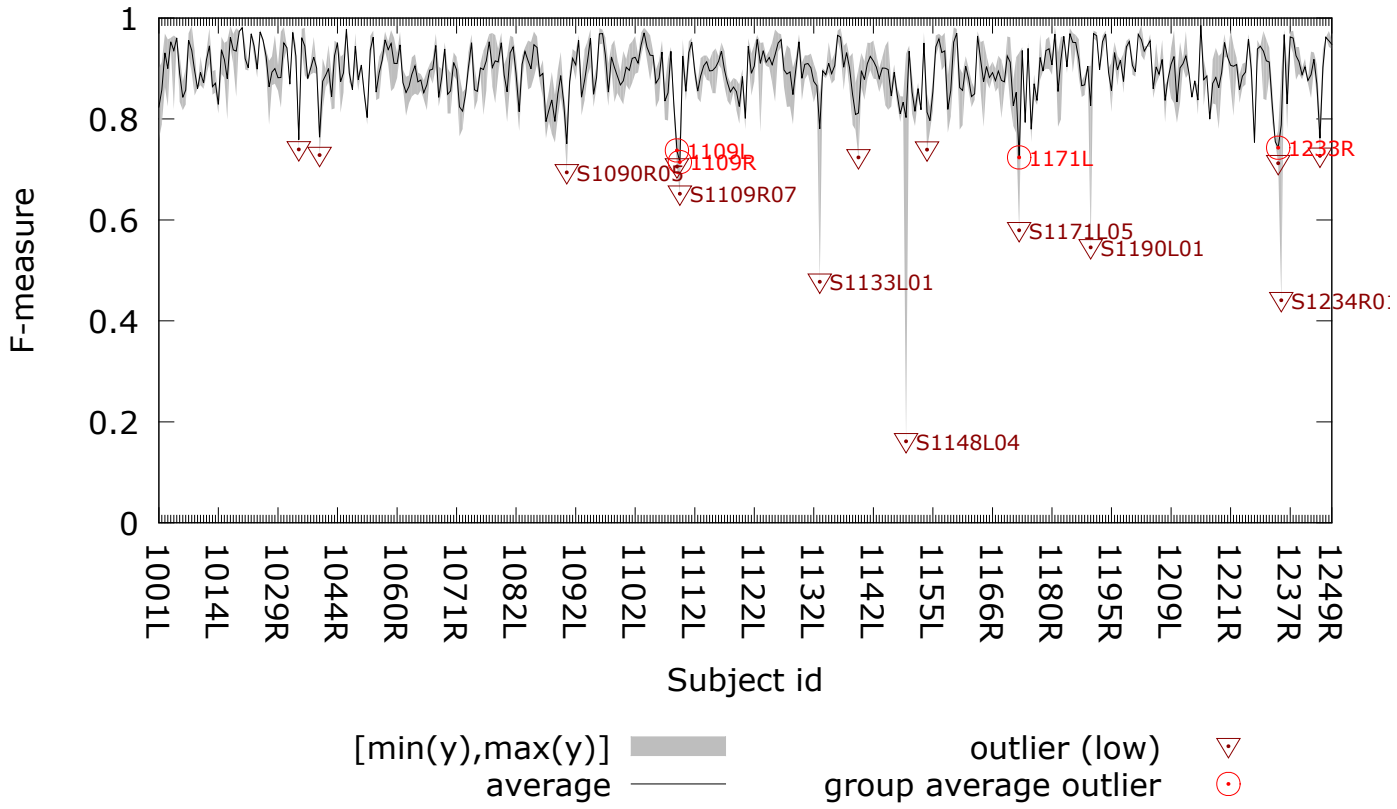
5.5.1 Per Iris Evaluation



Low point outlier

- S1090R05
- S1109L03
- S1109L05
- S1109R01
- S1109R02
- S1109R05
- S1109R06
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1171L01
- S1171L02
- S1171L05
- S1190L01
- S1233R01
- S1233R02
- S1234R01
- S1246R03

5.5.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

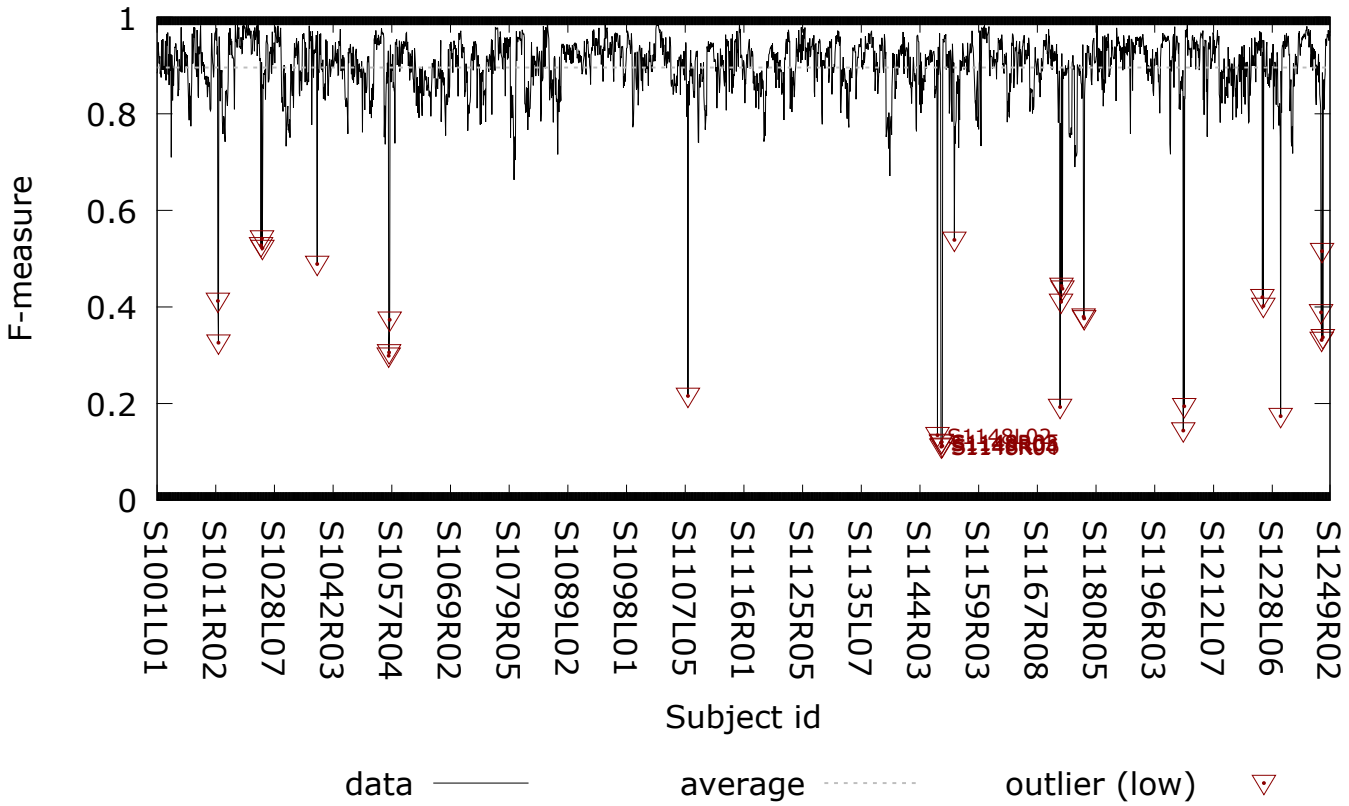
- 1109L
- 1109R
- 1171L
- 1233R

Low outlier per group

- S1035L03
- S1041L05
- S1090R05
- S1109L05
- S1109R07
- S1133L01
- S1139R03
- S1148L04
- S1153L05
- S1171L05
- S1190L01
- S1233R02
- S1234R01
- S1246R03

5.6 wahet

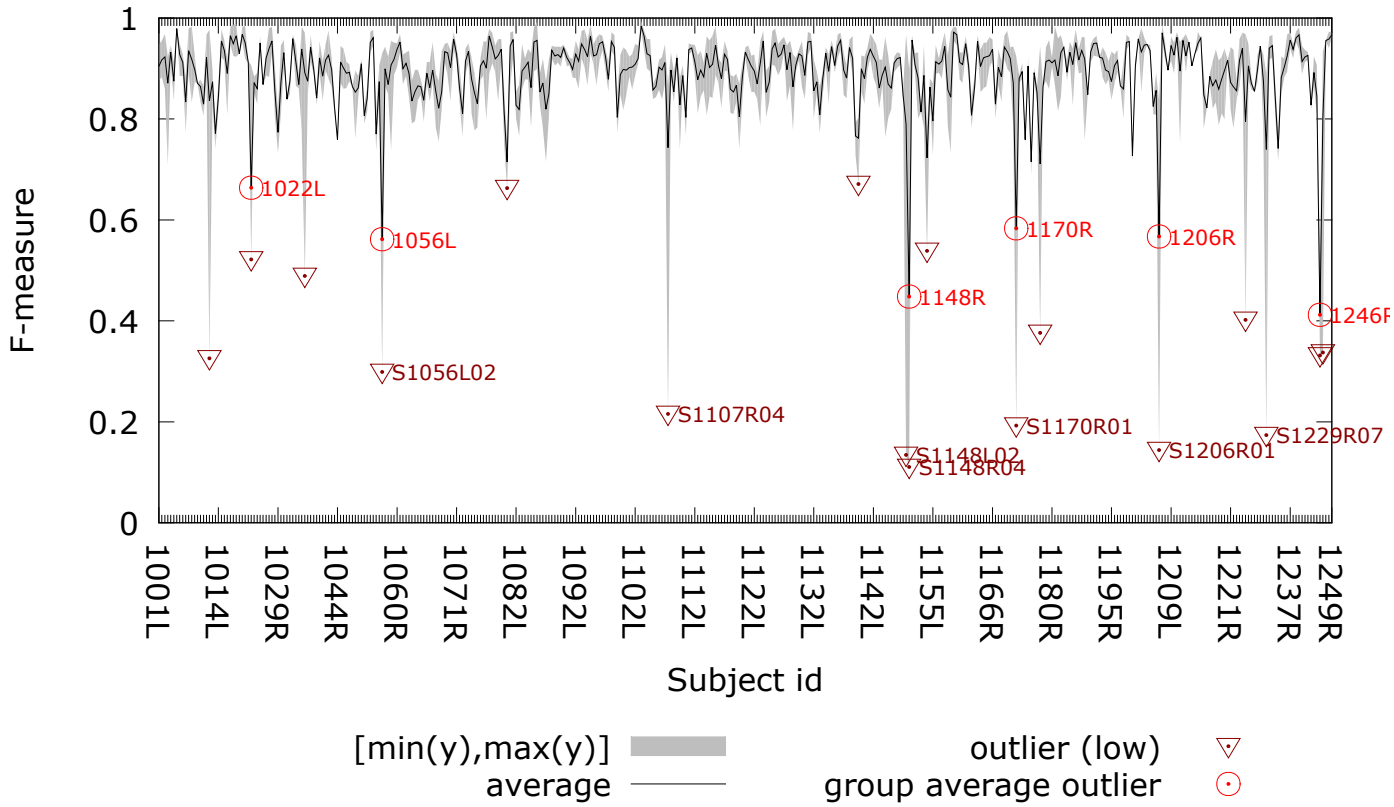
5.6.1 Per Iris Evaluation



Low point outlier

- S1011R07
- S1011R08
- S1022L02
- S1022L04
- S1022L05
- S1036R09
- S1056L02
- S1056L03
- S1056L04
- S1107R04
- S1148L02
- S1148R03
- S1148R04
- S1148R05
- S1148R06
- S1153L01
- S1170R01
- S1170R03
- S1170R04
- S1170R06
- S1178L04
- S1178L05
- S1206R01
- S1206R03
- S1225L04
- S1225L06
- S1229R07
- S1246R01
- S1246R02
- S1246R03
- S1247R02

5.6.2 Grouped Evaluation – `S(\d{4}[LR])`



Group average outlier

- 1022L
- 1056L
- 1148R
- 1170R
- 1206R
- 1246R

Low outlier per group

- S1011R08
- S1022L05
- S1036R09
- S1056L02
- S1080R02
- S1107R04
- S1139R03
- S1148L02
- S1148R04
- S1153L01
- S1170R01
- S1178L05
- S1206R01
- S1225L06
- S1229R07
- S1246R02
- S1247R02

Chapter 6

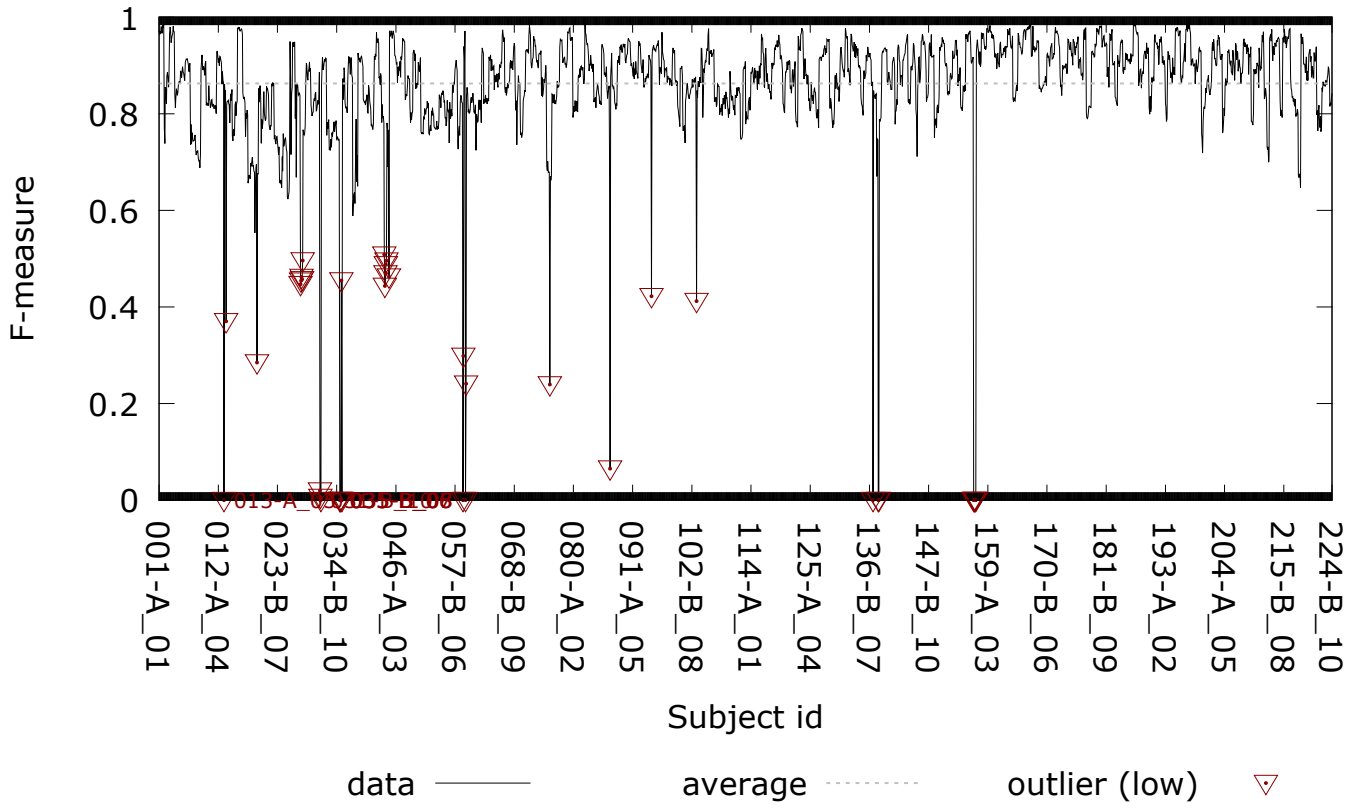
iitd – Operator A

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator A on *iitd*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	96.80%	11.20%	78.87%	13.25%	86.28%	11.39%
gst	90.06%	16.65%	85.86%	10.46%	86.60%	11.87%
iffp	93.92%	10.68%	79.76%	11.42%	85.53%	9.54%
osiris	94.04%	6.43%	91.01%	7.61%	92.23%	5.80%
wahet	97.43%	8.12%	79.42%	12.41%	87.02%	9.72%

6.1 caht

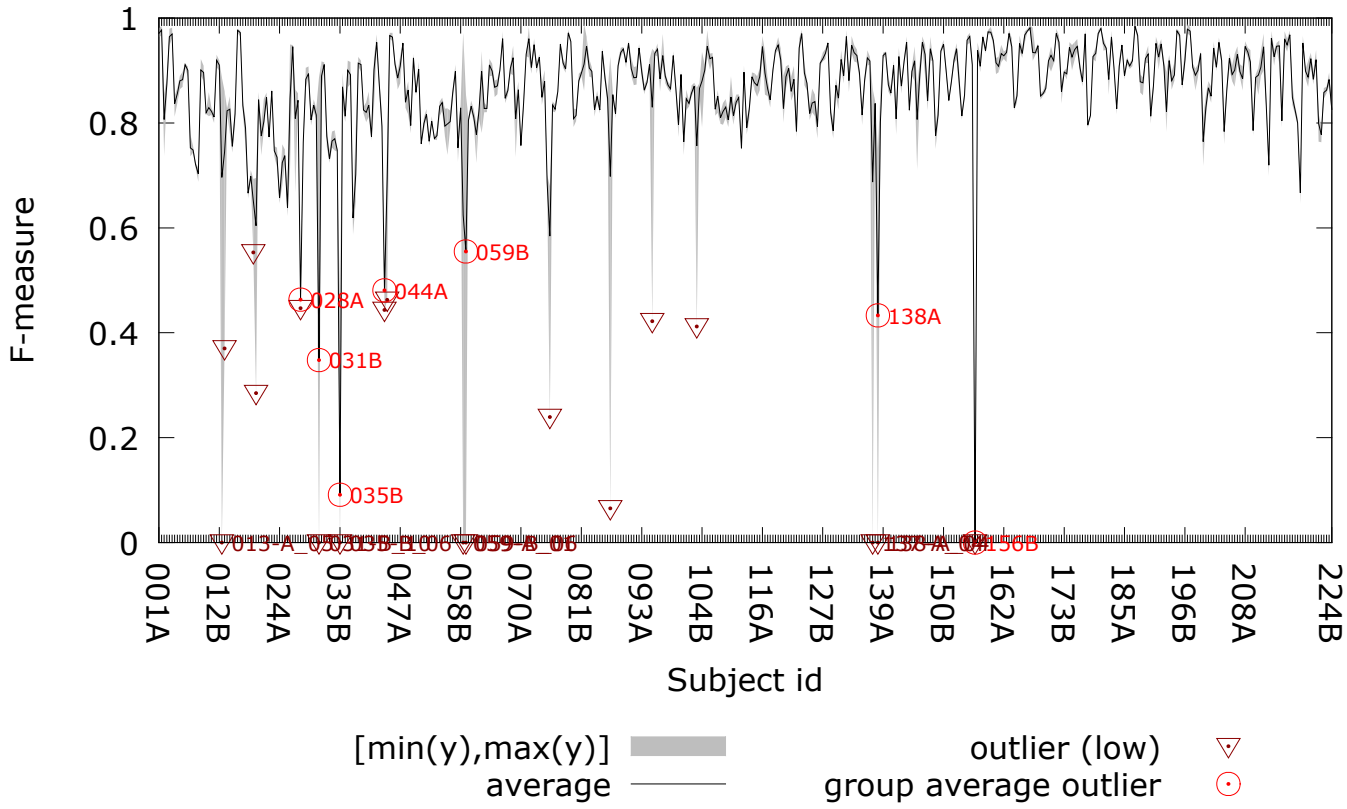
6.1.1 Per Iris Evaluation



Low point outlier

- 013-A_05
- 013-B_09
- 019-B_08
- 028-A_01
- 028-A_02
- 028-A_03
- 028-A_04
- 028-A_05
- 031-B_08
- 031-B_09
- 031-B_10
- 035-B_06
- 035-B_07
- 035-B_08
- 035-B_09
- 035-B_10
- 044-A_01
- 044-A_02
- 044-A_03
- 044-A_04
- 044-A_05
- 044-B_10
- 059-A_01
- 059-A_02
- 059-B_06
- 059-B_07
- 075-B_07
- 087-A_02
- 095-A_01
- 103-B_07
- 137-A_04
- 138-A_04
- 138-A_05
- 156-B_06
- 156-B_07
- 156-B_08
- 156-B_09
- 156-B_10

6.1.2 Grouped Evaluation – `(\d{3})-(.)`



Group average outlier

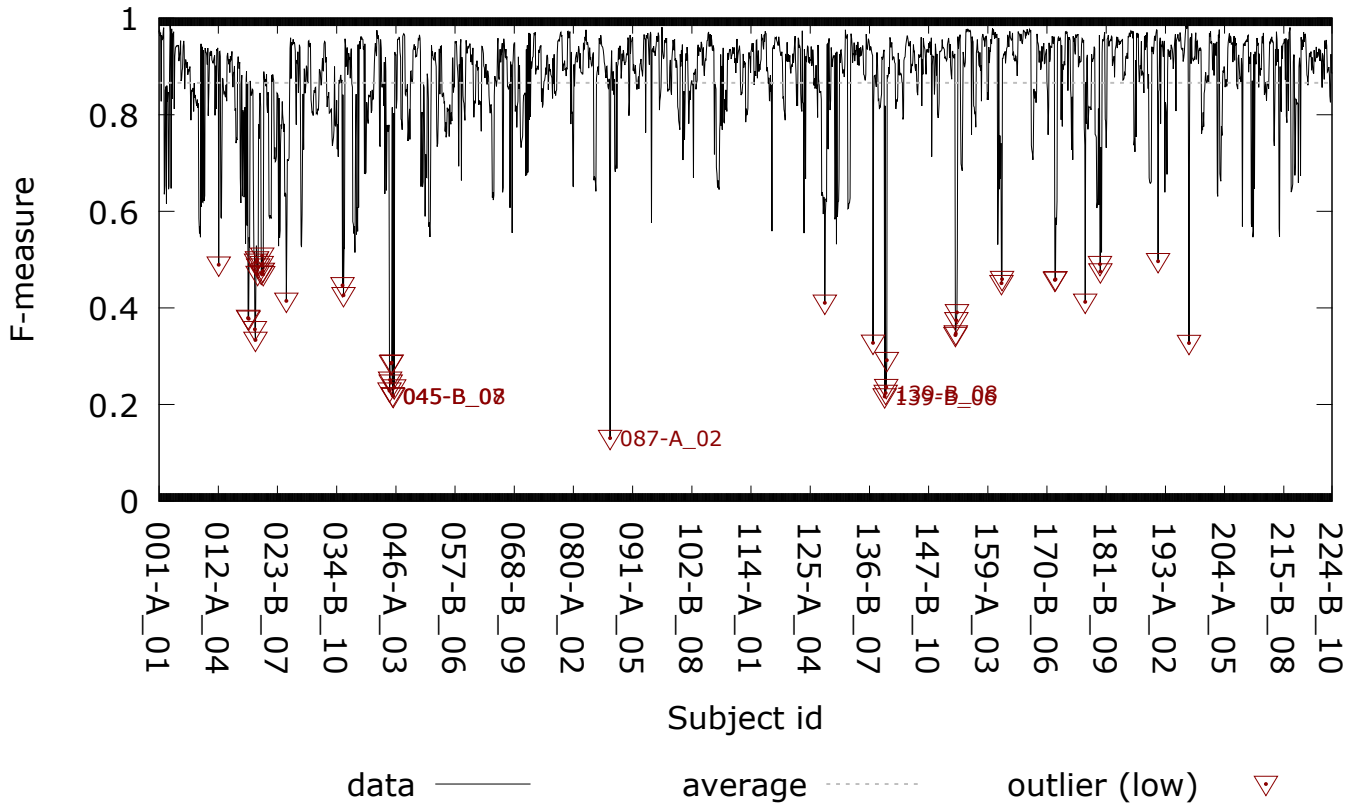
- 028A
- 031B
- 035B
- 044A
- 059B
- 138A
- 156B

Low outlier per group

- 013-A_05
- 013-B_09
- 019-A_04
- 019-B_08
- 028-A_01
- 031-B_10
- 035-B_06
- 044-A_02
- 044-B_10
- 059-A_01
- 059-B_06
- 075-B_07
- 087-A_02
- 095-A_01
- 103-B_07
- 137-A_04
- 138-A_04
- 156-B_06

6.2 gst

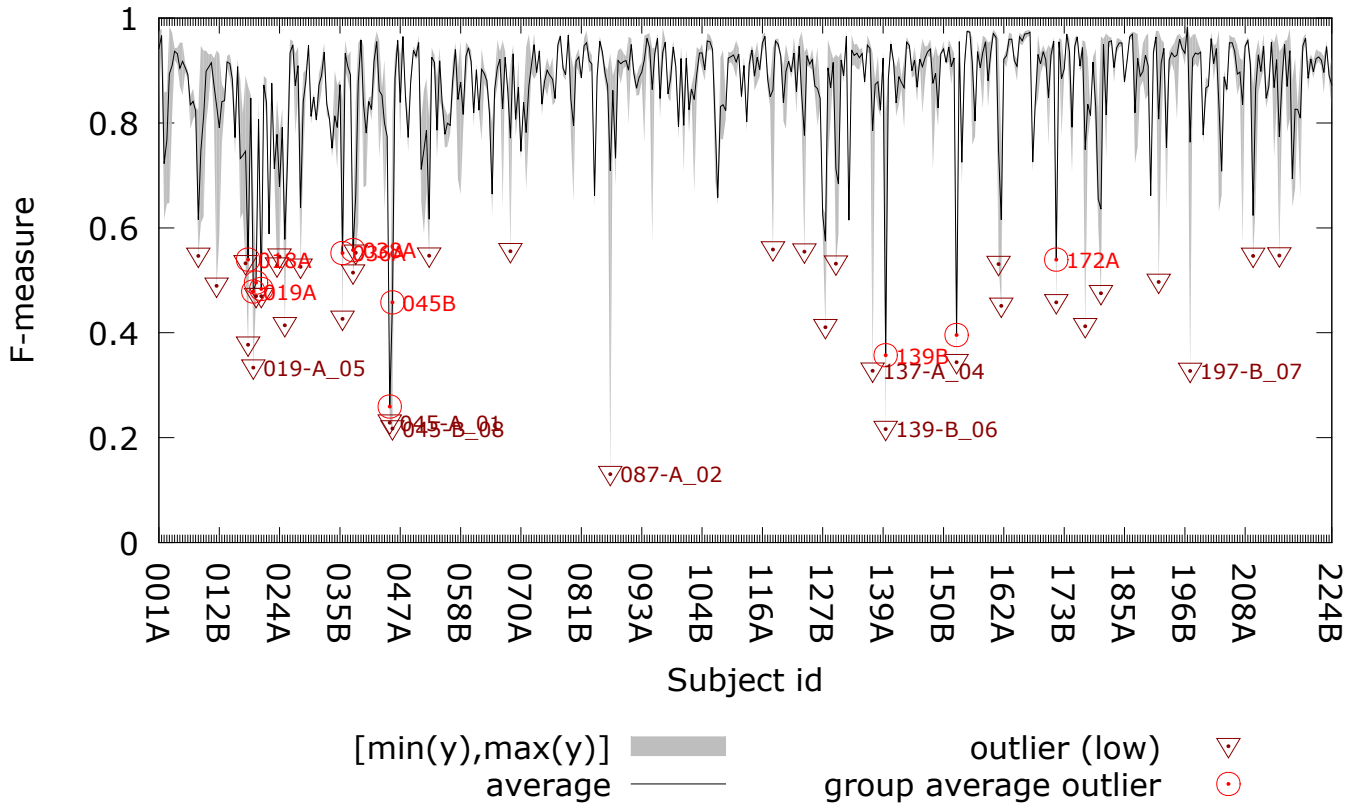
6.2.1 Per Iris Evaluation



Low point outlier

- 012-A_05
- 018-A_01
- 018-A_02
- 019-A_04
- 019-A_05
- 019-B_06
- 019-B_08
- 019-B_09
- 019-B_10
- 020-B_06
- 020-B_07
- 020-B_08
- 020-B_09
- 020-B_10
- 025-A_04
- 036-A_01
- 036-A_03
- 045-A_01
- 045-A_02
- 045-A_03
- 045-A_04
- 045-A_05
- 045-B_07
- 045-B_08
- 045-B_10
- 087-A_02
- 128-A_02
- 137-A_04
- 139-B_06
- 139-B_08
- 139-B_09
- 139-B_10
- 153-A_01
- 153-A_02
- 153-A_03
- 153-A_04
- 161-B_09
- 161-B_10
- 172-A_01
- 172-A_02
- 177-B_09
- 180-B_07
- 180-B_08
- 191-B_08
- 197-B_07

6.2.2 Grouped Evaluation – `(\d{3})-(.)`



Group average outlier

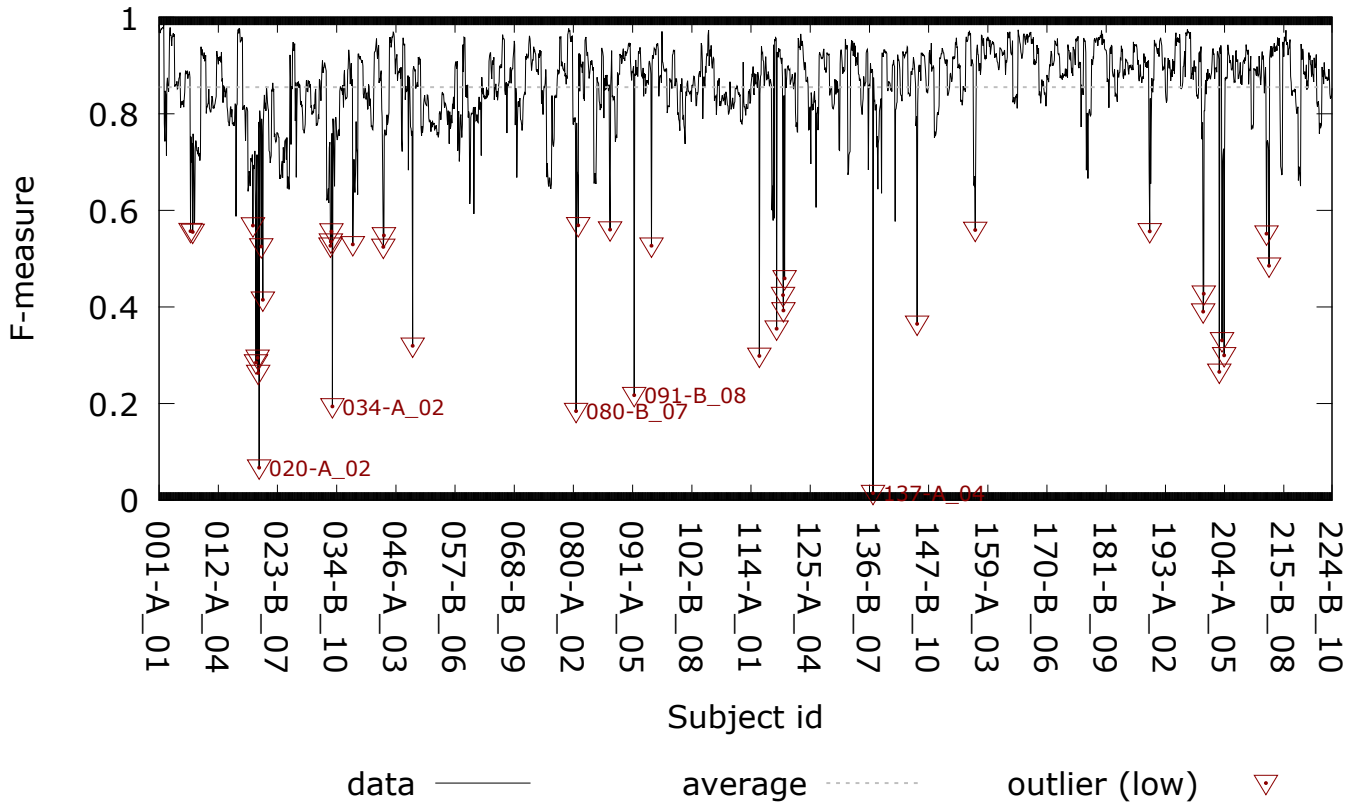
- 018A
- 019A
- 019B
- 020B
- 036A
- 038A
- 045A
- 045B
- 139B
- 153A
- 172A

Low outlier per group

- 008-B_10
- 012-A_05
- 017-B_06
- 018-A_02
- 019-A_05
- 019-B_09
- 020-B_10
- 023-B_09
- 024-A_01
- 025-A_04
- 028-A_03
- 036-A_03
- 038-A_05
- 038-B_08
- 045-A_01
- 045-B_08
- 052-B_08
- 068-A_05
- 087-A_02
- 118-A_01
- 124-A_02
- 128-A_02
- 130-A_04
- 137-A_04
- 139-B_06
- 153-A_01
- 161-A_02
- 161-B_09
- 172-A_01
- 177-B_09
- 180-B_08
- 191-B_08
- 197-B_07
- 209-B_09
- 214-B_10

6.3 iffp

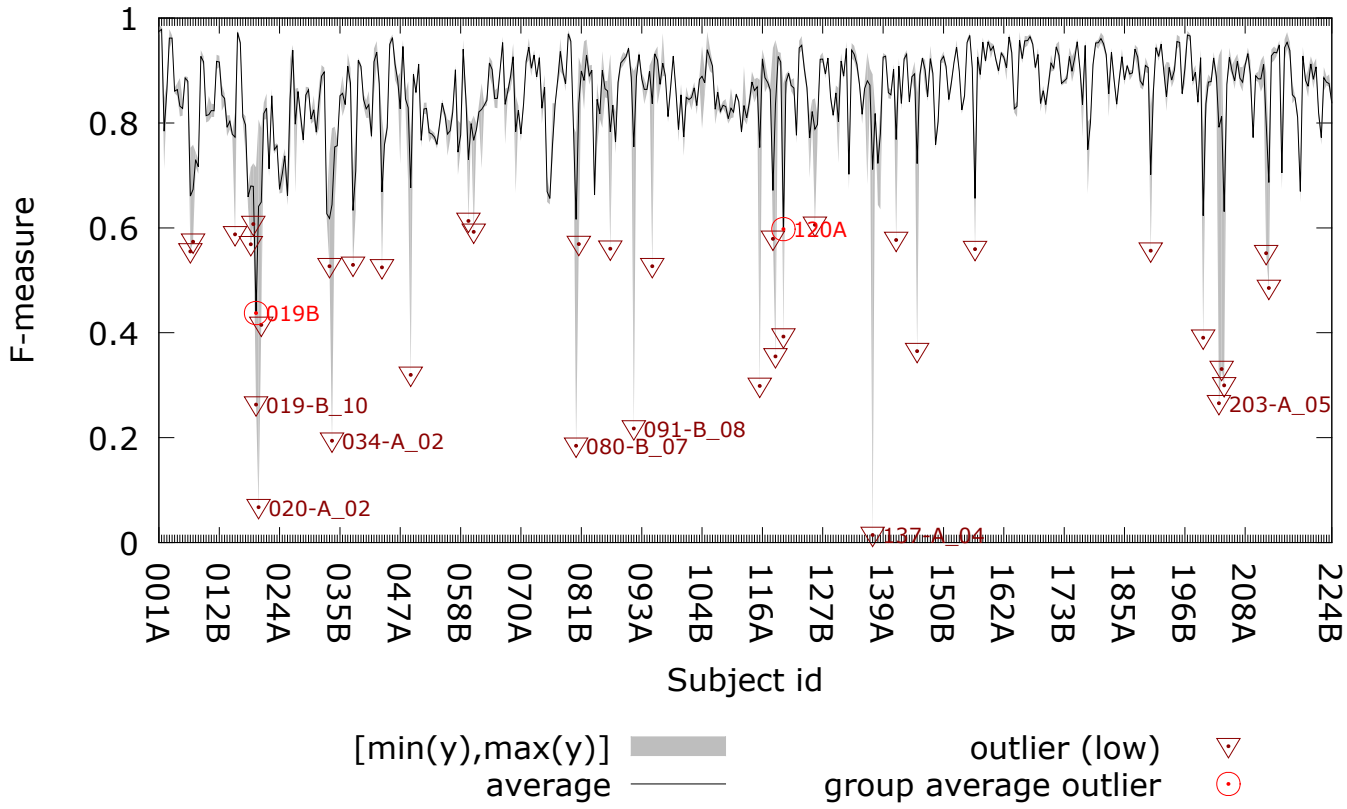
6.3.1 Per Iris Evaluation



Low point outlier

- 007-A_01
- 007-A_05
- 018-B_10
- 019-B_06
- 019-B_09
- 019-B_10
- 020-A_02
- 020-B_06
- 020-B_09
- 033-B_08
- 033-B_09
- 033-B_10
- 034-A_02
- 038-A_01
- 043-B_09
- 043-B_10
- 049-A_05
- 080-B_07
- 081-A_01
- 087-A_02
- 091-B_08
- 095-A_01
- 115-B_07
- 118-B_10
- 120-A_02
- 120-A_03
- 120-A_05
- 137-A_04
- 145-B_08
- 156-B_09
- 190-A_02
- 200-A_04
- 200-A_05
- 203-A_05
- 203-B_10
- 204-A_04
- 212-A_05
- 212-B_10

6.3.2 Grouped Evaluation – `(\d{3})-(.)`



Group average outlier

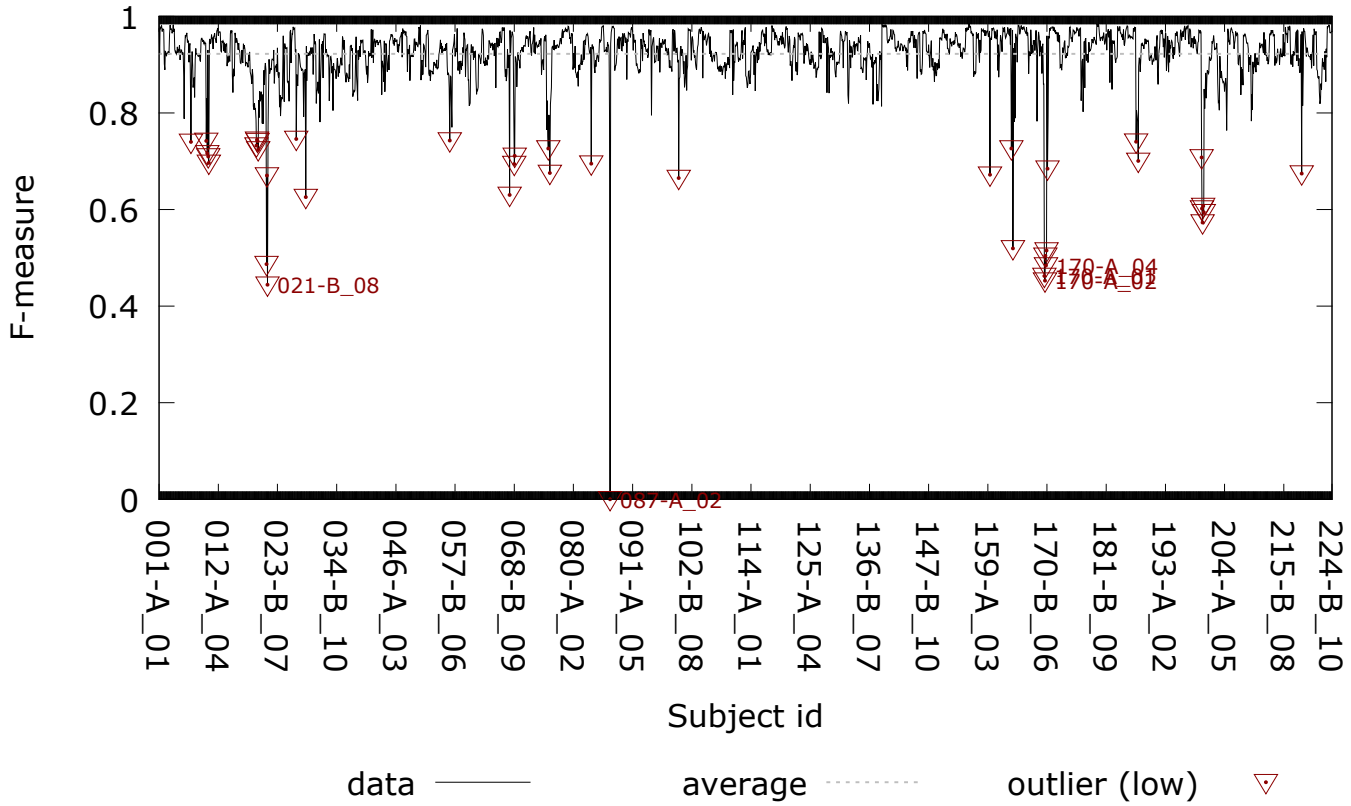
- 019B
- 120A

Low outlier per group

- 007-A_05
- 007-B_08
- 015-B_08
- 018-B_10
- 019-A_05
- 019-B_10
- 020-A_02
- 020-B_09
- 033-B_08
- 034-A_02
- 038-A_01
- 043-B_09
- 049-A_05
- 060-A_04
- 061-A_02
- 080-B_07
- 081-A_01
- 087-A_02
- 091-B_08
- 095-A_01
- 115-B_07
- 118-A_03
- 118-B_10
- 120-A_03
- 126-A_05
- 137-A_04
- 141-B_06
- 145-B_08
- 156-B_09
- 190-A_02
- 200-A_04
- 203-A_05
- 203-B_10
- 204-A_04
- 212-A_05
- 212-B_10

6.4 osiris

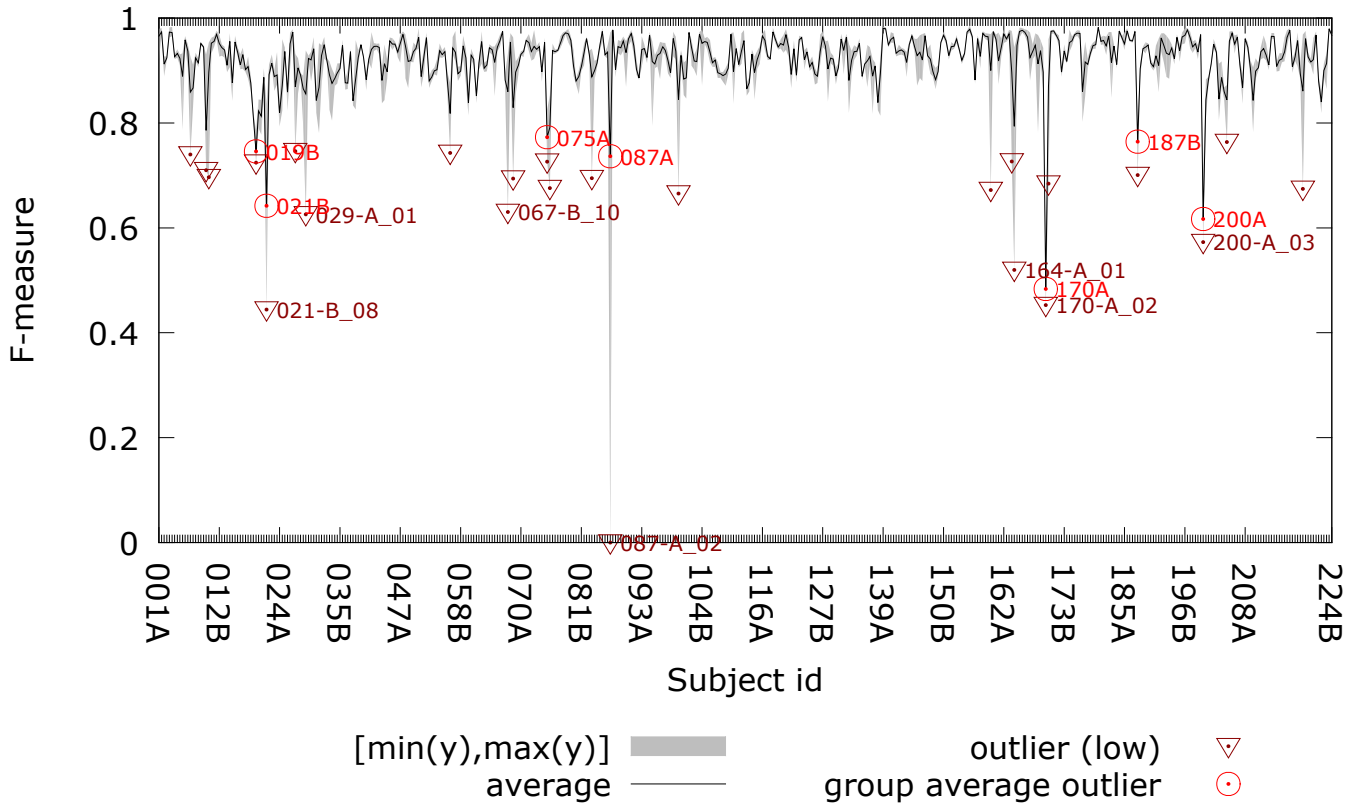
6.4.1 Per Iris Evaluation



Low point outlier

- 007-A_02
- 010-A_01
- 010-A_03
- 010-A_05
- 010-B_06
- 019-B_07
- 019-B_08
- 019-B_09
- 019-B_10
- 021-B_06
- 021-B_07
- 021-B_08
- 027-A_03
- 029-A_01
- 056-B_06
- 067-B_10
- 068-B_09
- 068-B_10
- 075-A_04
- 075-B_07
- 083-B_06
- 087-A_02
- 100-A_03
- 159-B_07
- 163-B_08
- 164-A_01
- 170-A_01
- 170-A_02
- 170-A_03
- 170-A_04
- 170-A_05
- 170-B_07
- 187-B_06
- 187-B_10
- 200-A_01
- 200-A_02
- 200-A_03
- 200-A_04
- 200-A_05
- 219-A_02

6.4.2 Grouped Evaluation – `(\d{3})-(.)`



Group average outlier

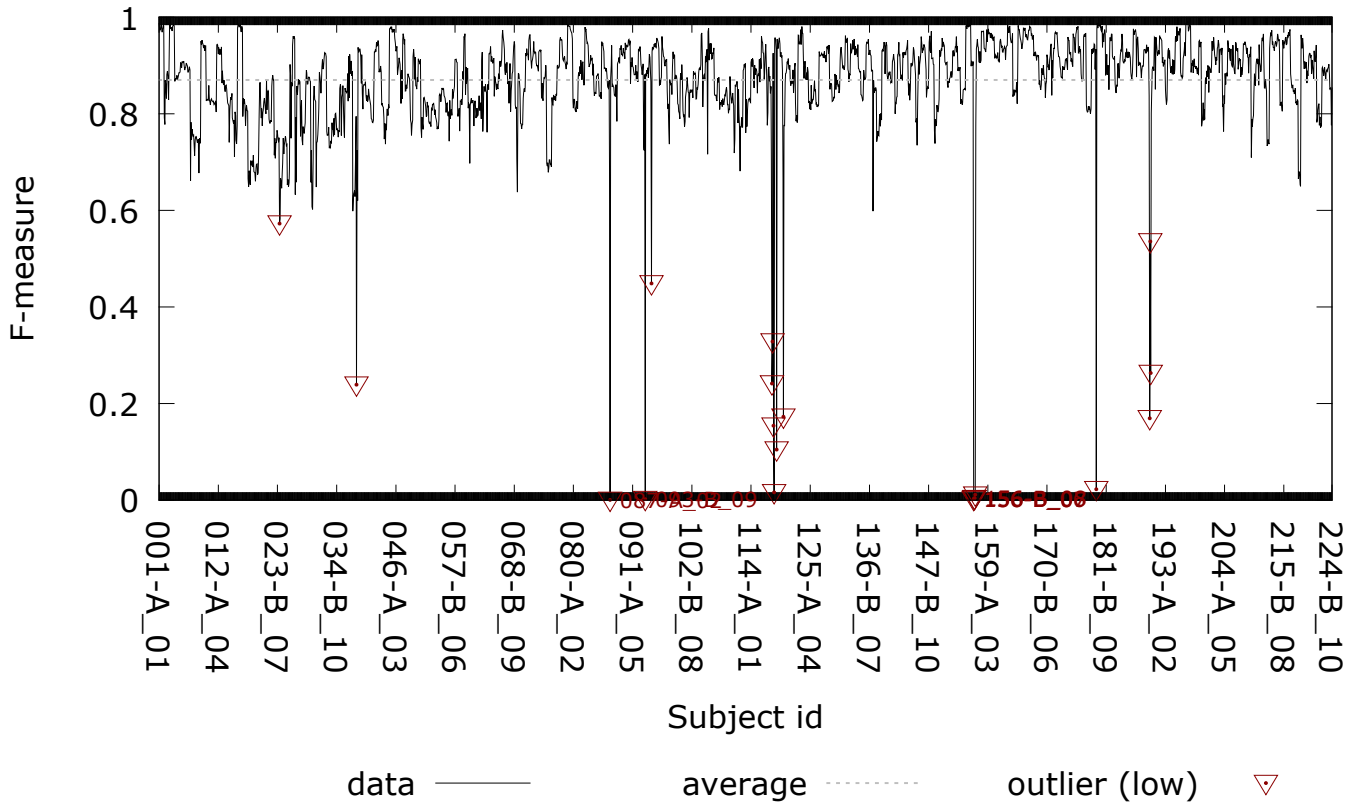
- 019B
- 021B
- 075A
- 087A
- 170A
- 187B
- 200A

Low outlier per group

- 007-A_02
- 010-A_05
- 010-B_06
- 019-B_10
- 021-B_08
- 027-A_03
- 029-A_01
- 056-B_06
- 067-B_10
- 068-B_09
- 075-A_04
- 075-B_07
- 083-B_06
- 087-A_02
- 100-A_03
- 159-B_07
- 163-B_08
- 164-A_01
- 170-A_02
- 170-B_07
- 187-B_10
- 200-A_03
- 204-B_09
- 219-A_02

6.5 wahet

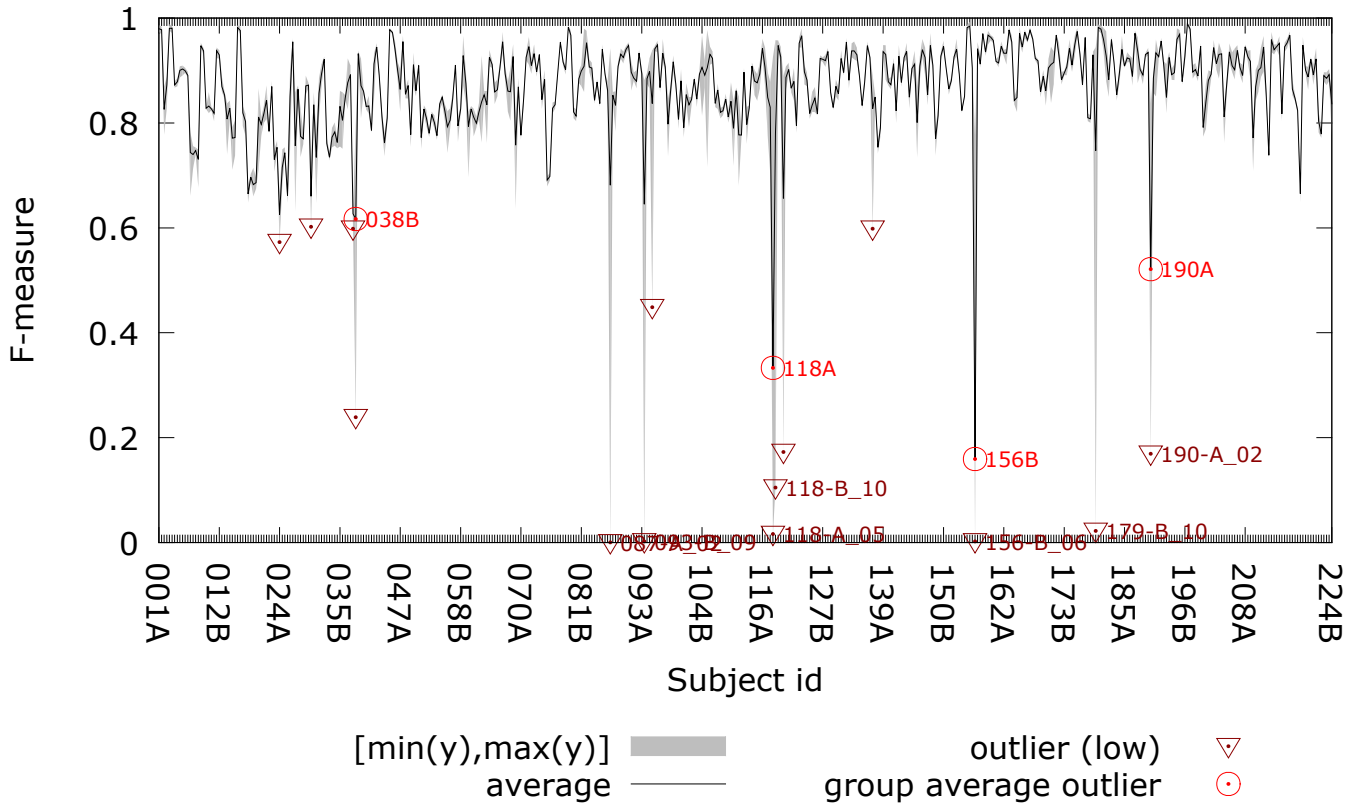
6.5.1 Per Iris Evaluation



Low point outlier

- 024-A_01
- 038-B_08
- 087-A_02
- 093-B_09
- 095-A_01
- 118-A_01
- 118-A_02
- 118-A_04
- 118-A_05
- 118-B_10
- 120-A_03
- 156-B_06
- 156-B_07
- 156-B_08
- 156-B_09
- 179-B_10
- 190-A_02
- 190-A_03
- 190-A_04

6.5.2 Grouped Evaluation – `(\d{3})-(.)`



Group average outlier

- 038B
- 118A
- 156B
- 190A

Low outlier per group

- 024-A_01
- 030-A_04
- 038-A_01
- 038-B_08
- 087-A_02
- 093-B_09
- 095-A_01
- 118-A_05
- 118-B_10
- 120-A_03
- 137-A_04
- 156-B_06
- 179-B_10
- 190-A_02

Chapter 7

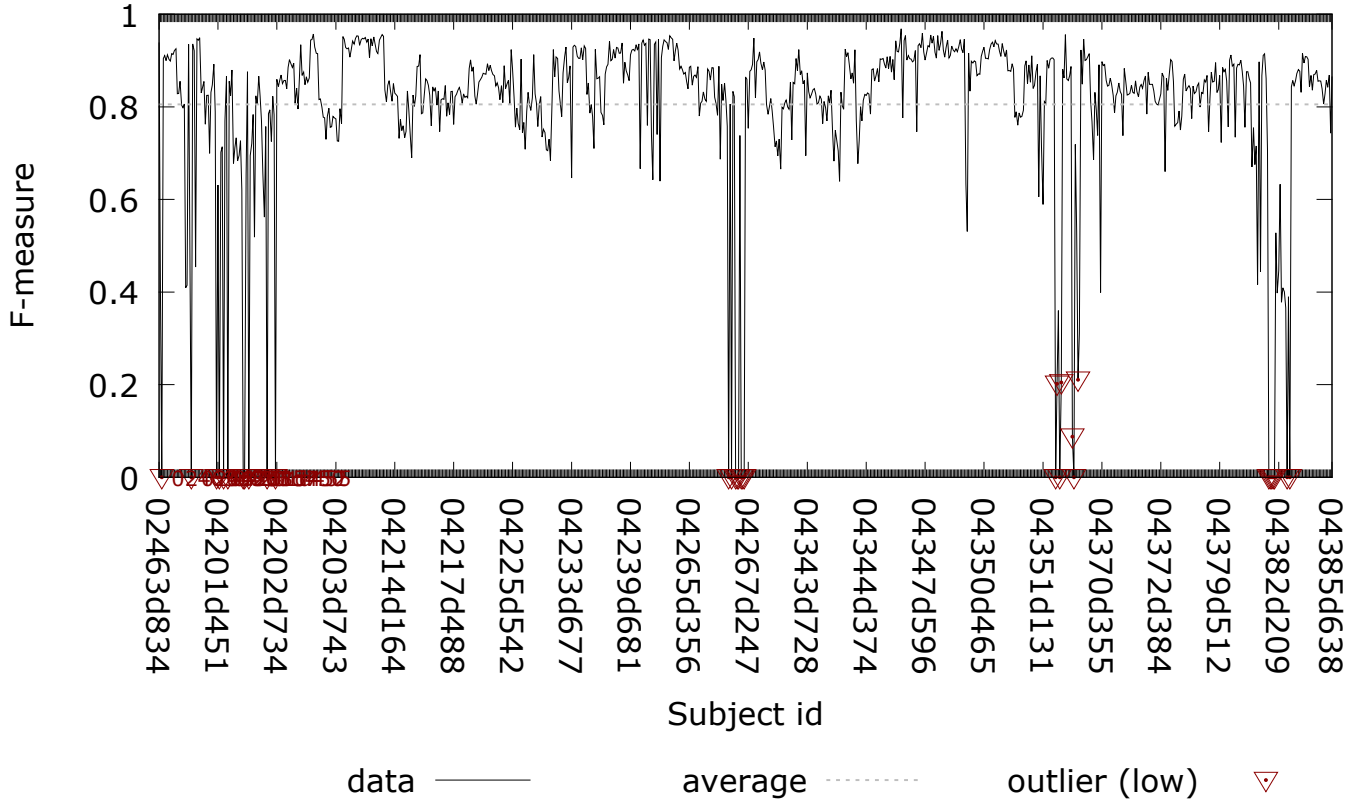
notredame – Operator A

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator A on *notredame*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	91.32%	20.11%	72.71%	18.62%	80.51%	18.57%
gst	91.07%	12.57%	83.72%	10.83%	86.44%	9.57%
iffp	92.62%	9.83%	79.55%	13.93%	85.06%	11.05%
osiris	90.00%	6.68%	95.08%	5.23%	92.27%	4.61%
wahet	93.65%	12.12%	82.24%	14.03%	86.79%	11.85%

7.1 caht

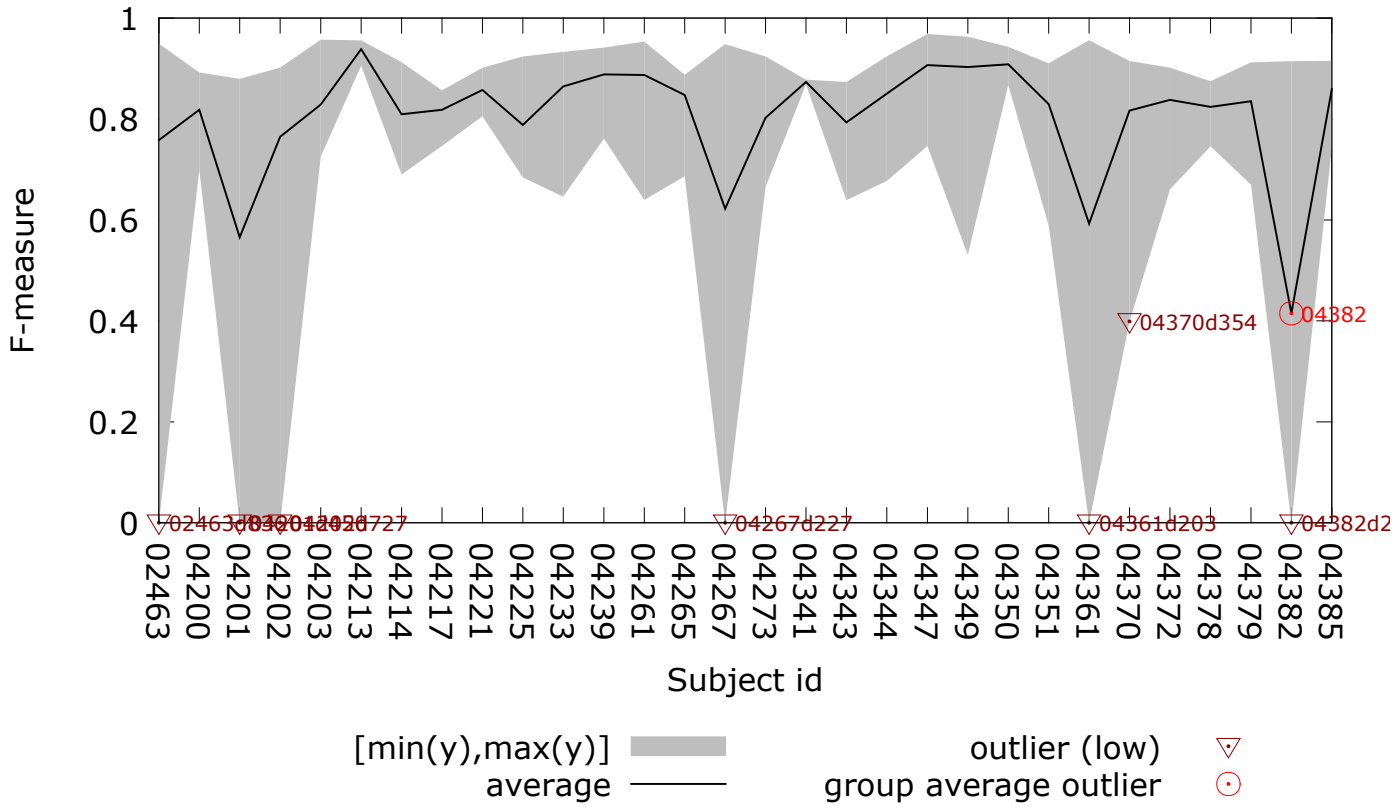
7.1.1 Per Iris Evaluation



Low point outlier

- 02463d836
- 02463d857
- 04201d450
- 04201d452
- 04201d455
- 04201d458
- 04201d469
- 04201d470
- 04201d473
- 04202d727
- 04202d733
- 04267d227
- 04267d229
- 04267d232
- 04267d239
- 04267d240
- 04267d242
- 04267d243
- 04267d244
- 04361d203
- 04361d204
- 04361d206
- 04361d207
- 04361d215
- 04361d216
- 04361d219
- 04382d202
- 04382d203
- 04382d204
- 04382d205
- 04382d206
- 04382d215
- 04382d217

7.1.2 Grouped Evaluation – `(\d*)d`



Group average outlier

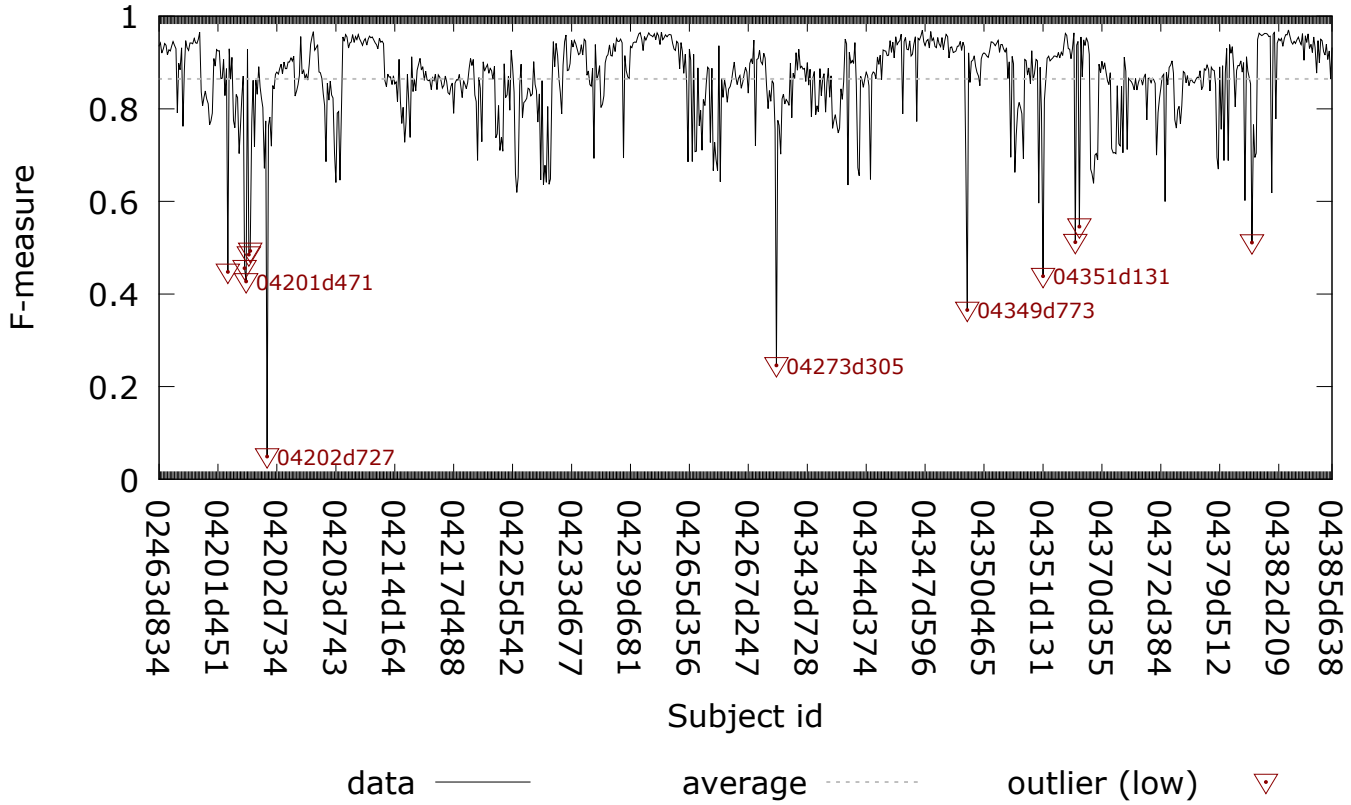
- 04382

Low outlier per group

- 02463d836
- 04201d450
- 04202d727
- 04267d227
- 04361d203
- 04370d354
- 04382d202

7.2 gst

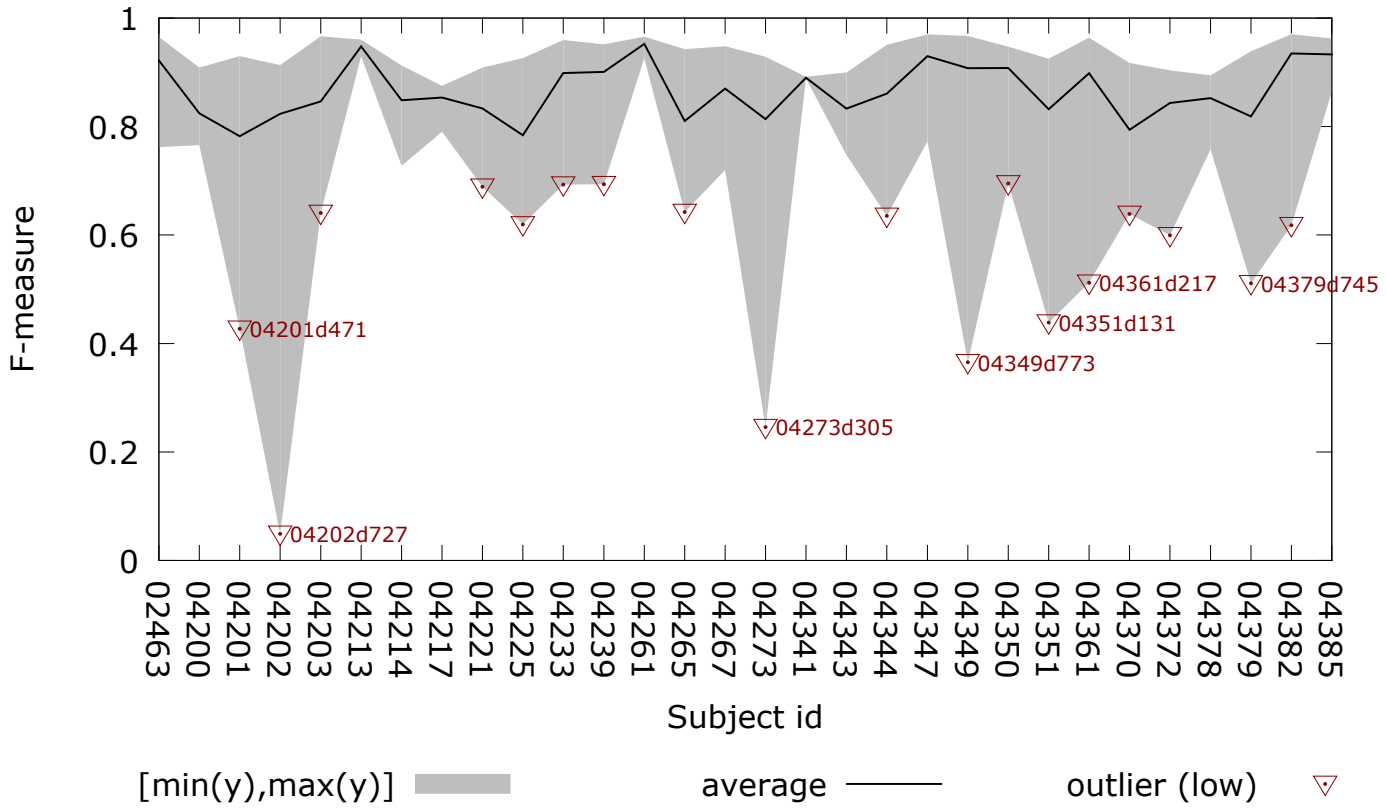
7.2.1 Per Iris Evaluation



Low point outlier

- 04201d458
- 04201d470
- 04201d471
- 04201d473
- 04201d474
- 04202d727
- 04273d305
- 04349d773
- 04351d131
- 04361d217
- 04361d220
- 04379d745

7.2.2 Grouped Evaluation – `(\d*)d`

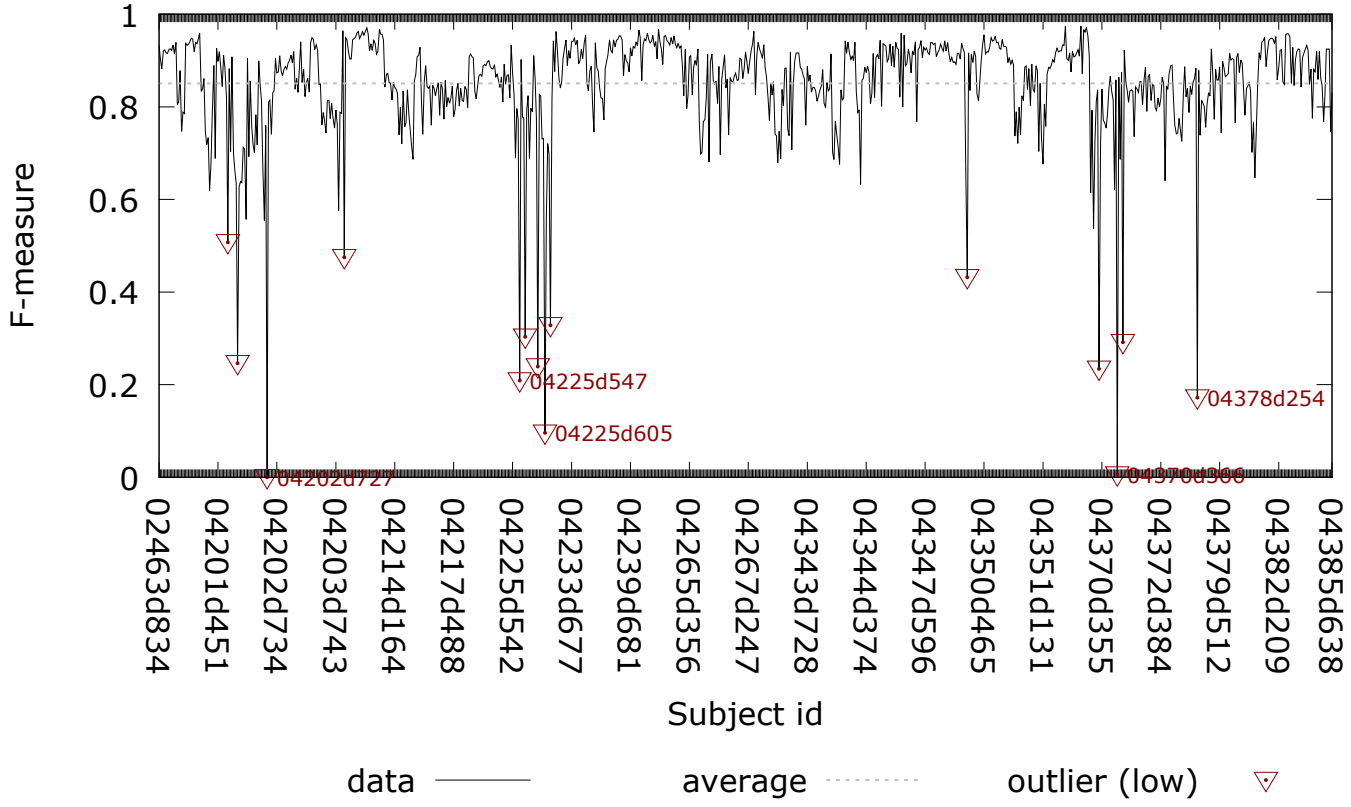


Low outlier per group

- 04201d471
- 04202d727
- 04203d743
- 04221d723
- 04225d545
- 04233d956
- 04239d676
- 04265d378
- 04273d305
- 04344d361
- 04349d773
- 04350d615
- 04351d131
- 04361d217
- 04370d349
- 04372d387
- 04379d745
- 04382d204

7.3 iffp

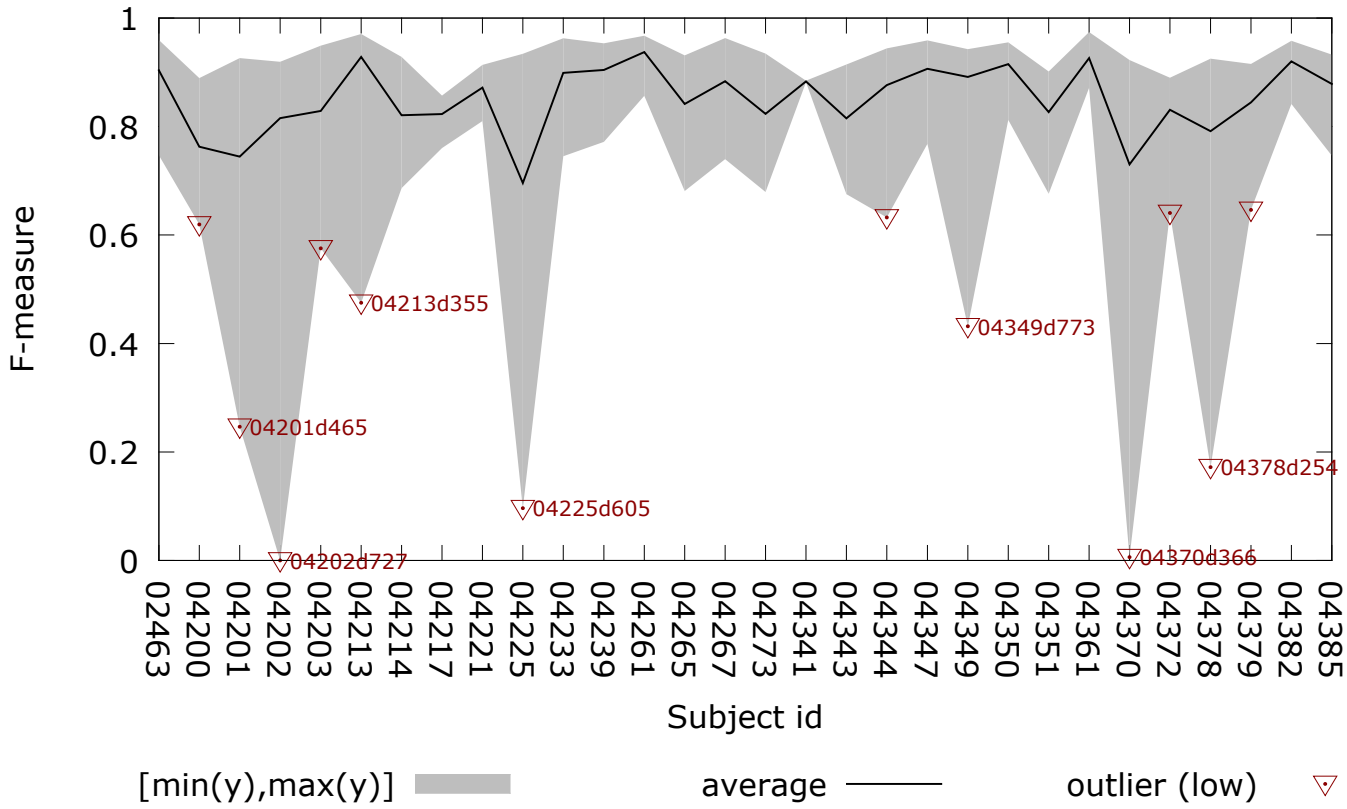
7.3.1 Per Iris Evaluation



Low point outlier

- 04201d458
- 04201d465
- 04202d727
- 04213d355
- 04225d547
- 04225d551
- 04225d560
- 04225d605
- 04225d609
- 04349d773
- 04370d353
- 04370d366
- 04370d370
- 04378d254

7.3.2 Grouped Evaluation – `(\d*)d`

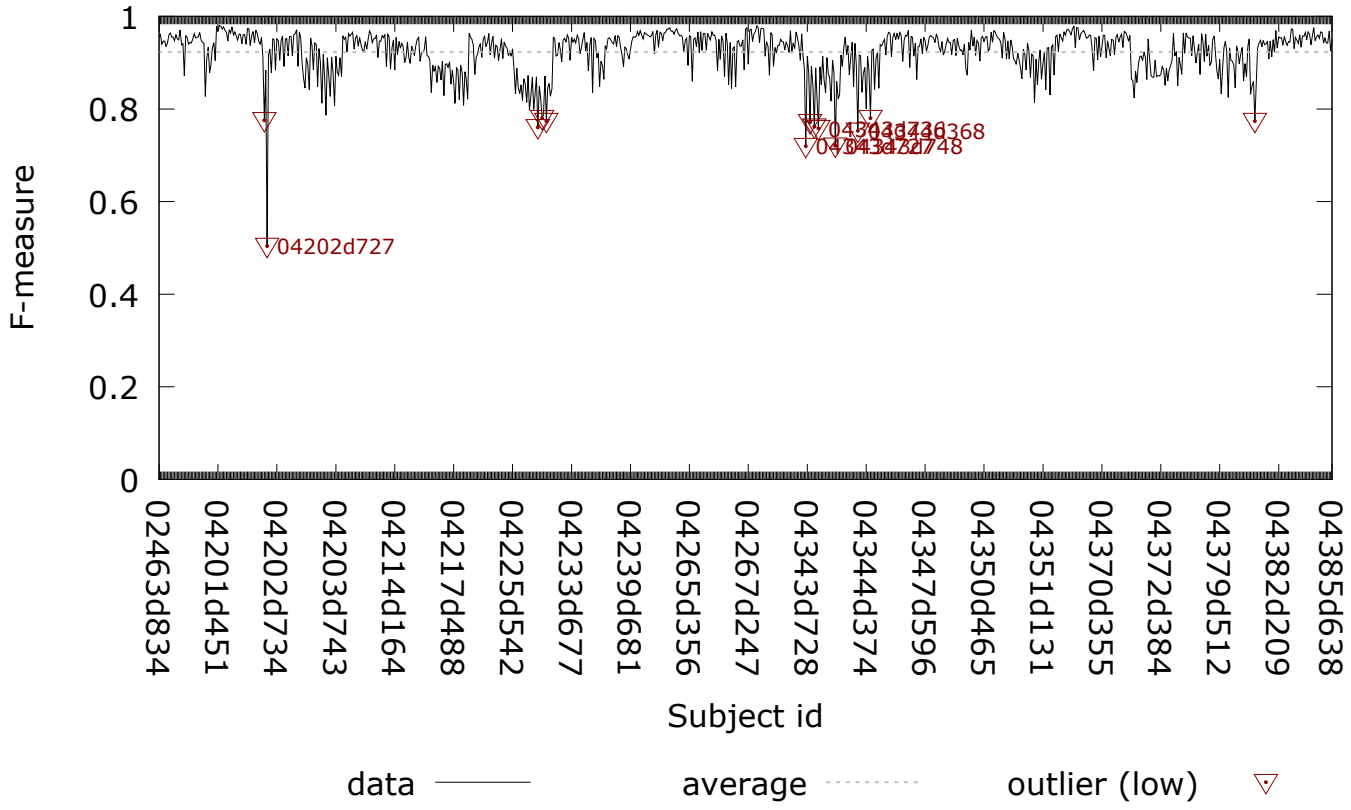


Low outlier per group

- 04200d084
- 04201d465
- 04202d727
- 04203d745
- 04213d355
- 04225d605
- 04344d370
- 04349d773
- 04370d366
- 04372d387
- 04378d254
- 04379d747

7.4 osiris

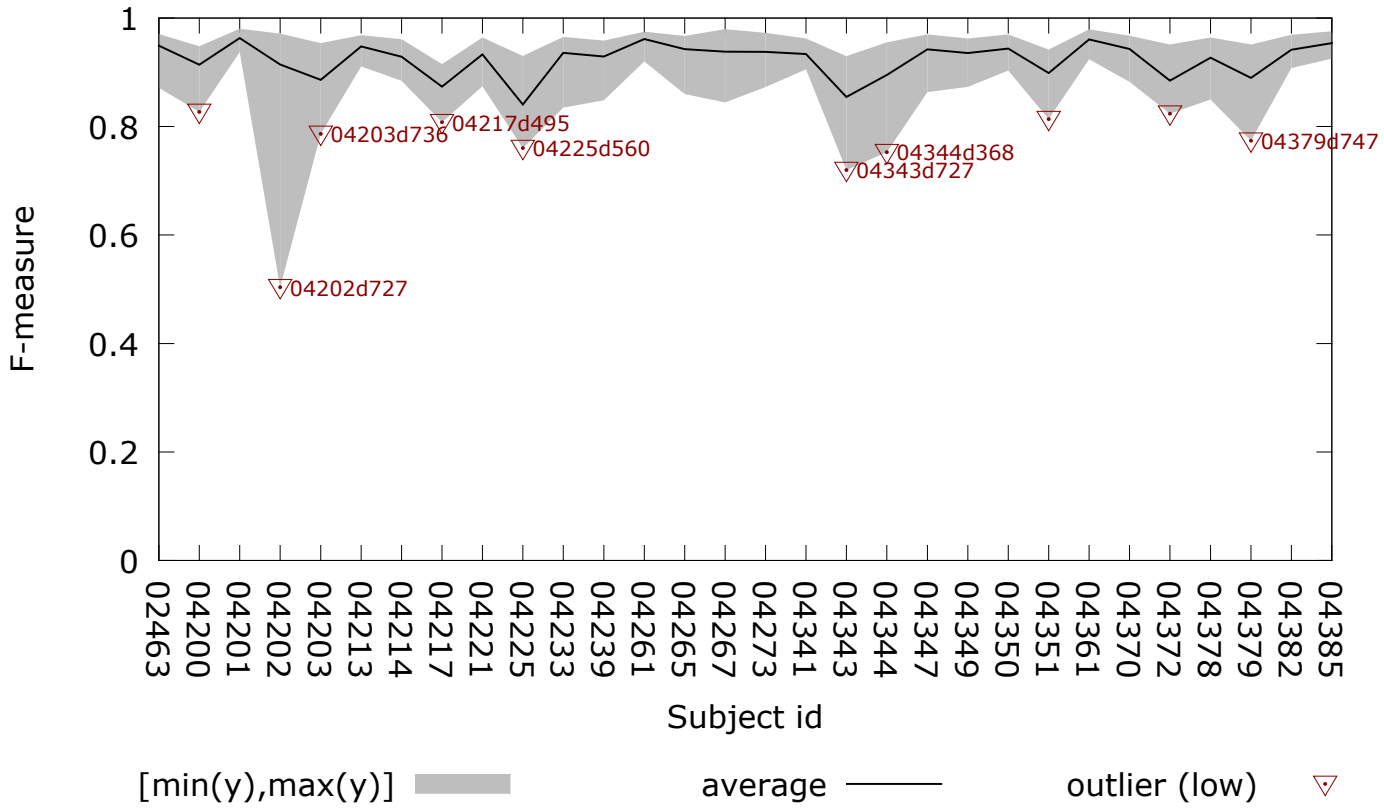
7.4.1 Per Iris Evaluation



Low point outlier

- 04202d725
- 04202d727
- 04225d560
- 04225d563
- 04225d606
- 04343d727
- 04343d730
- 04343d733
- 04343d736
- 04343d748
- 04344d368
- 04344d377
- 04379d747

7.4.2 Grouped Evaluation – `(\d*)d`

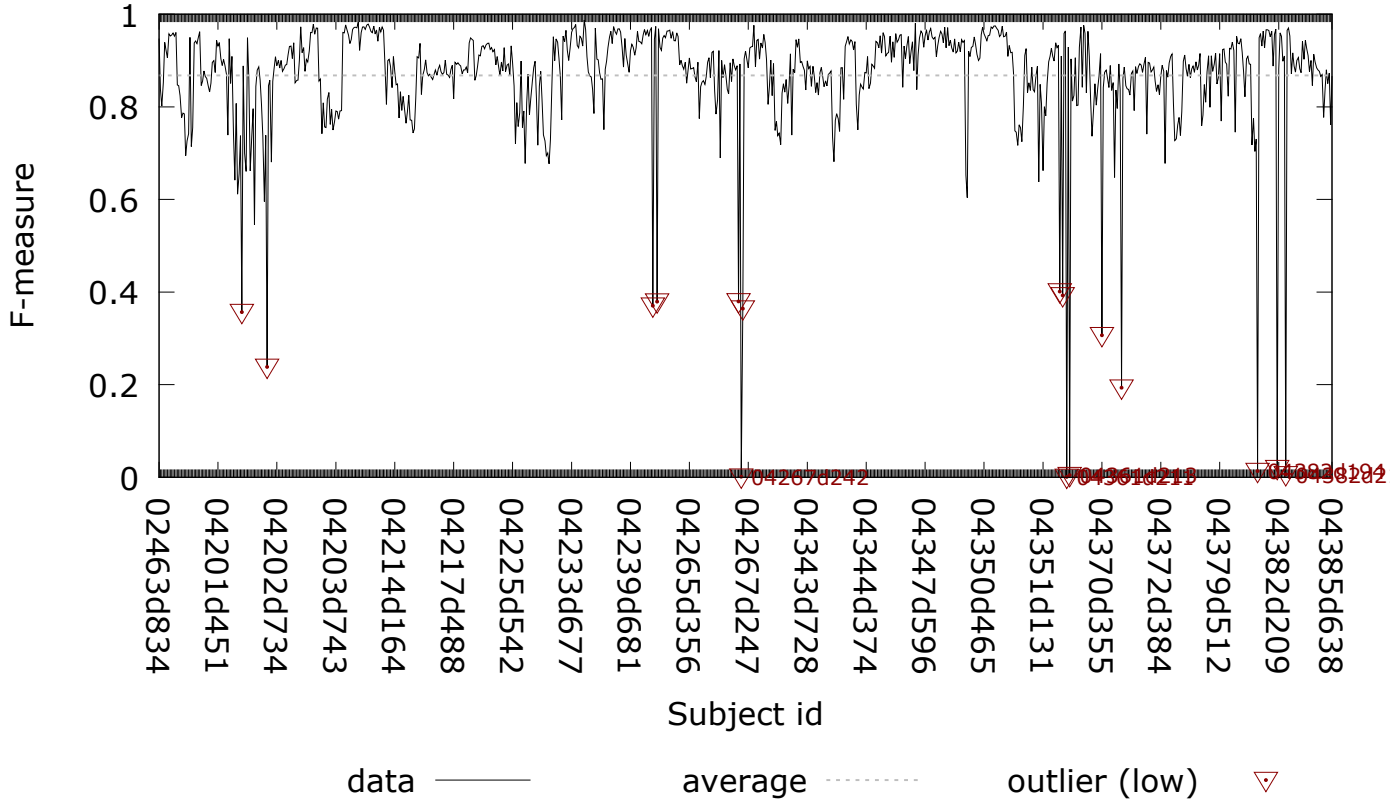


Low outlier per group

- 04200d081
- 04202d727
- 04203d736
- 04217d495
- 04225d560
- 04343d727
- 04344d368
- 04351d125
- 04372d365
- 04379d747

7.5 wahet

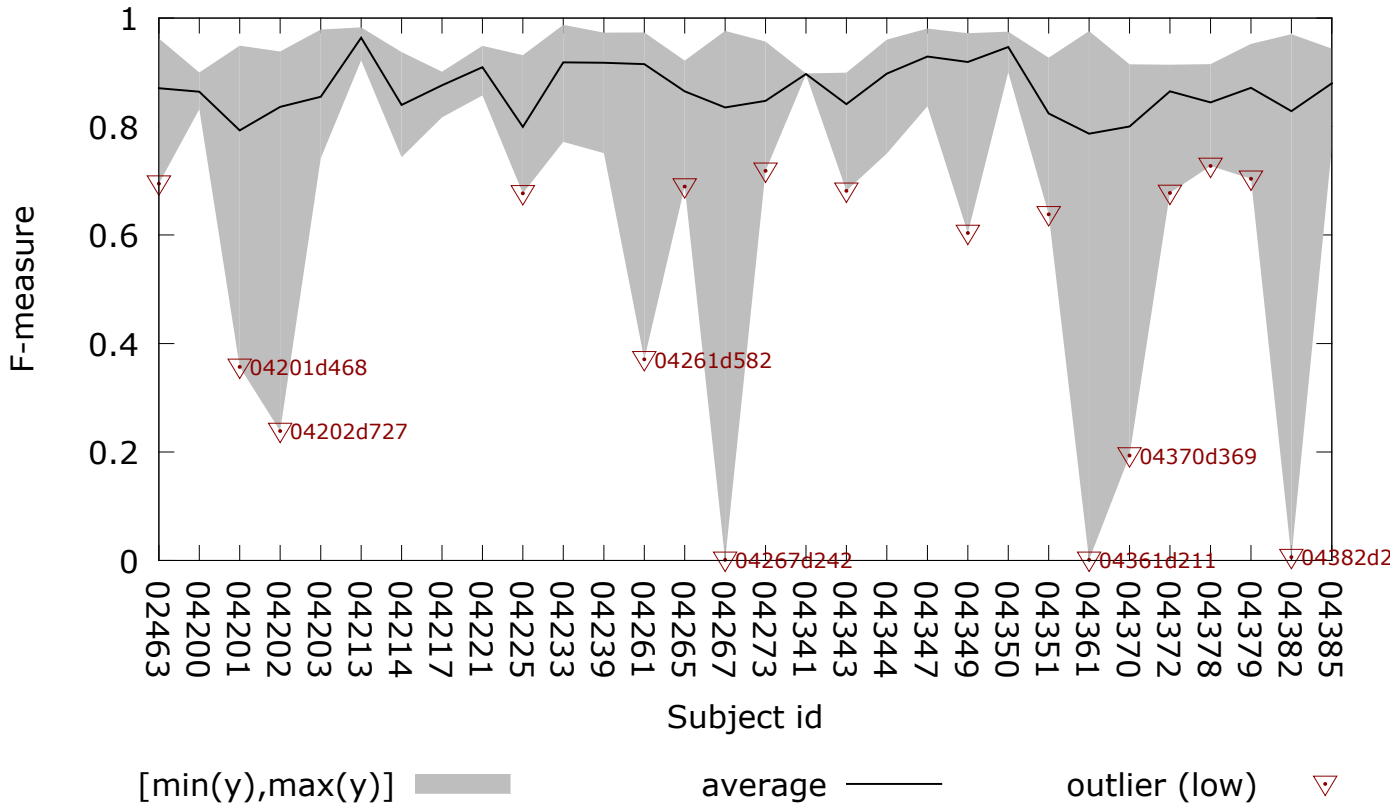
7.5.1 Per Iris Evaluation



Low point outlier

- 04201d468
- 04202d727
- 04261d582
- 04261d585
- 04267d240
- 04267d242
- 04267d243
- 04361d206
- 04361d208
- 04361d211
- 04361d213
- 04370d355
- 04370d369
- 04382d194
- 04382d208
- 04382d214

7.5.2 Grouped Evaluation – `(\d*)d`



Low outlier per group

- 02463d853
- 04201d468
- 04202d727
- 04225d608
- 04261d582
- 04265d378
- 04267d242
- 04273d308
- 04343d747
- 04349d773
- 04351d128
- 04361d211
- 04370d369
- 04372d387
- 04378d238
- 04379d747
- 04382d214

Chapter 8

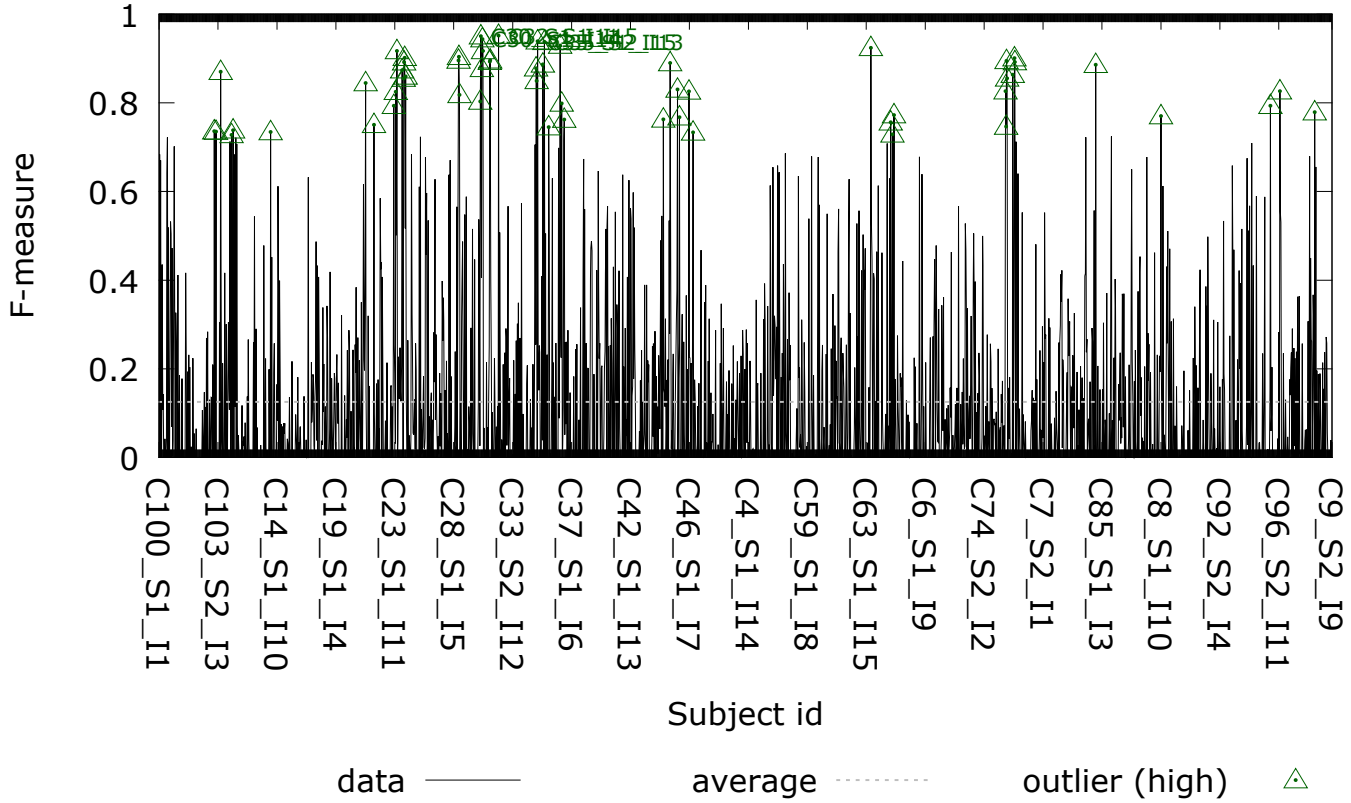
ubiris – Operator A

The $\mathcal{P}$, $\mathcal{R}$ and $\mathcal{F}$ values for the algorithmic generated masks when compared to ground truth provided by operator A on *ubiris*.

algo-rithm	$\mathcal{R}$		$\mathcal{P}$		$\mathcal{F}$	
	μ	σ	μ	σ	μ	σ
caht	18.02%	26.04%	11.39%	19.89%	12.55%	20.06%
gst	42.59%	40.53%	39.91%	34.39%	39.93%	36.55%
iffp	44.38%	37.42%	23.71%	26.94%	28.52%	29.68%
osiris	26.46%	31.52%	17.29%	28.81%	18.65%	28.47%
wahet	27.40%	34.48%	22.76%	31.03%	23.68%	31.90%

8.1 caht

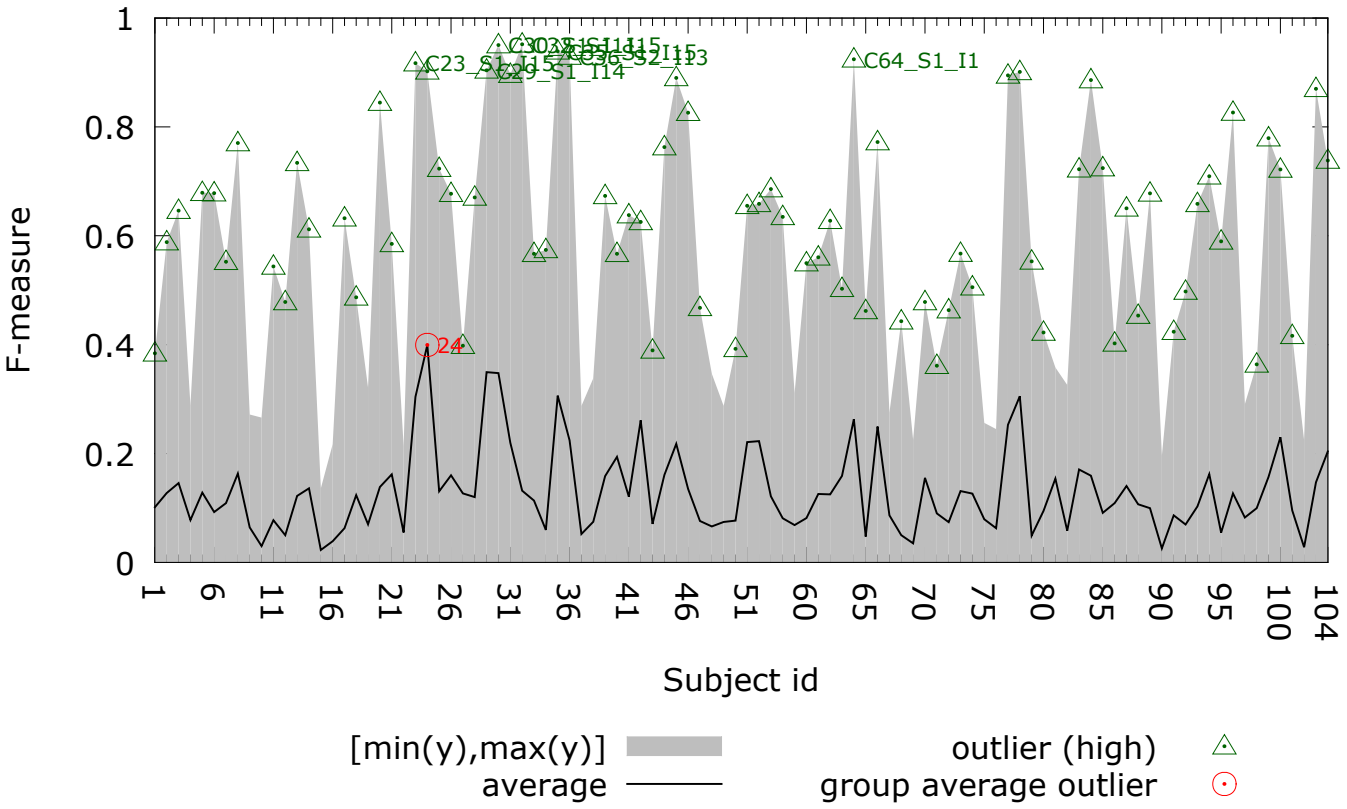
8.1.1 Per Iris Evaluation



High point outlier

- C103_S2_I10
- C103_S2_I13
- C103_S2_I8
- C104_S2_I13
- C104_S2_I2
- C13_S1_I13
- C20_S1_I15
- C20_S2_I2
- C23_S1_I1
- C23_S1_I13
- C23_S1_I15
- C24_S1_I10
- C24_S1_I13
- C24_S1_I14
- C24_S1_I15
- C24_S1_I3
- C29_S1_I13
- C29_S1_I14
- C29_S1_I15
- C30_S1_I10
- C30_S1_I11
- C30_S1_I13
- C30_S1_I14
- C30_S1_I15
- C31_S1_I13
- C31_S1_I14
- C32_S1_I15
- C35_S1_I12
- C35_S1_I13
- C35_S1_I15
- C35_S2_I10
- C35_S2_I13
- C35_S2_I7
- C36_S2_I13
- C36_S2_I2
- C36_S2_I7
- C44_S2_I2
- C45_S1_I14
- C45_S2_I13
- C45_S2_I3
- C46_S1_I6
- C46_S2_I13
- C64_S1_I1
- C66_S1_I3
- C66_S1_I6
- C66_S1_I9
- C77_S1_I12
- C77_S1_I13
- C77_S1_I14
- C77_S1_I15
- C78_S1_I11
- C78_S1_I14
- C78_S1_I15
- C84_S1_I6
- C8_S1_I10
- C96_S1_I10
- C96_S2_I13
- C99_S2_I6

8.1.2 Grouped Evaluation – `C(\d*)`



Group average outlier

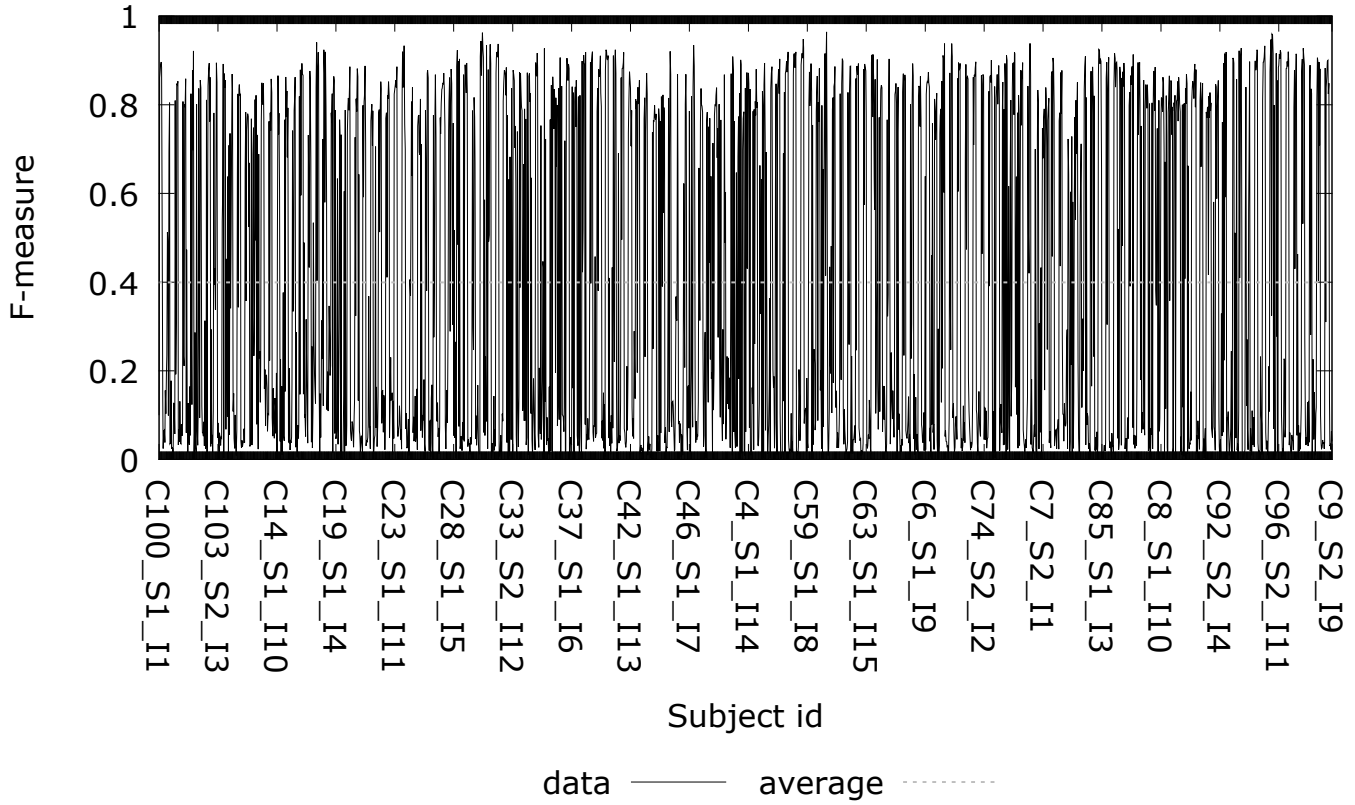
- 24

High outlier per group

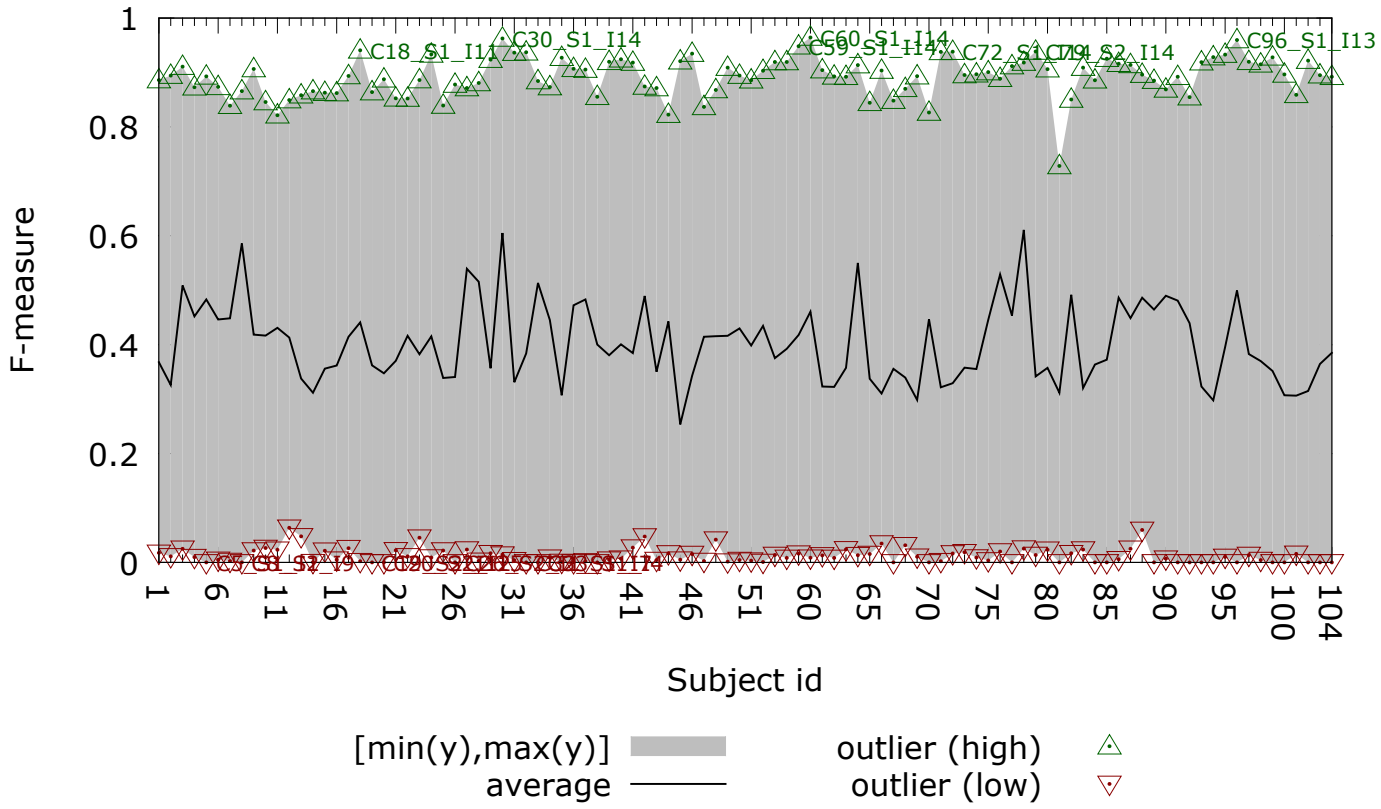
- C1_S2_I12
- C2_S1_I13
- C3_S1_I11
- C5_S1_I15
- C6_S1_I12
- C7_S2_I12
- C8_S1_I10
- C11_S1_I12
- C12_S1_I15
- C13_S1_I13
- C14_S1_I12
- C17_S2_I10
- C18_S1_I10
- C20_S1_I15
- C21_S1_I13
- C23_S1_I15
- C24_S1_I15
- C25_S2_I15
- C26_S1_I10
- C27_S1_I12
- C28_S1_I12
- C29_S1_I14
- C30_S1_I11
- C31_S1_I14
- C32_S1_I15
- C33_S1_I4
- C34_S1_I14
- C35_S1_I15
- C36_S2_I13
- C39_S1_I13
- C40_S1_I14
- C41_S1_I13
- C42_S1_I10
- C43_S2_I14
- C44_S2_I2
- C45_S1_I14
- C46_S1_I6
- C47_S1_I13
- C50_S2_I15
- C51_S1_I2
- C52_S1_I10
- C57_S1_I10
- C58_S1_I6
- C60_S1_I15
- C61_S1_I8
- C62_S1_I12
- C63_S1_I1
- C64_S1_I1
- C65_S1_I15
- C66_S1_I9
- C68_S1_I10
- C70_S1_I14
- C71_S1_I13
- C72_S1_I13
- C73_S1_I12
- C74_S1_I11
- C77_S1_I14
- C78_S1_I14
- C79_S1_I14
- C80_S2_I15
- C83_S1_I2
- C84_S1_I6
- C85_S2_I6
- C86_S1_I12
- C87_S1_I14
- C88_S1_I15
- C89_S1_I13
- C91_S2_I10
- C92_S1_I10
- C93_S2_I12
- C94_S2_I5
- C95_S1_I13
- C96_S2_I13
- C98_S1_I6
- C99_S2_I6
- C100_S2_I10
- C101_S2_I15
- C103_S2_I8
- C104_S2_I2

8.2 gst

8.2.1 Per Iris Evaluation



8.2.2 Grouped Evaluation – `C(\d*)`



High outlier per group

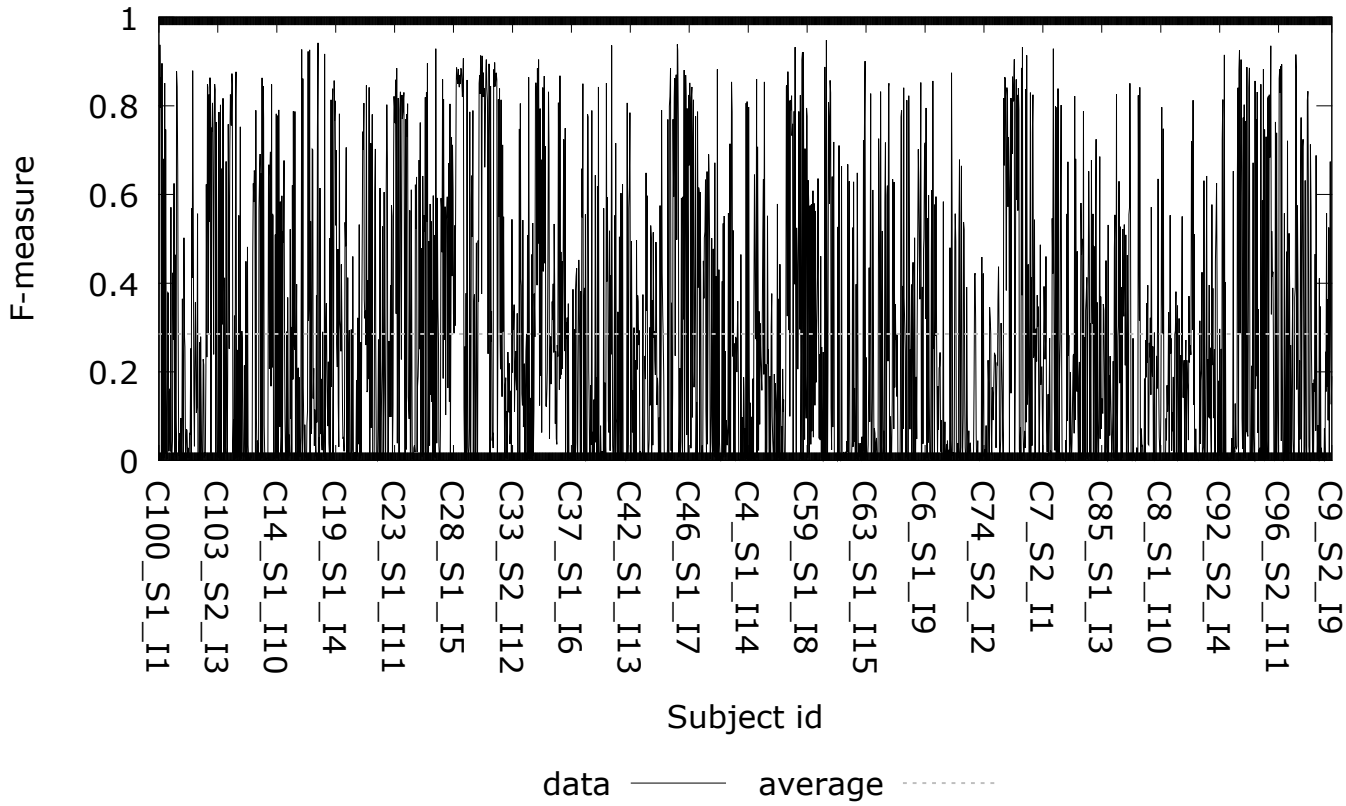
- C1_S1_I15
- C2_S1_I14
- C3_S1_I15
- C4_S1_I11
- C5_S1_I14
- C6_S2_I14
- C7_S2_I14
- C8_S2_I11
- C9_S1_I10
- C10_S1_I13
- C11_S1_I15
- C12_S1_I11
- C13_S1_I14
- C14_S1_I12
- C15_S1_I12
- C16_S1_I15
- C17_S1_I13
- C18_S1_I11
- C19_S1_I14
- C20_S1_I14
- C21_S1_I14
- C22_S1_I14
- C23_S1_I15
- C24_S1_I14
- C25_S1_I15
- C26_S1_I14
- C27_S1_I15
- C28_S1_I14
- C29_S1_I11
- C30_S1_I14
- C31_S1_I14
- C32_S1_I14
- C33_S1_I15
- C34_S1_I10
- C35_S2_I13
- C36_S2_I13
- C37_S1_I11
- C38_S1_I14
- C39_S2_I15
- C40_S1_I11
- C41_S1_I15
- C42_S1_I11
- C43_S2_I14
- C44_S2_I15
- C45_S1_I14
- C46_S2_I14
- C47_S1_I13
- C48_S2_I13
- C49_S1_I14
- C50_S2_I15
- C51_S1_I14
- C52_S1_I14
- C57_S1_I15
- C58_S1_I15
- C59_S1_I14
- C60_S1_I14
- C61_S2_I14
- C62_S2_I15
- C63_S1_I12
- C64_S1_I13
- C65_S1_I14
- C66_S1_I14
- C67_S1_I12
- C68_S1_I11
- C69_S1_I14
- C70_S1_I15
- C71_S1_I15
- C72_S1_I14
- C73_S1_I12
- C74_S1_I15
- C75_S1_I15
- C76_S1_I14
- C77_S1_I14
- C78_S1_I14
- C79_S2_I14
- C80_S1_I13
- C81_S1_I5
- C82_S1_I15
- C83_S1_I15
- C84_S1_I14
- C85_S1_I11
- C86_S1_I11
- C87_S1_I3
- C88_S1_I14
- C89_S2_I14
- C90_S2_I14
- C91_S1_I15
- C92_S2_I15
- C93_S1_I15
- C94_S1_I14
- C95_S2_I14
- C96_S1_I13
- C97_S1_I14
- C98_S1_I14
- C99_S1_I13
- C100_S1_I13
- C101_S2_I15
- C102_S1_I15
- C103_S2_I14
- C104_S1_I12

Low outlier per group

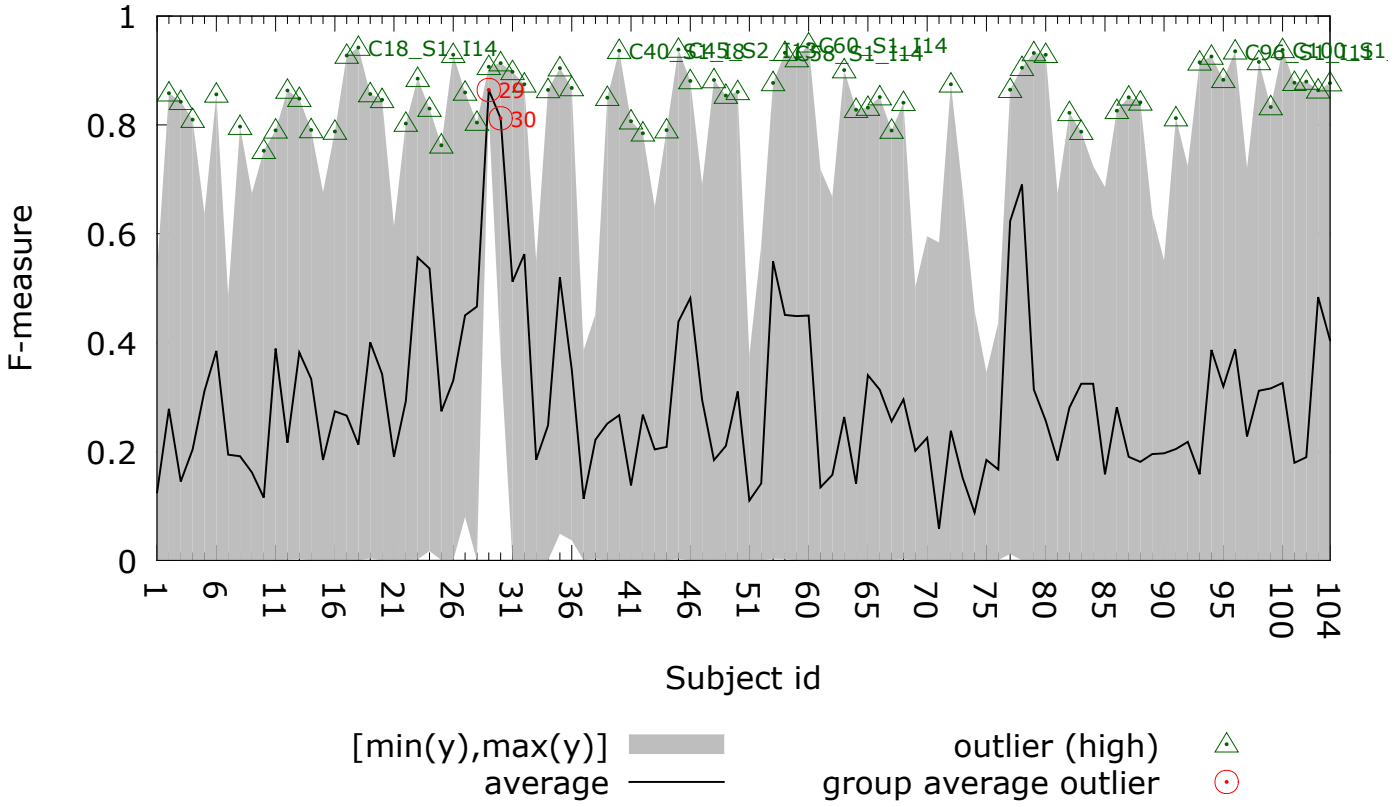
- C1_S2_I6
- C2_S1_I6
- C3_S1_I8
- C4_S1_I5
- C5_S1_I2
- C6_S2_I5
- C7_S1_I11
- C8_S1_I9
- C9_S2_I7
- C10_S1_I3
- C11_S1_I5
- C12_S1_I8
- C13_S1_I6
- C14_S1_I10
- C15_S1_I6
- C16_S1_I5
- C17_S2_I4
- C18_S1_I3
- C19_S2_I12
- C20_S2_I15
- C21_S1_I8
- C22_S1_I8
- C23_S1_I8
- C24_S1_I9
- C25_S2_I1
- C26_S2_I1
- C27_S1_I5
- C28_S1_I9
- C29_S1_I1
- C30_S1_I1
- C31_S1_I2
- C32_S1_I7
- C33_S1_I4
- C34_S2_I6
- C35_S2_I12
- C36_S2_I14
- C37_S1_I2
- C38_S1_I10
- C39_S1_I1
- C40_S1_I1
- C41_S1_I5
- C42_S1_I5
- C43_S2_I7
- C44_S2_I7
- C45_S2_I6
- C46_S1_I9
- C47_S1_I9
- C48_S2_I1
- C49_S2_I13
- C50_S2_I13
- C51_S1_I11
- C52_S1_I2
- C57_S1_I4
- C58_S1_I3
- C59_S1_I6
- C60_S1_I3
- C61_S2_I7
- C62_S2_I6
- C63_S1_I9
- C64_S1_I1
- C65_S1_I9
- C66_S1_I2
- C67_S1_I14
- C68_S1_I1
- C69_S1_I4
- C70_S1_I3
- C71_S1_I8
- C72_S1_I5
- C73_S1_I5
- C74_S1_I5
- C75_S1_I8
- C76_S1_I2
- C77_S1_I6
- C78_S1_I7
- C79_S2_I6
- C80_S2_I1
- C81_S1_I6
- C82_S1_I4
- C83_S1_I7
- C84_S1_I9
- C85_S1_I3
- C86_S2_I5
- C87_S1_I6
- C88_S1_I4
- C89_S2_I6
- C90_S2_I1
- C91_S2_I7
- C92_S2_I4
- C93_S1_I2
- C94_S1_I2
- C95_S2_I6
- C96_S1_I4
- C97_S1_I6
- C98_S1_I4
- C99_S2_I15
- C100_S2_I7
- C101_S2_I5
- C102_S1_I2
- C103_S1_I11
- C104_S1_I8

8.3 iffp

8.3.1 Per Iris Evaluation



8.3.2 Grouped Evaluation – `C(\d*)`



Group average outlier

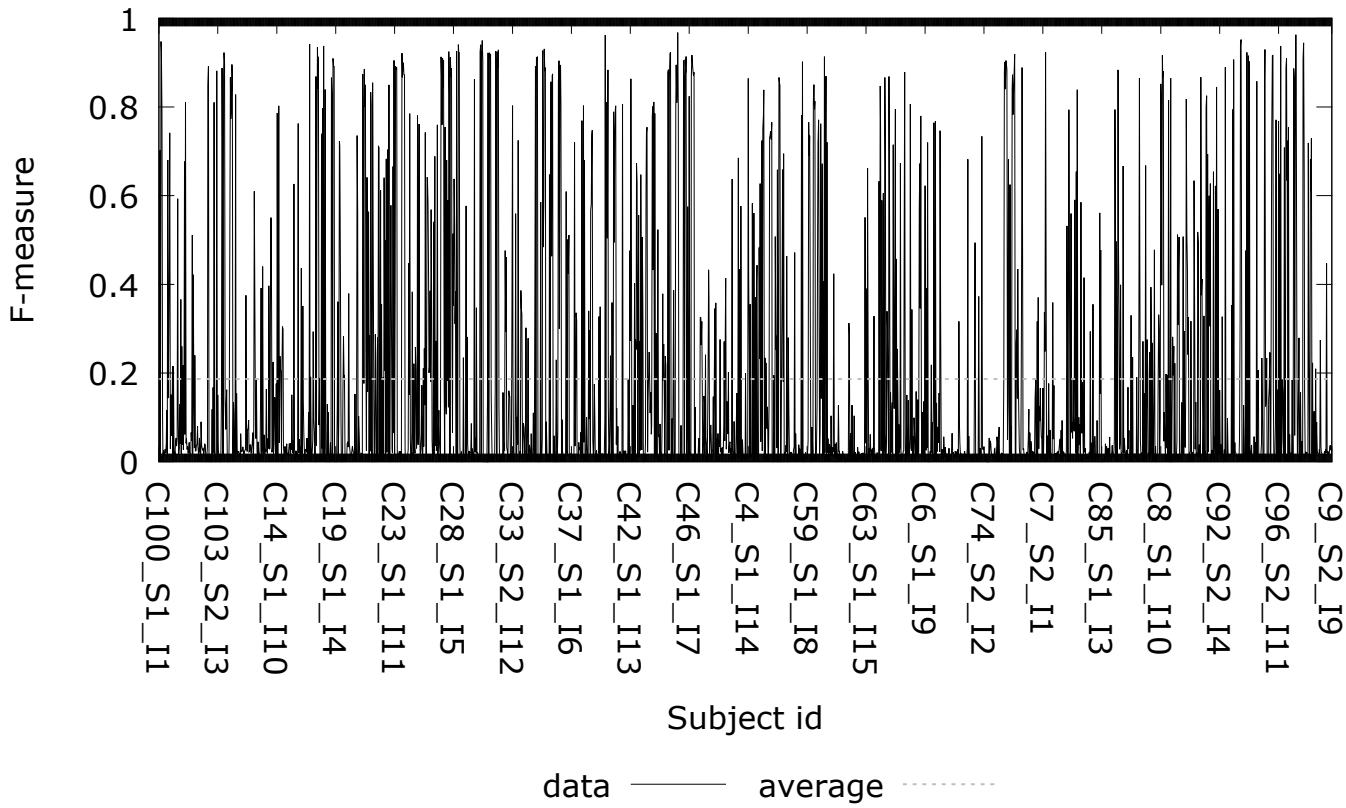
- 29
- 30

High outlier per group

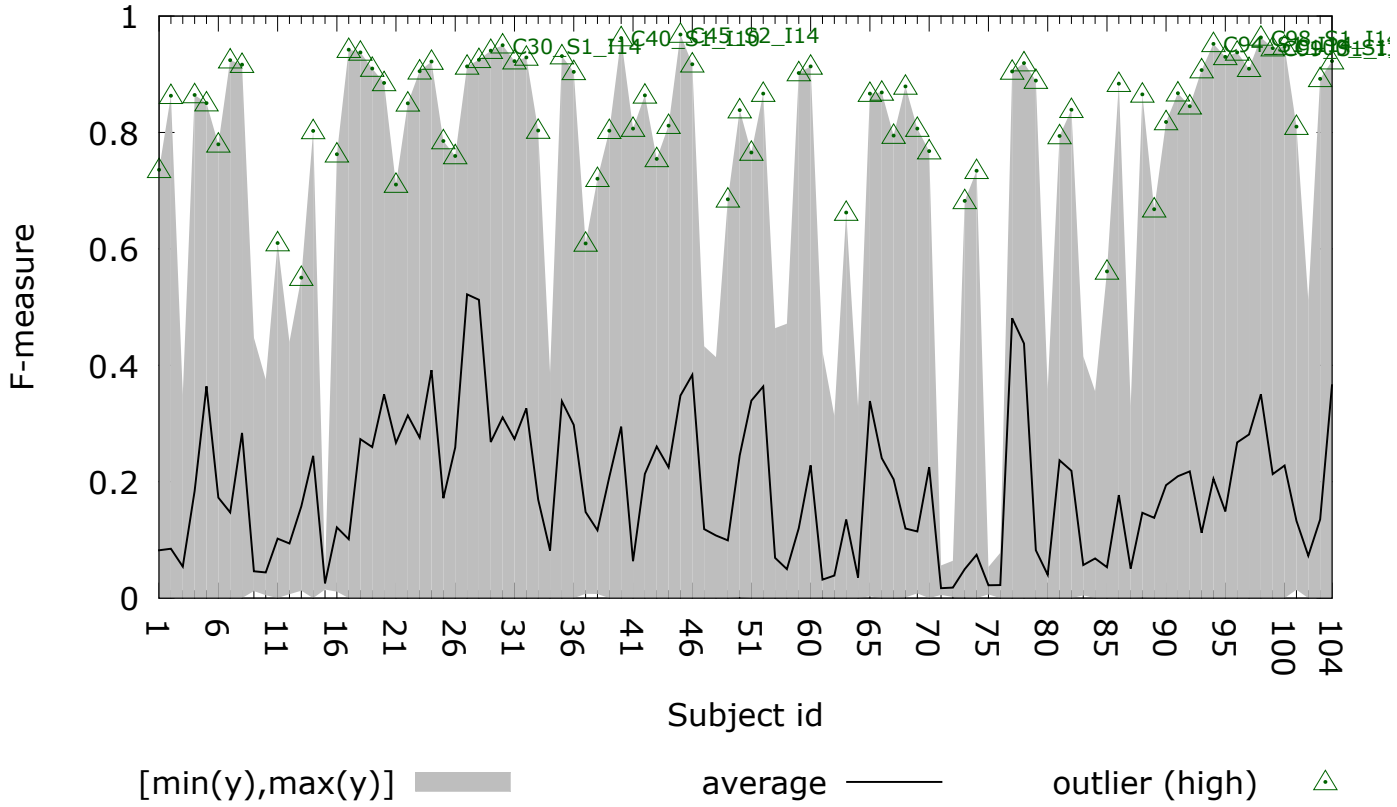
- C2_S1_I15
- C3_S1_I12
- C4_S1_I12
- C6_S2_I9
- C8_S1_I12
- C10_S1_I15
- C11_S1_I15
- C12_S1_I12
- C13_S1_I15
- C14_S1_I14
- C16_S1_I12
- C17_S1_I13
- C18_S1_I14
- C19_S1_I15
- C20_S1_I3
- C22_S1_I11
- C23_S1_I15
- C24_S1_I14
- C25_S2_I15
- C26_S2_I15
- C27_S1_I13
- C28_S1_I12
- C29_S1_I9
- C30_S1_I11
- C31_S1_I9
- C32_S1_I11
- C34_S2_I13
- C35_S1_I3
- C36_S2_I13
- C39_S1_I12
- C40_S1_I8
- C41_S1_I8
- C42_S1_I12
- C44_S2_I13
- C45_S2_I13
- C46_S1_I11
- C48_S1_I15
- C49_S1_I12
- C50_S1_I15
- C57_S1_I15
- C58_S1_I14
- C59_S1_I13
- C60_S1_I14
- C63_S1_I13
- C64_S1_I1
- C65_S1_I13
- C66_S1_I14
- C67_S1_I9
- C68_S1_I12
- C72_S1_I14
- C77_S1_I11
- C78_S1_I14
- C79_S1_I15
- C80_S1_I14
- C82_S1_I10
- C83_S1_I12
- C86_S1_I15
- C87_S1_I11
- C88_S1_I15
- C91_S1_I12
- C93_S1_I12
- C94_S1_I11
- C95_S2_I12
- C96_S1_I11
- C98_S1_I14
- C99_S1_I8
- C100_S1_I11
- C101_S1_I13
- C102_S1_I14
- C103_S1_I3
- C104_S2_I8

8.4 osiris

8.4.1 Per Iris Evaluation



8.4.2 Grouped Evaluation – `C(\d*)`

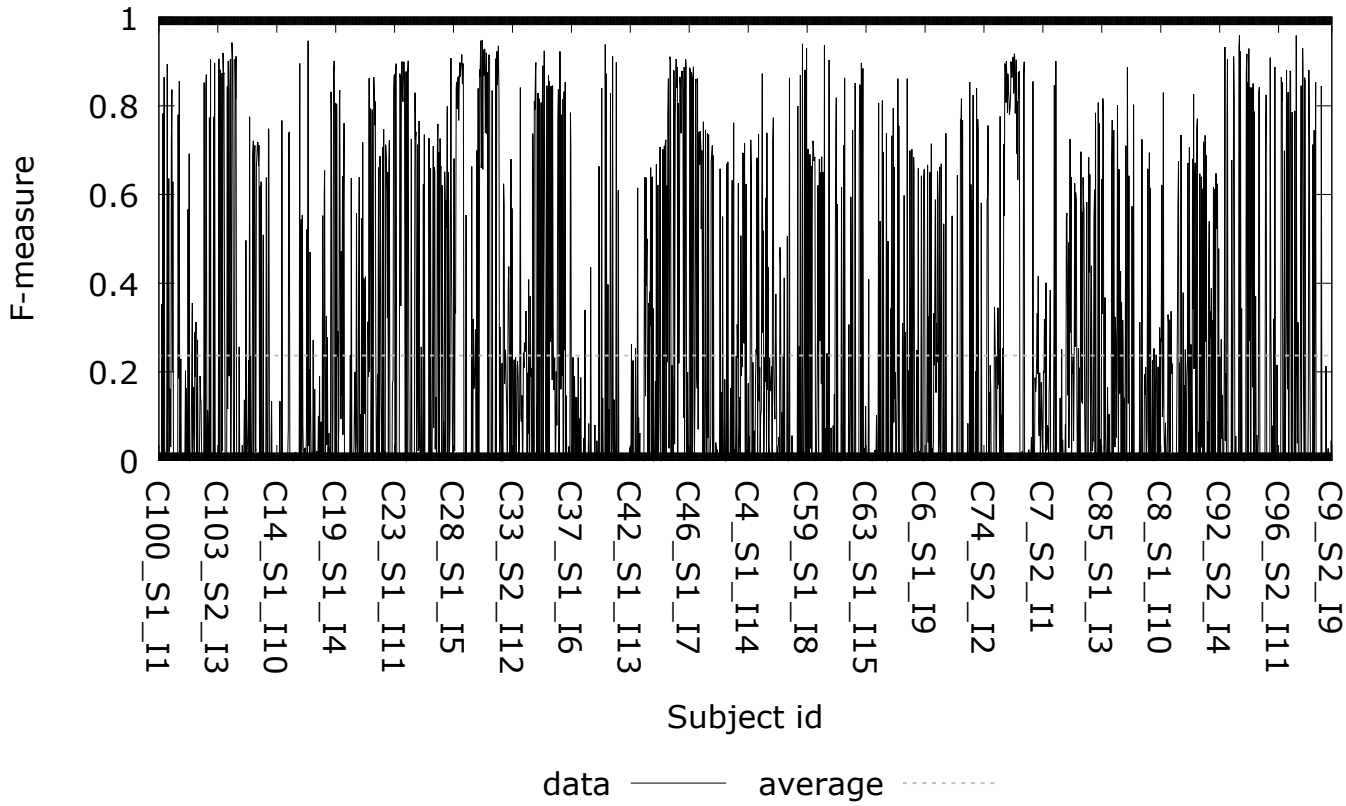


High outlier per group

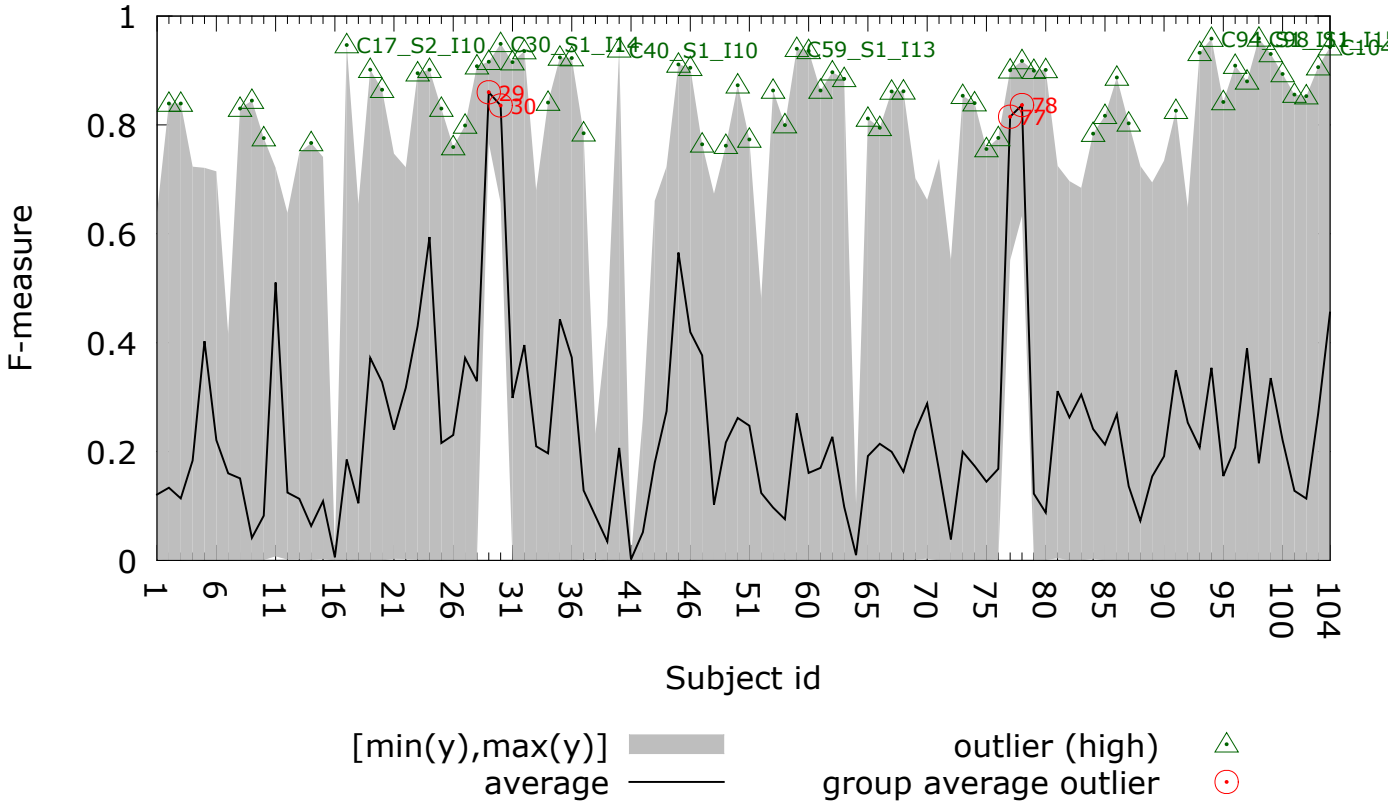
- C1_S2_I14
- C2_S2_I14
- C4_S1_I14
- C5_S1_I6
- C6_S1_I15
- C7_S2_I14
- C8_S1_I13
- C11_S1_I12
- C13_S1_I14
- C14_S1_I14
- C16_S1_I7
- C17_S2_I13
- C18_S2_I10
- C19_S1_I13
- C20_S1_I13
- C21_S1_I10
- C22_S1_I15
- C23_S1_I10
- C24_S1_I10
- C25_S1_I10
- C26_S2_I4
- C27_S1_I10
- C28_S1_I10
- C29_S1_I13
- C30_S1_I14
- C31_S1_I13
- C32_S1_I15
- C33_S2_I12
- C35_S2_I13
- C36_S2_I11
- C37_S1_I10
- C38_S1_I11
- C39_S1_I13
- C40_S1_I10
- C41_S1_I13
- C42_S1_I14
- C43_S2_I15
- C44_S1_I13
- C45_S2_I14
- C46_S2_I11
- C49_S2_I10
- C50_S2_I14
- C51_S1_I14
- C52_S1_I13
- C59_S1_I13
- C60_S1_I10
- C63_S1_I4
- C65_S1_I7
- C66_S1_I14
- C67_S1_I11
- C68_S1_I14
- C69_S1_I10
- C70_S1_I13
- C73_S2_I15
- C74_S2_I12
- C77_S1_I13
- C78_S1_I15
- C79_S1_I14
- C81_S1_I14
- C82_S1_I15
- C85_S1_I13
- C86_S1_I4
- C88_S1_I14
- C89_S1_I11
- C90_S2_I14
- C91_S2_I12
- C92_S2_I12
- C93_S2_I15
- C94_S1_I14
- C95_S2_I15
- C96_S2_I15
- C97_S1_I11
- C98_S1_I14
- C99_S1_I14
- C100_S1_I13
- C101_S2_I15
- C103_S1_I14
- C104_S1_I14

8.5 wahet

8.5.1 Per Iris Evaluation



8.5.2 Grouped Evaluation – `C(\d*)`



Group average outlier

- 29
- 30
- 77
- 78

High outlier per group

- C2_S2_I7
- C3_S1_I4
- C8_S1_I15
- C9_S1_I4
- C10_S2_I4
- C14_S1_I6
- C17_S2_I10
- C19_S1_I15
- C20_S2_I2
- C23_S1_I14
- C24_S1_I8
- C25_S1_I6
- C26_S2_I5
- C27_S1_I8
- C28_S1_I14
- C29_S1_I6
- C30_S1_I14
- C31_S1_I12
- C32_S1_I15
- C34_S1_I12
- C35_S2_I13
- C36_S2_I13
- C37_S1_I4
- C40_S1_I10
- C45_S1_I14
- C46_S1_I14
- C47_S1_I4
- C49_S1_I2
- C50_S2_I11
- C51_S1_I3
- C57_S1_I4
- C58_S1_I5
- C59_S1_I13
- C60_S1_I10
- C61_S2_I5
- C62_S2_I7
- C63_S1_I1
- C65_S1_I2
- C66_S1_I8
- C67_S1_I2
- C68_S1_I5
- C73_S2_I5
- C74_S1_I3
- C75_S1_I1
- C76_S1_I3
- C77_S1_I14
- C78_S1_I14
- C79_S1_I4
- C80_S1_I5
- C84_S1_I6
- C85_S1_I5
- C86_S2_I7
- C87_S1_I4
- C91_S1_I13
- C93_S1_I13
- C94_S1_I11
- C95_S1_I5
- C96_S1_I10
- C97_S1_I11
- C98_S1_I15
- C99_S1_I12
- C100_S2_I10
- C101_S1_I4
- C102_S2_I7
- C103_S2_I5
- C104_S2_I14