

MICCAI 2024

Marrakesh
MOROCCO

27TH INTERNATIONAL CONFERENCE ON MEDICAL IMAGE COMPUTING
AND COMPUTER ASSISTED INTERVENTION

6-10 OCTOBER 2024

PALMERAIE ROTANA RESORT

MARRAKESH / MOROCCO



Fetal Tissue Annotation and Segmentation Challenge (FeTA)

Overview and results

October 6th 2024

@FetaChallenge

<https://fetachallenge.github.io>





AGENDA



11:00 - 11:15 FeTA Challenge overview – M. Bach Cuadra

11:15 - 11:50 Power pitch presentations by top 5 teams:

- **Abdul Qayyum:** “Hybrid Cross Attention Transformer and CNN model for Feta Segmentation Task” (2 min)
- **Maximilian Zenk:** “Exploring the out-of-distribution generalization of nnU-Net for fetal brain tissue segmentation” (2 min)
- **Rachika E. Hamadache:** “NIC-VICOROB Team: Fetal Tissue Annotation and Segmentation challenge (FeTA 2024)”

Q/A

- **Robin Cremese:** “Mednext adoption for fetal brain MRI segmentation”
- **Tong Lyuyang:** “Team FeTA_Sigma: Prenatal Brain Segmentation and Biometry Algorithm Overview” (4 min)
- **Denis Peruzzo:** “CeSNE DIGAIR team”
- **Param Ahir:** power-pitch available at FeTA webpage

Q/A

11:50 - 12:00 FeTA winners ceremony – K. Payette

12:00 - 13:30 Joint PIPPI & FeTA Poster Session

ORGANIZERS



M. Bach Cuadra



K. Payette



A. Jakab



R. Licandro



M. Barkovich



H. B. Li



J. Hutter



T. Sanchez



V. Zalevskyi



M. Roulet



M. Kaandorp



L. Li



D. Fajardo-Rojas



Motivation

- In support to clinical risk stratification tools for early interventions, treatments, and clinical counselling.
- In vivo portray of complex neurodevelopmental events during human gestation

Challenges

- Data scarcity
- Data access
- Domain shifts

Acquisition, scanner, etc
Pre-processing
Pathology
Gestational age
SR methods

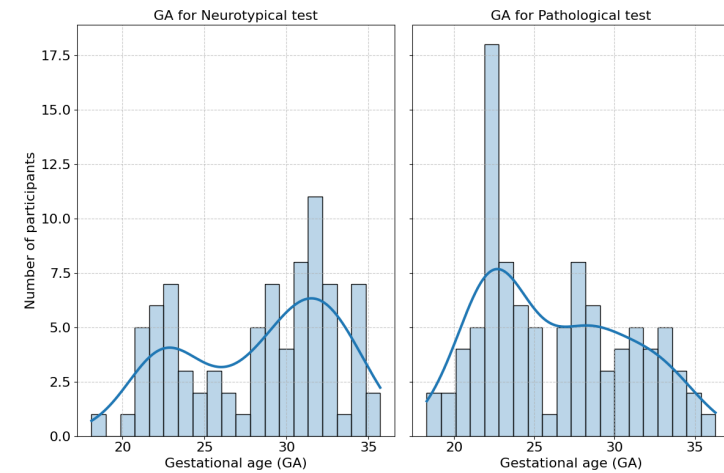
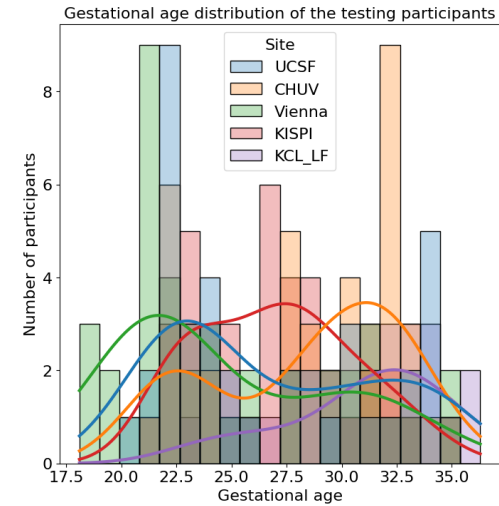
Our goal with FeTA Challenge

Encourage the development of effective, domain-generalizable and reproducible methods for analyzing high resolution reconstructed MR images of the developing fetal brain from gestational week 21-36

COHORTS

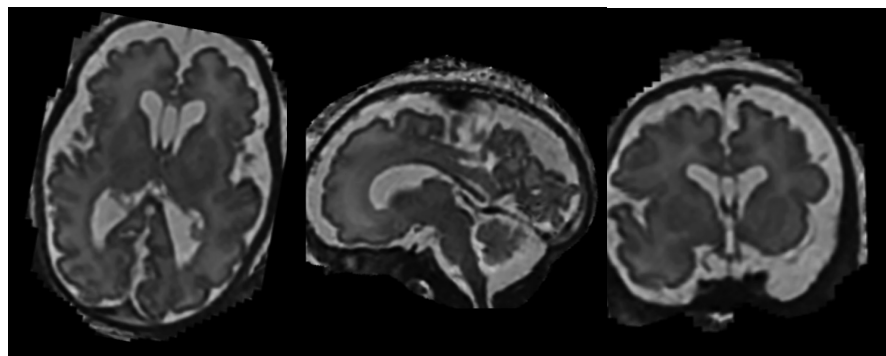
Site, Vendor & Field strength		Training	Testing
 UNIVERSITÄTS-KINDERSPITAL ZÜRICH	 3T 1.5T	x 80	x 40
 MEDIZINISCHE UNIVERSITÄT WIEN	 3T 1.5T	x 40	x 40
 CHUV Centre hospitalier universitaire vaudois	 3T 1.5T	x 0	x 40
 UCSF Benioff Children's Hospitals	 3T 1.5T	x 0	x 40
 KING'S College LONDON	 0.55T	x 0	x 20

Payette et al 2021 Nature Scientific Data, Payette et al 2023 Media, FeTA Challenge 2022
<https://arxiv.org/pdf/2402.09463>, Low-field data: Aviles-Verdera et al 2023 Radiology.

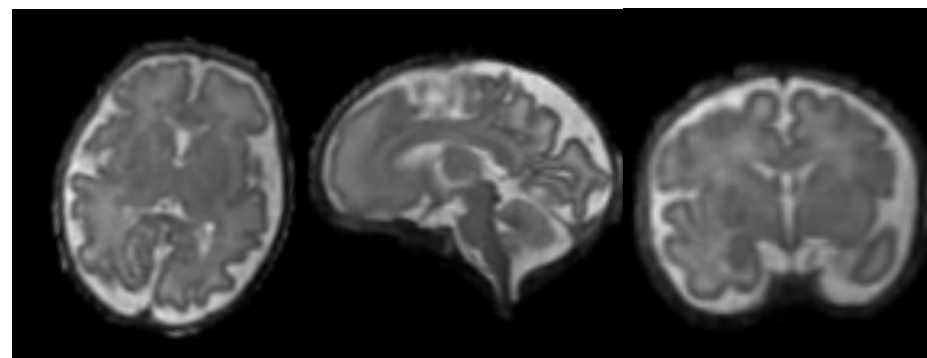


COHORTS

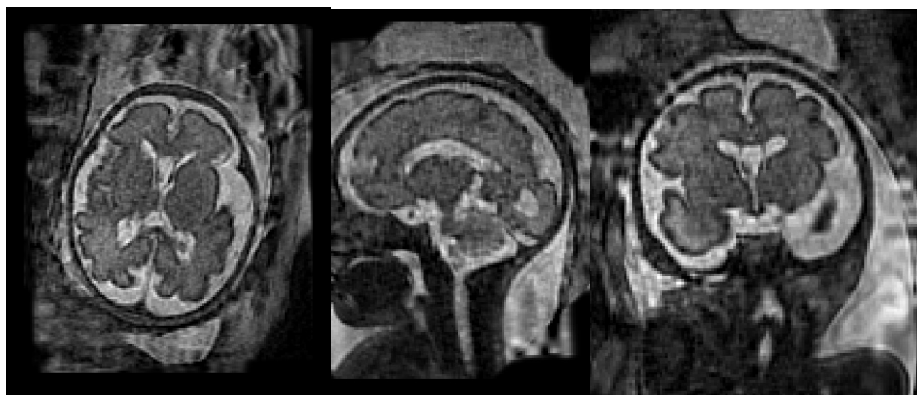
 & 3T IRTK



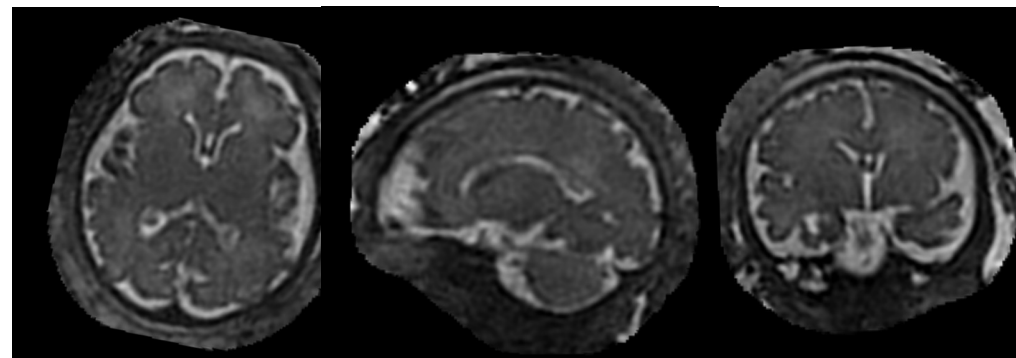
 & 1.5 T MIALSRTK



 & 1.5T Niftymic

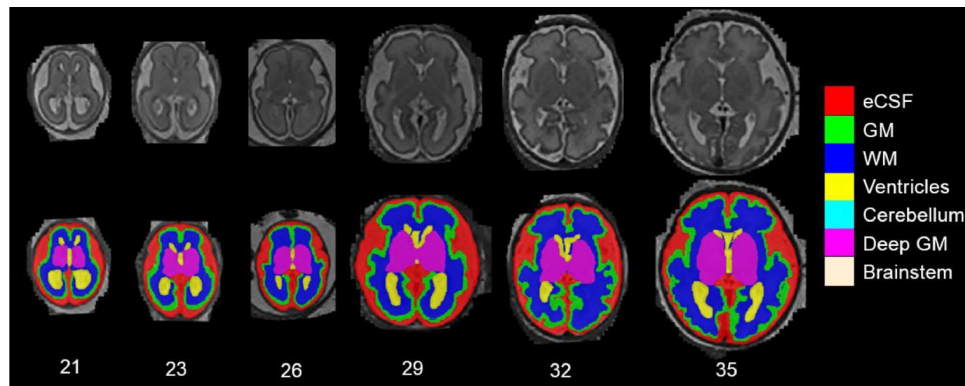


 0.55T & SVRTK



SEMANTIC SEGMENTATION (TASK 1)


Tissue
Segmentation




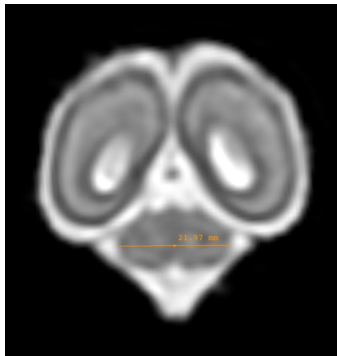
- Manual annotations of voxel-wise brain tissue class for LF MRI : 20 cases

- Same protocol than previous years
- Each person – 1 structure
- Fusion of structures
- Revisions by 2 expert raters
- Annotation time: from 8h to around 12h per case

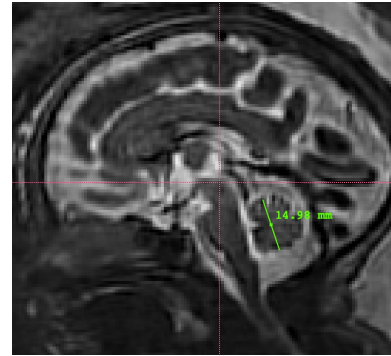
- Margaux Roulet
- Maurice Aschwanden
- Yvan Gomez
- Vladyslav Zalevskyi
- Raphael Gaubert-Rachmühl
- Céline Steger
- Andras Jakab
- Kelly Payette

REGRESSION (TASK 2)

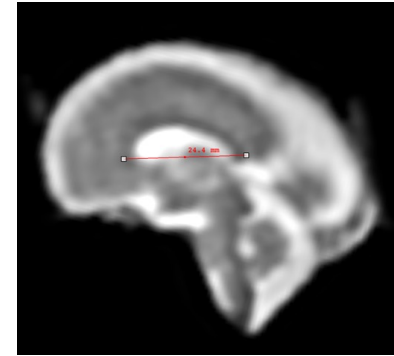

Biometry
Measurements



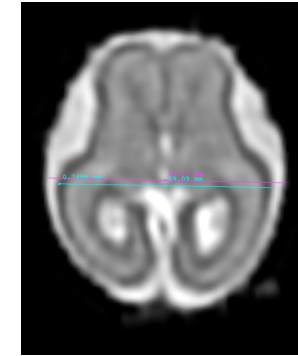
TCD_cor, maximum transverse cerebellar diameter



HV, height of the vermis, measured in the mid-sagittal plane.



LCC, length of the corpus callosum, measured in the mid-sagittal plane.



bBIP_ax, brain biparietal diameter : maximal brain diameter in the transverse plane through the atria.

sBIP_ax, skull biparietal diameter: the inner-to-inner table maximal skull diameter in the transverse plane through the atria.

Manual annotations of 5 selected biometry measurements for all 300 cases

- Same protocol as [1,2,3,4,5]
- Each person – 1 case,
- Splits by centers
- Revisions by 1 expert rater

1. Mériam Koob
2. Yvan Gómez
3. Maurice Aschwanden
4. Raphael Gaubert-Rachmühl
5. Andras Jakab



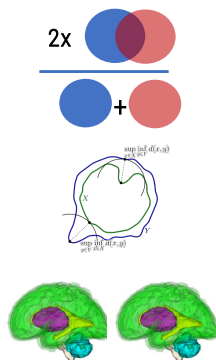
EVALUATION





Biometry
Measurements

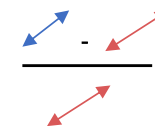


1. **Overlap** Dice similarity coefficient (DSC) ↑
2. **Distance** 95th percentile of Hausdorff distance (HD95) ↓
3. **Volume** similarity (VS) ↑
4. **Topology** Betti Number Error k (BNEk) ↓



1. Measurement Error in percentage (ME)

 Automated measurement
 Expert measurement



k-dimensional Betti numbers in a 3D object:

BN0: connected components

BN1: holes

BN2 cavities in a 3D object

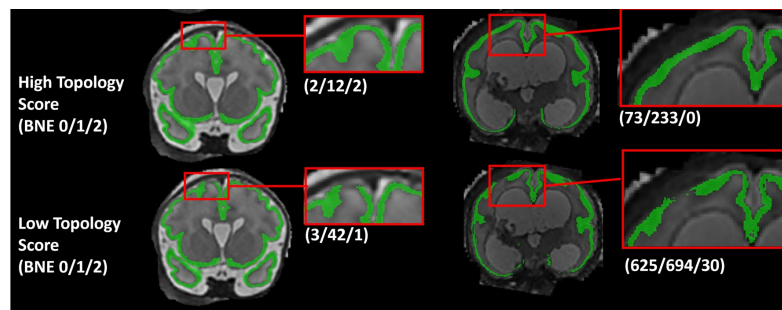


Figure extracted from [XX](#)

- Independent ranking per task
- Ranking per label and metric
- For each label, addition of 4 rankings
- All testing cases together

PARTICIPANT TEAMS



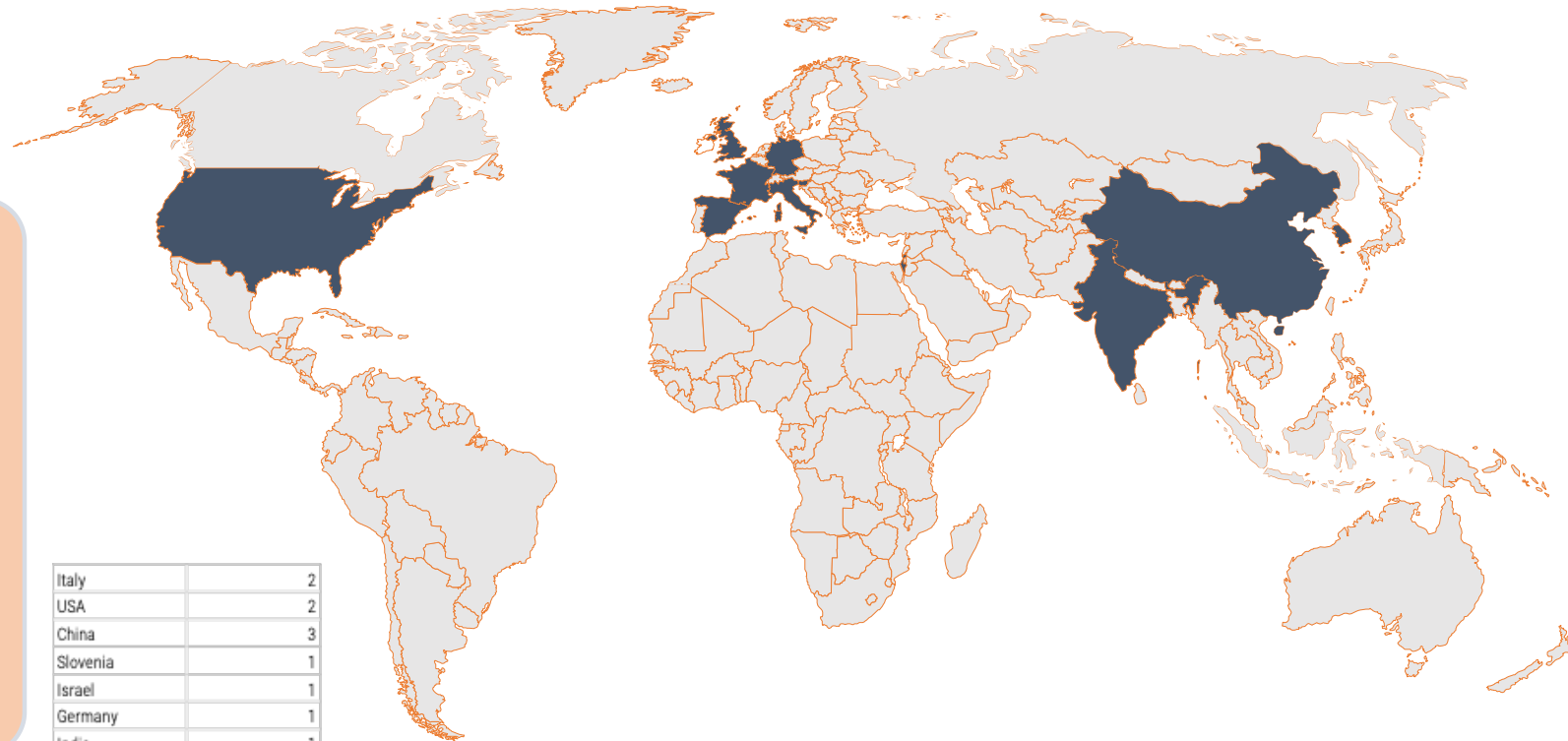
Tissue Segmentation

1. cemrg_feta
2. cesne-digair
3. falcons
4. feta-sigma
5. hilab
6. jwcrad
7. lit
8. Imrcmc
9. mayanko
10. Mic-dkfz-feta24
11. paramahir_2023
12. pasteurdbc
13. qd-neuroincyte
14. unipd-sum-aug
15. upfetal
16. vicorob



Biometry Measurements

1. cesne-digair
2. falcons
3. feta_sigma
4. jwcrad
5. paramahir_2023
6. pasteurdbc
7. qd-neuroincyte

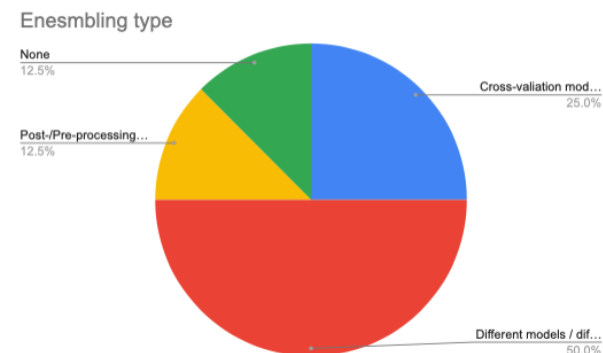
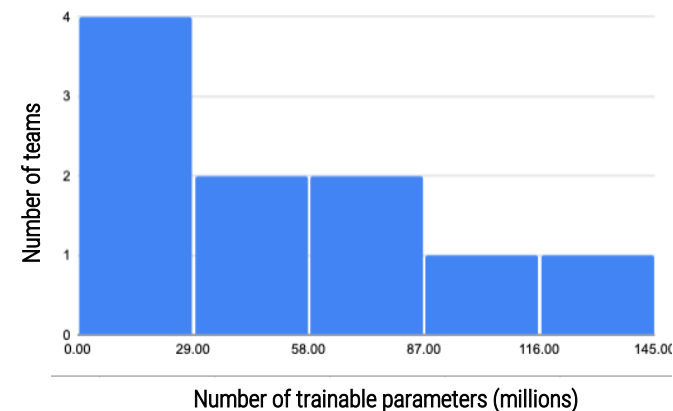


Italy	2
USA	2
China	3
Slovenia	1
Israel	1
Germany	1
India	1
France	1
Spain	2
South Korea	1
UK	1

SUBMITTED METHODS Segmentation

- Total Algorithms: 16
 - nnUnet: 9
 - U-Net + adaptations : 6
 - Swin*(Mamba, Unetr): 3
 - MedNeXt_L, SegVol, SegResNet: 3

- 3D / 2D: 14 / 2
- External datasets/atlasses: 5 (dHCP, Atlases or pre-trained foundation)
- All teams used Pytorch (except 1 TF)
- Ensemble learning: 9



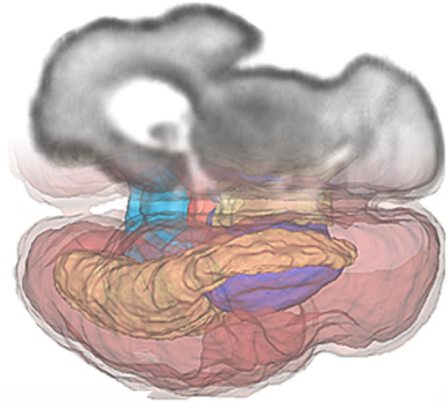


SUBMITTED METHODS

Biometry



- Total Algorithms: 7
 - nnUnet: 2
 - U-Net + adaptations : 4
 - CNN: 1
- 3D / 2D: 6 / 1
- External datasets/atlasses: 3 (dHCP, Atlases or pre-trained foundation)
- All teams used Pytorch (except 1 TF)
- All relied on segmentation map, some also input image
- Landmark heatmap: 2
- Landmark regression: 2
- Biometry regression: 2
- Missing description: 1



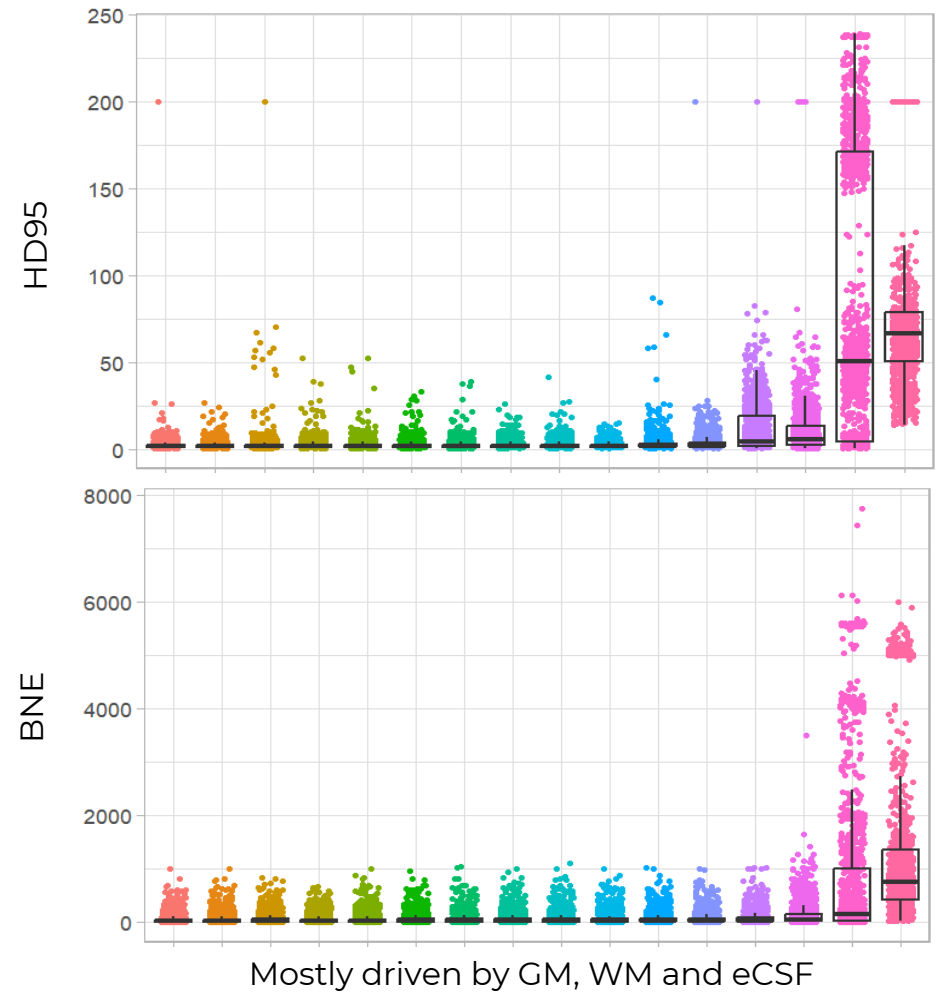
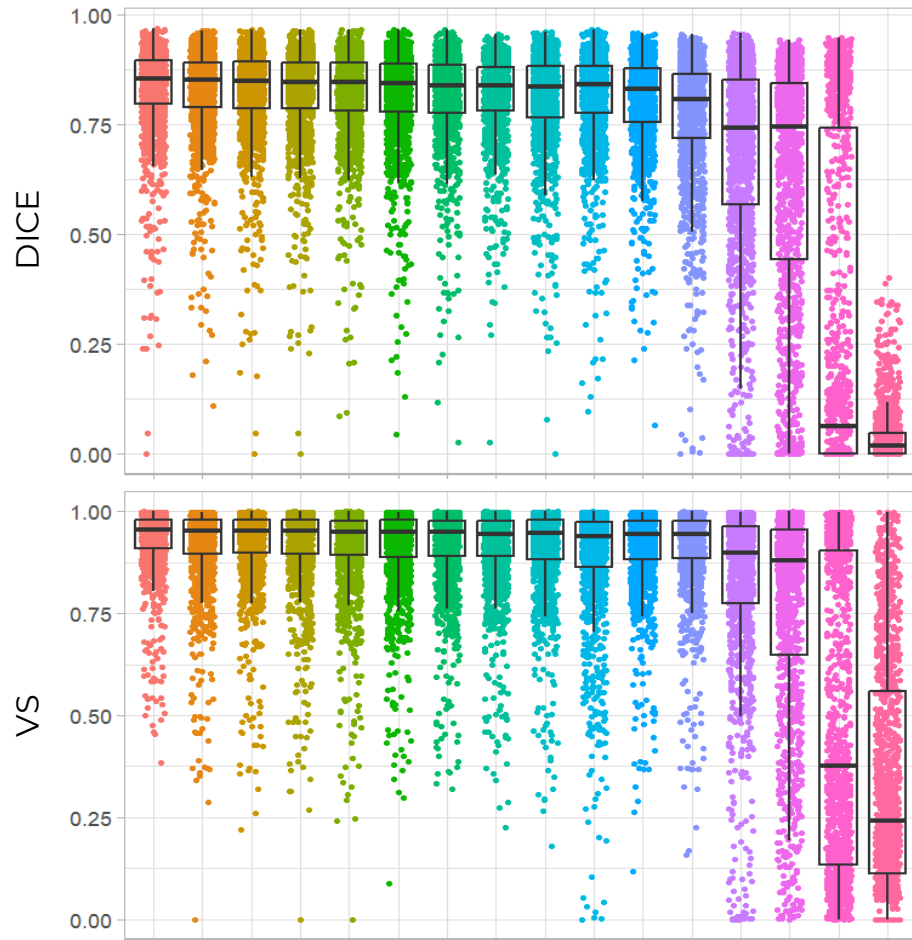
FeTA

SEGMENTATION TASK

RESULTS

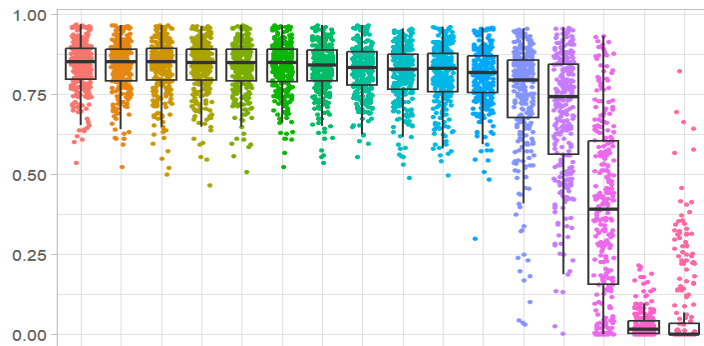
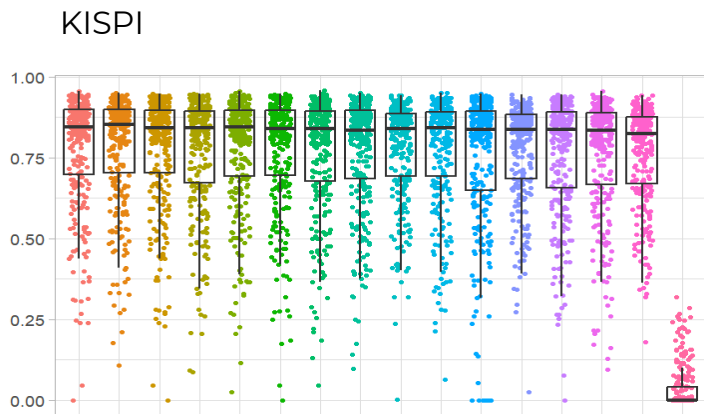
SEGMENTATION RESULTS: global test set

(Team colors are not consistent across plots)



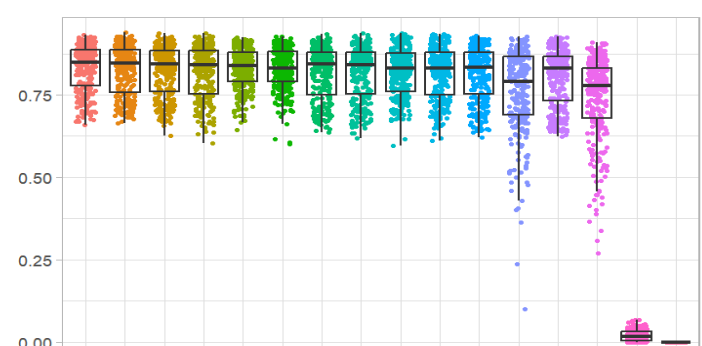
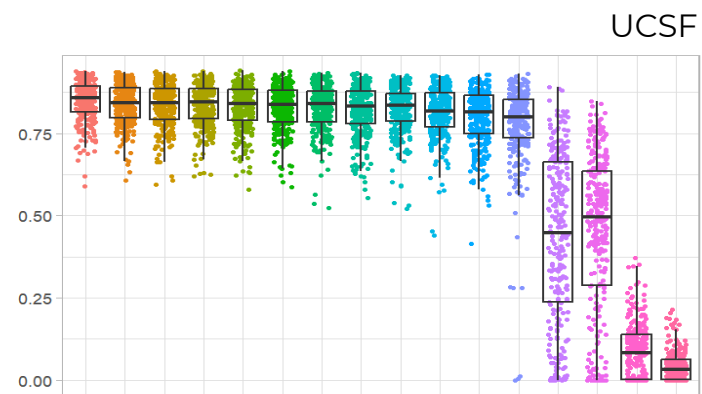
SEGMENTATION RESULTS: DICE per-site results

(Team colors are not consistent across plots)



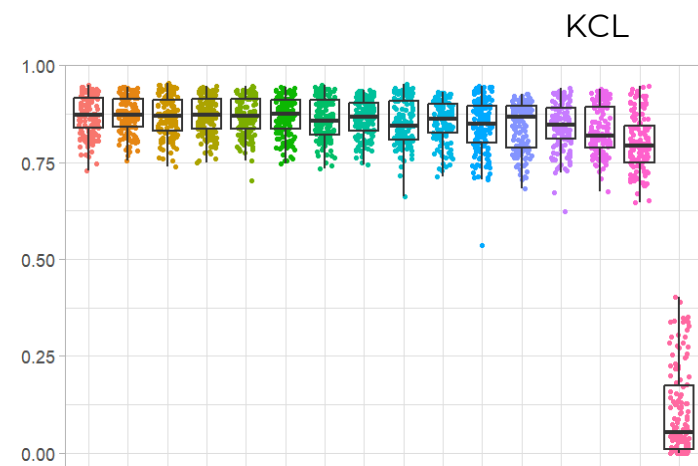
Vienna

In-domain

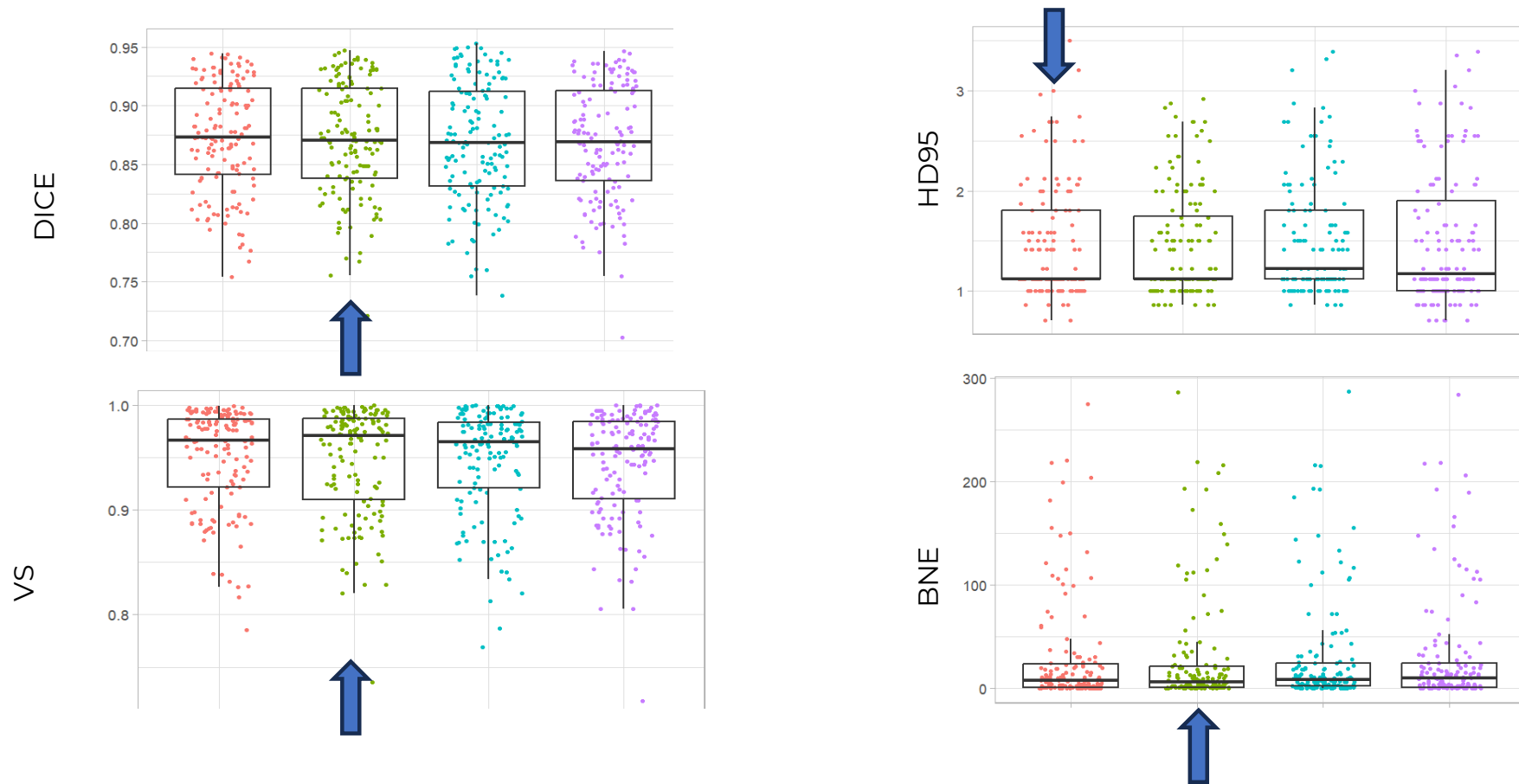


CHUV

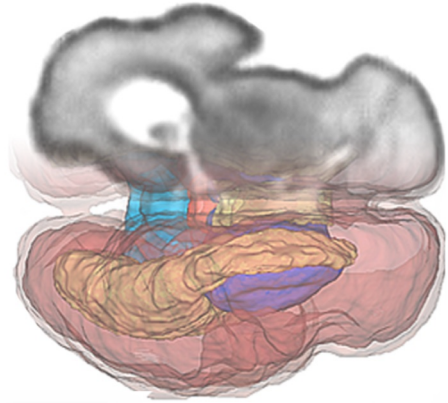
Out-of-domain



Comparison of 3 top teams on Low-Field 0.55T scanner with FeTA 2022 winner*



*FIT- nnUnet, <https://arxiv.org/pdf/2402.09463>

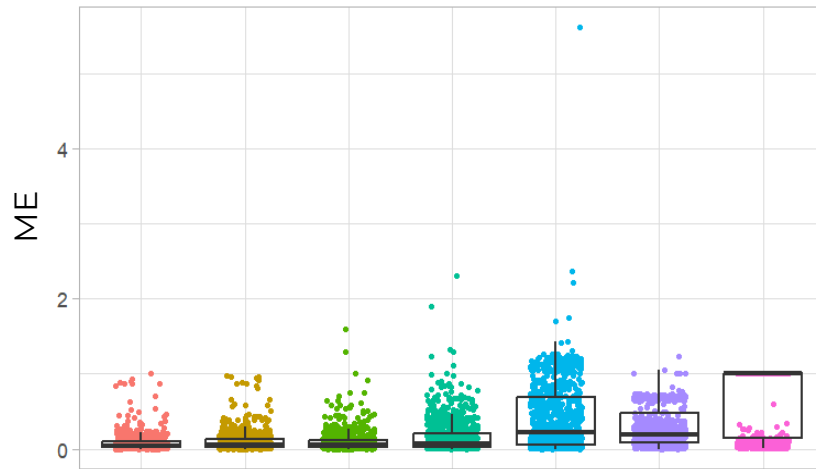


FeTA

BIOMETRY TASK

RESULTS

BIOMETRY RESULTS: all sites



Algorithm	HV	LCC	TCD	bBIP	sBIP	ME
Algorithm	0.103	0.112	0.072	0.054	0.048	0.077
Algorithm	0.098	0.177	0.123	0.04	0.047	0.096
Algorithm	0.116	0.126	0.137	0.057	0.055	0.098
Algorithm	0.435	0.205	0.054	0.065	0.037	0.158
Algorithm	0.428	0.328	0.479	0.384	0.378	0.401
Algorithm	0.293	0.285	0.308	0.263	0.256	0.281
Algorithm	0.107	0.088	0.027	0.035	0.097	0.071

BIOMETRY RESULTS: baseline comparisons

- We setup two regression model baselines:
 1. Uses only GA values
 2. Combine GA and total brain volume

Algorithm	HV	LCC	TCD	bBIP	sBIP	Total ME
Baseline (GA + GA ² + Brain Vol.)	0.106	0.103	0.101	0.042	0.034	0.077
Algorithm	0.103	0.112	0.072	0.054	0.048	0.077
Baseline (GA + GA ²)	0.108	0.122	0.108	0.068	0.065	0.094
Algorithm	0.098	0.177	0.123	0.04	0.047	0.096
Algorithm	0.116	0.126	0.137	0.057	0.055	0.098
Algorithm	0.435	0.205	0.054	0.065	0.037	0.158
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Algorithm	0.293	0.285	0.308	0.263	0.256	0.281
Algorithm	0.107	0.088	0.027	0.035	0.097	0.071

Further analysis of the results & paper writing

- Annotation of SR image quality ^[1,2] : link between quality and generalization
- Comparing results from normal and pathological cases
- Segmentation task:
 - Exploring *normalized* Dice ^[3] and GA effects
 - Deeper insights from topology errors
 - Comparison with previous top teams (from FeTA2022) ^[4]
- Biometry task:
 - Inter-rater variability ^[5]
 - Baseline models comparison
 - Moving to landmark error estimation



THANKS !



- Volunteers accepting to participate in studies
- Funding institutions
- All participating teams !!!



Swiss National
Science Foundation



HASLERSTIFTUNG





AGENDA



11:00 - 11:15 FeTA Challenge overview – M. Bach Cuadra

11:15 - 11:50 Power pitch presentations by top 5 teams:

- **Abdul Qayyum:** “Hybrid Cross Attention Transformer and CNN model for Feta Segmentation Task” (2 min)
- **Maximilian Zenk:** “Exploring the out-of-distribution generalization of nnU-Net for fetal brain tissue segmentation” (2 min)
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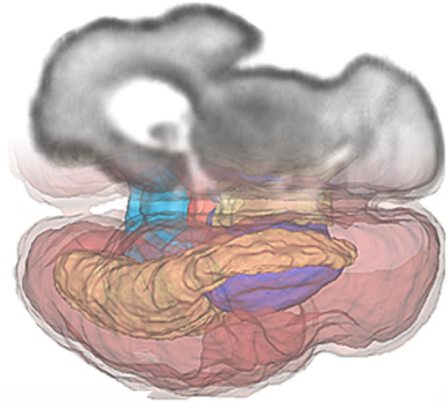
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Q/A

11:50 - 12:00 FeTA winners ceremony – K. Payette

12:00 - 13:30 Joint PIPPI & FeTA Poster Session



FeTA

SEGMENTATION TASK

WINNERS

FeTA Segmentation Rankings

Ranking	Team Name
1
2
3
4	Feta_sigma
5	Pasteur DBC
6	UPFetal24
7	LIT Ranked 1st for Topology metric
8	cesne-digair Ranked 1st for Volume Similarity
9	Hilab

Ranking	Team Name
10	unipd-sum-aug
11	lmrcmc
12	jwcrad
13	qd_neuroincyte
14	falcons
15	ichilov-tau-maya
16	paramahir_2023

mic-dkfz-feta2024

Maximilian Zenk, Michael Baumgartner, Klaus Maier-Hein

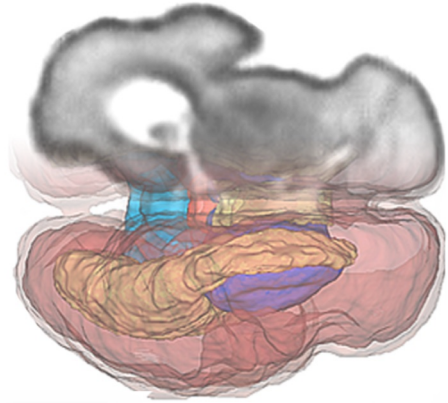
ViCOROB

Rachika Elhassna Hamadache, Amina Bouzid, Ricardo Montoya del Ángel, Marawan Elbatel, Cansu Yalçın, Hadeel Awwad, Adrià Casamitjana, Arnau Oliver, Robert Martí Marly, Xavier Lladó Bardera

cemrg_feta

Abdul Qayyum, Moona Mazher, Steven A Niederer





FeTA

BIOMETRY TASK

WINNERS



FeTA Biometry Rankings



Ranking	Team Name
1
2
3
4	PasteurDBC
5	qd_neuroincyte
6	Paramahir_2024
7	falcons

jwcrad

Jae Won Choi

cesne-digair

Tommaso Ciceri, Marina Di Stefano, Giulia Frigerio, Giorgio Longari, Francesca Maccarone, Simone Melzi, Denis Peruzzo, Rocco Prudentino, Gloria Rizzato

feta_sigma

Jiang Jingwen, Zhang Chengsheng, Wang Hanling, Zhang Xuezhi, Cao Jiarui, Tong Lyuyang, Du Bo



Challenge Pictures





THANKS !



- Volunteers accepting to participate in studies
- Funding institutions
- All participating teams !!!



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