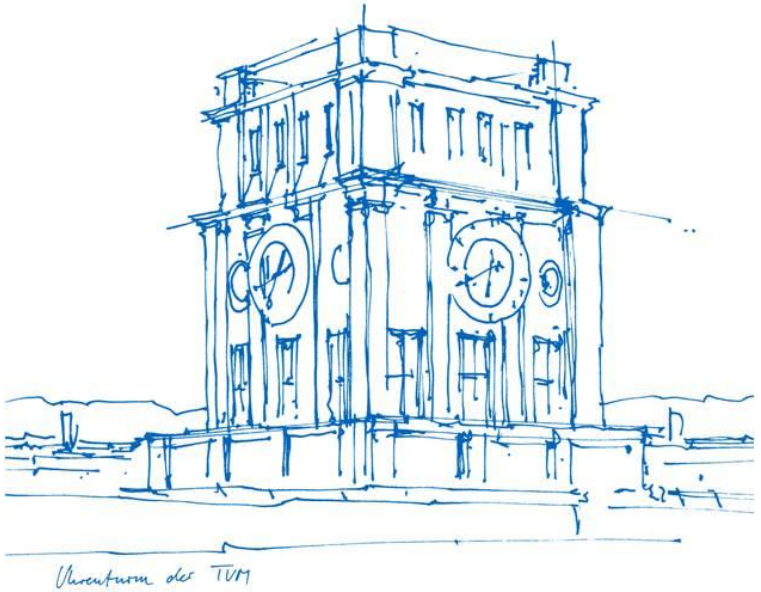
MMS Status Update

Spinal Cord MRI

MultipleMS Meeting 20.09.2024

ECTRIMS Copenhagen



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Conversion to BIDS (Brain Imaging Data Structure)

Challenges:

- 40k heterogeneous scans
- DICOM ➔ NIfTI & JSON
- Systemize (BIDS)

Metadata processing:

- Parser extracts dicom tags
- Inconsistent quality/availability

BIDS entities:

- subject (i.e. DE11755)
- session (i.e. 20171223 ➔ M00)
- sequence (numeric counter)
- acquisition (i.e. iso)
- suffix = MRI contrast (i.e. T2w)

```
DE1-1755_M0
├── 2
│   ├── 3D_DIR_125mm_cs85_dnstong.zip
│   ├── 3D_DIR_125mm_cs85_no_denoise.zip
│   ├── 3D_DIR_1mm_iso_cs55.zip
│   ├── 3D_MPRage_94_cs75.zip
│   ├── 3D_T2_Brain_VIEW_cs8.zip
│   ├── cs15_T1_mDixon_TSE_cor_25mmKM.zip
│   ├── cs15_T1_mDixon_TSE_cor_25mm.zip
│   ├── cs18_T2_mDixon_TSE_cor_25mm_1.zip
│   ├── cs18_T2_mDixon_TSE_cor_25mm_2.zip
│   ├── cs18_T2_mDixon_TSE_cor_25mm.zip
│   ├── DEFAULTPSSERIES_1.zip
│   ├── DEFAULTPSSERIES_2.zip
│   ├── DEFAULTPSSERIES_3.zip
│   ├── DEFAULTPSSERIES_4.zip
│   ├── DEFAULTPSSERIES_5.zip
│   ├── DEFAULTPSSERIES_6.zip
│   ├── DEFAULTPSSERIES_7.zip
│   ├── DEFAULTPSSERIES.zip
│   ├── DICOM_FILES.zip
│   ├── MPRSmartBrain.zip
│   ├── PatientAlignedMPRAWPLAN_SMARTPLAN_TYPE_BRAIN.zip
│   ├── readme_american.txt
│   ├── readme_german.txt
│   ├── scs15_T1_mDixon_TSE_cor_25mm_1.zip
│   ├── scs15_T1_mDixon_TSE_cor_25mm_2.zip
│   ├── scs15_T1_mDixon_TSE_cor_25mm_3.zip
│   ├── scs15_T1_mDixon_TSE_cor_25mm.zip
│   ├── T21mmax.zip
│   └── tmp_zip_dir
```

```
sub-DE11755/
├── ses-20171223
│   └── anat
│       ├── sub-DE11755_ses-20171223_sequ-102_acq-ax_MPRAGE.json
│       ├── sub-DE11755_ses-20171223_sequ-103_acq-ax_MPRAGE.json
│       ├── sub-DE11755_ses-20171223_sequ-201_acq-ax_DIR.json
│       ├── sub-DE11755_ses-20171223_sequ-201_acq-ax_DIR.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-301_acq-sag_DIR.json
│       ├── sub-DE11755_ses-20171223_sequ-301_acq-sag_DIR.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-303_acq-sag_DIR.json
│       ├── sub-DE11755_ses-20171223_sequ-303_acq-sag_DIR.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-305_acq-sag_DIR.json
│       ├── sub-DE11755_ses-20171223_sequ-305_acq-sag_DIR.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-401_acq-cor_MPRAGE.json
│       ├── sub-DE11755_ses-20171223_sequ-401_acq-cor_MPRAGE.nii.gz
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│       ├── sub-DE11755_ses-20171223_sequ-501_acq-cor_T1w.nii.gz
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│       ├── sub-DE11755_ses-20171223_sequ-602_acq-ax_T2w.json
│       ├── sub-DE11755_ses-20171223_sequ-602_acq-ax_T2w.nii.gz
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│       ├── sub-DE11755_ses-20171223_sequ-701_acq-cor_T2w.nii.gz
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│       ├── sub-DE11755_ses-20171223_sequ-901_acq-cor_T1w.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-902_acq-cor_T1w.json
│       ├── sub-DE11755_ses-20171223_sequ-902_acq-cor_T1w.nii.gz
│       ├── sub-DE11755_ses-20171223_sequ-903_acq-cor_T1w.json
│       └── sub-DE11755_ses-20171223_sequ-903_acq-cor_T1w.nii.gz
```
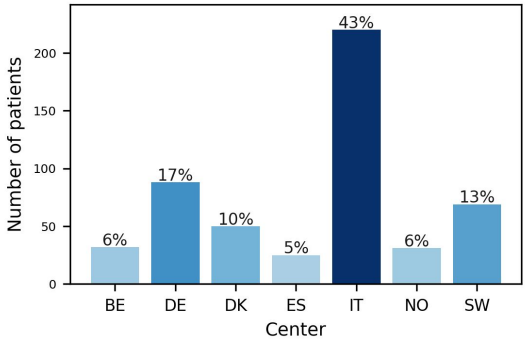

Dataset Specifications

QMENTA

Total data (raw)



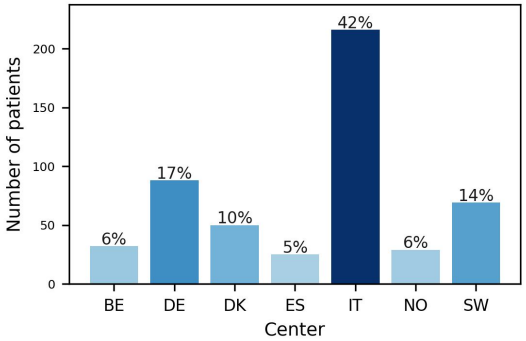
~510 patients
~40k files
~400 GB

Recent update:
~10k new files!

Conversion

BIDS

Total data (BIDS)

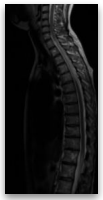


510 patients
~25k files ~65%
~360 GB ~90%

Classification

Spinal cord data
507 patients
~10k files

~40%



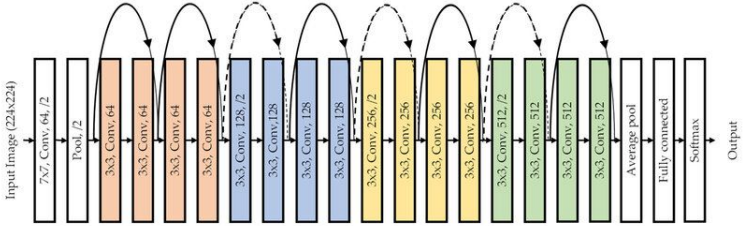
Brain data
510 patients
~15k files

~60%

Extraction of Spinal Cord Data with a Neural Network

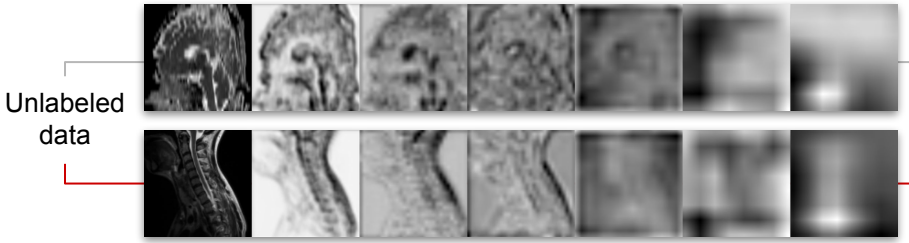
Classification:

- >1000 manually labeled scans
- Training neural network (ResNet-18)
- Inference (anatomical label “desc”)

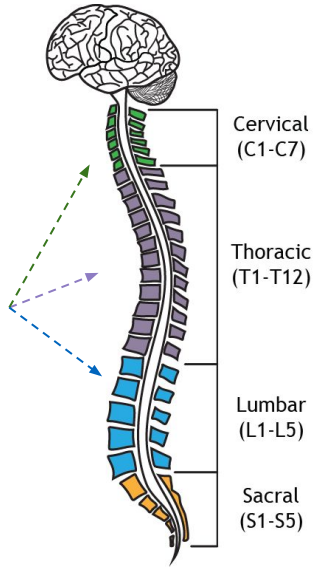


Results:

- Very reliable
- Modality-agnostic
- Few FP/FN ➔ QC



Feature maps at increasing network depths



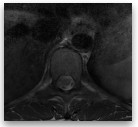
T2-weighted Spinal Cord MRI: Sessions

Sagittal T2w SC

Update: 441 subjects

Center	M00		M12		M24		M36		M48	
BE	32	100%	0	0%	24	75%	14	44%	0	0%
DE	87	100%	0	0%	76	87%	0	0%	0	0%
DK	50	100%	46	92%	38	76%	26	52%	22	44%
ES	25	100%	0	0%	18	72%	1	4%	0	0%
IT	105	100%	25	24%	13	12%	7	7%	3	3%
NO	14	100%	13	93%	13	93%	11	79%	12	86%
SW	25	100%	10	40%	20	80%	3	12%	0	0%
Total	338	100%	94	28%	202	60%	62	18%	37	11%

Axial T2w SC



Update: 414 subjects

Center	M00		M12		M24		M36		M48	
BE	32	100%	0	0%	23	72%	12	38%	0	0%
DE	87	100%	0	0%	76	87%	0	0%	0	0%
DK	50	100%	41	82%	38	76%	24	48%	22	44%
ES	0	0%	0	0%	0	0%	0	0%	0	0%
IT	121	100%	43	36%	28	23%	16	13%	3	2%
NO	13	100%	13	100%	13	100%	11	85%	12	92%
SW	24	100%	9	38%	21	88%	4	17%	0	0%
Total	327	100%	106	32%	199	61%	67	20%	37	11%

MRI “OK” validation

	M00			M24		
	OK	NOK	N/A	OK	NOK	N/A
Brain	498	12	5	422	88	5
SC (cervical)	498	12	5	419	91	5
SC (thoracic)	496	14	5	416	94	5

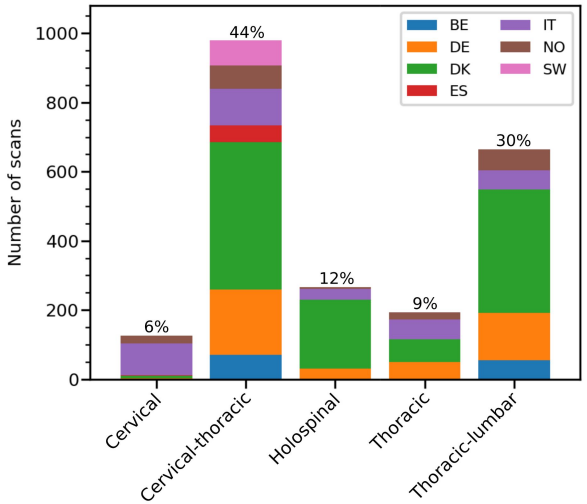
T2-weighted Spinal Cord MRI: Chunks

Data of interest:

- Chunk: cervical, thoracic
- Contrast: T2-weighted
- Orientation: sagittal, axial

Status quo:

- Largest subcohort cervical
- Cervical sagittal T2 scans:
  >2300 manually labeled
- Potential for longitudinal lesion count and volumetric analysis



Outlook: AI-based Segmentation Pipeline

1. Spinal cord and lesion segmentation

2. Vertebrae labeling

3. Template-based analysis