Inclusion of attention gates in a 3D CNN model improves the performance in new T2 lesion quantification

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Multiple Sclerosis

Every 5 minutes a new case of MS is diagnosed worldwide

MS affects more than **2.8M worldwide**

3 out of 4 of new diagnosed cases will be **women**

Annual global costs exceed **€ 145.000 M**

Multiple Sclerosis (Spain)

55.000 patients diagnosed in Spain

Prevalence of **120** patients / 100.000 habitants

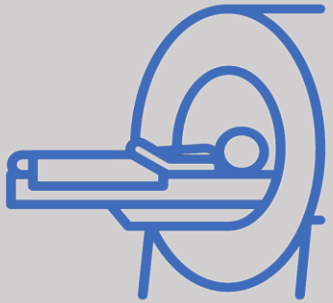
A new case is diagnosed every **5 hours**

Annual global costs exceed **€ 2300 M** (**€ 43.000 PPPY**)

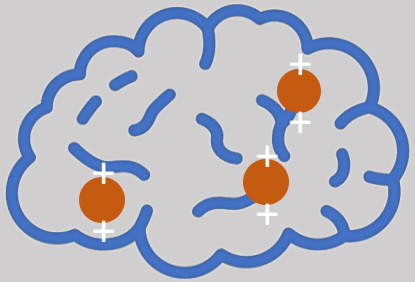
Multiple Sclerosis (treatment)

Disease modifying treatments (DMT)
€ 40.000 PPPY

DMT can slow down the **progression** of the disease



MRI biomarkers evaluate the response to treatments



MRI brain lesions are nowadays the best **biomarker**

New / enlarging T2 lesions

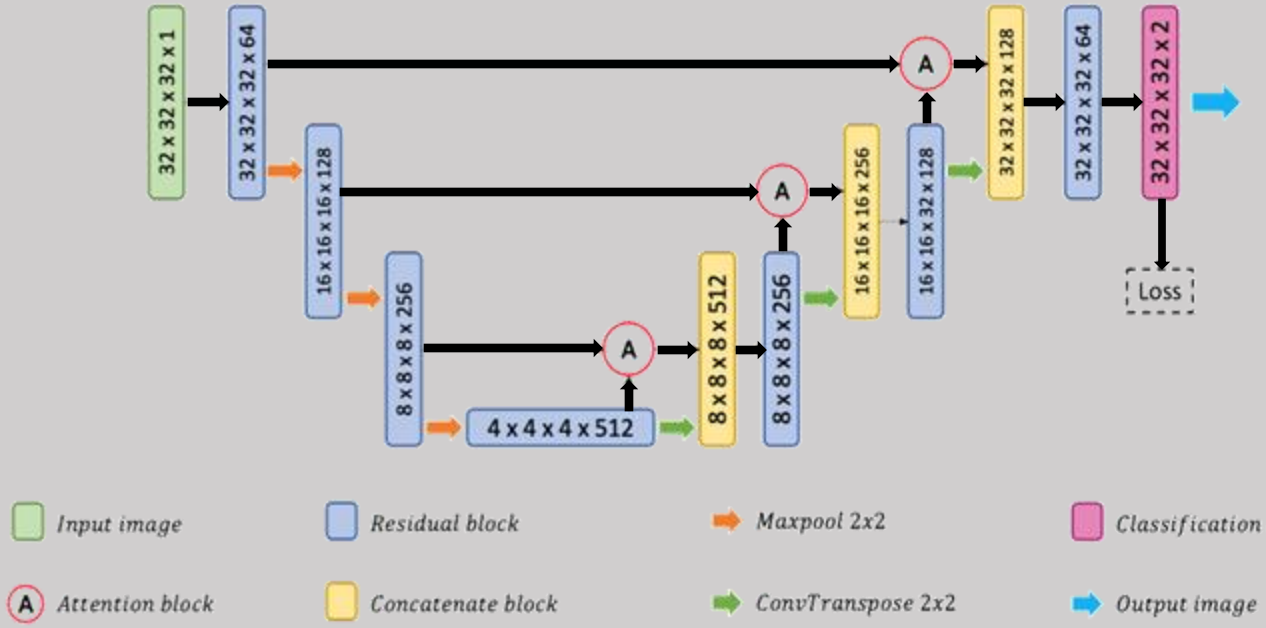
Nowadays most neuradiologists perform **visual inspection**

Prone to **errors** due to **repositioning**, diffuse and **confluent** chronic lesions

Visual inspection decreases the **sensitivity** detecting lesion activity

Sub-optimal administration of the best **personalized** treatment

3D ResU-Net with Attention Gates (AGResU-Net)



3D Convolutional Neural Network

3D architecture

↑ Sensitivity

↑ Accuracy

Attention gates

Focus on relevant regions

Ignore irrelevant zones

MRI data

Acquired at **Josep Trueta** hospital (Girona).

100 subjects with 2 MRI (mean interval of 14 months [range 6 – 36 months]).

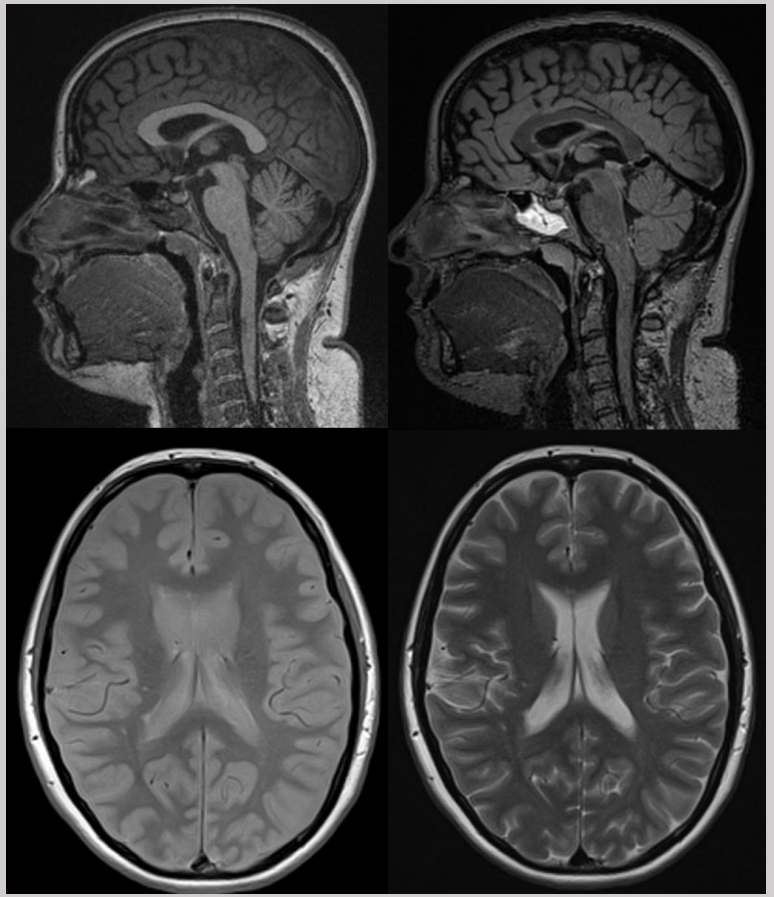
2 x **Philips Achieva 1.5T** scanner.

Four sequences using the **same protocol**:

- 3D-FLAIR
- 3D-T1-w
- T2-w
- PD-w

SAGITAL 3D-T1_MPRAGE (TR/TE/TI=2300/2.98/900ms, voxel size=1x1x1mm)

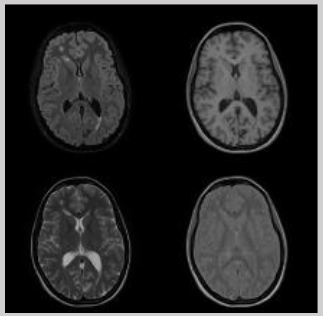
3D-FLAIR (TR/TE=5000/394ms, voxel size=1x1x1mm)



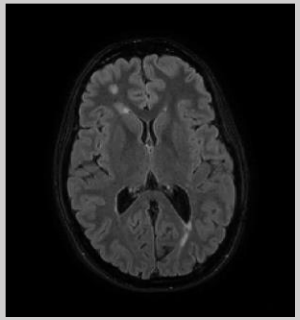
AXIAL PD_T2_tse (TR/TE1/TE2=2500/16/91ms, voxel size=0.8x0.8x3mm)

Methodology: automated methods

Two different methods are used to determine de number of **new / enlarging** T2 lesions



M1 - Four input sequences



M2 - FLAIR only + Attention Gates

Methodology: evaluation

All methods are compared to a **gold standard** (reference outcome of new / enlarging lesion) that is composed as follows:

Gold standard

=

Visual radiological report

+

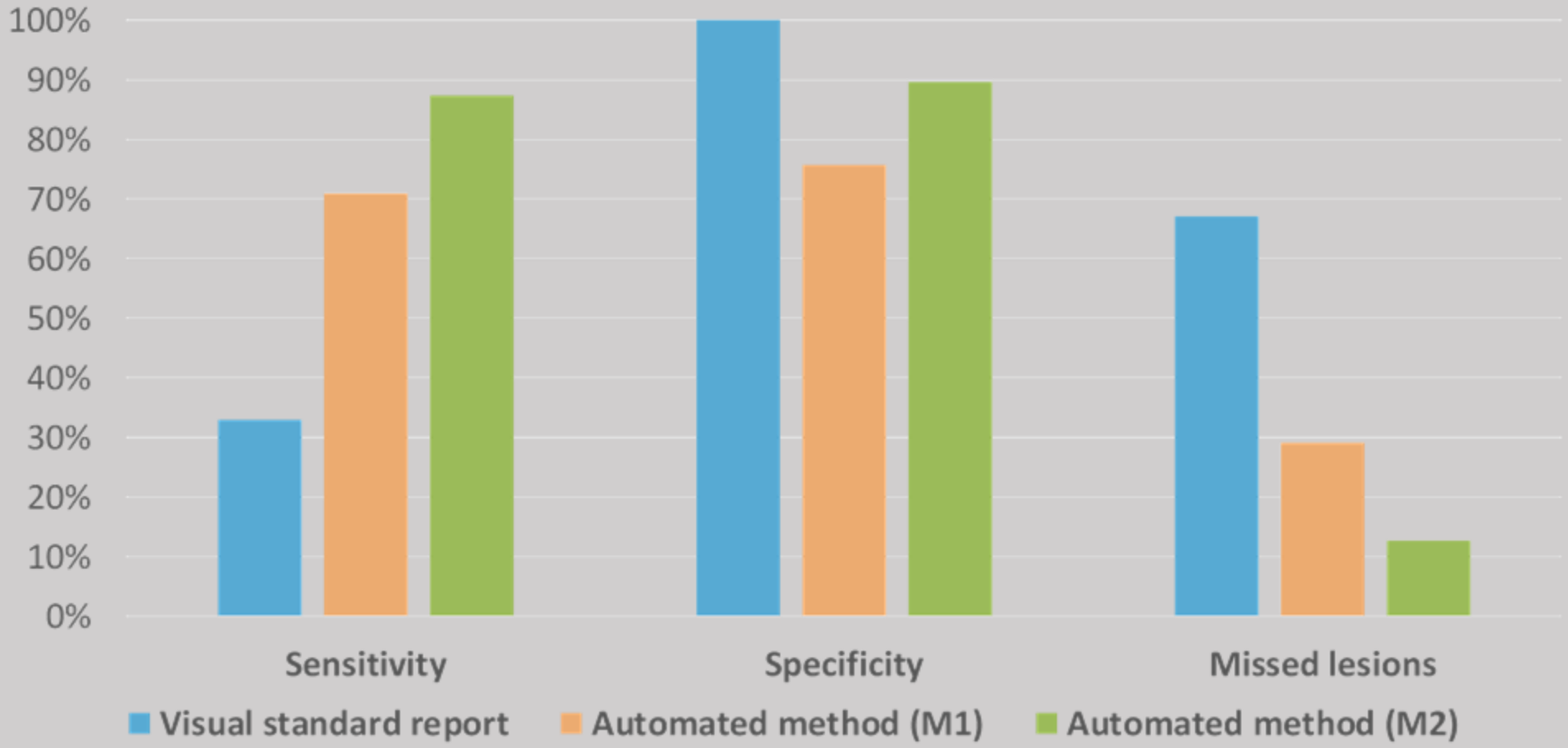
Automated method

+

One expert radiologist (> 15 years of experience)

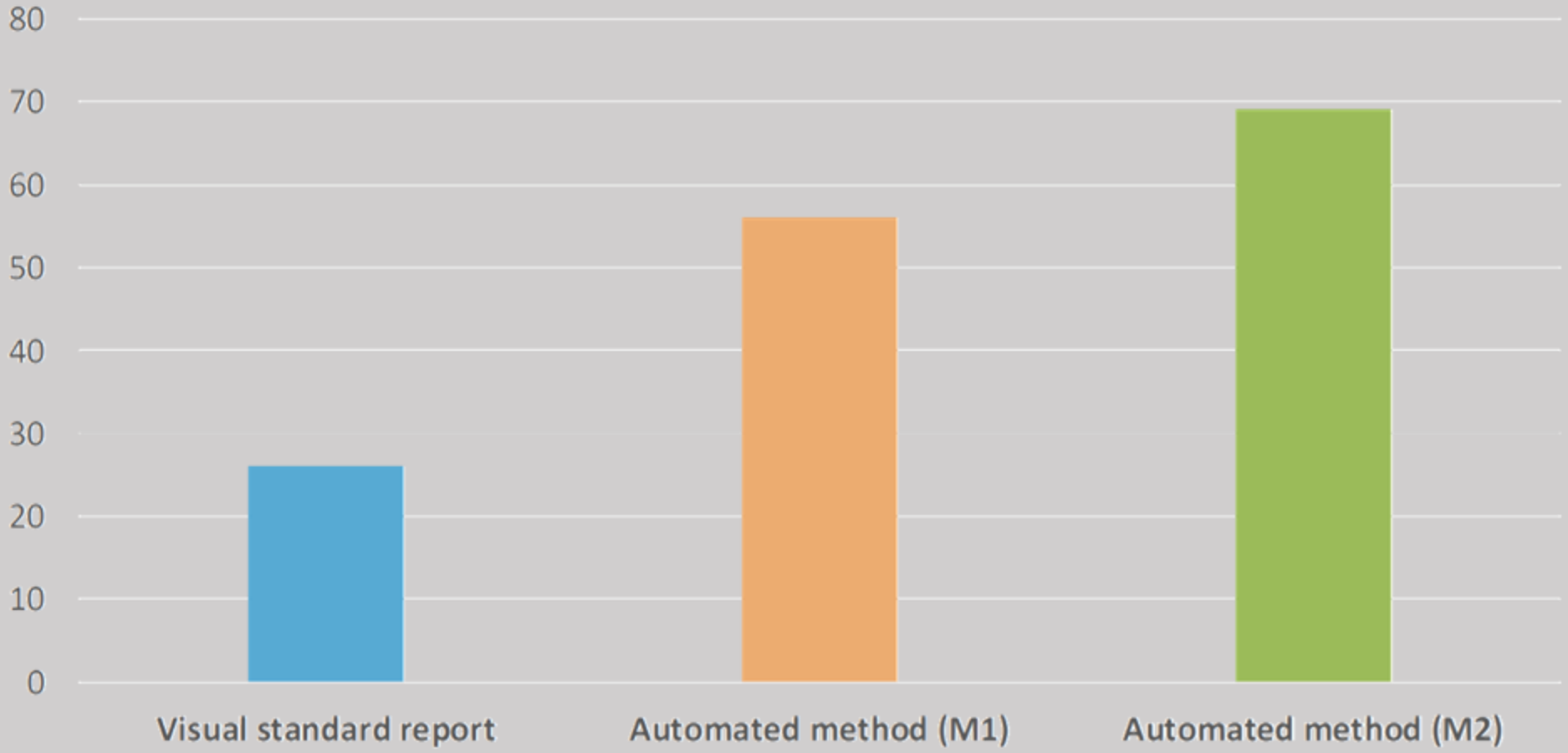
Results: visual standard report vs. automated methods

Visual standard report (VSR) obtained less than **35%** of sensitivity while **M1 and M2** reached **76%** and **90%**, respectively



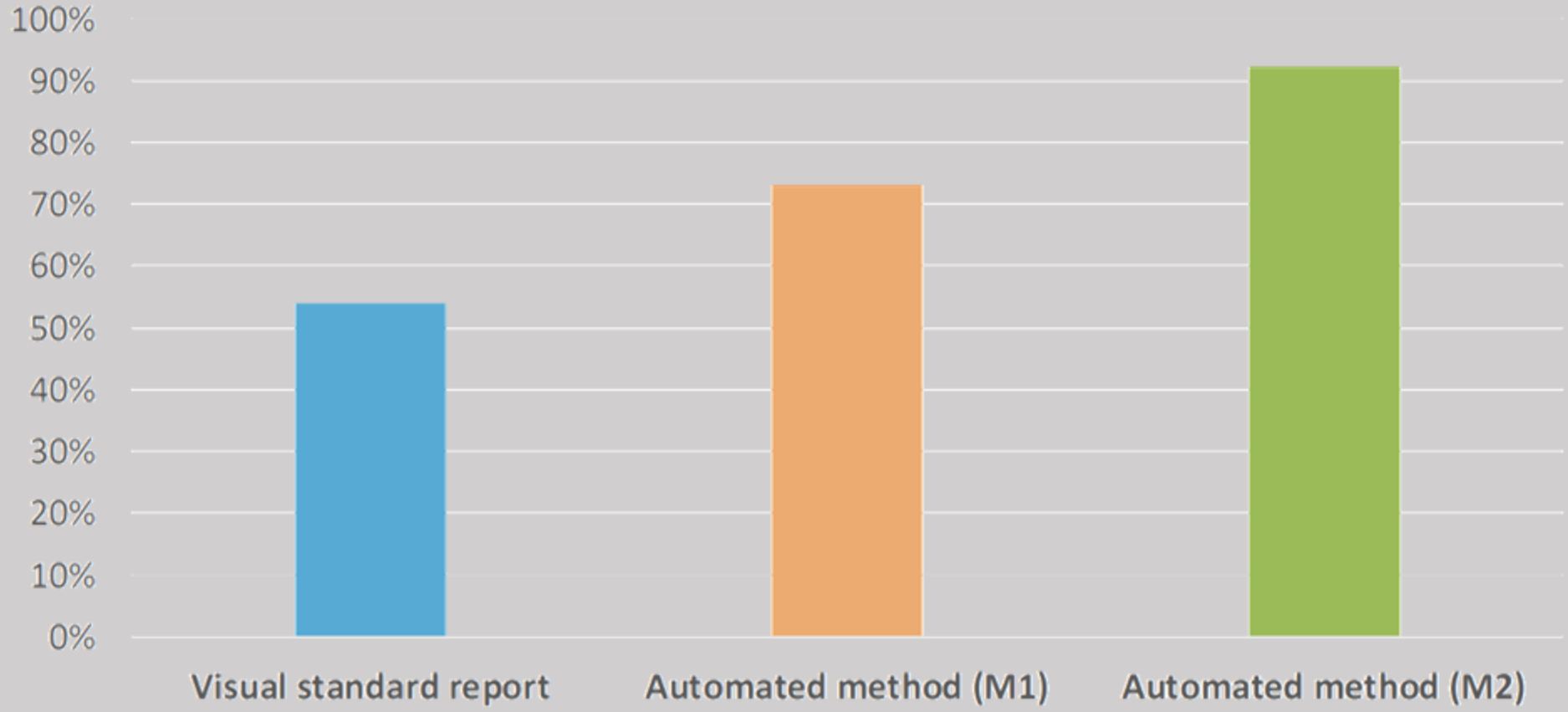
Results: visual standard report vs. automated methods

VSR detected **26 lesions** over 100 patients. **M1** raised the value to **56** and **M2** extended the count to **69**



Results: radiological activity

VSR identified **14 patients** with **26 NEDA-compatible lesions**
M1 identified **19 patients** with **59 lesions**
M2 found **24 patients** with **69 lesions**



Conclusions

Attention gates improved **detection** of T2 lesions in MS patients **significantly**

AGResU-Net with FLAIR sequences only **outperformed other methods**

Suitable to assist the radiologist **during the treatment** response in MS patients

Thanks

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