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New Haven
Health

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CREATION AND IMPLEMENTATION PACS-INTEGRATED VASARI FEATURE CLASSIFICATION TOOL FOR PCSNL SYSTEMATIC CLASSIFICATION

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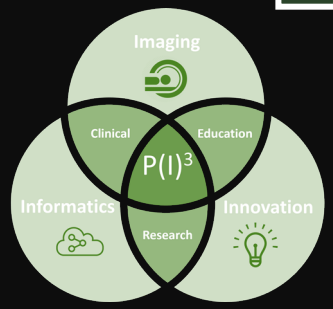

Brain Tumors Research Group
Yale Radiology and Biomedical Imaging

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INTRODUCTION

- Consistent classification is crucial in the era of ML and NLP in order to facilitate and optimize algorithm creation and validation.
- This can be achieved by using a standardized set of defined visual features and vocabulary, such as the VASARI set.

- Current available tools require use of multiple platforms in order to extract these features making it a laborious and inefficient process
- Our project involved the creation of a PACS-integrated tool which allows for real-time VASARI feature extraction, which are then automatically available to other users

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INNOVATIVE INFORMATIC APPROACH: FHIR FORMS

FHIR forms:

- Fast
- Healthcare
- Interoperability
- Resources

BENEFITS

- Easy & hassle-free integration & Implementation
- Enhances the healthcare delivery speed by making data accessible in a readable format
- Structures & standardizes data for machine-based processing & other automated clinical support
- Reduces the time-consuming document-based information exchange between systems by feeding the information directly into workflows
- Offers inbuilt traceability mechanisms to HL7 RIM & other content-based models supporting alignment with the existing practices & prototypes, even they don't have any knowledge of RIM or any other deviation of HL7 version 3

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MATERIALS & METHODS

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- The manual approach for VASARI feature extraction involved online consulting of the VASARI set, evaluation of the images on the PACS, and entering the information for each individual patient into an excel sheet prior to sharing with other users

- For the creation of our tool, the VASARI feature set was integrated into the PACS application programming interface

- After clicking the VASARI tool icon in the PACS, the features appear in a separate pop-up window, with options to be selected by the user

- The answers can then be saved directly into the PACS and reviewed by other users

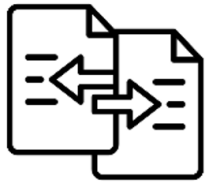
VASARI Feature Manual Extraction

Consulting of the online available VASARI features set

→

Evaluation of the images on the PACS for each feature

→

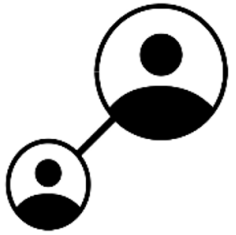


Separate data collection sheet

→

Entering the information for each feature into Excel sheet

→



Information available to other users only after being sent specifically to each user

↑

This process needs to be repeated for all 29 VASARI Features for each patient

↓

PACS-Integrated VASARI Tool Software

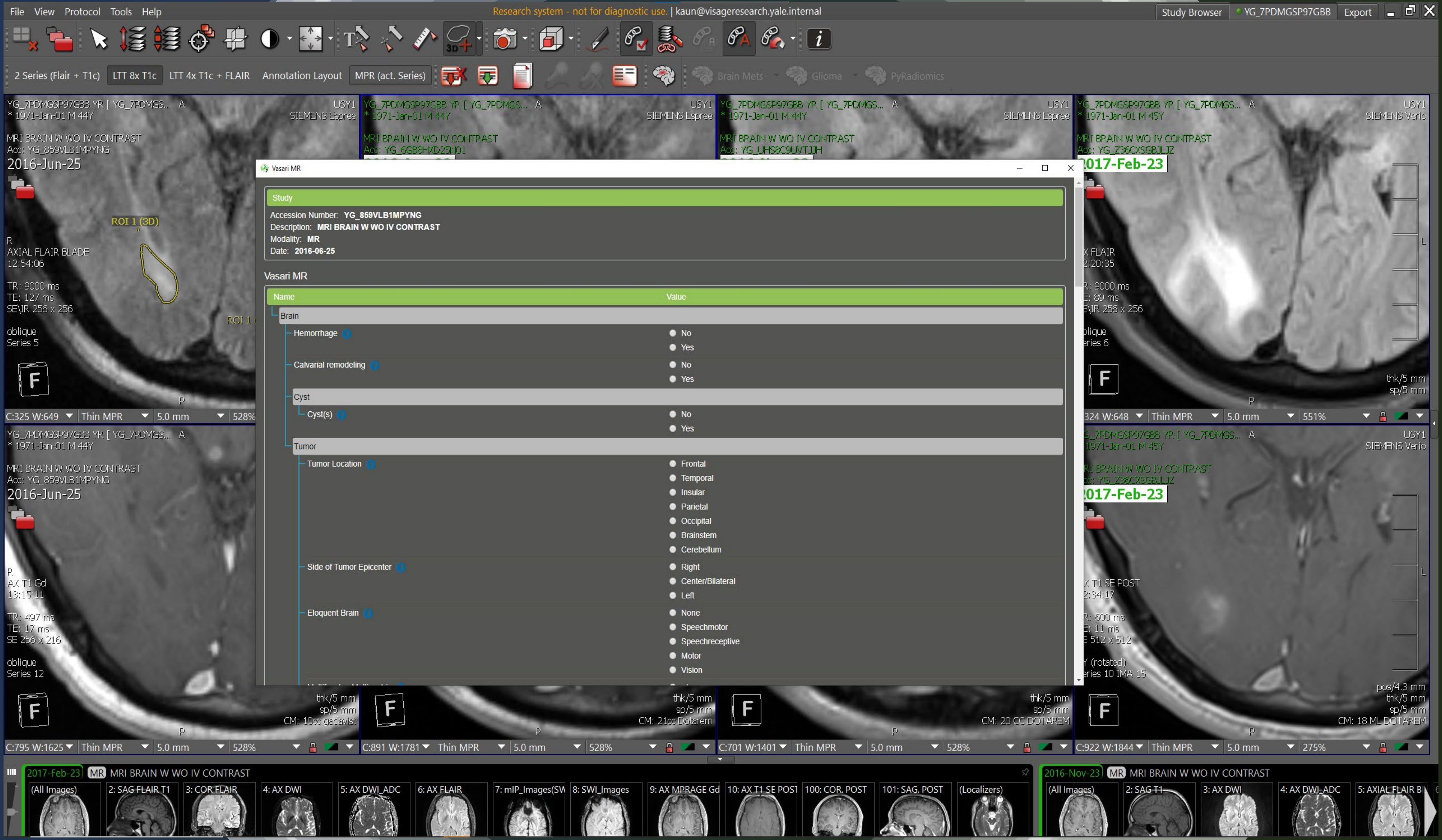
Selection of the VASARI tool in PACS

→

Simultaneous image evaluation & VASARI feature extraction by checking boxes in a pre-defined checklist

→

Data can be saved directly into PACS where it is automatically available to all other users with pre-defined access


File View Protocol Tools Help
Research system - not for diagnostic use. | kaun@visageresearch.yale.internal
Study Browser
YG_7PDMGSP97GBB
Export
2 Series (Flair + T1c)
LTT 8x T1c
LTT 4x T1c + FLAIR
Annotation Layout
MPR (act. Series)
Brain Mets
Glioma
PyRadiomics
MRI BRAIN W WO IV CONTRAST
Acc: YG_859VLB1MPYNG
2016-Jun-25
ROI 1 (3D)
AXIAL FLAIR BLADE
12:54:06
TR: 9000 ms
TE: 127 ms
SE\IR 256 x 256
oblique
Series 5
2017-Feb-23
Vasari MR
Study
Accession Number: YG_859VLB1MPYNG
Description: MRI BRAIN W WO IV CONTRAST
Modality: MR
Date: 2016-06-25
Vasari MR
Name
Value
Brain
Hemorrhage
No
Yes
Calvarial remodeling
No
Yes
Cyst
Cyst(s)
No
Yes
Tumor
Tumor Location
Frontal
Temporal
Insular
Parietal
Occipital
Brainstem
Cerebellum
Side of Tumor Epicenter
Right
Center/Bilateral
Left
Eloquent Brain
None
Speechmotor
Speechreceptive
Motor
Vision
AX T1 Gd
13:15:11
TR: 497 ms
TE: 17 ms
SE 256 x 216
oblique
Series 12
CM: 10cc gadavist
CM: 21cc Dotarem
CM: 20 CC DOTAREM
CM: 18 ML DOTAREM
C:795 W:1625
Thin MPR
5.0 mm
528%
2017-Feb-23
MR
MRI BRAIN W WO IV CONTRAST
(All Images)
2: SAG FLAIR T1
3: COR FLAIR
4: AX DWI
5: AX DWI_ADC
6: AX FLAIR
7: mIP_Images(SW
8: SWI_Images
9: AX MPRAGE Gd
10: AX T1 SE POST
100: COR. POST
101: SAG. POST
(Localizers)
2016-Nov-23
MR
MRI BRAIN W WO IV CONTRAST
(All Images)
2: SAG T1
3: AX DWI
4: AX DWI-ADC
5: AXIAL FLAIR B

Eloquent Brain	Multifocal or Multicentric	T1/FLAIR RATIO Tumor	Pial invasion	Ependymal invasion	Cortical involvement	Deep WM invasion	Satellites

File Home Insert Draw Page Layout Formulas Data Review View Help Acrobat PDFelement Comments Share

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	B	C	I	J	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	Gender	Age	Survival (days)	Typical vs Atypical	Hemorrhage	Calvarial remodeling	Cyst(s)	Tumor location	Side of Tumor	Eloquent Brain	Multifocal or Multicentric	T1/FLAIR RATIO Tumor	Pial invasion	Ependymal invasion	Cortical involvement	Deep WM invasion	Satellites	Lesion size	Proportion of Edema	Edema Crosses	Enhancement Quality	Proportion Enhancing	Thickness of enhancing	Definition of the	Enhancing tumor	Proportion nCET	Proportion Necrosis	Definition of the non-
2	M	53	120	Atypical	1=Yes	0=No	0=No	2=Temporal	3=Left	2=Speech Motor	2=Multicentric	1=Expansive	1=Yes	1=Yes	1=Yes	0=No	1=Yes	14	3	0=No	2=Marked/Avid	2	4=Thick/solid	1=n/a	0=No	4=34-67%	4	0=n/a
3	M	69	48	Typical	0=No	0=No	0=No	1=Frontal	3=Left	4=Motor	0=Neither	1=Expansive	0=No	0=No	0=No	1=Yes	0=No	8	3	0=No	2=Marked/Avid	4	1=n/a	3=Poorly defir	0=No	2=<5%	2	0=n/a
4	F	71	2942	Typical	0=No	0=No	0=No	6=Cerebellum	2=Center/BL	4=Motor	2=Multicentric	2=Mixed	0=No	1=Yes	0=No	1=Yes	1=Yes	6	2	0=No	2=Marked/Avid	3	1=n/a	2=Well-define	0=No	3=6-33%	3	0=n/a
5	F	67	244	Typical	0=No	0=No	0=No	4=Parietal	2=Center/BL	4=Motor	1=Multifocal	1=Expansive	0=No	1=Yes	0=No	1=Yes	1=Yes	16	3	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	1=Yes	2=<5%	2	0=n/a
6	F	86	62	Typical	0=No	0=No	0=No	1=Frontal	1=Right	2=Speech Motor	1=Multifocal	1=Expansive	0=No	0=No	1=Yes	0=No	1=Yes	10	1	0=No	2=Marked/Avid	4	1=n/a	2=Well-define	0=No	2=<5%	2	0=n/a
7	F	70	2004	Atypical	1=Yes	0=No	0=No	1=Frontal	1=Right	4=Motor	0=Neither	1=Expansive	1=Yes	1=Yes	1=Yes	0=No	1=Yes	16	2	1=Yes	2=Marked/Avid	2	4=Thick/solid	2=Well-define	1=Yes	4=34-67%	4	0=n/a
8	F	64	211	Typical	0=No	0=No	0=No	1=Frontal	2=Center/BL	4=Motor	2=Multicentric	3=Infiltrative	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	5	4	0=No	2=Marked/Avid	4	1=n/a	2=Well-define	0=No	2=<5%	2	0=n/a
9	F	79	381	Typical	0=No	0=No	0=No	1=Frontal	2=Center/BL	2=Speech Motor	2=Multicentric	1=Expansive	1=Yes	0=No	1=Yes	1=Yes	1=Yes	15	3	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	0=No	2=<5%	2	0=n/a
10	F	58	812	Typical	0=No	0=No	0=No	1=Frontal	3=Left	2=Speech Motor	2=Multicentric	1=Expansive	0=No	1=Yes	1=Yes	0=No	1=Yes	7	3	0=No	2=Marked/Avid	4	1=n/a	2=Well-define	2	2=<5%	2	0=n/a
11	M	33	57	Atypical	1=Yes	0=No	1=Yes	3=Insular	2=Center/BL	3=Speech Receptive	2=Multicentric	1=Expansive	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	13	3	0=No	2=Marked/Avid	3	4=Thick/solid	2=Well-define	0=No	3=6-33%	3	0=n/a
12	M	70	38	Typical	0=No	0=No	1=Yes	2=Temporal	3=Left	2=Speech Motor	1=Multifocal	1=Expansive	1=Yes	0=No	1=Yes	0=No	1=Yes	17	3	0=No	2=Marked/Avid	3	4=Thick/solid	2=Well-define	0=No	3=6-33%	3	0=n/a
13	M	42	69	Typical	0=No	0=No	0=No	2=Temporal	3=Left	2=Speech Motor	2=Multicentric	1=Expansive	0=No	0=No	1=Yes	1=Yes	1=Yes	12	3	0=No	2=Marked/Avid	3	4=Thick/solid	2=Well-define	0=No	3=6-33%	3	0=n/a
14	M	66	767	Atypical	1=Yes	0=No	0=No	3=Insular	1=Right	4=Motor	1=Multifocal	1=Expansive	1=Yes	1=Yes	0=No	1=Yes	1=Yes	17	3	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	0=No	2=<5%	2	0=n/a
15	F	79	122	Typical	0=No	0=No	0=No	1=Frontal	2=Center/BL	1=None	2=Multicentric	1=Expansive	1=Yes	1=Yes	0=No	0=No	1=Yes	7	2	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	1=Yes	2=<5%	2	0=n/a
16	F	82	160	Typical	0=No	0=No	0=No	6=Cerebellum	1=Right	1=None	2=Multicentric	1=Expansive	0=No	1=Yes	0=No	0=No	0=No	7	2	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	1=Yes	2=<5%	2	0=n/a
17	M	64	203	Atypical	1=Yes	0=No	0=No	2=Temporal	2=Center/BL	2=Speech Motor	2=Multicentric	1=Expansive	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	17	3	1=Yes	2=Marked/Avid	3	4=Thick/solid	2=Well-define	1=Yes	3=6-33%	3	0=n/a
18	M	75	89	Typical	0=No	0=No	0=No	1=Frontal	3=Left	4=Motor	1=Multifocal	1=Expansive	0=No	0=No	1=Yes	0=No	1=Yes	3	2	2	1=Mild/Minimal	4	2=None	3=Poorly defir	0=No	2=<5%	2	0=n/a
19	M	84	60	Typical	0=No	0=No	0=No	1=Frontal	1=Right	4=Motor	0=Neither	1=Expansive	1=Yes	0=No	1=Yes	0=No	0=No	17	3	0=No	2=Marked/Avid	4	2=None	2=Well-define	0=No	2=<5%	2	0=n/a
20	M	62	132	Atypical	1=Yes	0=No	0=No	6=Cerebellum	3=Left	1=None	1=Multifocal	1=Expansive	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	10	2	1=Yes	2=Marked/Avid	3	4=Thick/solid	3=Poorly defir	1=Yes	3=6-33%	3	0=n/a
21	F	68	1237	Atypical	1=Yes	0=No	1=Yes	4=Parietal	3=Left	3=Speech Receptive	0=Neither	1=Expansive	1=Yes	0=No	1=Yes	0=No	0=No	17	3	0=No	2=Marked/Avid	2	4=Thick/solid	2=Well-define	0=No	4=34-67%	4	0=n/a
22	M	74	159	Typical	0=No	0=No	1=Yes	1=Frontal	1=Right	2=Speech Motor	2=Multicentric	3=Infiltrative	1=Yes	1=Yes	1=Yes	1=Yes	0=No	15	2	1=Yes	2=Marked/Avid	4	1=n/a	2=Well-define	1=Yes	2=<5%	2	0=n/a
23	M	27	680	Atypical	1=Yes	0=No	1=Yes	1=Frontal	2=Center/BL	4=Motor	2=Multicentric	1=Expansive	1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	10	3	0=No	2=Marked/Avid	2	4=Thick/solid	2=Well-define	0=No	4=34-67%	4	0=n/a
24	M	82	765	Typical	0=No	0=No	0=No	2=Temporal	1=Right	3=Speech Receptive	1=Multifocal	1=Expansive	0=No	0=No	1=Yes	1=Yes	1=Yes	16	3	0=No	2=Marked/Avid	4	2=None	2=Well-define	0=No	2=<5%	2	0=n/a
25	F	65	342	Atypical	0=No	0=No	0=No	1=Frontal	2=Center/BL	2=Speech Motor	2=Multicentric	1=Expansive	0=No	1=Yes	0=No	1=Yes	1=Yes	1	2	0=No	1=Mild/Minimal	0	2=None	3=Poorly defir	0=No	6=100%	1	0=n/a
26	M	75	141	Atypical	1=Yes	0=No	0=No	6=Cerebellum	2=Center/BL	1=None	2=Multicentric	1=Expansive	0=No	1=Yes	0=No	0=No	1=Yes	5	2	1=Yes	2=Marked/Avid	3	1=n/a	2=Well-define	1=Yes	3=6-33%	3	0=n/a
27	M	75	168	Atypical	1=Yes	0=No	0=No	1=Frontal	3=Left	1=None	0=Neither	1=Expansive	0=No	1=Yes	0=No	0=No	0=No	5	3	0=No	2=Marked/Avid	3	2=None	2=Well-define	0=No	3=6-33%	3	0=n/a
28	F	89	723	Typical	0=No	0=No	0=No	1=Frontal	3=Left	1=None	0=Neither	3=Infiltrative	0=No	1=Yes	0=No	1=Yes	1=Yes	7	1	0=No	2=Marked/Avid	3	4=Thick/solid	2=Well-define	0=No	3=6-33%	3	2=Irregular
29	M	68	210	Atypical	1=Yes	0=No	1=Yes	2=Temporal	3=Left	3=Speech Receptive	0=Neither	2=Mixed	0=No	0=No	1=Yes	0=No	0=No	9	2	0=No	2=Marked/Avid	3	4=Thick/solid	2=Well-define	0=No	3=6-33%	3	0=n/a
30	F	68	29	Atypical	1=Yes	0=No	0=No	5=Occipital	3=Left	5=Vision	0=Neither	1=Expansive	0=No	1=Yes	1=Yes	0=No	0=No	5	3	1=Yes	2=Marked/Avid	4	4=Thick/solid	2=Well-define	0=No	2=<5%	2	0=n/a
31	F	61	97	Atypical	0=No	0=No	0=No	4=Parietal	3=Left	3=Speech Receptive	1=Multifocal	1=Expansive	0=No	0=No	1=Yes	0=No	1=Yes	9	3	0=No	1=Mild/Minimal	1	4=Thick/solid	3=Poorly defir	0=No	5=68-95%	5	0=n/a
32	M	62	264	Atypical	0=No	0=No	0=No	4=Parietal	1=Right	2=Speech Motor	1=Multifocal	1=Expansive	0=No	1=Yes	1=Yes	1=Yes	1=Yes	10	2	0=No	2=Marked/Avid	2	4=Thick/solid	2=Well-define	0=No	4=34-67%	4	2=Irregular
33	F	79	236	Atypical	1=Yes	0=No	0=No	4=Parietal	3=Left	1=None	0=Neither	1=Expansive	1=Yes	0=No	1=Yes	0=No	0=No	6	3	0=No	2=Marked/Avid	3	1=n/a	2=Well-define	0=No	3=6-33%	3	0=n/a
34	F	58	673	Typical	0=No	0=No	0=No	1=Frontal	1=Right	1=None	2=Multicentric	3=Infiltrative	0=No	1=Yes	1=Yes	1=Yes	1=Yes	9	2	0=No	2=Marked/Avid	3	1=n/a	2=Well-define	0=No	3=6-33%	3	0=n/a
35	F	75	21	Atypical	1=Yes	0=No	0=No	1=Frontal	2=Center/BL	4=Motor	2=Multicentric	1=Expansive	0=No	1=Yes	1=Yes	1=Yes	1=Yes	14	3	1=Yes	2=Marked/Avid	2	4=Thick/solid	2=Well-define	1=Yes	4=34-67%	4	0=n/a

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RESULTS

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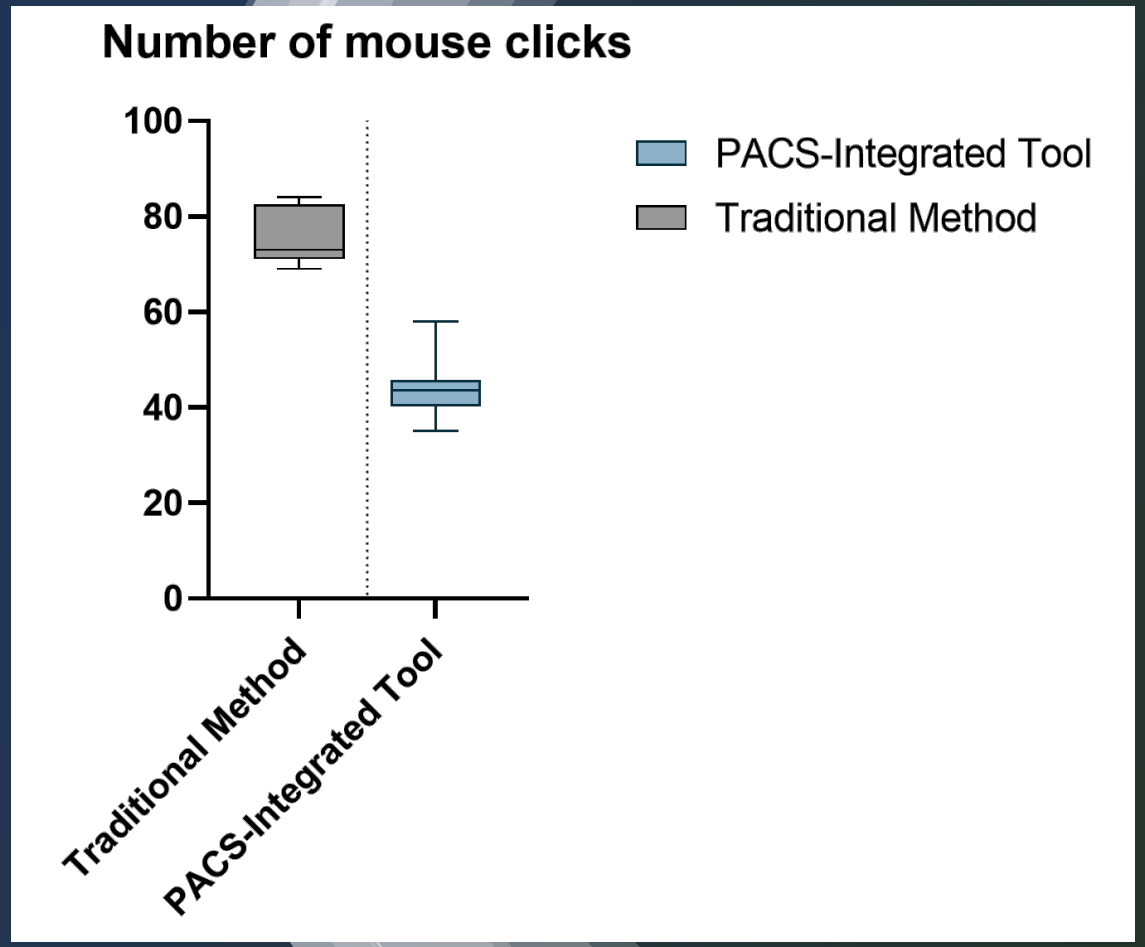

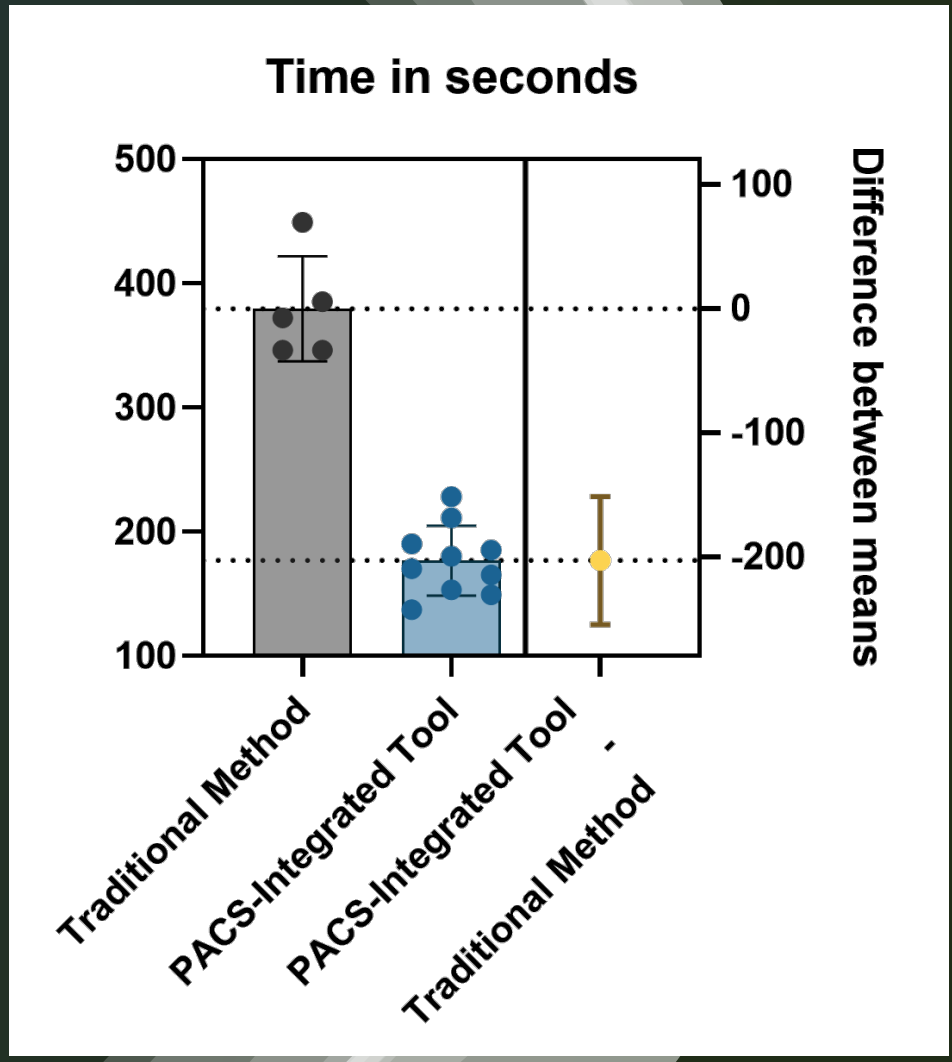

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RESULTS

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- Standardization
- Dramatically improved efficiency
  - 50% time required per patient
  - Allows batch exporting of the VASARI features simultaneously for multiple patients prior to data analysis and processing

- Uses
  - NLP for algorithm creation
  - Education
  - One analysis can be used for multiple projects
  - Automatic extraction of data from EMR

THANK YOU FOR YOUR ATTENTION

- ImagineQuant
- Questions? Feel free to contact us:
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