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COMPARATIVE STUDY OF BRAIN METASTASIS SEGMENTATION DATASETS AND MODELS

Brain Metastases

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Introduction

Brain metastases (BMs) are the most prevalent form of intracranial tumors in adults, significantly impacting the lives of cancer patients. An estimated 98,000 to 170,000 cases occur annually in the United States alone, making BMs a frequent complication of cancer and a common type of brain tumor [1]. Studies indicate that 20% to 40% of patients diagnosed with a primary cancer will develop secondary tumors in the brain, marking it as a major site for metastatic spread [2].

The management of brain metastases poses substantial challenges in clinical settings, particularly due to the complexity of their treatment which includes radiotherapy, surgery, and advanced drug therapies. The advancements in imaging techniques, particularly MRI, play a crucial role in the diagnosis and management of BMs. However, the manual tasks involved in the diagnosis and treatment planning, such as lesion identification and segmentation, are time-consuming and susceptible to human error.

To address these challenges, machine learning (ML) and deep learning (DL) techniques are being developed to automate these critical tasks, potentially increasing accuracy and efficiency in clinical workflows. Nonetheless, the progress in this field is hampered by the scarcity of publicly available datasets specifically curated for brain metastases, which is crucial for training and validating these AI models.

Chapter 1

Datasets for Brain Metastasis Segmentation

Table 1.1 presents a comparison of several pivotal datasets used in brain metastasis segmentation research. These datasets encompass a diverse range of imaging techniques and clinical data sourced from multiple institutions, enhancing the robustness and applicability of research outcomes.

The "Brain metastases MRI dataset" [3], "BrainMetShare" [4], and "UCSF-BMSR" [5] provide extensive MRI data along with validated segmentations, which are crucial for the development of segmentation algorithms. These datasets are openly accessible, and I have successfully downloaded them.

The "Pretreat-MetsToBrain-Masks" dataset, while publicly available, has presented unique challenges due to issues with the IBM Aspera download protocol. Nevertheless, it offers a comprehensive array of clinical and imaging data, including detailed segmentations of both major and subtle lesions.

The "BraTS 2023" [6] dataset provides MRI studies with semi-automatic and expert-drawn segmentations. However, accessing this dataset **requires official permission**. Similarly, the "BraTS 2024" [7] dataset can only be accessed by **participating in the challenge**.

BraTS 2024 challenge Deadlines:

- Mid-June to July 31: Validation phase (Segmentation file submissions). The exact start date of submissions will depend on the challenge (as it includes several challenges).
- July 31: Hard deadline for the submission of short papers in CMT, reporting methods and results based on training and validation data.

Table 1.1: Comparison of Brain Metastasis Segmentation Datasets

Dataset Name	**Year**	**Source**	**Number of Patients**	**Access Status**	**Key Features**
Brain metastases MRI dataset	2023	Scientific Data	75	Open Access	Comprehensive clinical and radiomic data, 637 high-resolution MRIs, semi-automatic segmentations
BrainMetShare	2023	Stanford	156	Open Access	156 whole brain MRIs, multi-modal sequences, radiologist-validated segmentations
BraTS 2023 Challenge Data	2023	MICCAI BraTS	Multiple	Requires Permission	Multi-parametric MRI, advanced segmentations, focus on varying lesion sizes
BraTS 2024 Challenge Data	2024	MICCAI BraTS	Multiple	Requires Participation	Expanded dataset, includes additional external datasets, refined segmentations by neuroradiologists
Pretreat-MetsToBrain-Masks	2023	IBM-Aspera-Connect	200	Public, issues with Aspera IBM	200 patients, clinical and qualitative/quantitative imaging information, sub-centimeter lesions, manual 3D segmentations
UCSF-BMSR	2023	The University of California San Francisco	412	Public, UCSF provided, non-commercial usage	Multimodal brain MRI, expert annotations, detailed segmentation

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