Clinical Project Notes

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- **"Time is Brain"**: In the case of a stroke, time is a crucial factor that significantly influences how much brain tissue is irreversibly damaged and how much can still be saved.
- In the treatment of ischemic stroke patients, it's crucial to identify which parts are irreversibly destroyed (core) and which parts can still be rescued (penumbra). The penumbra surrounds the core.
- As time passes, the core becomes larger ("Time is Brain").
- **Perfusion CT**: Measures blood flow in the brain over time (every 1–2 seconds over 45–60 seconds), using a contrast agent.
- Different software packages use different deconvolution algorithms and thresholds, which can lead to varying estimations of core and penumbra volumes.
- **Lesion masks**:
  - Represent binary infarct masks in the dataset, derived from MRI images.
  - Show actual final infarct areas and are co-registered to the NCCT (Non-Contrast CT).
  - Serve as ground truth (i.e., the "truth" your model is supposed to predict).
- **Goal**: Predict MRI-based lesion masks from CT data, bridging the gap between the CT image and the later MRI image (Paper 2 does exactly that).

- **Goal of the paper "A Robust Ensemble Algorithm for Ischemic Stroke Lesion Segmentation: Generalizability and Clinical Utility Beyond the ISLES Challenge"**: Automatically segment lesions from MRI (DWI, ADC, FLAIR), not CT prediction.
- **CT and MRI-based analysis**:
  - **CT (Acute phase)**:
    * Performed first, faster execution (minutes vs. MRI 30–45 minutes), *time is brain.*
    * CT scanners are mobile, available in every hospital and at any time.
    * No need for patient to lie still.
    * Cheaper.
    * MRI can be affected by metal implants, pacemakers; patients might be unconscious and quick action is necessary.
    * Shows mainly structural/anatomical changes.
    * Useful for quick differentiation between ischemic and hemorrhagic stroke.
  - **MRI (Follow-up)**:
    * Offers better soft tissue contrast.
    * More accurate display of final infarct volume.
- **Paper: A Robust Ensemble Algorithm for Ischemic Stroke Lesion Segmentation**:
  - DWI is the only imaging technique reliably demonstrating parenchymal injury within minutes to hours from stroke onset.
  - Frameworks like `nnU-Net` used by participants.
  - `nnU-Net`: Enables largely automated and optimized segmentation of medical images by automatically finding and applying the best configuration for a dataset.
  - Uses Dice loss function: Effective for optimizing overlap accuracy between model segmentations and actual labels.
  - Important question: Can deep learning identify ischemic lesions in scans from an unseen imaging center (another hospital)?
  - Even similar CNNs can perform variably due to factors like hyperparameter tuning, stochastic optimization, and data splitting.

  - Ensemble model achieved high accuracy even in clinical applications with varying conditions (different clinics, lesion sizes, stroke phases, image patterns, brain regions).
  - Limitation: Lack of multi-center representation.

- **Paper: ISLES 2024 – The first longitudinal multimodal multicenter real-world dataset in (sub-)acute stroke**:
  - First dataset with both follow-up MRI (2–9 days after stroke) and acute CT images (non-contrast, angiography, and perfusion), as well as clinical data up to three months.
  - Goal: Predict MRI-based lesion masks from CT data, bridging the gap.

- **Additional clinical data**:
  - Age, sex, pre-existing conditions, lab values, treatment times (e.g., onset-to-door), NIHSS and mRS scores (at admission, 24h, discharge, 3 months).

- **Dataset structure**:
  - `sesX` = session X
  - `raw_data`: contains unprocessed image data.
  - `derivatives`: processed/derived data.
  - `phenotype`: contains clinical/demographic CSV files.

- **Perfusion maps** (e.g., CBF, CBV, MTT, TTP):
  - Derived volumetric data visualizing blood perfusion parameters, not raw CT.
  - **CBF (Cerebral Blood Flow)**: Blood flow per time through a brain volume (ml/100g tissue/min).
  - **CBV (Cerebral Blood Volume)**: Total blood volume in a brain region (ml/100g tissue).
  - **MTT (Mean Transit Time)**: Average time for blood to pass through a region.
  - **TTP (Time to Peak)**: Time to maximum contrast agent concentration in an area.

  - These parameters help differentiate between irreversibly damaged (core) and salvageable (penumbra) tissue.
  - In ISLES24 dataset, usually found in a separate folder, e.g., `perfusion maps`.

- **Sessions**:
  - `ses-01`: Initial, acute scans:
    * NCCT (Non-Contrast CT)
    * CTA (CT Angiography)
    * CT Perfusion (source for perfusion maps)
  - `ses-02`: Contains lesion mask (from later MRI)