BASICS:
Bayesian method
(MRI DSC & CT)

1. BAYESIAN APPROACH FOR PERFUSION IMAGING IN A NUTSHELL

- Dynamic susceptibility contrast (DSC) sequence is performed after the injection of intravenous contrast agent to non invasively assess tissue and vascular perfusion characteristics.

- Accurate perfusion measurement provides important diagnostic information on pathological conditions.

- The acquired data are then post-processed to obtain perfusion maps with different parameters, such as BV (blood volume), BF (blood flow), MTT (mean transit time), TTP (time to peak), Delay, BAT5 (bolus arrival time 5%).

- The Bayesian method used to compute those parameters is a rigorous probabilistic estimation of hemodynamic parameters fully adaptive and delay insensitive\(^1\).
2. ADVANTAGES OF THE BAYESIAN APPROACH OVER SVD APPROACHES: ACCURATE ESTIMATION OF THE HEMODYNAMIC PARAMETERS

- The Bayesian post-processing is a rigorous and recently described probabilistic estimation of hemodynamic parameters given the standard perfusion model\(^1\),\(^2\). This method has already been validated using simulations on sophisticated MR digital phantoms and, from a quantitative point of view, outperforms SVD-based deconvolution methods\(^3\),\(^4\).

- This approach leads to a better estimation of hemodynamic parameters as CBF, CBV or MTT evaluation.

![Perfusion maps of the digital phantom generated by different algorithms (SVD based algorithms and Bayesian approach)](image)

Figure 1: Perfusion maps of the digital phantom generated by different algorithms (SVD based algorithms and Bayesian approach) (Courtesy of Prof M. Sasaki and Prof K. Kudo, Iwate Medical Center, Morioka, Japan).

- Computed maps with the Bayesian approach:
  - **rBF**: Relative Blood Flow
  - **Delay**: delay map
  - **MTT**: Mean Transit Time
  - **TTP**: Time To Peak
  - **rBV**: Relative Blood Volume
  - **Sigma**: noise level in the concentration time curve
  - **err_rBF**: relative error when estimating the blood flow
  - **err_Delay**: absolute error of delay

REFERENCES:

3. TRUE ARTERIAL-TISSUE DELAY (ATD) ASSESSMENT

- The use of a Bayesian analysis also permits calculation of true delay map.
- Just like Tmax for SVD-based methods, the arterial-tissue delay is defined as the time discrepancy between the arrival of the bolus in the tissue concentration-time function and the AIF.
- However, the SVD Tmax always overestimates the true delay. Tmax is strongly dependent on true MTT while it should not. Conversely, the ATD is a pure arterial-tissue delay estimate, regardless of the MTT.
- As a consequence, the Bayesian algorithm provides very accurate and pure estimates of the true delay in any case.

4. ROBUSTNESS OF THE BAYESIAN APPROACH

- The Bayesian method is more accurate and more robust against noise and truncation than oSVD, particularly in low SNR acquisition.
- For instance, CTP SNR are too low to reliably estimate MTT with SVD in acute stroke hypoperfused areas.

Acute stroke patient (CTP) with left MCA occlusion. An increased MTT is expected on the lesion side. A positive correlation for the Bayesian MTT (on the left) is noticed contrary to the oSVD MTT (on the right) with a negative correlation (negative values).