**PET image reconstruction with CNN deep learning**

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**Introduction**

**Positron Emission Tomography (PET)**

Positron Emission Tomography is a medical imaging modality capable of measuring functionality within the human body. Positrons are introduced to a patient through an activity uptake resulting in photon pairs 180° apart. Energy discrimination is used to minimize Compton scattered events.

In PET, one of the main challenges is determining how to best reconstruct the images from the sinogram data. The current clinical reconstruction methods include:

1. **Filtered back-projection (FBP)**
2. **Iterative reconstruction**

However, FBP reconstructions introduce blurring effects and iterative reconstructions are computationally expensive.

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**Methods**

**Training/Testing Simulations:**

1. **Activity uptake simulation:** Analytically generated high intensity = high activity uptake

2. **Sinogram simulation:**
   - Radon transform
   - Poisson noise

**Training CNN**

100,000 training sets

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**Results**

**Testing CNN**

- Poisson loss, adam optimizer, 100 epochs

<table>
<thead>
<tr>
<th>Sinogram</th>
<th>True</th>
<th>CNN</th>
<th>FBP</th>
<th>CNN error</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td><img src="image5.png" alt="Image" /></td>
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**Error Analysis**

CNN vs FBP reconstruction methods: Error analysis

- Mean Squared Error
- Structural Similarity

**Conclusion and Future Work**

CNN reconstruction showed lower error and higher similarity than FBP methods. Overall, CNN reconstruction may be used to improve image quality, reduce computational time and expand the amount of useful data measured for PET imaging.

**Future Work:**
- Realistic sinograms - Monte Carlo simulations
- Energy windows - utilizing Compton scattered events
- Real PET data

**References:**


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