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  author = {F. P. Vidal and J. Louchet and {J.-M.} Rocchisani and \'E. Lutton},
  title = {Flies for {PET}: An Artificial Evolution Strategy for Image Reconstruction in Nuclear Medicine},
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  address = {Philadelphia, Pensilvania, USA},
  annotation = {AAPM Annual Meeting, Jul~18--22, 2010},
  abstract = {Purpose: We propose an evolutionary approach for image
reconstruction in nuclear medicine. Our method is based on
a cooperative coevolution strategy (also called Parisian evolution):
the ``fly algorithm''.
Method and Materials: Each individual, or fly,
corresponds to a 3D point that mimics a radioactive emitter, i.e.
a stochastic simulation of annihilation events is performed to compute
the fly's illumination pattern. For each annihilation, a photon is
emitted in a random direction, and a second photon is emitted in
the opposite direction. The line between two detected photons is
called line of response (LOR). If both photons are detected by
the scanner, the fly's illumination pattern is updated.
The LORs of every fly are aggregated to form the population total
illumination pattern. Using genetic operations to optimize the position
of positrons, the population of flies evolves so that the population
total pattern matches measured data. The final population of flies
approximates the radioactivity concentration.
Results: We have developed numerical phantom models to assess
the reconstruction algorithm. To date, no scattering and no tissue attenuation
have been considered. Whilst this is not physically correct, it allows us
to test and validate our approach in the simplest cases.
Preliminary results show the validity of this approach in both 2D and
fully-3D modes. In particular, the size of objects, and
their relative concentrations can be retrieved in the 2D mode.
In fully-3D, complex shapes can be reconstructed.
Conclusions: An evolutionary approach for PET reconstruction has been proposed
and validated using simple test cases. Further work will therefore include
the use of more realistic input data (including random events and scattering),
which will finally lead to implement the correction of scattering within our algorithm.
A comparison study against ML-EM and/or OS-EM methods will also need to be conducted.},
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}
```

Flies for PET: An artificial evolution strategy for image reconstruction in nuclear medicine

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Purpose

We propose an evolutionary approach for image reconstruction in nuclear medicine. Our method is based on a cooperative coevolution strategy (also called Parisian evolution): the "fly algorithm".

Method and Materials

Each individual, or fly, corresponds to a 3D point that mimics a radioactive emitter, i.e. a stochastic simulation of annihilation events is performed to compute the fly's illumination pattern. For each annihilation, a photon is emitted in a random direction, and a second photon is emitted in the opposite direction. The line between two detected photons is called line of response (LOR). If both photons are detected by the scanner, the fly's illumination pattern is updated. The LORs of every fly are aggregated to form the population total illumination pattern. Using genetic operations to optimize the position of positrons, the population of flies evolves so that the population total pattern matches measured data. The final population of flies approximates the radioactivity concentration.

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We have developed numerical phantom models to assess the reconstruction algorithm. To date, no scattering and no tissue attenuation have been considered. Whilst this is not physically correct, it allows us to test and validate our approach in the simplest cases. Preliminary results show the validity of this approach in both 2D and fully-3D modes. In particular, the size of objects, and their relative concentrations can be retrieved in the 2D mode. In fully-3D, complex shapes can be reconstructed.

Conclusions

An evolutionary approach for PET reconstruction has been proposed and validated using simple test cases. Further work will therefore include the use of more realistic input data (including random events and scattering), which will finally lead to implement the correction of scattering within our algorithm. A comparison study against ML-EM and/or OS-EM methods will also need to be conducted.

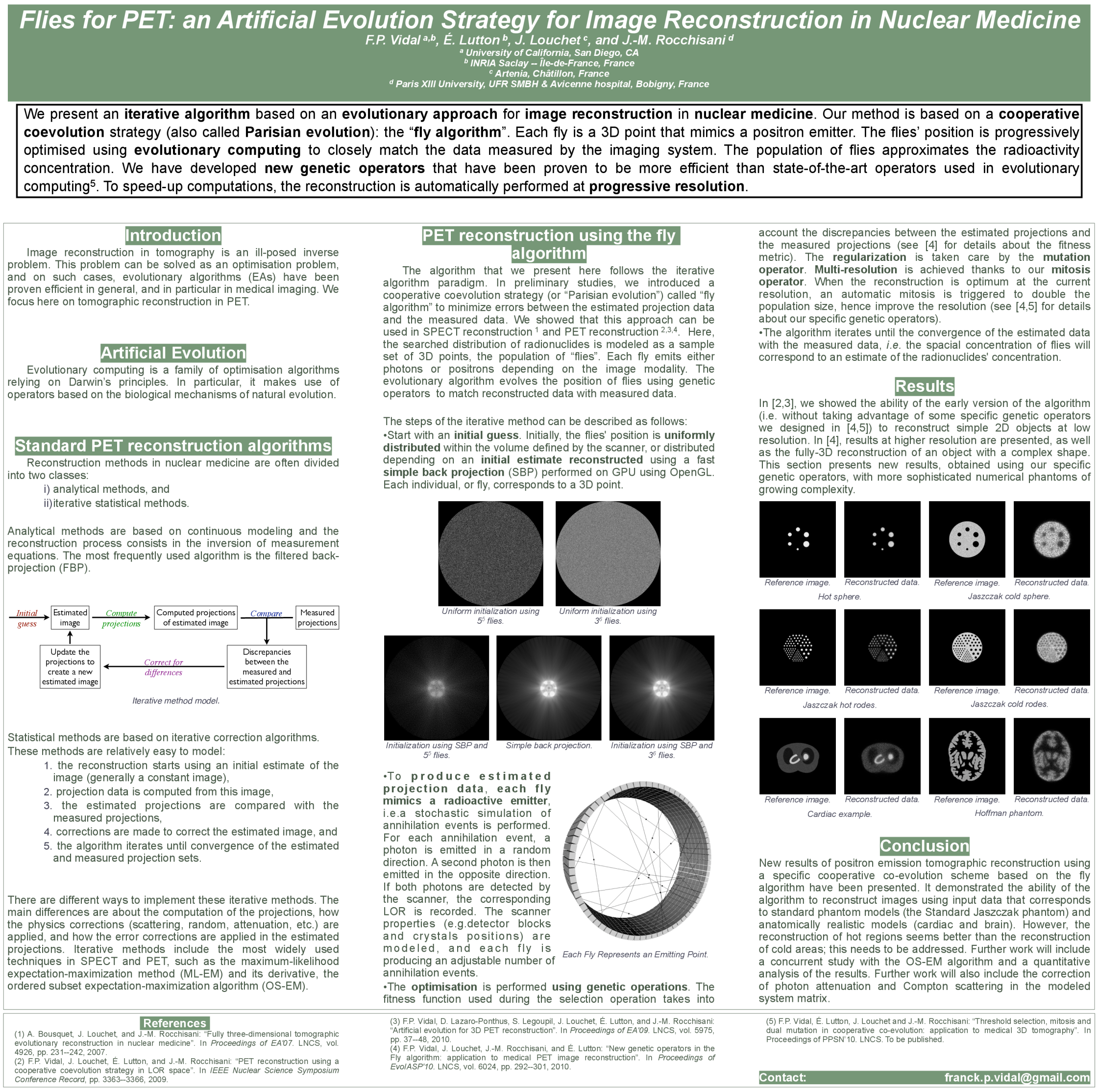

Figure 1: Poster presented at AAPM Annual Meeting, Philadelphia, Pensilvania, USA, Jul 18–22, 2010.