SimpleX Radiative Transfer

Sterrewacht
Leiden

The SimpleX Method: Transport on a Voronoi-Delaunay Grid

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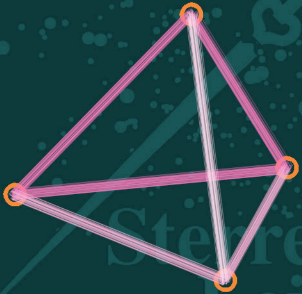
The SimpleX Method



The SimpleX Method

[1] Transport medium represented by a point distribution

[2] Points serve as nodes in a Delaunay triangulation

[3] Markov transport on the resulting grid

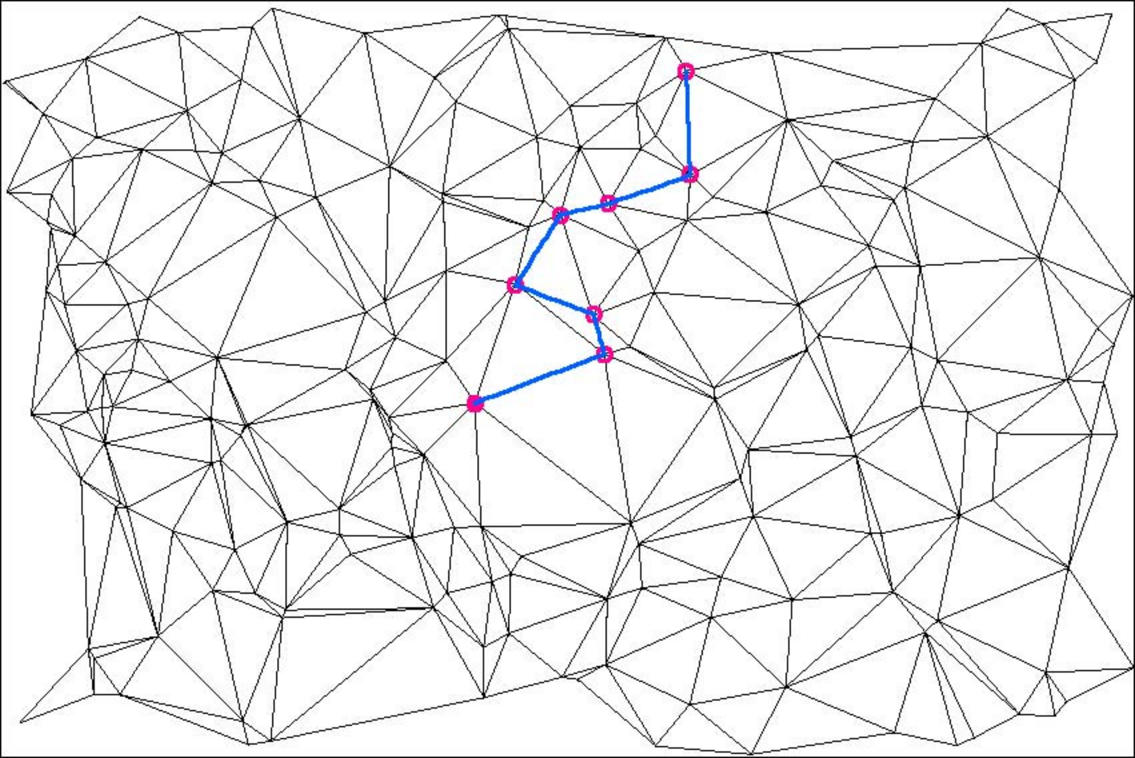
The SimpleX Method

Transport medium represented
by a point distribution
Medium = gas & dust (rad hydro)
Medium = wires & beams (web)
Medium = vacuum (lattice QCD)

The SimpleX Method

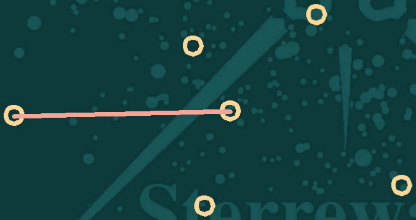
Transport medium represented
by a point distribution
Represented: $n(\infty) = \rho$
Represented: $n = f(\rho)$

$f(\rho)$ chosen to optimize transport

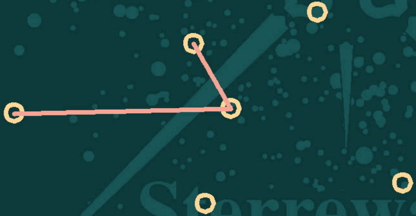


The SimpleX Method

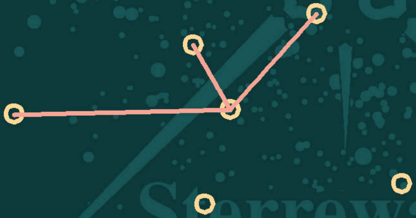
The SimpleX Method



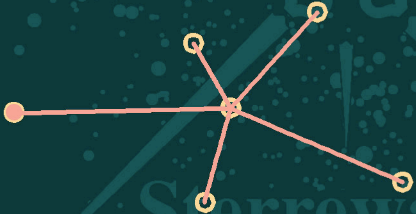
The SimpleX Method



The SimpleX Method



The SimpleX Method



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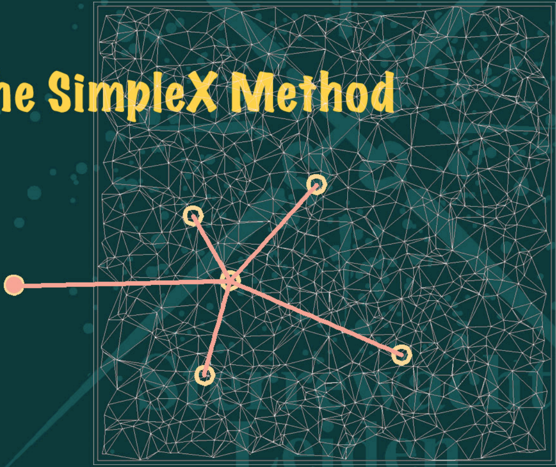
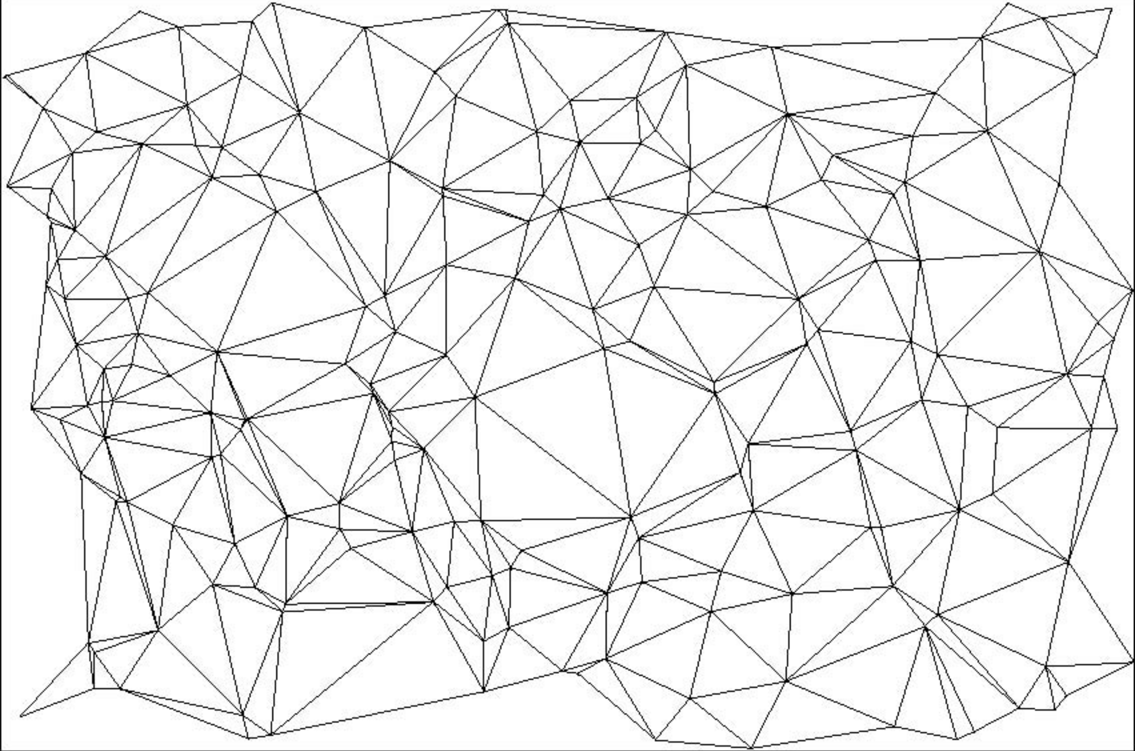
The SimpleX Method





Mean free path λ in a density field ρ with particle mass m and collision cross section σ is

$$\lambda = \frac{m}{\rho\sigma}$$

Delaunay length L in a point process with density n and spatial dimension D is

$$L = \alpha n^{-1/D}$$

Setting $\lambda = L$ gives

$$n = \left(\frac{\alpha\sigma}{m}\right)^D \rho^D$$

The SimpleX Method

Radiative transfer:
medium represented
by the point distribution

$$\mathbf{n} = \rho^{D}$$

The SimpleX Method

$$\mathbf{n} = \rho^{D}$$

mean Delaunay length
equal to mean free path

Diffusion time t with speed v between N collisions over a macroscopic distance L is

$$t = N \frac{\lambda}{v} = \left(\frac{L}{\lambda}\right)^2 \frac{\lambda}{v} = \frac{L^2}{\lambda v}$$

If we require L to be the Delaunay length, then

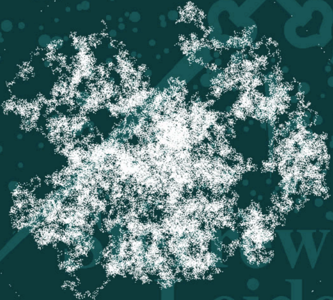
$$n = \left(\frac{\alpha^2 \sigma}{vtm}\right)^{D/2} \rho^{D/2}$$

The SimpleX Method

$$\mathbf{n} = \rho^{D/2}$$

mean Delaunay length
equal to diffusion length

The SimpleX Method



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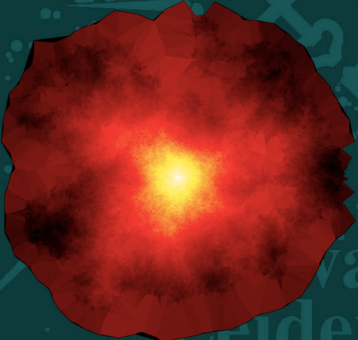

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