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Nonlocal macroscopic models of multi-population pedestrian flows for walking facilities optimization

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We consider a class of nonlocal crowd dynamics models for N populations with different destinations trying to avoid each other in a confined walking domain.
This can be formalized in a initial-boundary value problem for a system of nonlocal conservation laws, where the velocity vector field of each population depends on a nonlocal operator depending on the current density distribution.
To account for the presence of obstacles, we proposed to evaluate the nonlocal operators on the convolution product of a kernel with the extended density including the presence of obstacles.
Under suitable regularity assumptions, we prove a well-posedness result for the corresponding weak entropy solutions.
The trick of incorporating the obstacles in the nonlocal operator allows to avoid including them in the vector field of preferred directions.
In particular, we can address shape optimization problems aiming at finding the optimal position of the obstacles to minimize the total travel time,
rewriting them as standard PDE-constrained optimization. In addition, to accelerate the numerical optimization procedure,
we propose to address the computational bottleneck represented by the convolution products by a Finite Difference scheme that couples high-order WENO approximations
for spatial discretization, a multi-step TVD method for temporal discretization, and a high-order numerical derivative formula to approximate the derivatives of nonlocal terms, and in this way avoid excessive calculations

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