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The Scalar Auxiliary Variable method for the numerical simulation of the Keller-Segel model.

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The Keller-Segel model is used to represent chemotaxis among living organisms. This movement is observed in a wide range of situations in nature, such as the motion of bacteria, immune and cancer cells toward biological signals.
This model is a nonlinear Fokker-Planck equation, well-known for its mathematical difficulty.
Numerous numerical techniques exist to simulate this equation. However, a lot of them fail to retrieve the energy associated with the model at the discrete level while being efficient. Here, we apply the recent Scalar Auxiliary Variable method (SAV), that has been introduced to design numerical schemes that preserve the structure of the continuous model.
The method permits to design a linear semi-implicit scheme for the Keller-Segel model that retrieves a modified energy at the discrete level.
We discuss the efficiency of this technique compared to nonlinear numerical methods and examine its limits.

This presentation is based on the two following articles:

- Shen, J., Xu, J., & Yang, J. (2018). The scalar auxiliary variable (SAV) approach for gradient flows. Journal of Computational Physics, 353, 407-416.
- Poulain, A. (2020). Scalar auxiliary variable finite element scheme for the parabolic-parabolic Keller-Segel model. arXiv preprint arXiv:2007.01601.

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