CI²MA
Centro de Investigación en Ingeniería Matemática

Seminario de Análisis Numérico y Modelamiento Matemático de Estudiantes

An optimal control problem for anti-inflammatory treatments of Alzheimer's disease

We present and analyze an optimal control problem to model anti-inflammatory treatment strategies for Alzheimer's disease, using a system of differential equations that captures interactions between Aβ-peptides, microglial cells, interleukins, and neurons. These interactions operate through mechanisms such as protein polymerization, inflammation processes, and neural stress responses. In particular, inflammation is highlighted as a key factor in the onset and progression of Alzheimer's disease, driven by a hysteresis effect related to the degradation rate d of monomers and the initial concentration of interleukins. This implies a critical inflammation threshold that determines whether the disease persists over the long term. The optimal control problem we propose seeks to minimize the concentration of toxic oligomers by modulating interleukin production and degradation rates, representing potential anti-inflammatory treatment effects. Under natural constraints on treatment dose efficacy and cumulative exposure, our goal is to assess whether it is possible to shift the system from a persistent disease state to a disease-free equilibrium. We provide a characterization of the optimal solution and supplement our theoretical findings with numerical simulations, which illustrate the system's behavior under different parameter settings and the imposed constraints of the optimal control problem.

References

[1]. Estavoyer, M., Torres, N., Blohm, J., Banerjee, M., & Pujo-Menjouet, L. (2025). Spatial pattern analysis of A Aβ-monomer model with inflammation processes for Alzheimer's disease. Mathematical Modelling of Natural Phenomena, 20, 22.

[2]. Torres, N., Molina, E., & Pujo-Menjouet, L. (2025). An optimal control problem for anti-inflammatory treatments of Alzheimer's disease: N. Torres et al. Journal of Mathematical Biology, 91(1) :1–26.

Dr. Nicolás Torres Escorza
Université Côte d'Azur, Francia
Investigador Postdoctoral en Matemáticas Aplicadas

Martes 16 de diciembre
13:00 - 14:00 horas
Auditorio Hermann Alder
Weller, CI²MA, UdeC