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Studying Z-ring formation following nucleoid partitioning in escherichia coli by microscopy flow-cytometry and machine learning

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Cell division in *Escherichia coli* includes the formation of a Z-ring at mid-cell, which occurs following nucleoid partitioning and establishes the location of cell division. In rare cases, the Z-ring fails to form. We investigated if there are cell properties that lead to this event. For this, we engineered cells expressing FtsZ proteins tagged with a Green Fluorescence Protein (GFP) and nucleoid-associated HupA proteins tagged with mCherry, to visualize nucleoids. First, from time-lapse multi-modal confocal microscopy, we show that, as the FtsZ proteins converge to mid-cell to form the Z-ring, both the green and red fluorescence intensity of the cells increase, which can thus be used as a criteria for classifying the cells', respectively, presence/absence of a Z-ring and nucleoid number. Next, we observed the cells by flow-cytometry and searched for correlations between failing to form a Z ring when having two nucleoids and biophysical parameters of the cell, such as size and granularity. For this, we apply supervised machine learning, namely, logic-based (decision tree) and instance-based (K-Nearest Neighbor) techniques and support vector machines, to assess if the flow-cytometer channels FSCH, FSCA, SSCH, SSCA and Width parameter values can be used to predict the Z-ring formation in cells with two nucleoids. Using 10-fold cross-validation, we find the accuracy to be ~70% for all techniques applied. We thus argue that the failure to form a Z-ring in an E. coli cell with partitioned nucleoids is a stochastic, but not entirely random event, as it can, to an extent, be predicted from information associated to the cells' biophysical parameters. Overall, we find that combining microscopy (detailed data) with flow-cytometry and machine learning (BIG data), can be of use for studying how the cells' biophysical parameters affect their metabolic processes.

Biography

Bilena Almeida has an integrated Master's degree in Biomedical Engineering from NOVA University of Lisbon, Portugal. She is currently a PhD student in Biomedical Sciences at Tampere University of Technology, Finland.

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