

Algorithm for confrontation assay quantification (ACAQ): Label-free image analysis supported by Hessian filtering

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Label-free image segmentation

Workflow based on fluorescence labelling: A. Workflow based on fluorescence labelling; B. Hessian filtering identifies macrophages and spores; C. Label-free segmentation of immune cells and invading spores.

Application 1: direct biological effects of cell labelling

Labelling all spores, outside spores and macrophages; Labelling the macrophages decreases phagocytosis; Labelling the fungal spores increases their phagocytosis; Labelling macrophages with live-cell dye decreases their phagocytic activity [2]; Labelling fungal spores with FITC increases their vulnerability to immune cell reactions. [2]

Application 2: the geographical origin determines the vulnerability of fungi

The Lichtheimia species; Clustered phagocytic behaviour; Geography vs. phagocytic behaviour; Geography vs. fungal morphology; The geographical origin determines the phagocytic vulnerability; Fungi from Africa are the most resistant to macrophages; Fungi from Asia are the most vulnerable to phagocytosis. [3]

Application 3: tracking of unlabelled nematodes

Label-free analysis of *C. elegans* activity quantifies unique worm-fungus-bacteria endosymbiosis; Unlabelled nematodes are also segmentable via ACAQ; Worm motility ratio reveals endosymbiotic protection of fungi. [4]; Morphokinetic segmentation identifies liver tissue components; Intravital imaging aids the optimization of nanoparticle delivery. [5]

Application 4: intravital imaging of the liver

Drug delivery study without direct tissue labeling; Worm motility ratio reveals endosymbiotic protection of fungi. [4]; Morphokinetic segmentation identifies liver tissue components; Intravital imaging aids the optimization of nanoparticle delivery. [5]

[GitHub](https://github.com/applied-systems-biology/ACAQ) <https://github.com/applied-systems-biology/ACAQ>

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References:

- [1] Cseresnyes et al. 2018. *Cytometry A* 93(3): 346-356
- [2] Cseresnyes et al. 2020. *Funct Microbiol* 11:195
- [3] Cseresnyes et al. 2021. *Environ Microbiol* 23(2): 456-458
- [4] Bittner et al. 2021. *PNAS* 118(37)
- [5] Muljape et al. 2021. *ACS Nano* 15(7): 1298-1313

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