# AIgarMIC: a Python package for automated interpretation of agar dilution minimum inhibitory concentration testing

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Summary

Minimum inhibitory concentration (MIC) is a laboratory test used to estimate the susceptibility of a microorganism to an antibiotic. The result is used to determine whether it is possible to use that same drug to treat a patient's infection. Agar dilution is a reference method for MIC testing. However, the interpretation of agar dilution plates is time-consuming and prone to intra- and inter-operational error when read by laboratory personnel. AIgarMIC is a Python package for automated interpretation of agar dilution methodology. AIgarMIC processes laboratory images to identify bacterial growth on each position on solid agar containing different dilutions of an antimicrobial agent to generate a 3-dimensional growth matrix. The growth matrix is then used to identify the antimicrobial concentration at which microbial growth is inhibited – defining the minimum inhibitory concentration. AIgarMIC can be imported for use in Python scripts, or can be run through a command-line interface. Users can customise AIgarMIC to their workflow with bespoke models, or use the pre-trained models provided. AIgarMIC automates the collection of multiple data and minimizes measurement error.

Statement of need

Antimicrobial susceptibility testing (AST) is required to ensure timely and appropriate antimicrobial therapy worldwide. AST is also used to quantify the incidence and prevalence of antimicrobial resistance in hospitals, regions and countries. Agar dilution is a standard AST method – it has the advantage of being relatively inexpensive, and enables high throughput. However, the implementation of agar dilution is often limited by the time required to interpret plates, a process that is also subject to significant intra- and inter-observer variability.

The aim of `AIgarMIC` is to standardise and automate the interpretation of agar dilution plates. Typical users of `AIgarMIC` are likely to include:

- Laboratories that are currently performing agar dilution MIC testing, but wish to automate and standardise the interpretation of their results,
- Laboratories that have a need for moderate–high throughput MIC testing, but do not have access to other automated assays and systems.

Related resources

Users of `AIgarMIC` may also be interested in the following related resources and software:

- Laboratory protocols for agar dilution MIC testing, such as those published by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) (EUCAST, 2000) or by Wiegand et al (Wiegand et al., 2008).
- Software such as `cellprofiler` as a general biological image analysis tool that can be used for tasks beyond the scope of `AIgarMIC` (Lamprecht et al., 2007).

Additionally, `AIgarMIC` also comes with a collection of assets (example images and pre-trained models) to help users get started with the software (Gerada, Harper, Howard, Reza, Hope, & Liverpool Clinical Laboratories, 2024).

Laboratory validation

`AIgarMIC` has undergone research validation against a wide range of antimicrobials, against a gold standard of manual annotation. It has mainly been tested on clinical *Escherichia coli* strains (Gerada, Harper, Howard, Reza, & Hope, 2024).

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