

WormGUIDES: an interactive single cell developmental atlas and tool for collaborative multidimensional data exploration. [1]

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Abstract

BACKGROUND: Imaging and image analysis advances are yielding increasingly complete and complicated records of cellular events in tissues and whole embryos. The ability to follow hundreds to thousands of cells at the individual level demands a spatio-temporal data infrastructure: tools to assemble and collate knowledge about development spatially in a manner analogous to geographic information systems (GIS). Just as GIS indexes items or events based on their spatio-temporal or 4D location on the Earth these tools would organize knowledge based on location within the tissues or embryos. Developmental processes are highly context-specific, but the complexity of the 4D environment in which they unfold is a barrier to assembling an understanding of any particular process from diverse sources of information. In the same way that GIS aids the understanding and use of geo-located large data sets, software can, with a proper frame of reference, allow large biological data sets to be understood spatially. Intuitive tools are needed to navigate the spatial structure of complex tissue, collate large data sets and existing knowledge with this spatial structure and help users derive hypotheses about developmental mechanisms.

RESULTS: Toward this goal we have developed WormGUIDES, a mobile application that presents a 4D developmental atlas for *Caenorhabditis elegans*. The WormGUIDES mobile app enables users to navigate a 3D model depicting the nuclear positions of all cells in the developing embryo. The identity of each cell can be queried with a tap, and community databases searched for available information about that cell. Information about ancestry, fate and gene expression can be used to label cells and craft customized visualizations that highlight cells as potential players in an event of interest. Scenes are easily saved, shared and published to other WormGUIDES users. The mobile app is available for Android and iOS platforms.

CONCLUSION: WormGUIDES provides an important tool for examining developmental processes and developing mechanistic hypotheses about their control. Critically, it provides the typical end user with an intuitive interface for developing and sharing custom visualizations of developmental processes. Equally important, because users can select cells based on their position and search for information about them, the app also serves as a spatially organized index into the large body of knowledge available to the *C. elegans* community online. Moreover, the app can be used to create and publish the result of exploration: interactive content that brings other researchers and students directly to the spatio-temporal point of insight. Ultimately the app will incorporate a detailed time lapse record of cell shape, beginning with neurons. This will add the key ability to navigate and understand the developmental events that result in the coordinated and precise emergence of anatomy, particularly the wiring of the nervous system.

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