Your peer-review comments:

Editor's Decision Reject

As the reviewers pointed out, the paper is rather difficult to understand and it is unclear what are the actual new contributions.

PeerJ Staff Note - this decision was reviewed and approved by Nigel Andrew, a PeerJ Section Editor covering this Section

Reviewer 1

Basic reporting

The manuscript is not written in a very clear way. The abstract gives the information that one can distinguish between different types of animal development by using a four-dimensional spatial representation. However, it is not clearly explained what is the contribution of the manuscript in the abstract. The contribution is not mentioned until the last paragraph of the introduction part. After reading the whole paper, it seems that the contribution is not to find a way to distinguish between different types of animal development, but a statistical approach to understanding spatial diversity in the embryo. I suggest the authors to reformulate the abstract and introduction part to clearly explain the research problem, the existing methods for solving the problem, and the contributions of the paper in addressing the problem.

In lines 92-95, "Four complementary analyses..." The explanation about the four analyses inside the parentheses looks like there are only three analyses instead of four. I suggest the author to reformulate this part.

In line 148, "Five analyses were..." I can only find explicitly explanation about the first analyses, i.e., the one in line 149, and the last, i.e., the one in line 164 started with the word finally. The other three are hidden in between.

In line 141, what are these hypotheses? I do not find a clear mention about hypotheses before. There are a lot of usage of "should" in the abstract. Do these "shoulds" indicate hypotheses?

In the conclusion part, the author concluded that the paper offered a statistical approach to understanding spatial diversity in the embryo. I would expect the author to mention this approach in the last paragraph of the introduction part. From the introduction part, I do not get any clue about a "statistical approach".

In lines 365-367, the author pointed out the shortcomings of the existing Sulston lineage tree and technologies; it would be better to explicitly point out that the approach presented in this paper overcomes these shortcomings.

There are also some typos:
The sentence in line 339 does not finish.

Mixed usage of "3-D", "Three-dimensional", and "3-dimensional" in the manuscript. Please be consistent.

In line 188, "long" should be "along".

In lines 193 and 263, it is a little strange to see "16-, 64-, and 7 level" instead of "16-,64-, 128-cell".

In line 266, I do not see gray connections in the figure.

In line 360, "allow" should be "allows".

Experimental design

no comment

Validity of the findings

no comment

Reviewer 2

Basic reporting

While the paper's English is generally free of grammatical etc. errors, the density of the paper approaches that of a black hole. It will not be difficult to change it so that it is understandable by non-specialist (I will refer to line numbers below).
42: say what it means for the development to be mosaic or regulative
56: spatial smearing---it needs to be clear here that this can be observed only by comparing many embryos (it will not be clear to a nonspecialist!)
62: a nonspecialist will not know what 'tissue induction' means or
66 'cell focusing'
73 what does it mean to be a one-cell tissue? the standard definition of 'tissue' (perhaps because of familiarity with animals with regulative development?) is that it is a number of cells, specialized (perhaps belonging to various types); is it at all relevant here?
83 a casual reader will not know that Woods et al. 2014 deals with a model
85 superdiffusive signature: say what it means, do not refer to a paper that will not be easy to understand
104 square root is of the sum of all the terms, not just the first term. x, y, z in the equation are (I suppose) not the actual coordiates, but the differences between coordinates, they are never defined
110 I know what a tree is and I know what tree-like reticulation network is, but by definition a tree is

an acyclic connected graph, so what is the point in stressing that the trees they are dealing with are non-reticulating?

110 cell AB and P1: a nonspecialist will not know what these are. Why not describe how the C. elegans development starts, and why not actually draw a lineage graph?

141 "to test these hypotheses": how is the reader supposed to remember what these are after reading the Methods section?!

142 sample sizes; in line 115 the authors say there are 261 embryos; these numbers do not add up to 261; does it mean that some embryos provided the data at different stages?

145 bipartite; but didn't the authors called it octopartite at line 110?

151 4 level condition etc; why confuse the reader and refer sometimes to a 16-cell (etc) embryo and sometimes 4-level condition etc. (yes, I do know that 64=2^6, but it remains confusing); the confusion culminates in line 263-264

151-152 remained? do they mean that they chose to analyze them as such or that 64- and 128- cells could not be analyzed using a bipartite tree?

153 separability: this is only supported by the text that will follow, so perhaps "we will show, using these visualizations, the separability..."

166-167 why? this is not obvious

173-174 shown if figures; figure shows; I find it easier to follow the text if the authors make an observation and simply refer to (a) figure(s) that support(s) it; what the figure shows should be said in the figure caption.

177 what are we supposed to actually see in fig. 3? that the points of the same colour can be clustered by eye, by mentally putting an 2-d border between the points with different colours?

181 again, what are we supposed to see in fig. 4? that the points with one colour can be separated by a curve from the points with a different colour (but that they are not linearly separable?)

186-188 I see one graph above another graph, with two axes each; so what is meant by left vs right panel? what does the comparison indicate? what does it mean?

191 a verb seems missing following 'to'; do they mean that they assign biologically-based categories to clusters created by unsupervised clustering?

195 what do they mean by rate? that 80% of cells in G1 are descendants of AB? but then the numbers need to add up to 100%, for G2 and 64-cell embryo, 0.33 would descend from AB, and 0.80 descend for P1, this does not make sense; so (I need to guess) what they mean is that of all cells in AB, 0.80 belong to G1 and 0.20 belong to G2; this stretches the meaing of the word "predict"; I guess they mean that cells descending from AB belong mostly to G1?...

199...perhaps the correct word would be 'estimate': the position of the cells allows to estimate to which lineage a cell belongs (but then the numbers need to be presented from the point of view of knowing the cluster of the cell and 'guessing' the lineage; what would be the tpr, fdr of such an estimation?

211-224 are we just looking for negative numbers in the table? if so, then why not interpret those rather than simply listing in the text what can be simply read from the table?!

230 how did they estimate the exponent? this is not trivial

233 'moves' what do you mean?

236-239 I do not understand this par at all

242 node: first say that each cell in a lineage is assigned to a node in this graph (?)

247 physical interaction or occupying a similar position in 3d? what does it mean that a cell at one developmental stage occupies a similar position to a cell at a different stage? why should it matter? what is the threshold distance for drawing an edge between the cells when creating these particular figures?

260-216 this is too abstract to understand

266-277 this should go to the figure caption

269 (Table 7) are those thresholds of relative distance? then I do not get it---if the threshold to create an edge is 0.25 relative distance does it mean that cells at most 0.25 of relative distance apart are connected by an edge? if so, then a larger threshold should result in higher density... (more cells will be connected); and by the way, do they mean network density as usually defined (the number of edges in the graph divided by the number of possible edges)? if so, this number cannot be larger than 1!

270 network summary statistics; what is their interpretation in this context? what does it mean that the network is modular, for example, in this context?

286 (Table 8) row 5 and 6 can be put in row 3, for example "0.68 (0.31, 0.37)", this would make it clear that 0.31 and 0.37 sum to 0.68 (yes, I know that the numbers are rounded to two digits, but say so in the caption)

308 connectivity; is this for the graph at a specific threshold?

378 again, what does it mean (and what are the consequences thereof) that a cell from some developmental stage occupies the same position in the embryo as some cell(s) at a different stage?

Experimental design

not applicable; see above

Validity of the findings

difficult to say because the paper needs to address the issues of readability and understandability first