Precision matters for position decoding in the early fly embryo
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University — Genetic networks can determine cell fates in multicellular organisms
with precision that often reaches the physical limits of the system. However, it is
unclear how the organism uses this precision and whether it has biological content.
Here we address this question in the developing fly embryo, in which a genetic network
of patterning genes reaches 1% precision in positioning cells along the embryo axis.
The network consists of three interconnected layers: an input layer of maternal
gradients, a processing layer of gap genes, and an output layer of pair-rule genes
with seven-striped patterns. From measurements of gap gene protein expression in
hundreds of wild-type embryos we construct a “decoder”, which is a look-up table
that determines cellular positions from the concentration means, variances and co-
variances. When we apply the decoder to measurements in mutant embryos lacking
various combinations of the maternal inputs, we predict quantitative changes in
the output layer such as missing, altered or displaced stripes. We confirm these
predictions by measuring pair-rule expression in the mutant embryos. Our results
thereby show that the precision of the patterning network is biologically meaningful
and a necessary feature for decoding cell positions in the early fly embryo.

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