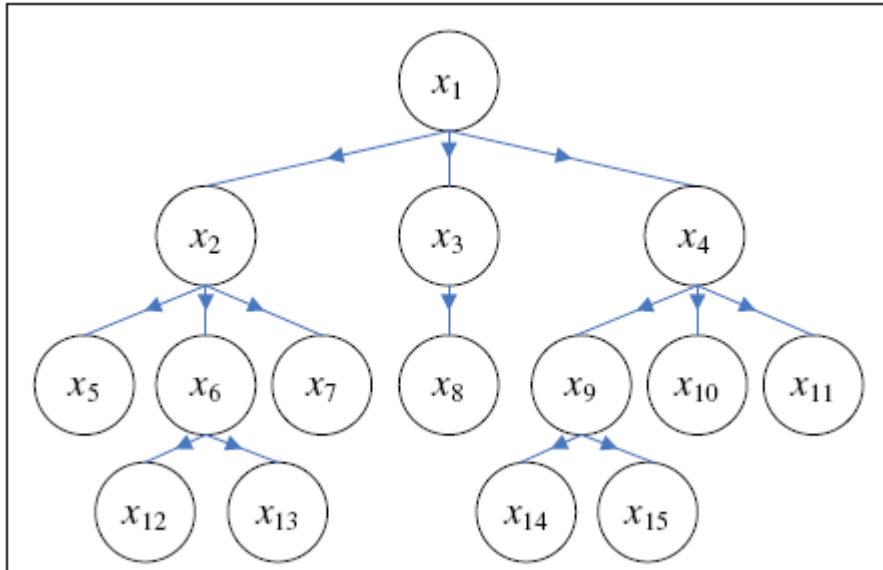


# Projection onto A Nonnegative Max-Heap

Jun Liu, Liang Sun, Jieping Ye  
Arizona State University

# Heredity Principle induced by Nonnegative Max-Heap



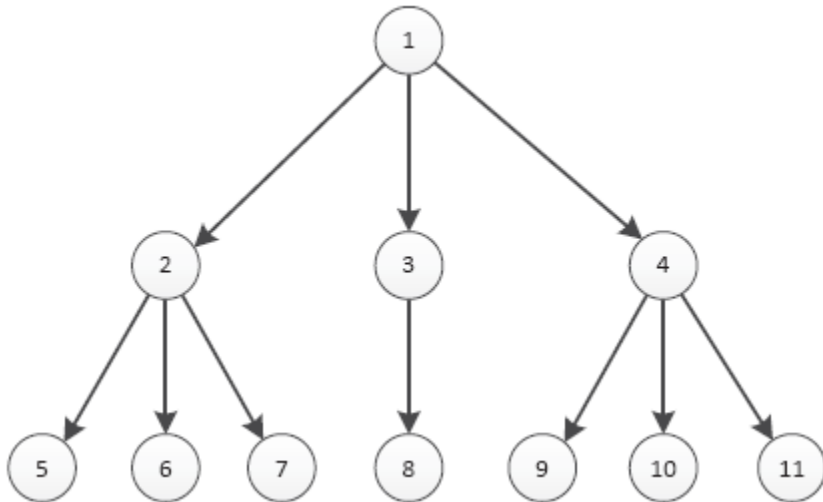
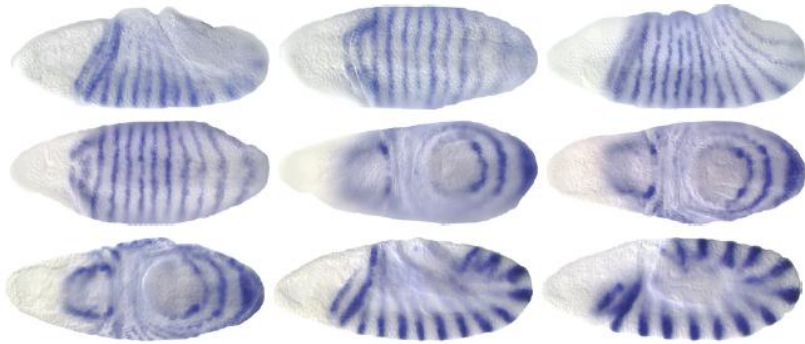
Key Contributions:

- Develop an analytical top-down algorithm for the projection onto  $P$
- Develop an efficient bottom-up algorithm with empirically linear time complexity

$$P = \{\mathbf{x} \geq 0, x_i \geq x_j \forall (x_i, x_j) \in E^t\},$$

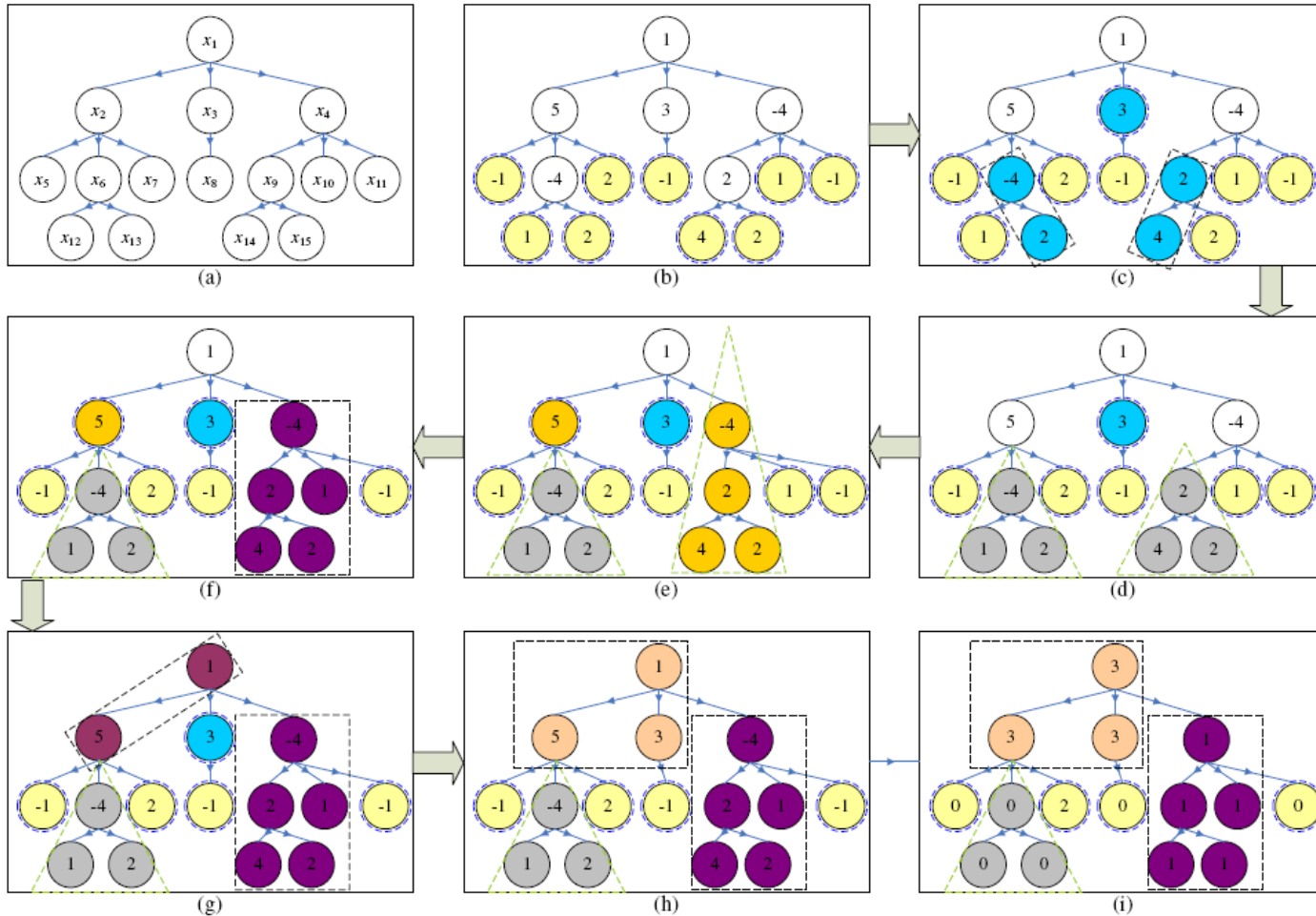
$$\min_{\mathbf{x} \in P} f(\mathbf{x})$$

# *Drosophila* Gene Expression Images

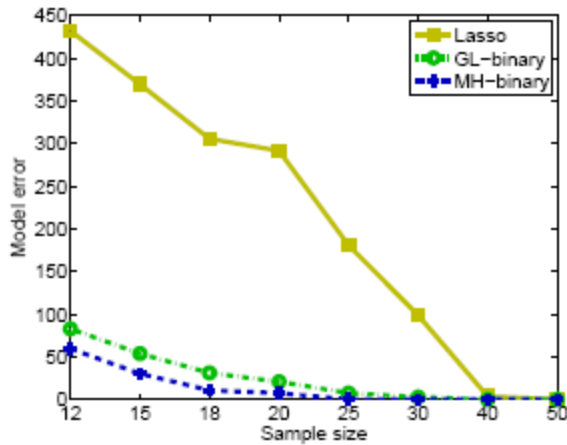


1. cellular blastoderm;
2. segmentally repeated;
3. yolk;
4. ectoderm anlage in statu nascendi;
5. pair rule;
6. segment polarity;
7. gap;
8. yolk nuclei;
9. procephalic ectoderm anlage in statu nascendi;
10. foregut anlage in statu nascendi
11. clypeolabrum anlage in statu nascendi

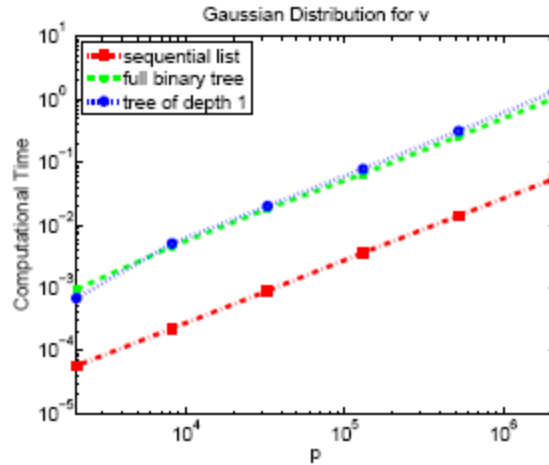
# A Bottom-Up Algorithm



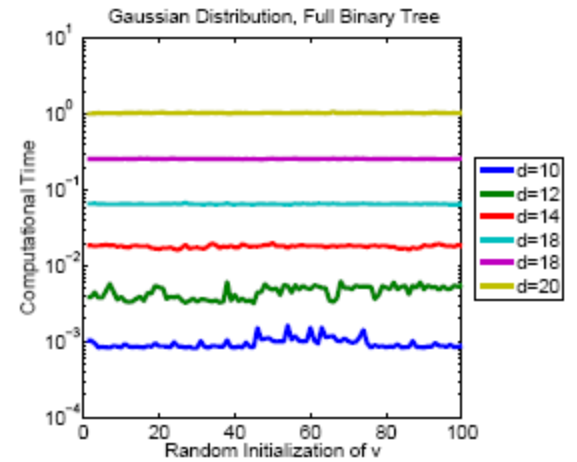
# Empirical Evaluation



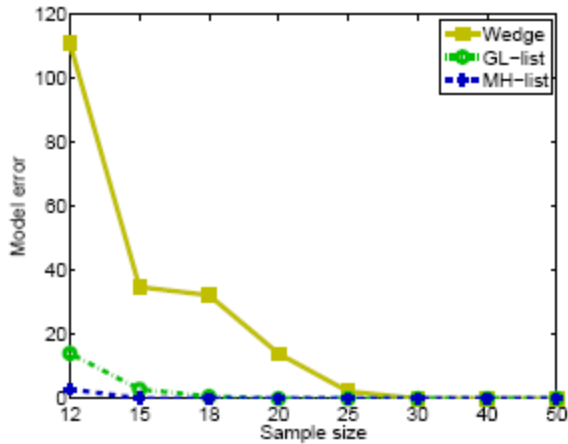
(a)



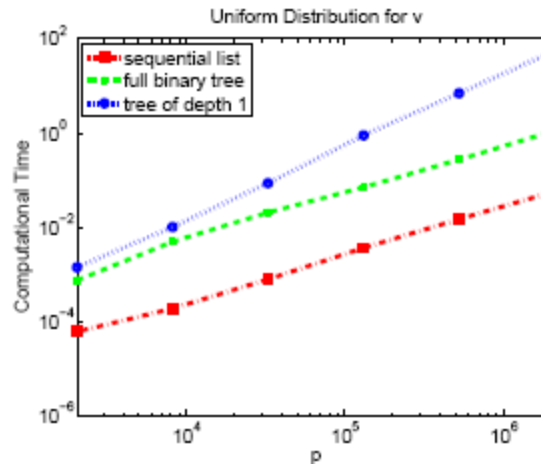
(c)



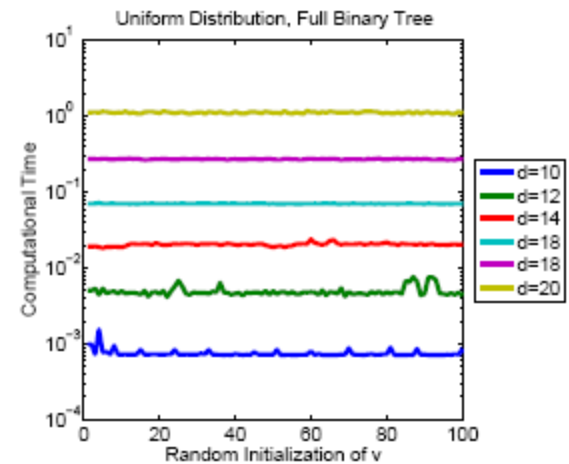
(e)



(b)



(d)



(f)