From Parallel Object Recognition to Frameworks
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### Object Recognition
- **Trained Categories**: Bottles, Apple Logos, Mugs
- **Image Queries**: Swans, Giraffes
- **Outputs**: Object Recognition System

### Parallel Graph Traversal on Images
- Graph representation of an image
  - Each pixel is represented by a node
  - Neighborhood relationship between pixels represented by edges
- BFS graph traversal algorithm is widely used in region and boundary analysis
- Parallelization strategies
  - Transform the BFS traversal problem into structured grids computation
  - Apply the task queue implementation strategy pattern

### Parallel Pair-wise Distance
- Widely used to measure the difference between features
  - Parallelization strategies
    - Inner product based algorithm
    - Outer product based algorithm
  - Experimental Results
    - If the # of vector pairs is small, apply the inner product algorithm
    - If the # of vector pairs is large, apply the outer product algorithm

### Training
- Distance computation
  - Chi-square distance between each feature vector
  \[ d_{\chi^2}(x, y) = \sum_{i=1}^{n} \frac{(x_i - y_i)^2}{x_i + y_i} \]
- Weight learning
  - Find discriminative features
  - Quadratic optimization problem
  - Solve by simplex algorithm

### System Performance
- **Detection Quality**
  - **Speedup by Parallel Implementation**
    - Contour Detection: Core i7 2.34x, Tesla 10.6x
    - Segmentation: Core i7 2.24x, Tesla 6.36x
    - Feature: Core i7 2.37x, Tesla 28.6x
    - Hough Voting: Core i7 1.68x, Tesla 49.5x
    - Classification: Core i7 4.53x, Tesla 72.5x

### Future Plan
- Implement more parallel feature extraction algorithms
- Apply the parallel object recognition system to larger benchmarks
- Develop frameworks for graph traversal and pair-wise distance computation
- The framework should optimize performance by auto-tuning methods