

# CTY Course Syllabus

## Data Structures and Algorithms (DATA)

### Summary

Morning: New concepts, lectures, group activities, discussion  
 Afternoon: Programming exercises, problem solving  
 Evening: Review, thought experiments, puzzles, challenges

### Detailed Schedule

#### Week 1 – Introduction, complexity, recursion

Day	Morning	Afternoon	Evening
<b>Sunday (Intro)</b>			<ul style="list-style-type: none"> <li>• Course overview</li> <li>• Honor code</li> <li>• Pre-assessment</li> </ul>
<b>Monday (Growth)</b>	<ul style="list-style-type: none"> <li>• Searching problem</li> <li>• Rates of growth</li> </ul>	<ul style="list-style-type: none"> <li>• Java programming</li> </ul>	<ul style="list-style-type: none"> <li>• Discussion</li> </ul>
<b>Tuesday (Big-O)</b>	<ul style="list-style-type: none"> <li>• Asymptotic complexity</li> <li>• Scalability</li> <li>• Big-O notation</li> <li>• Maximum Subsequence Sum</li> </ul>	<ul style="list-style-type: none"> <li>• Benchmarking/profiling code</li> <li>• Arrays / Linked lists</li> </ul>	<ul style="list-style-type: none"> <li>• Complexity problems</li> </ul>
<b>Wednesday (Sorting)</b>	<ul style="list-style-type: none"> <li>• Sorting: selection, insertion, bubble</li> </ul>	<ul style="list-style-type: none"> <li>• Sorting activities</li> </ul>	<ul style="list-style-type: none"> <li>• Sorting visualizations</li> </ul>
<b>Thursday (Recursion)</b>	<ul style="list-style-type: none"> <li>• Recursion and fractals</li> <li>• Designing recursive functions</li> <li>• Fibonacci</li> <li>• Turtle graphics (fractal trees)</li> </ul>	<ul style="list-style-type: none"> <li>• Lab / problem solving</li> <li>• Tower of Hanoi</li> </ul>	<ul style="list-style-type: none"> <li>• Recursion challenges</li> </ul>
<b>Friday (Divide &amp; Conquer)</b>	<ul style="list-style-type: none"> <li>• Recursion continued</li> <li>• Merge and mergesort</li> </ul>	<ul style="list-style-type: none"> <li>• Collaborative activity: drawing merges and fractals</li> </ul>	

## Week 2 – Data structures and graphs

Day	Morning	Afternoon	Evening
<b>Sunday (Misc)</b>			<ul style="list-style-type: none"><li>• Quiz</li><li>• Jeopardy review</li></ul>
<b>Monday (Linear ADTs)</b>	<ul style="list-style-type: none"><li>• Stacks / queues</li><li>• Trees</li><li>• Quicksort, Induction</li><li>• Comparison-sort lower bound</li><li>• Bucket sort</li></ul>	<ul style="list-style-type: none"><li>• Tree ADT lab</li></ul>	<ul style="list-style-type: none"><li>• Lab continued</li><li>• Using stacks for postfix expression evaluation</li></ul>
<b>Tuesday (Search ADTs)</b>	<ul style="list-style-type: none"><li>• Hash tables</li><li>• Heaps</li><li>• AVL trees</li><li>• Building heaps and trees</li></ul>	<ul style="list-style-type: none"><li>• Lab</li></ul>	<ul style="list-style-type: none"><li>• Problems/challenges</li><li>• Recursive path counting</li></ul>
<b>Wednesday (Graphs)</b>	<ul style="list-style-type: none"><li>• Graph representation</li><li>• Modeling with graphs</li><li>• Euler/Hamiltonian paths</li><li>• MST: Prim/Kruskal</li></ul>	<ul style="list-style-type: none"><li>• Lab</li></ul>	<ul style="list-style-type: none"><li>• Puzzles/challenges</li></ul>
<b>Thursday (Greedy algorithms)</b>	<ul style="list-style-type: none"><li>• Dijkstra's algorithm</li><li>• BFS/DFS</li></ul>	<ul style="list-style-type: none"><li>• Quicksort lab</li></ul>	<ul style="list-style-type: none"><li>• Designing greedy algorithms</li></ul>
<b>Friday (Network flows)</b>	<ul style="list-style-type: none"><li>• Dynamic programming</li><li>• Lab / review</li></ul>	<ul style="list-style-type: none"><li>• Graph coloring</li><li>• Generalized geography</li></ul>	

## Week 3 – Algorithm design, computability, complexity

Day	Morning	Afternoon	Evening
<b>Sunday</b>			<ul style="list-style-type: none"> <li>Special: Xeno plumbers sketch</li> </ul>
<b>Monday (Dynamic Programming)</b>	<ul style="list-style-type: none"> <li>Dijkstra review</li> <li>Graph applications and discussion</li> </ul>	<ul style="list-style-type: none"> <li>BFS lab</li> </ul>	<ul style="list-style-type: none"> <li>Graph lab</li> <li>Jeopardy review</li> </ul>
<b>Tuesday (Intractability)</b>	<ul style="list-style-type: none"> <li>Group problem solving               <ul style="list-style-type: none"> <li>TSP approximation via MST</li> <li>Topological sort</li> <li>Inversion counting via divide &amp; conquer</li> <li>Greedy interval scheduling</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Problem solving continued</li> <li>Presentations</li> </ul>	<ul style="list-style-type: none"> <li>Catch-up time for labs</li> </ul>
<b>Wednesday (Intractability)</b>	<ul style="list-style-type: none"> <li>Karatsuba multiplication</li> <li>Turing machines and non-determinism</li> </ul>	<ul style="list-style-type: none"> <li>Problem solving:               <ul style="list-style-type: none"> <li>Closest points in a plane</li> <li>String edit distance</li> <li>Knapsack / subset sum</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Problem solving continued</li> <li>Presentations</li> <li>3-SAT</li> </ul>
<b>Thursday (Misc)</b>	<ul style="list-style-type: none"> <li>3-SAT reductions</li> <li>Reduction problem solving</li> </ul>	<ul style="list-style-type: none"> <li>Problem solving presentations</li> </ul>	<ul style="list-style-type: none"> <li>Review</li> <li>Post assessment</li> </ul>
<b>Friday (Misc)</b>	<ul style="list-style-type: none"> <li>Large numbers</li> <li>Uncomputability</li> <li>Busy beaver</li> </ul>		