#4 Growth and Mutation
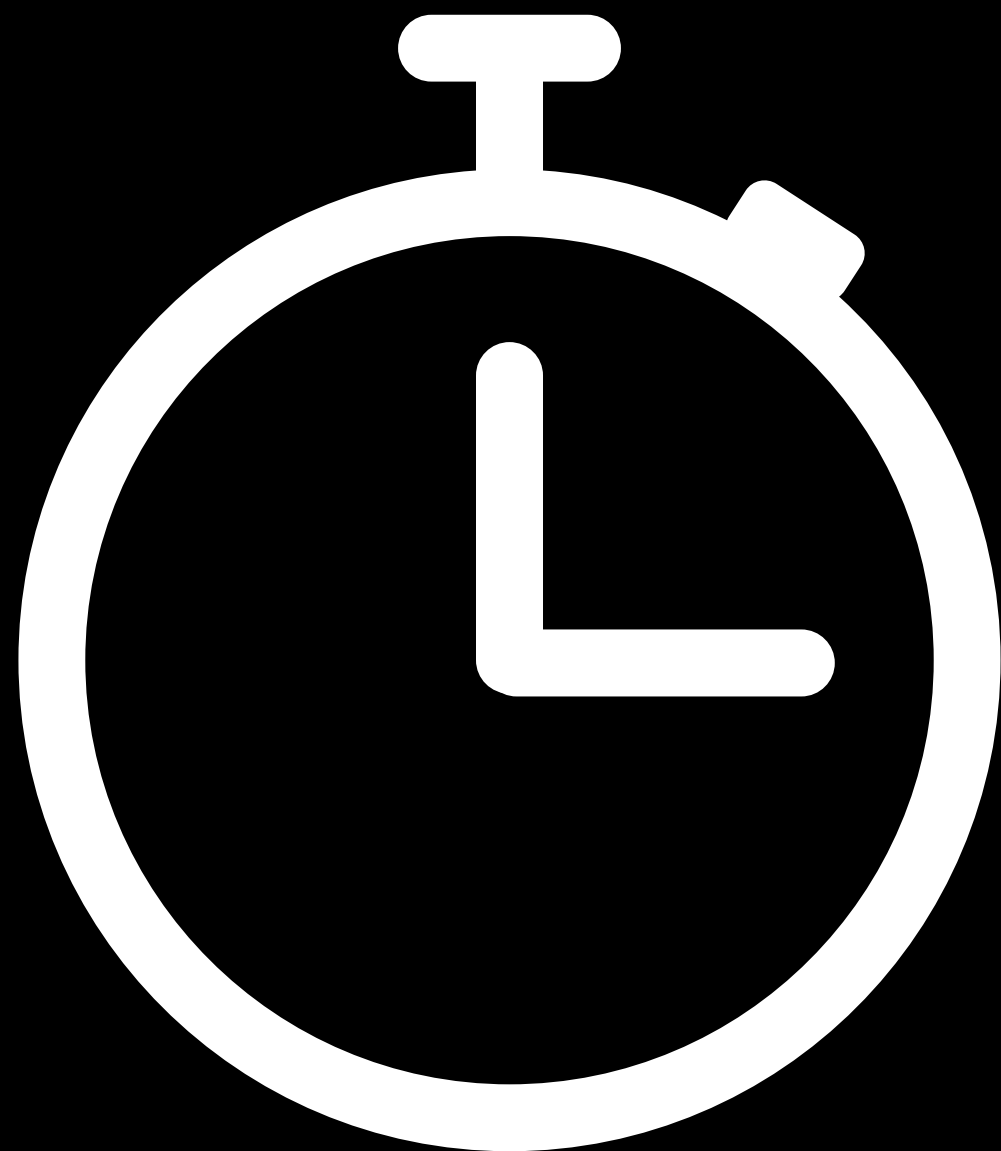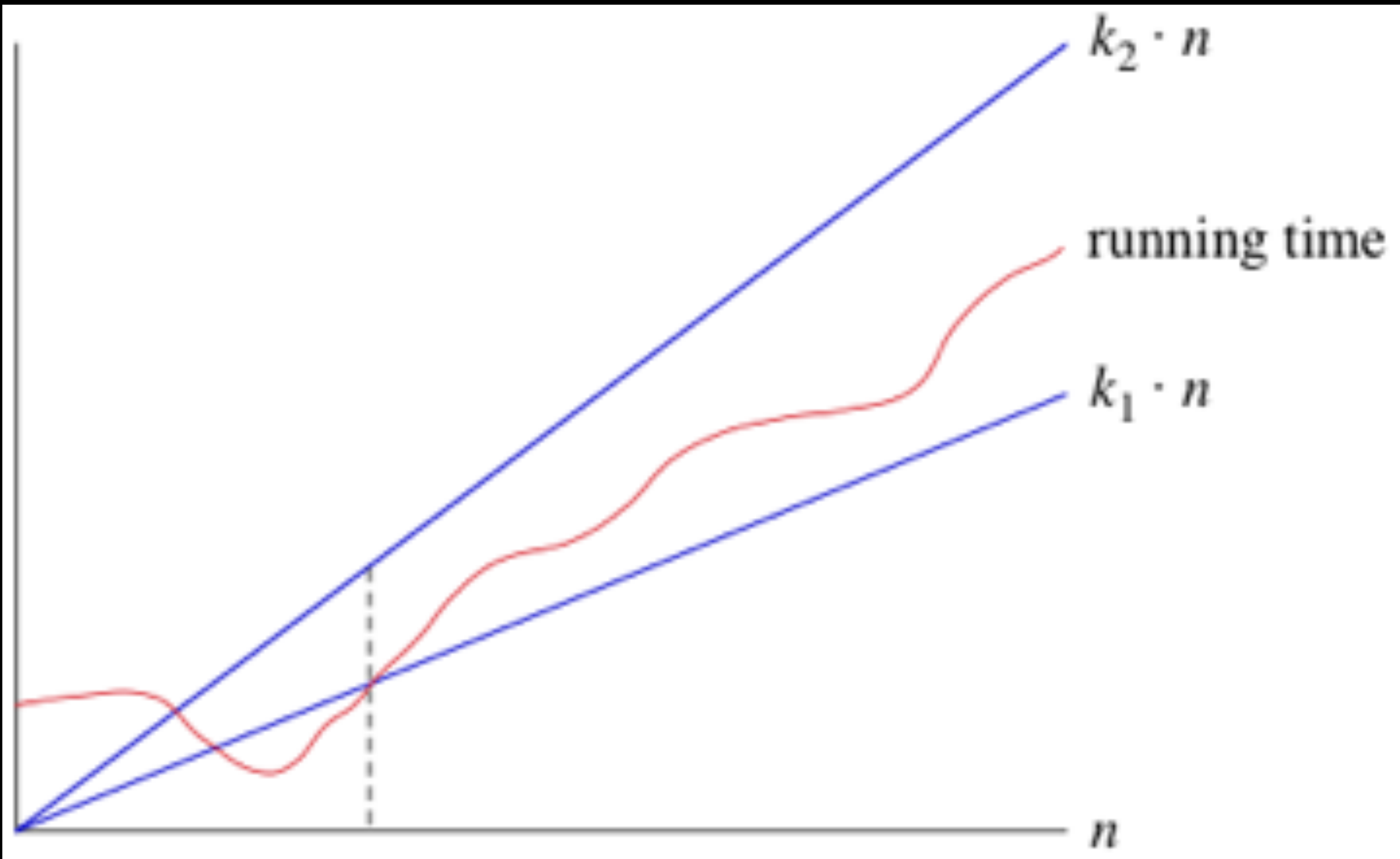
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Is your refrigerator running? If so, better hope it's Θ(1)!
- My poor attempt at an orders of growth joke

'Go' Matches Between **Lee** Sedol and **AlphaGo** Push AI Boundaries ...

South Korea's **Lee** Sedol, 33, surrendered in the first of five "Go" matches against Google-owned computer program **AlphaGo** on Wednesday.

🦚 nbcnews.com

AlphaGo seals 4-1 victory over Go grandmaster **Lee** Sedol ...

Google DeepMind's **AlphaGo** program triumphed in its final game against South Korean Go grandmaster **Lee** Sedol to win the series 4-1, providing further evidence of the ...

Ⓖ theguardian.com

Google DeepMind's **AlphaGo** takes on Go champion **Lee** Sedol in ...

Google's AI system **AlphaGo** has defeated **Lee** Sedol, champion of the Chinese board game Go, in the first of a five-game challenge match.

🦚 cnbc.com

Orders of Growth

Some quick rules

- In the class, we care about **average case performance** (big Θ)
- Simplify by removing constants
- Simplify by keeping largest terms

$$\Theta(\log n + n / 2)$$

$$\Theta(\log n + n)$$

$$\Theta(n)$$

$$\Theta(\log_{10} n)$$

$$\Theta(\log n / \log 10)$$

$$\Theta(\log n)$$

$$\Theta(n \log n) < \Theta((\log n)^{\log n})?$$

Disclaimer: this isn't a mathematically precise way of comparing growth functions. This is also probably beyond typical exam difficulty in this course.

$$\Theta(n \log n) < $$

$$\Theta((\log n)^{\log n})$$

$$\Theta(\log\,(n\,\log\,n)) <$$

$$\Theta(\log\,[(\log\,n)^{\log\,n}])$$

$$\Theta(\log n + \log \log n) <$$

$$\Theta(\log n \log \log n)$$

$$\Theta(\log n) <$$

$$\Theta(\log n \log \log n)$$

Nonlocal

Old rule: you cannot modify variables outside your frame

New rule: you can modify, but must specify with nonlocal

List Mutation

- Recall that slicing a list makes a copy

- Can also modify a list "in place"