CSCI 136:
Data Structures
and
Advanced Programming

Lecture 21-1

Trees, part 1

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Williams

Outline

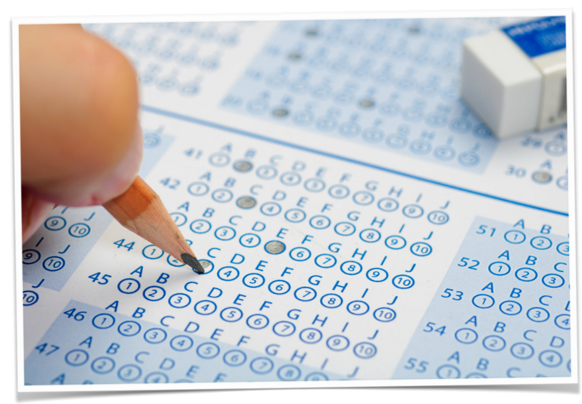
Talent

Trees

Think of someone you know who is **talented**.

Were they **born** with **better abilities** than you?

Despite years (>100) of effort, scientists have **never** identified a universal, reliable measure of innate ability.



"The Role of Deliberate Practice in the Acquisition of Expert Performance", Ericsson et al., Psychological Review (1993)

No universal, reliable measure of innate ability.

The relation of IQ to exceptional performance is rather weak in many domains, including music (Shuter-Dyson, 1982) and chess (Doll & Mayr, 1987).

For scientists, engineers, and medical doctors that complete the required education and training, the correlations between ability measures and occupational success are only around 0.2, accounting for only 4% of the variance (Baird, 1985).

In a review of more than one hundred studies, Ghiselli (1966) found the average correlation between success-on-the-job measuring and aptitude-test scores to be 0.19.

In summary, the search for stable heritable characteristics that could predict or at least account for the superior performance of eminent individuals has been surprisingly unsuccessful.

Takeaway: "innate ability" is probably a **myth**.

What factor does matter? **Practice**.

Binet (Varon, 1935) started out using tests of basic perceptual and cognitive capacities to measure IQ, but found large practice effects, which were later documented by Gibson (1969).

"The Role of Deliberate Practice in the Acquisition of Expert Performance", Ericsson et al., Psychological Review (1993)

But **mere repetition** is **not enough**.

Bryan and Harter (1897, 1899) identified plateaus in skill acquisition, when for long periods subjects seemed unable to attain further improvements.

[W]ith mere repetition, improvement of performance was often arrested at less than maximal levels, and further improvement required effortful reorganization of the skill.

Keller (1958) later showed that these plateaus … were not an inevitable characteristic of skill acquisition, but could be avoided by different and better training methods.

"The Role of Deliberate Practice in the Acquisition of Expert Performance", Ericsson et al., Psychological Review (1993)

Life tip #11:

Experts **practice deliberately**.

We view elite performance as the product of … maximal efforts to improve performance in a domain through an optimal distribution of deliberate practice. This view provides us with unique insights into the potential for and limits to modifying the human body and mind. Many … characteristics, traditionally believed to be fixed, can adapt and change in response to intense practice sustained for years.

Deliberate practice is purposeful and systematic practice requiring **focused attention** and is conducted with **the specific goal of improving performance**.

Deliberate practice is **exhausting**.

"The Role of Deliberate Practice in the Acquisition of Expert Performance", Ericsson et al., Psychological Review (1993)

Life tip #11:

How does one **sustain** deliberate practice?

Our empirical studies [show] that experts carefully schedule deliberate practice and limit its duration to avoid exhaustion and burnout.

The **learning algorithm**:

1. **Start early**.
2. **Focus** solely on learning task. (i.e., no Instagram)
3. **Stop** after some time period. (~1 hr)
4. **Repeat** later. (e.g., the next day)

"The Role of Deliberate Practice in the Acquisition of Expert Performance", Ericsson et al., Psychological Review (1993)

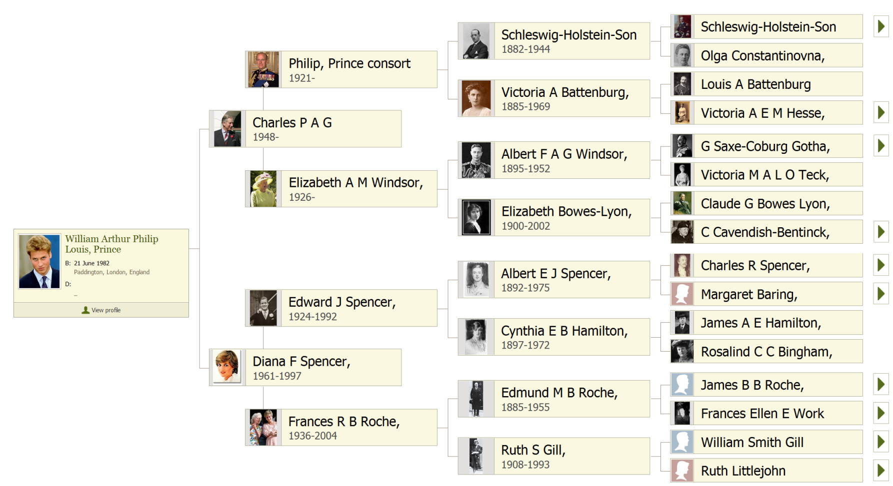
Trees

Motivation

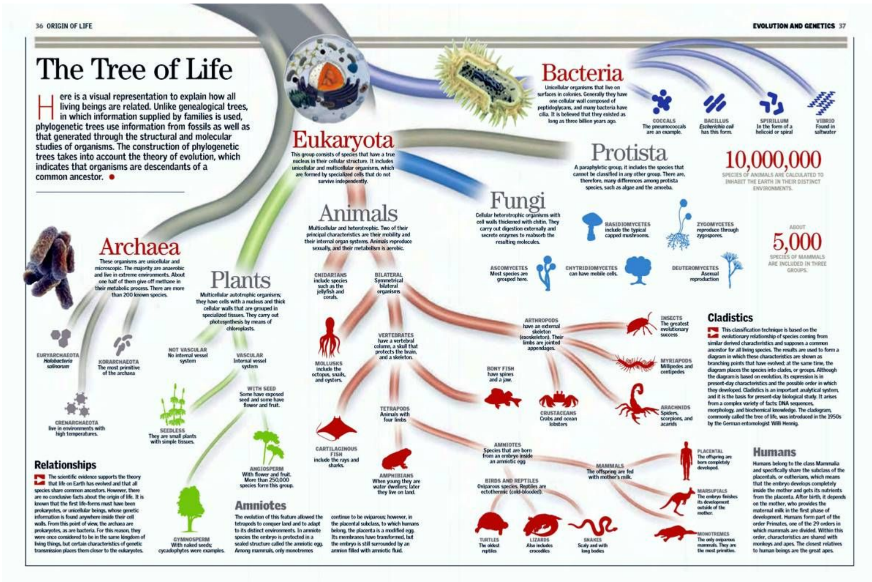
Information is often **hierarchical**.

Trees facilitate **encoding** such information on a computer.

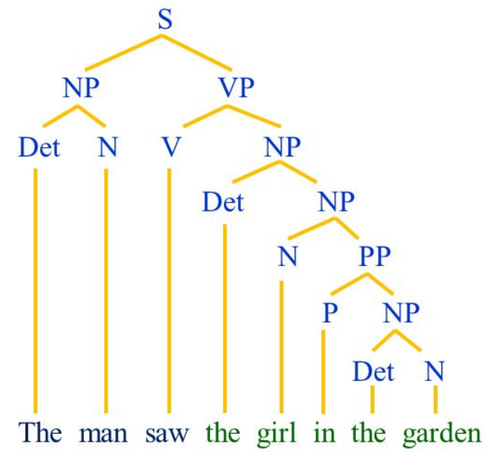
Uses



Uses



Uses



Uses

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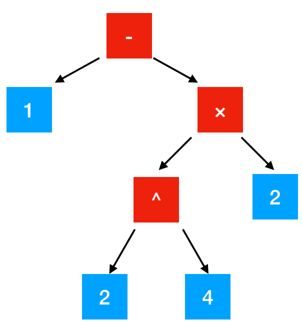


List ADT

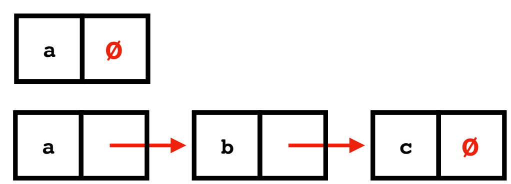
A **list** is a recursive data structure that stores information sequentially. A list is either:

- **empty** (i.e., Ø) or
- a **node** containing a **value** and a reference to a **list**.

The empty list: ø

List of length 1:

List of length 3:



Tree ADT

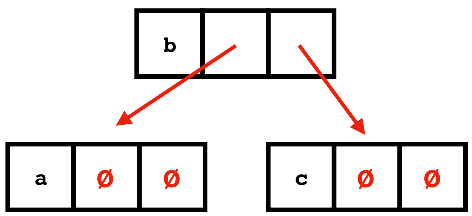
A **tree** is a recursive data structure that stores information hierarchically. A tree is either:

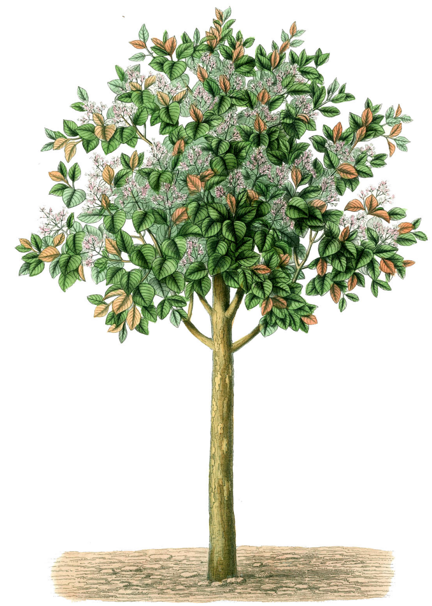
- **empty** (i.e., ∅), or
- a **node** containing a **value** and references to one or more **trees**.

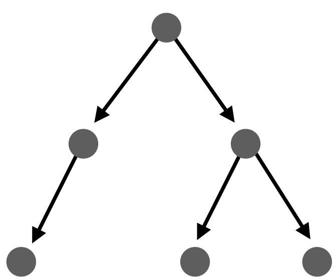
The empty tree:

Ø

A non-empty tree:







Recap & Next Class

This lecture:

Talent

Binary Tree ADT

Next lecture:

Terminology

Implementation