MATH1510 - Discrete Mathematics
Trees

University of Newcastle

UoN

What's an Algorithm?

- An **algorithm** is a step-by-step procedure for accomplishing a task.
- **Algorithms:**
  - require input;
  - consistent of finitely many precisely defined steps; and
  - generate output.
- The word comes from "Al-Khwārizmī" - the mathematician who wrote a book, published in 825AD, whose title translates: *On calculation with Hindu-Arabic numeral system*. Algorithms were initially about numerical computations, but now have wider application/meaning.

Example: an algorithm to make pancakes

1. Sift one cup of flour into a bowl
2. Add a pinch of salt
3. Stir in two eggs
4. Stir in one cup of milk
5. Heat a frying pan and add some butter
6. Pour some mixture into the pan
7. Wait till mixture solid; flip; wait a few more seconds
8. Remove pancake from pan
9. Repeat steps 6 to 8 until all mixture is used

Questions: What's the input? What's the output? Are the steps well defined?
NB: If written in French, it would be the same algorithm, in a different language.

Tasks for which we consider some algorithms

- Shuffling/permuting a list
- Sorting a list
  - Selection Sort
  - Merge Sort
- Searching a Sorted list
  - Binary search

An algorithm to 'shuffle'/permute a list:

- **Input:** a list $(a_0, \ldots, a_{n-1})$ of n items
- Put them in an array $A[0] = a_0, \ldots, A[n-1] = a_{n-1}$
- For $k = n-1, n-2, \ldots, 2, 1$ do
  - Select random $r \in \{0, \ldots, k\}$
  - Swap $A[r] \leftrightarrow A[k]$
- **Output:** the shuffled list $(b_0, \ldots, b_{n-1}) = (A[0], \ldots, A[n-1])$

NB: We need another algorithm for generating the random numbers.

Example

Apply the algorithm to the list

bandicoot, bilby, echidna, kangaroo, koala, platypus, possum, wallaby

with random numbers $3, 6, 2, 5, 1, 2, 1$.