SENG2011: Workshop on Reasoning about Programs

Course Outline Q&A

8th January, 2023

Questions:

1. **Write a program in your favourite procedural language that does linear search in an array**

2. **The logical formula $p \to \neg q$ is equivalent to which of the following:**

$$[\mathbf{A}]\ \neg p \to q, [\mathbf{B}]\ \neg(p \to q), [\mathbf{C}]\ q \to \neg p, [\mathbf{D}]\ \neg q \vee \neg p$$

3. **Prove by induction that $n! \geq 2^{n-1}$ for $n \geq 1$**

Answers:

1. **Below is a linear search for a key in an array, written in the C language.**

```
/*
   Does array 'a' of length 'len' contain the key 'val'?
   If true, return the index of the key. If false, return -1
 */
int LinearSearch(int a[], int len, int val)
{
   int found = -1;                // assume not found
   for (int i=0; i<len && found==-1; i++)
   {
      if (a[i] == val) found = i; // found the key
   }
   return found;
}
```

2. **The logical formula $p \to \neg q$ is equivalent to** $[\mathrm{C}]\ q \to \neg p$, **and to** $[\mathrm{D}]\ \neg q \vee \neg p$

3. **Proof by induction that $n! \geq 2^{n-1}$ for $n \geq 1$.**

   Base case: $n = 1 : 1! \geq 2^0$ is true

   Inductive hypothesis: assume true for $n = k : k! \geq 2^{k-1}$

   Inductive step: prove true for $n = k + 1$, that is, prove $(k+1)! \geq 2^k$

$$\begin{aligned}
(k+1)! &= (k+1) \times k! && \text{property of factorials} \\
&\geq (k+1) \times 2^{k-1} && \text{substitute IH into previous line} \\
&\geq 2 \times 2^{k-1} = 2^k && k+1 \geq 2 \text{ for } k \geq 1, \text{ property of exponents} \\
&\text{QED}
\end{aligned}$$