List Comprehensions

Example: `[ x * x | x <- [1..5], odd x]` $=$ `[1,9,25]`

$$\texttt{[}\ \underline{\mathsf{exp}}\ \texttt{|}\ \underline{\mathsf{var}}\ \texttt{<-}\ \underline{\mathsf{exp}}',\ \texttt{Q]} \ = \ \texttt{concat (map f}\ \underline{\mathsf{exp}}'\texttt{)}$$
$$\texttt{where f}\ \underline{\mathsf{var}}\ \texttt{=}\ \texttt{[}\underline{\mathsf{exp}}\texttt{|Q]}$$

$$\begin{aligned}
& \texttt{[}\ \underline{\mathsf{exp}}\ \texttt{|}\ \underline{\mathsf{var}}\ \texttt{<-}\ \texttt{[a}_1\texttt{,...,a}_n\texttt{], Q]} \\
= \ & \texttt{concat (map f [a}_1\texttt{,...,a}_n\texttt{]) where f}\ \underline{\mathsf{var}}\ \texttt{=}\ \texttt{[}\underline{\mathsf{exp}}\texttt{|Q]} \\
= \ & \texttt{f a}_1\ \texttt{++...++ f a}_n\ \texttt{where f}\ \underline{\mathsf{var}}\ \texttt{=}\ \texttt{[}\underline{\mathsf{exp}}\texttt{|Q]} \\
= \ & \texttt{[}\underline{\mathsf{exp}}\ \texttt{| Q]}\ [\texttt{x/a}_1]\ \texttt{++...++}\ \texttt{[}\underline{\mathsf{exp}}\ \texttt{| Q]}\ [\texttt{x/a}_n].
\end{aligned}$$

$$\texttt{[}\ \underline{\mathsf{exp}}\ \texttt{|}\ \underline{\mathsf{exp}}',\ \texttt{Q]} \ = \ \texttt{if}\ \underline{\mathsf{exp}}'\ \texttt{then [}\underline{\mathsf{exp}}\texttt{|Q] else []}$$

Quicksort in an Imperative Language (JAVA)

```
static void qsort(int[] a, int lo, int hi) {
      int h, l, p, t;

      if (lo <= hi) { l = lo;
                      h = hi;
                      p = a[hi];

          do { while ((l < h) && (a[l] <= p))
                   l = l+1;
                while ((h > l) && (a[h] >= p))
                   h = h-1;
                if (l < h) {  t = a[l];
                              a[l] = a[h];
                              a[h] = t;      }
          } while (l < h);

          t = a[l];
          a[l] = a[hi];
          a[hi] = t;

          qsort( a, lo, l-1);
          qsort( a, l+1, hi); }  }
```