Ordered lists in \LaTeX using the \texttt{enumerate} environment

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1 Ordered Lists using the \texttt{enumerate} environment

Under the \texttt{\enumerate} environment, ordered lists are generated using the control sequence \texttt{\item} in each entry. Each enumerated item can be labeled and referred through the \texttt{\label{}} and \texttt{\ref{}} commands, respectively. The default \textit{numbering styles} in the nested four listings under the \enumerate environment are:

- 1, 2, \ldots 4 for the first level (arabic numbers)
- (a), (b) \ldots (d) for the second level (lowercase letters)
- i, ii, \ldots iv for the third level (lowercase Roman numerals)
- A, B \ldots C for the fourth level (uppercase letters)

while their \textit{referring styles} are:

- 1, 2, \ldots 4 for the first level
1(a), 1(b) ... 1(d) for the second level

1(a)i, 1(a)ii, ... 1(a)iv for the third level

1(a)iA, 1(a)iB ... 1(a)iC for the fourth level

We will use as an example of nested list up to the fourth depth level, a list consisting of countries, states, regions and cities from our continent. The \LaTeX{} code and its output are shown side by side with the help of package \texttt{fancyvrb-ex} [2]. This will be done with all the examples in this article.

1. Brazil

(a) Rio de Janeiro

(b) Sao Paulo

(c) Parana

   i. Oeste Par.

   ii. Centro-Sul Par.

      A. Curitiba

      B. S. J. dos Pinhais

   iii. Centro-Sul Par.

   iv. Sudoeste Par.

(d) Bahia

(e) Mato Grosso do Sul

2. Cuba

(a) Villa Clara

(b) Havana

3. Argentina

If at any part of the current document we need to refer to the item S. J. dos Pinhais, for example, which is at the deepest level of our list (the fourth), we can invoke the \texttt{\ref{}} command using the corresponding label we associated to this item in \LaTeX{} code, in this
case {it:sjp}, as the command’s argument. The same logical is applied to indicate the region, state and country where S. J. dos Pinhais is located as shown below:

The city 1(c)iiB is located at the region of 1(c)ii in the state 1c that belong to the country 1.

2 Modifying the numbering styles

In \LaTeX lists each level has an associated \texttt{\labelenumXX} and \texttt{\theenumXX} variables, where \texttt{XX = i \ldots iv} point for the level. The \texttt{enumXX} is the counter that increase its value at each call to the \texttt{item} inside of the \texttt{enumerate} environment. Let’s check the current values of these variables at level one:

\begin{verbatim}
\begin{itemize}
  \item \texttt{\theenumi} = 3
  \item \texttt{\labelenumi} = 3.
\end{itemize}
\end{verbatim}

Since the default numbering styles for the first level are arabic numbers, the first time that \LaTeX code found an \texttt{item} inside the \texttt{enumerate} environment the counter \texttt{enumi} is set to the value 1. But this happens three times at the first level in our example list (it has three countries) so a call to the value stored in the counter, which is made through \texttt{\theenumi} returns a value of 3. The \texttt{\labelenumi} just adds a lower point to \texttt{\theenumi}.

The same logical applies to the second level, as shown below:

\begin{verbatim}
\begin{itemize}
  \item \texttt{\theenumii} = b
  \item \texttt{\labelenumii} = (b)
\end{itemize}
\end{verbatim}

The \texttt{enumii} has counted only from \texttt{a \ldots b} since in the example list only two countries (Brazil and Cuba) have some of their states listed. The numbering styles for each depth
can be modify by the user through the \renewcommand{\label}{\style} command, where \texttt{\label} is the list depth being modified and \texttt{\style} is how you want that number to be shown. We can styled both, the \texttt{\labelenumXX} and the \texttt{\theenumXX} variables using the following macros:

- \texttt{\alph{number}}: lowercase letters
- \texttt{\Alph{number}}: uppercase letters
- \texttt{\arabic{number}}: numbers
- \texttt{\roman{number}}: lowercase roman numerals
- \texttt{\Roman{number}}: uppercase roman numerals

For example, let’s change the number style to uppercase roman numerals at the first depth of our example list. This can be accomplished through the command

\renewcommand{\labelenumi}{\Roman{enumi}}:

If we invoke the new values for the controlling variables, this is the result:

\begin{verbatim}
\begin{itemize}
  \item \texttt{\theenumi} = 3
  \item \texttt{\labelenumi} = III:
  \item \texttt{\labelenumi} = III:
\end{itemize}
\end{verbatim}

We have styled only the \texttt{\labelenumi} variable but the \texttt{\theenumi} remains counting using the default arabic numbers. The result of invoking a cross reference to Cuba e.g. which has the \texttt{\label{it:cub}} is the following:

\begin{verbatim}
\ref{it:cub} = 2
\end{verbatim}

In spite of the fact that Cuba is now identified by a II: in the example list, as can be easily verified reprinting the original code:
I: Brazil

(a) Rio de Janeiro
(b) Sao Paulo
(c) Parana
   i. Oeste Par.
   ii. Centro-Sul Par.
      A. Curitiba
      B. S. J. dos Pinhais
   iii. Centro-Sul Par.
   iv. Sudoeste Par.
(d) Bahia
(e) Mato Grosso do Sul

II: Cuba

(a) Villa Clara
(b) Havana

III: Argentina

In order to maintaining the equivalence between the true label of the entry in the list and its cross reference we should also styled \theenumi variable using this command (without the colon):

\renewcommand{\theenumi}{\Roman{enumi}}

Invoking again the position of Cuba in the list we have:

\ref{it:cub} = 2
\begin{itemize}
\item \verb!\ref{it:cub}! = \ref{it:cub}
\end{itemize}
Clearly the cross reference remains incorrect. Remember that the variable `\theenumi` is updated at each call to the command `\item` and this only can be done if we run again the code for our example list. But we will not do that because it will destroy all our previous demonstrations, unless we change the `\label` of each item. Indeed, the style of any cross reference to our example list will change to uppercase roman numerals in the whole document as it should, since that means that the `\ref` command always find at the whole document for the most recent value of the associate identifier.

Any of the forms we have seen in this section for modifying the numbering styles in nested lists should be valid unless any other instruction, placed right before of the `\begin{enumerate}` modify its effects. For example, consider the following list:

```
\begin{enumerate}
  \item Local approaches. \label{it:la}
  \begin{enumerate}
    \item The NSIF Concept.
    \item The SED Concept.
  \end{enumerate}
  \item Global approaches. \label{it:ga}
  \begin{enumerate}
    \item The NS Concept.
    \item The SS Concept.
  \end{enumerate}
\end{enumerate}
```

As expected, the labels at the first level depth remains using uppercase roman numerals. We can return to the default configuration placing the following command at at the beginning of the environment, as follows:

```
\renewcommand{\labelenumi}{\arabic{enumi}}
```
1 Local approaches.
   (a) The NSIF Concept.
   (b) The SED Concept.

2 Global approaches.
   (a) The NSC Concept.
   (b) The SS Concept.
3 Placing some fixed text in a nested list

Quite often it is necessary to put some fixed text in each entry of a numbered list. More common examples include words as Example, Question, etc. This can be done by redefining the \labelenumXX commands. The following example consists of a hypothetical test with two questions, two items each. We will use only the first letter of the word Question. The \renewcommand is necessary only due to the introduction of the letter Q plus a call to the counter at the first level depth. Except for this letter, the rest of the code would be unnecessary because the\labelenumi is the default value for the \labelenumi in the enumerate environment.

\renewcommand{\labelenumi}{Q - \theenumi}

Q - 1 Discourse on these local approaches:
(a) The NSIF
(b) The SED

Q - 2 Discourse on these global approaches:
(a) The NSC
(b) The SSC

If the label for the second item of the first question is \label{it:sed} we realize that the cross reference to this line does not include the letter Q:

\begin{itemize}
\item \verb!\ref{it:sed}! = \ref{it:sed}
\end{itemize}

This is not a main drawback since the only thing that we do for fixing is to insert the letter Q or even the entire word Question before calling the \ref command. There are other alternatives using, for example the enumerate or enumitem packages. Note that the names for the package and environment are the same (enumerate) but this is just a
coincidence.

4 Including section number in list number

We arrive to \texttt{thesection = 4}, which obviously tell us that is the \LaTeX{} macro we should use in order to incorporate the section number to the labels and counters in the \texttt{enumerate} environment. Once again, the \texttt{\renewcommand} will be used to accomplish this task:

\begin{verbatim}
\renewcommand{\theenumi}{\thesection.\arabic{enumi}}
\begin{enumerate}
\item Discourse on these local approaches:
  \begin{enumerate}
  \item The NSIF \label{it:nsif1}
  \item The SED \label{it:sed1}
  \end{enumerate}
\item Discourse on these global approaches:
  \begin{enumerate}
  \item The NSC \label{it:nsc1}
  \item The SSC \label{it:ssc1}
  \end{enumerate}
\end{enumerate}
\end{verbatim}

Since section 3 we add the letter \texttt{Q} to the \texttt{\labelenumi} of any \texttt{enumerate} environment and we know from the section 2 that this setup will be valid if no other modification is found before the \texttt{\begin{enumerate}}. For this reason the letter is preserved in the above list. Also note that we changed the \texttt{\label} of the entries at the second level. Can you guest the reason of that? If you answered \texttt{not to modify this cross reference}, you are right. Let’s make a cross reference to the topic \texttt{SED} which stands for \textit{Strain Energy Density}

\begin{verbatim}
\ref{it:sed} = 4.1b
\end{verbatim}

As expected, the cross reference now includes the section number.

\begin{verbatim}
\begin{itemize}
\item [\verb!\ref{it:sed}!] = \ref{it:sed1}
\end{itemize}
\end{verbatim}
References
