Fast algorithm to embed bigger subproblem to D-Wave machine

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1. Digest
Embedding algorithm to obtain high accurate solution for large problem is proposed

2. Conventional method

1. \texttt{qbsolv}
   Iterative solver for large problem
   Extract subproblem optimization

2. heuristic embedding
   Grid graph to D-Wave2000Q

Complete graph embedding is used ⇒ size of subproblem become small
Computational time is too long to use for iterative solver

We expect fast algorithm to embed bigger subproblem improves the solution accuracy

3. Proposed method

\begin{itemize}
\item < proposed method > select part of variables which can be easily embedded
\item < conventional method > subproblem is embedded after subproblem is extracted
\end{itemize}

Extracting and embedding subproblem to chimera

4. Result 1
We evaluated the computational time of our algorithm
\begin{itemize}
\item grid graph 300 x 300 variables
\item complete graph 1,000 variables
\item chimera graph 10^2~10^3qubits
\end{itemize}

\begin{itemize}
\item \textbf{< computational time >}
\item \textbf{< size of subproblem >}
\end{itemize}

\begin{itemize}
\item \textbf{< example of subproblem1 >}
\item \textbf{< example of subproblem2 >}
\end{itemize}

the computational time is of order $N_q^{1.7}$

5. Result 2
We solved the 3D $\pm J$ Ising model by our method and compared with the complete graph embedding
\begin{itemize}
\item 10 x 10 x 10 variables
\item 400 variables
\item complete graph embedding
\item iteration
\end{itemize}

\begin{itemize}
\item \textbf{< solution accuracy >}
\end{itemize}

Accurate solution can be obtained with much smaller number of iteration

\begin{itemize}
\item optimize
\item subproblem 4 x 4 x 4 variables
\end{itemize}

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