

An example *Geophysics* article, with a two-line title

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ABSTRACT

This is an example of using `geophysics.cls` for writing *Geophysics* papers.

INTRODUCTION

The nonlinear relation between the physical properties of earth and natural phenomena explain the wave behaviour is responsible for FWI to stuck in local minima if the starting model is not lie within the basin of attraction. in this both are used together because both have advantages and disadvantages global is best in exploration and local is best in exploitation. PSO is easily parallelized. Some of the appealing facts of PSO are its convenience, simplicity and easiness of implementation requiring. The prominent features of PSO are its easy implementation, robustness to control parameters and computation efficiency compared with other existing heuristic algorithms such as genetic algorithm in a continuous problem. method

METHODOLOGY

This approach involves two steps. First, a coarse velocity model is prepared using PSO by optimizing the depth, interface velocity, and the rate of change of velocity between interfaces. This model serves as an initial model for conventional gradient-based FWI in the second step.

Particle Swarm Optimization

Particle Swarm Optimization (PSO) is a stochastic method developed by James Kennedy and Russell Eberhart in 1995. Inspired by the social behavior of birds flocking to find food, they formulated a mathematical model to simulate this behavior. This model is widely applied to solve various optimization problems. They identified that the fundamental principle guiding birds' food-finding behavior is their ability to communicate with each other. Each bird in the process knows its current position ($x_i(t)$) and best position ($p_i(t)$), determined by evaluating the fitness using a cost function. Additionally, each bird shares its best position with others, contributing to the collective knowledge of the flock's best position ($g(t)$). Each bird's next

Example

movement is adjusted by its own best, the flock's best, and its current position. This iterative process continues at each step, ultimately converging towards a globally optimal position through the collaborative effort of all birds. This natural phenomenon is mathematically described by velocity 1, and position update equation 2.

- $\mathbf{x}_i(t)$ be the position of particle i at iteration t .
- $\mathbf{v}_i(t)$ be the velocity of particle i at iteration t .
- $\mathbf{p}_i(t)$ be the personal best position of particle i until iteration t .
- $\mathbf{g}(t)$ be the global best position among all particles until iteration t .
- w be the inertia weight.
- c_1 and c_2 be the cognitive and social acceleration coefficients, respectively.
- r_1 and r_2 be random numbers uniformly distributed in the range $[0, 1]$.

The velocity and position update rules for each particle are given by:

$$\mathbf{v}_i(t+1) = w\mathbf{v}_i(t) + c_1r_1(\mathbf{p}_i(t) - \mathbf{x}_i(t)) + c_2r_2(\mathbf{g}(t) - \mathbf{x}_i(t)) \quad (1)$$

$$\mathbf{x}_i(t+1) = \mathbf{x}_i(t) + \mathbf{v}_i(t+1) \quad (2)$$

Where:

- w controls the influence of the previous velocity (inertia).
- c_1 and c_2 represent the trust of the particle in itself and in the swarm, respectively.
- r_1 and r_2 introduce stochasticity to the particle's movement.

Inertia weight (w), acceleration coefficients (c_1, c_2), population size of swarm, and iterations are the controlling parameters influence the updates. Inertia weight is most important tuning parameter in PSO algorithm which provide a balance between exploration and exploitation abilities of PSO by tuning the contribution of velocity. the value of weight between 0.4 to 0.9 provide a good convergence. (c_1, c_2) are cognitive and social coefficients decide by the confidence on particle's own and swarms' best position this influence the updated velocity. number of particles in swarm also affect the convergence as search space is increased with number of particles and provide a better convergence, experimentally it was studied that around 30 particles are good for finding the solution within optimal iterations. number of iterations affects all iterative optimization algorithms same is true for PSO. this contribution of different parameters make it is necessary to decide the combination of these parameters precisely because these parameters affect the performance of PSO.

THEORY

This is another section.

Equations

Section headings should be capitalized. Subsection headings should only have the first letter of the first word capitalized.

Here are examples of equations involving vectors and tensors:

$$\mathbf{R} = \begin{pmatrix} R_{XX} & R_{YX} \\ R_{XY} & R_{YY} \end{pmatrix} = \mathbf{P}_{M \rightarrow R} \mathbf{D} \mathbf{P}_{S \rightarrow M} \mathbf{S} \quad , \quad (3)$$

and

$$R_{j,m}(\omega) = \sum_{n=1}^N P_j^{(n)}(\mathbf{x}_R) D^{(n)}(\omega) P_m^{(n)}(\mathbf{x}_S) \quad . \quad (4)$$

4 Note that the macro for the `\tensor` command has been changed to force tensors to be bold uppercase, in compliance with current SEG submission standards. This is so that documents typeset to the old standards will print out according to the new ones: e.g., tensor **T** (note converted to uppercase).

Figures

Figure 1 shows what it is about.

Multiplot

The first argument of the `multiplot` command specifies the number of plots per row.

Tables

ACKNOWLEDGMENTS

I wish to thank Ivan Pšenčík and Frédéric Billette for having names with non-English letters in them. I wish to thank Červený (2000) for providing an example of how to make a bib file that includes an author whose name begins with a non-English character and Forgues (1996) for providing both an example of referencing a Ph.D. thesis and yet more non-English characters.

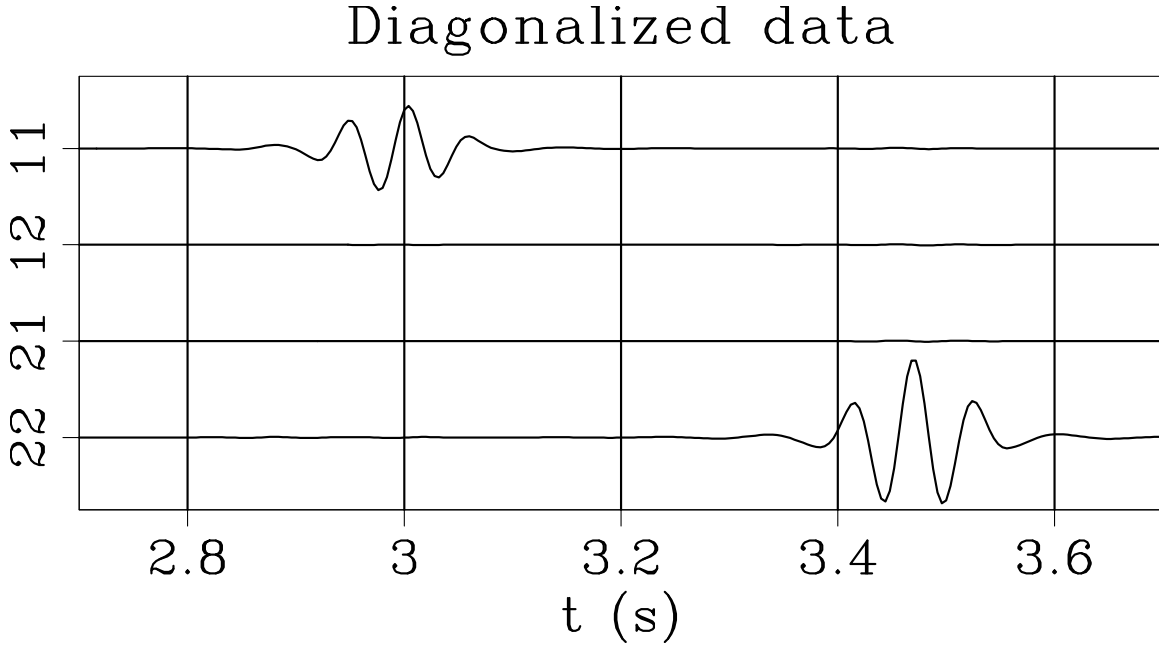


Figure 1: This figure is specified in the document by `\plot{waves}{width=\textwidth}{This caption.}`.

APPENDIX A

APPENDIX EXAMPLE

According to the new SEG standard, appendices come before references.

$$\frac{\partial U}{\partial z} = \left\{ \sqrt{\frac{1}{v^2} - \left[\frac{\partial t}{\partial g} \right]^2} + \sqrt{\frac{1}{v^2} - \left[\frac{\partial t}{\partial s} \right]^2} \right\} \frac{\partial U}{\partial t} \quad (\text{A-1})$$

It is important to get equation A-1 right. See also Appendix B.

APPENDIX B

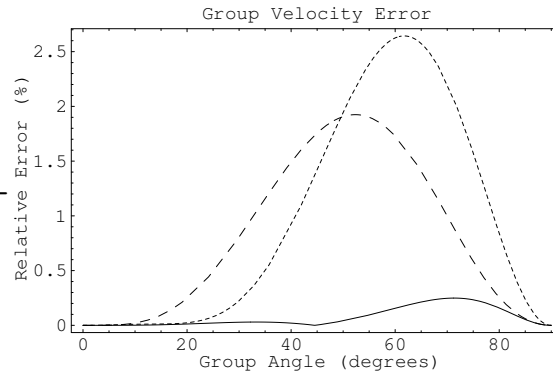
ANOTHER APPENDIX

$$\frac{\partial U}{\partial z} = \left\{ \sqrt{\frac{1}{v^2} - \left[\frac{\partial t}{\partial g} \right]^2} + \sqrt{\frac{1}{v^2} - \left[\frac{\partial t}{\partial s} \right]^2} \right\} \frac{\partial U}{\partial t} \quad (\text{B-1})$$

Too lazy to type a different equation but note the numeration.

The error comparison is provided in Figure B-1.

Figure B-1: This figure is specified in the document by `\sideplot{errgrp}{width=0.8\textwidth}{This caption.}`.



APPENDIX C

THE SOURCE OF THIS DOCUMENT

```
%\documentclass[paper]{geophysics}
\documentclass[paper,revised]{geophysics}
\usepackage{cleveref} %for cref

% An example of defining macros
\newcommand{\rs}[1]{\mathstrut\mbox{\scriptsize\rm #1}}
\newcommand{\rr}[1]{\mbox{\rm #1}}

\begin{document}

\title{An example \emph{Geophysics} article, \\ with a two-line title}

\renewcommand{\thefootnote}{\fnsymbol{footnote}}

\ms{GEO-Example} % paper number

\address{
\footnotemark[1]BP UTG, \\
200 Westlake Park Blvd, \\
Houston, TX, 77079 \\
\footnotemark[2]Bureau of Economic Geology, \\
John A. and Katherine G. Jackson School of Geosciences \\
The University of Texas at Austin \\
University Station, Box X \\
Austin, TX 78713-8924}
\author{Joe Dellinger\footnotemark[1] and Sergey Fomel\footnotemark[2]}

\footer{Example}
\lefthead{Dellinger \& Fomel}
```

`\righthead{\emph{Geophysics} example}`

`\maketitle`

`\begin{abstract}`

This is an example of using `\textsf{geophysics.cls}` for writing
`\emph{Geophysics}` papers.

`\end{abstract}`

`\section{Introduction}`

The nonlinear relation between the physical properties of earth and natural phenomena. Some of the appealing facts of PSO are its convenience, simplicity and easiness of implementation. The prominent features of PSO are its easy implementation, robustness to control parameters. `\method \ref{method}`

`\section{Methodology}`

`\label{method}`

This approach involves two steps. First, a coarse velocity model is prepared using PSO. `\subsection{Particle Swarm Optimization}`

Particle Swarm Optimization (PSO) is a stochastic method developed by James Kennedy and

`\begin{itemize}`

`\item \(\mathbf{x}_i(t)\)` be the position of particle `\(i\)` at iteration `\(t\)`.

`\item \(\mathbf{v}_i(t)\)` be the velocity of particle `\(i\)` at iteration `\(t\)`.

`\item \(\mathbf{p}_i(t)\)` be the personal best position of particle `\(i\)` until iteration `\(t\)`.

`\item \(\mathbf{g}(t)\)` be the global best position among all particles until iteration `\(t\)`.

`\item \(\mathbf{w}\)` be the inertia weight.

`\item \(\mathbf{c}_1\)` and `\(\mathbf{c}_2\)` be the cognitive and social acceleration coefficients,

`\item \(\mathbf{r}_1\)` and `\(\mathbf{r}_2\)` be random numbers uniformly distributed in the range `\([0, 1]\)`.

`\end{itemize}`

The velocity and position update rules for each particle are given by:

`\begin{equation}`

`\label{eqn:ps01}`

$$\mathbf{v}_i(t+1) = \mathbf{w} \mathbf{v}_i(t) + \mathbf{c}_1 \mathbf{r}_1 (\mathbf{p}_i(t) - \mathbf{x}_i(t)) + \mathbf{c}_2 \mathbf{r}_2 (\mathbf{g}(t) - \mathbf{x}_i(t))$$

`\end{equation}`

`\begin{equation}`

`\label{eqn:ps02}`

$$\mathbf{x}_i(t+1) = \mathbf{x}_i(t) + \mathbf{v}_i(t+1)$$

`\end{equation}`

Where:

`\begin{itemize}`

`\item \(\mathbf{w}\)` controls the influence of the previous velocity (inertia).

\item \((c_1)\) and \((c_2)\) represent the trust of the particle in itself and in the
\item \((r_1)\) and \((r_2)\) introduce stochasticity to the particle's movement.
\end{itemize}
Inertia weight \((w)\), acceleration coefficients \((c_1, c_2)\), population size
this contribution of different parameters make it is necessary to decide the combination
\section*{Theory}

This is another section.

\subsection{Equations}

Section headings should be capitalized. Subsection headings should only have the first letter of the first word capitalized.

Here are examples of equations involving vectors and tensors:

```
\begin{equation}
\tensor{R} =
\pmatrix{R_{\rs{XX}} & R_{\rs{YX}} \cr R_{\rs{XY}} & R_{\rs{YY}}}
=
\tensor{P}_{\M\rightarrow R} \; ; \; \tensor{D} \; ; \; \tensor{P}_{\S\rightarrow M}
\; ; \; ; \; \tensor{S} \; \backslash \; \backslash \; \backslash \; ,
\label{SVD}
\end{equation}
and
\begin{equation}
R_{\{j,m\}}(\omega) =
\sum_{n=1}^N \backslash , \; \backslash ,
P_{\{j\}}^{(n)}(\mathbf{x}_R) \backslash , \; \backslash ,
D^{(n)}(\omega) \backslash , \; \backslash ,
P_{\{m\}}^{(n)}(\mathbf{x}_S) \backslash \; \backslash \; \backslash .
\label{SVDray}
\end{equation}
\ref{SVDray}
```

Note that the macro for the \verb#\tensor# command has been changed to force tensors to be bold uppercase, in compliance with current SEG submission standards. This is so that documents typeset to the old standards will print out according to the new ones: e.g., tensor $\$ \backslash \text{tensor}{t} \$$ (note converted to uppercase).

\subsection*{Figures}
\renewcommand{\figdir}{Fig} % figure directory

Figure~\ref{fig:waves} shows what it is about.

\plot{waves}{width=\textwidth}

```
{This figure is specified in the document by \texttt{
  $\backslash$plot\{waves\}\{width=$\backslash$textwidth\}\{This caption.\}\}.
}
```

```
\subsubsection{Multiplot}
```

The first argument of the `\texttt{multiplot}` command specifies the number of plots per row.

```
\subsection{Tables}
```

```
\begin{acknowledgments}
```

I wish to thank Ivan P\v{s}en\v{c}\'\i{k} and Fr\'ed\'eric Billette for having names with non-English letters in them. I wish to thank \cite{Cervený} for providing an example of how to make a bib file that includes an author whose name begins with a non-English character and \cite{forges96} for providing both an example of referencing a Ph.D. thesis and yet more non-English characters.

```
\end{acknowledgments}
```

```
\append{Appendix example}
```

```
\label{example}
```

According to the new SEG standard, appendices come before references.

```
\begin{equation}
```

```
\frac{\partial U}{\partial z} =
```

```
\left\{
```

```
\sqrt{\frac{1}{v^2}} - \left[\frac{\partial t}{\partial g}\right]^2 +
```

```
\sqrt{\frac{1}{v^2}} - \left[\frac{\partial t}{\partial s}\right]^2
```

```
\right\}
```

```
\frac{\partial U}{\partial t}
```

```
\label{eqn:partial}
```

```
\end{equation}
```

It is important to get equation~\ref{eqn:partial} right. See also Appendix~\ref{equations}.

```
\append[equations]{Another appendix}
```

```
\begin{equation}
```

```
\frac{\partial U}{\partial z} =
```

```
\left\{
```

```
\sqrt{\frac{1}{v^2}} - \left[\frac{\partial t}{\partial g}\right]^2 +
```



```

\sqrt{\frac{1}{v^2} - \left[\frac{\partial t}{\partial s}\right]^2}
\right\}
\frac{\partial U}{\partial t}
\label{eqn:partial2}
\end{equation}

```

Too lazy to type a different equation but note the numeration.

The error comparison is provided in Figure~\ref{fig:errgrp}.

```

\sideplot{errgrp}{width=0.8\textwidth}
{This figure is specified in the document by \texttt{
    $\backslash$sideplot\{errgrp\}\{width=0.8$\backslash$text\-width\}\{This caption.
}

```

```

\append{The source of this document}

```

```

\verbatiminput{geophysics_paper.tex}

```

```

\append{The source of the bibliography}

```

```

\verbatiminput{geophysics_reference.bib}

```

```

\newpage

```

```

\bibliographystyle{seg} % style file is seg.bst

```

```

\bibliography{geophysics_reference}

```

```

\end{document}

```

APPENDIX D

THE SOURCE OF THE BIBLIOGRAPHY

```

@Book{lamport,
  author = {L[eslie] Lamport},
  title = {{\LaTeX: A} Document Preparation System},
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  year = 1994
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    year =    2004
}

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  title = {Seismic Ray Method},
  year = {2000},
  publisher = {Cambridge University Press}
}

@PHDTHESIS{forgues96,
  author = {E. Forgues},
  title = {Inversion linearis\'ee multi-param\'etres via la th\'eorie des rais},
  school = {Institut Fran\c{c}ais du P\'etrole - University Paris VII},
  year = {1996}
}

```

REFERENCES

- Červený, V., 2000, Seismic ray method: Cambridge University Press.
- Forgues, E., 1996, Inversion linearisée multi-paramètres via la théorie des rais: PhD thesis, Institut Français du Pétrole - University Paris VII.