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

Joe Dellinger[*] *and Sergey Fomel*[†]

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 phenomina expalin 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. 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 movement is influenced 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 in equation 1, 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:

$$\mathbf{v}_i(t+1) = w\mathbf{v}_i(t) + c_1 r_1(\mathbf{p}_i(t) - \mathbf{x}_i(t)) + c_2 r_2(\mathbf{g}(t) - \mathbf{x}_i(t)) \tag{1}$$

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

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.

w, c_1, c_2, and population size of swarm are the controlling parameters decide the updates. this make it is neccesar to decide the values of these parameters precisecly such that a good cnvergence and effiecint optimised values of variables can be obtained within the computationally feasible iterations.

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:

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

and

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

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 $\mathbf{T}$ (note converted to uppercase).

Figures

Figure 1 shows what it is about.

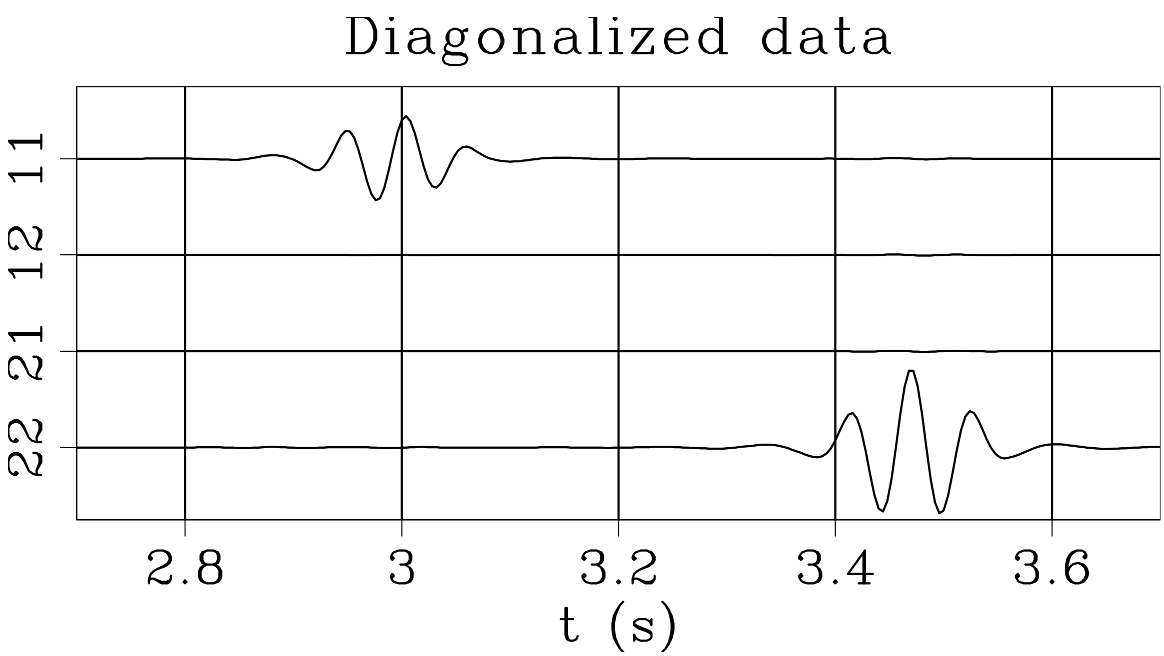

Figure 1: This figure is specified in the document by `\plot{waves}{width=\textwidth}{This caption.}`.

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.

APPENDIX A

APPENDIX EXAMPLE

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

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

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

APPENDIX B

ANOTHER APPENDIX

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

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

The error comparison is provided in Figure B-1.

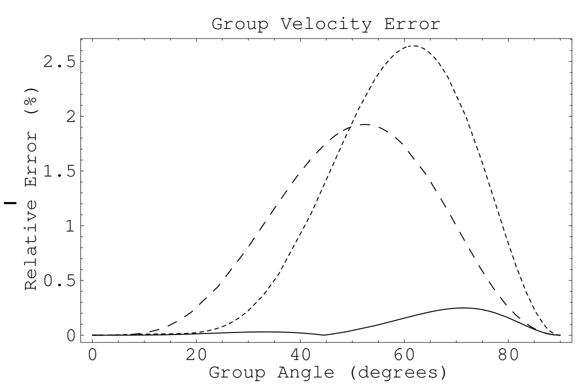

Figure B-1: This figure is specified in the document by `\sideplot{errgrp}{width=0.8\textwidth}{This caption.}`.

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 phenomina
```

```
method \ref{method}
\section{Methodology}
\label{method}
This approach involves two steps. First, a coarse velocity model is prepared using PS
\subsection{Particle Swarm Optimization}
Particle Swarm Optimization (PSO) is a stochastic method developed by James Kennedy a
\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 i
\item \( \mathbf{g}(t) \) be the global best position among all particles until itera
\item \( w \) be the inertia weight.
\item \( c_1 \) and \( c_2 \) be the cognitive and social acceleration coefficients,
\item \( r_1 \) and \( r_2 \) be random numbers uniformly distributed in the range \(
\end{itemize}

The velocity and position update rules for each particle are given by:
\begin{equation}
\label{eqn:pso1}
\mathbf{v}_i(t+1) = w \mathbf{v}_i(t) + c_1 r_1 (\mathbf{p}_i(t) - \mathbf{x}_i(t)) +

\end{equation}

\begin{equation}
\label{eqn:pso2}
\mathbf{x}_i(t+1) = \mathbf{x}_i(t) + \mathbf{v}_i(t+1)
\end{equation}

Where:
\begin{itemize}
\item \( w \) controls the influence of the previous velocity (inertia).
\item \( c_1 \) and \( c_2 \) represent the trust of the particle in itself and in th
\item \( r_1 \) and \( r_2 \) introduce stochasticity to the particle’s movement.
\end{itemize}
\(w\), \(c_1\), \(c_2\), and population size of swarm are the controlling parameters
\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} \ \ \  ,
\label{SVD}
\end{equation}
and
\begin{equation}
R_{j,m}(\omega) =
\sum_{n=1}^{N} \, \,
P_{j}^{(n)}(\mathbf{x}_R) \, \,
D^{(n)}(\omega) \, \,
P_{m}^{(n)}(\mathbf{x}_S) \ \ \ .
\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
$\tensor{t}$ (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{Cerveny} 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{forgues96} 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},
  publisher =   {Addison-Wesley},
  year =   1994
}

@Book{kopka,
  author =  {H[elmut] Kopka and P[atrick] W[] Daly},
  title =   {Guide to {\LaTeX}},
  publisher =   {Addison-Wesley},
  year =   2004
}

@preamble{"\newcommand{\SortNoop}[1]{}"}
@Book{Cerveny,
  author = {V[] {\SortNoop{Cerveny}}\v{C}erven\'{y}},
  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.