

Day 1, exercise 4: Vigilance

Richel Bilderbeek

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v : fraction of foraging time invested in being watchful.

S : survival probability.

$$S(v) = v$$

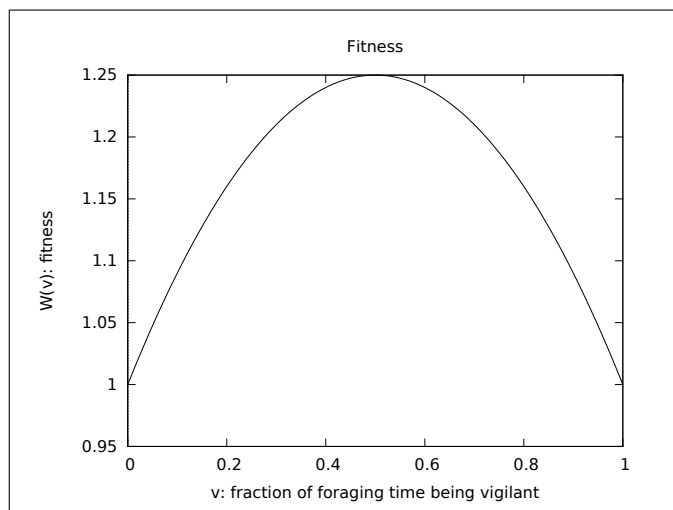
F : foraging efficiency.

$$F(v) = 1.0 - v^2$$

$W(v)$: fitness. $W(v) = S(v) + F(v)$

$$W(v) = -v^2 + v + 1.0$$

Plotted this looks like:



To calculate the maximum or minimum, set the derivate to zero and solve it:

$$\frac{d}{dv} W(v) = 1 - 2v = 0$$

$$v = \frac{1}{2}$$

Thus, the optimal vigilance level v equals:

$$\frac{1}{2}$$

This optimal vigilance level results in a fitness of:

$$W\left(\frac{1}{2}\right) = 1.25$$

To find out if it is a fitness minimum or maximum, calculate the second derivative and find out its value at the minimum or maximum:

$$\frac{d^2}{dv^2} W(v) = -2$$

Thus, it is a maximum.

A Script file

```
#!/bin/bash
maxima_input_file="Day1_4_vigilance.txt"
tex_output_file="Day1_4_vigilance_output.tex"
md_output_file="Day1_4_vigilance_output.md"
html_output_file="Day1_4_vigilance_output.html"

if [ -e $tex_output_file ]
then
    rm $tex_output_file
fi

maxima -b $maxima_input_file
pdflatex $tex_output_file
pandoc -o $md_output_file $tex_output_file
pandoc -o $html_output_file $tex_output_file
```

B Maxima file

```
/* Maxima batch file */

/* Load libraries */
load("stringproc")$

/* Input filename */
```

```

bash_filename:"Day1_4_vigilance.sh"$
maxima_filename:"Day1_4_vigilance.txt"$ /* this file */

/* Output filenames */
tex_filename:"Day1_4_vigilance_output.tex"$
pdf_filename:"/home/richel/GitHubs/Maxima/
    Day1_4_vigilance_output.pdf"$

/* Write results to TeX file */
stream: openw(tex_filename)$
printf(stream,"\\documentclass{article}~%")$
printf(stream,"~%")$
printf(stream,"\\usepackage{listings}~%")$
printf(stream,"\\usepackage{graphicx}~%")$
printf(stream,"~%")$
printf(stream,"\\title{Day 1, exercise 4: Vigilance}~%")$
printf(stream,"\\author{Richel Bilderbeek}~%")$
printf(stream,"\\date{\\today}~%")$
printf(stream,"~%")$
printf(stream,"\\begin{document}~%")$
printf(stream,"~%")$
printf(stream,"\\maketitle~%")$
printf(stream,"~%")$

printf(stream,"$v$: fraction of foraging time invested in
    being watchful.\\\\~%")$
printf(stream,"$$$: survival probability.~%")$

Survival(v) := S(v) = v;

printf(stream,tex(Survival(v),false))$
printf(stream,"$F$: foraging efficiency.~%")$

Foraging(v) := F(v) = 1.0 - (v^2);

printf(stream,tex(Foraging(v),false))$
printf(stream,"$W(v)$: fitness.~%")$
printf(stream,"$W(v) = S(v) + F(v)$~%")$

Fitness(v) := W(v) = '(rhs(Survival(v)) + rhs(Foraging(v)
    ));

printf(stream,tex(Fitness(v),false))$
printf(stream,"Plotted this looks like:\\\\\\\\\\\\\\~%")$

plot2d(

```

```

    rhs(Fitness(v)), [v, 0.0, 1.0],
    [title, "Fitness"],
    [xlabel, "v: fraction of foraging time being vigilant"],
    [ylabel, "W(v): fitness"],
    [color, black],
    [pdf_file, pdf_filename]
);

printf(stream, "\\fbox{\\includegraphics[scale=0.5]{"}$
printf(stream, pdf_filename)$
printf(stream, "}}\\\\\\\\\\\\\\\\~%")$

printf(stream, "To calculate the maximum or minimum, set
the derivate to zero and solve it:~%")$

FitnessDeriv(v) := diff(W(v), v) = ''(diff(rhs(Fitness(v)),
v));

maximum: solve(rhs(FitnessDeriv(v))=0)[1];

printf(stream, tex(FitnessDeriv(v)=0, false))$
printf(stream, tex(maximum, false))$

printf(stream, "Thus, the optimal vigilance level $v$
equals:")$
printf(stream, tex(rhs(maximum), false))$
printf(stream, "~%")$

printf(stream, "This optimal vigilance level results in a
fitness of:")$
printf(stream, tex(Fitness(rhs(maximum)), false))$
printf(stream, "~%")$

printf(stream, "To find out if it is a fitness minimum or
maximum,~%")$
printf(stream, "calculate the second derivative~%")$
printf(stream, "and find out its value at the minimum or
maximum:~%")$

FitnessDerivDeriv(v) := diff(W(v), v, 2) = ''(diff(rhs(
FitnessDeriv(v)), v));

printf(stream, tex(FitnessDerivDeriv(v), false))$

if rhs(FitnessDerivDeriv(v))<0
then

```

```

    printf(stream,"Thus, it is a maximum.~%")
else
    printf(stream,"Thus, it is a minimum.~%")
;

printf(stream,"~%")$
printf(stream,"\\appendix~%")$
printf(stream,"~%")$
printf(stream,"\\section{Script file}~%")$
printf(stream,"~%")$
printf(stream,"\\lstinputlisting [language=C++,
    showstringspaces=false , breaklines=true , frame=single] { "
    )$
printf(stream,bash_filename)$
printf(stream,"}~%")$
printf(stream,"~%")$
printf(stream,"\\section{Maxima file}~%")$
printf(stream,"~%")$
printf(stream,"\\lstinputlisting [language=C++,
    showstringspaces=false , breaklines=true , frame=single] { "
    )$
printf(stream,maxima_filename)$
printf(stream,"}~%")$
printf(stream,"~%")$
printf(stream,"\\section{\\LaTeX~~file}~%")$
printf(stream,"~%")$
printf(stream,"\\lstinputlisting [language=tex ,
    showstringspaces=false , breaklines=true , frame=single] { "
    )$
printf(stream,tex_filename)$
printf(stream,"}~%")$
printf(stream,"~%")$
printf(stream,"\\end{document}~%")$
close(stream)$

```

C \LaTeX file

```

\documentclass{article}

\usepackage{listings}
\usepackage{graphicx}

\title{Day 1, exercise 4: Vigilance}
\author{Richel Bilderbeek}

```

```

\date{\today}

\begin{document}

\maketitle

 $v$ : fraction of foraging time invested in being watchful.
 $S$ : survival probability.
 $S(v) = v$ 
 $F$ : foraging efficiency.
 $F(v) = 1.0 - v^2$ 
 $W(v)$ : fitness.
 $W(v) = S(v) + F(v)$ 
 $W(v) = -v^2 + v + 1.0$ 
Plotted this looks like:\\
\fbbox{\includegraphics[scale=0.5]{/home/richel/GitHubs/Maxima/Day1_4_vigilance_output.pdf}}\\
To calculate the maximum or minimum, set the derivate to zero and solve it:
 $\frac{d}{dv} W(v) = 1 - 2v = 0$ 
 $v = \frac{1}{2}$ 
Thus, the optimal vigilance level  $v$  equals:  $\frac{1}{2}$ 

This optimal vigilance level results in a fitness of:  $W(\frac{1}{2}) = 1.25$ 

To find out if it is a fitness minimum or maximum, calculate the second derivative and find out its value at the minimum or maximum:
 $\frac{d^2}{dv^2} W(v) = -2$ 
Thus, it is a maximum.

\appendix

\section{Script file}

\lstinputlisting[language=C++,showstringspaces=false,
breaklines=true,frame=single]{Day1_4_vigilance.sh}

\section{Maxima file}

\lstinputlisting[language=C++,showstringspaces=false,
breaklines=true,frame=single]{Day1_4_vigilance.txt}

```

```
\section{\LaTeX~file}

\lstinputlisting[language=tex,showstringspaces=false,
    breaklines=true,frame=single]{Day1_4_vigilance_output.
tex}

\end{document}
```