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clc          % clear the command window
clear       % clear all variables
format compact % condense command window output
format long g % +, bank, hex, long, rat, short, short g, short eng

% This is a MATLAB document to compute Christoffel symbols and geodesic equations, using a given metric

syms xa theta r g Gamma op f(r)

xa (1) = r;      % t : xa are the dimension labels for x
xa (2) = theta;  % r

n = 2; % dimensions

% metric initialization
op=[r*cos(theta),r*sin(theta),f(r)];
g (1, 1) = sum(diff(op,xa(1)).*diff(op,xa(1)));
g (1, 2) = sum(diff(op,xa(1)).*diff(op,xa(2)));
g (2, 1) = g (1, 2);
g (2, 2) = sum(diff(op,xa(2)).*diff(op,xa(2)));

gi = inv (g);

disp('g=')

```

g=

```
simplify(g)
```

ans =

$$\begin{pmatrix} \left(\frac{\partial}{\partial r} f(r)\right)^2 + 1 & 0 \\ 0 & r^2 \end{pmatrix}$$

```
disp('g^-1=')
```

g^-1=

```
simplify(gi)
```

ans =

$$\begin{pmatrix} \frac{1}{\left(\frac{\partial}{\partial r} f(r)\right)^2 + 1} & 0 \\ 0 & \frac{1}{r^2} \end{pmatrix}$$

```

% Generate Christoffel symbols
% Gamma = zeros (n, n, n); Can't use zeros directly because the array is symbolic, and would be
for gamma = 1:n
    for beta = 1:n

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for alpha = 1:n
    Gamma (alpha, beta, gamma) = 0;
end
end
end

% Christoffel
for delta = 1:n
    for gamma = 1:n
        for beta = 1:n
            for alpha = 1:n
                Gamma (beta, gamma, delta) = Gamma (beta, gamma, delta) + ...
                    0.5 * gi (alpha, delta) * ...
                    (diff (g (alpha, beta), xa (gamma)) + ...
                    diff (g (alpha, gamma), xa (beta)) - ...
                    diff (g (beta, gamma), xa (alpha)));
            end
        end
    end
    disp(['Gamma(i,j,', num2str(delta) ')'])

    simplify(Gamma (:, :, delta))
end

```

```
Gamma(i,j,1)
ans =
```

$$\begin{pmatrix} \frac{\frac{\partial}{\partial r} f(r) \frac{\partial^2}{\partial r^2} f(r)}{\left(\frac{\partial}{\partial r} f(r)\right)^2 + 1} & 0 \\ 0 & -\frac{r}{\left(\frac{\partial}{\partial r} f(r)\right)^2 + 1} \end{pmatrix}$$

```
Gamma(i,j,2)
ans =
```

$$\begin{pmatrix} 0 & \frac{1}{r} \\ \frac{1}{r} & 0 \end{pmatrix}$$