

September 13, 2024

AI For Research and Education

Live Demos!

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ChatGPT (GPT3.5)

- ❖ Fast
- ❖ Can hallucinate
- ❖ Can generate URLs, citations
 - ❖ often fake information
- ❖ Best for information discussions on issues prior to Nov. 2021

GPT-4

- ❖ Debut in March 2023
- ❖ Still the best ChatBot in September 2023 (not for long)
- ❖ Can provide accurate citations
- ❖ Better capabilities overall
- ❖ More reliable than GPT-3 overall
 - ❖ Plugins
 - ❖ Advanced Data Analytics
 - ❖ (one or the other, but not both)

Using Analytics

- ❖ Create a table that includes all capitals of the worlds, their longitude and latitude, and their population. Create and display a scattergram of population (displayed as a circle with a radius proportional to the $\log(\text{population})$), as a function of longitude and latitude.
- ❖ Analytics cannot be shared
- ❖ Actual conversation

Klein-Gordon Equation in Polar Coordinates

- ❖ Write the Fermi-Dirac equations in a standalone Latex file. Add explanations for all symbols used.
- ❖ How about a file for the Klein-Gordon equation, expressed in spherical coordinates?
- ❖ Propose appropriate latex / tex macros to simplify the Latex expression of the Klein-Gordon equations just generated. Rewrite the macros and simplify the equations. Produce a new standalone latex file.

```
\documentclass[12pt]{article}
```

```
\usepackage{amsmath}
```

```
\usepackage{amsfonts}
```

```
\usepackage{amssymb}
```

```
\title{Klein-Gordon Equation in Spherical Coordinates (Simplified)}
```

```
\author{ChatGPT}
```

```
\date{\today}
```

```
% Define the macros
```

```
\newcommand{\pderiv}[2]{\frac{\partial #1}{\partial #2}}
```

```
\newcommand{\pderivtwo}[2]{\frac{\partial^2 #1}{\partial #2^2}}
```

```
\newcommand{\psir}{\psi(r, \theta, \phi)}
```

```
\begin{document}
```

```
\maketitle
```

```
\section{Introduction}
```

The Klein-Gordon equation is a relativistic quantum mechanical wave equation that describes scalar particles. When expressed in spherical coordinates, it accounts for the symmetry and properties inherent to spherical systems. This document presents a simplified notation using LaTeX macros.

```
\section{Equation}
```

Using the defined macros, the time-dependent Klein-Gordon equation in spherical coordinates $((r, \theta, \phi))$ is:

```
\begin{equation}
```

```
\frac{1}{c^2} \pderivtwo{\psir}{t} - \frac{1}{r^2} \pderiv{{r} \left( r^2 \pderiv{\psir}{r} \right) - \frac{1}{r^2 \sin \theta} \pderiv{{\theta} \left( \sin \theta \pderiv{\psir}{\theta} \right) - \frac{1}{r^2 \sin^2 \theta} \pderivtwo{\psir}{\phi} + \frac{m^2 c^2}{\hbar^2} \psir = 0
```

Klein-Gordon Equation in Spherical Coordinates (Simplified)

ChatGPT

September 13, 2023

1 Introduction

The Klein-Gordon equation is a relativistic quantum mechanical wave equation that describes scalar particles. When expressed in spherical coordinates, it accounts for the symmetry and properties inherent to spherical systems. This document presents a simplified notation using LaTeX macros.

2 Equation

Using the defined macros, the time-dependent Klein-Gordon equation in spherical coordinates (r, θ, ϕ) is:

$$\frac{1}{c^2} \frac{\partial^2 \psi(r, \theta, \phi)}{\partial t^2} - \frac{1}{r^2} \frac{\partial}{\partial r} \left(r^2 \frac{\partial \psi(r, \theta, \phi)}{\partial r} \right) - \frac{1}{r^2 \sin \theta} \frac{\partial}{\partial \theta} \left(\sin \theta \frac{\partial \psi(r, \theta, \phi)}{\partial \theta} \right) - \frac{1}{r^2 \sin^2 \theta} \frac{\partial^2 \psi(r, \theta, \phi)}{\partial \phi^2} + \frac{m^2 c^2}{\hbar^2} \psi = 0 \quad (1)$$

Where:

- $\psi(r, \theta, \phi)$ is the scalar field.
- c is the speed of light.
- m is the rest mass of the scalar particle.
- \hbar is the reduced Planck's constant.
- r, θ, ϕ are the radial, polar, and azimuthal coordinates, respectively.

3 Conclusion

Using LaTeX macros can significantly simplify the notation and readability of complex equations like the Klein-Gordon equation. This is especially useful for documents with repeated use of similar terms or structures.

Role Playing

- ❖ Professor of Computer Science
 - ❖ (use roles that are well known on the web)
- ❖ Astrophysicist, playwright, high-school student, doctoral student
- ❖ A Linux terminal
- ❖ Shakespeare explains function overloading in C++ ([link](#))
- ❖ Julia Childs explains how to make a french baguette

Chat Interruptions

- ❖ In GPT, you can interrupt a conversation that goes on and on ...
- ❖ Beware: the context has been cut off.
 - ❖ GPT has no memory except the context
 - ❖ The reply to the next question *cannot* take into account anything that was not stated

Quiz generation

- ❖ Students can create their own quizzes on any topic
- ❖ Keep in mind that the chatbot is sometimes wrong.
 - ❖ good thing: keeps students on their toes
- ❖ Quizzes can be generated in multiple languages, at any level of difficulty
- ❖ Quiz types:
 - ❖ True/False
 - ❖ Multiple Choice
 - ❖ Free format
 - ❖ auto grading might then be an issue

Lesson Plans

- ❖ Develop course materials on any topic
- ❖ At any level of difficulty
- ❖ With illustration provided by the AI or the user
- ❖ With or without code examples
- ❖ Have the Chatbot generate synthetic data
- ❖ Using DataAnalytics, the chatbot can plot results
 - ❖ However: DataAnalytics must be enabled before starting the chat session

Writing Code

- ❖ Write a Code in C++
- ❖ Translate it to Javascript
- ❖ Create a simple Website
- ❖ Have GPT write code to create a client / server
- ❖ Analyze stack traces generated by code errors
- ❖ To try: translate assembler code (i.e., decompile) to readable code

Writing

- ❖ Fix grammatical errors
- ❖ Change the tone of text
- ❖ Completely rewrite text
- ❖ Write letters of recommendation
- ❖ Write speeches, blogs, reports
- ❖ Extract information from text (Abbreviations, links, definitions)