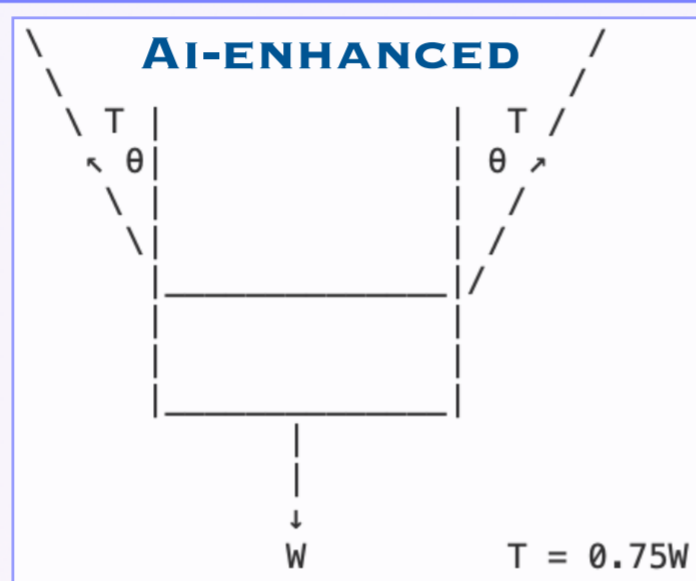
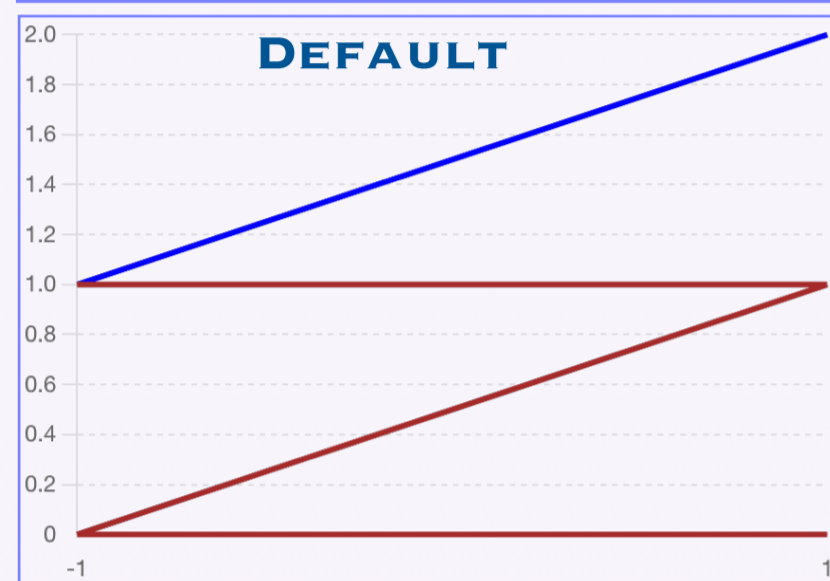


WHAT? ○ A **customised** Large Language Model (LLM) designed to help students **engage** with introductory university physics, particularly those with learning differences such as ADHD and dyslexia - The **PHYSUALISER**

WHY? ○ AI is **revolutionary** and has the **potential** to significantly enhance **accessibility** in physics courses by addressing the unique challenges faced by neurodivergent students

HOW? ○ According to the Universal Design for Learning (UDL), it is important to represent information in a **variety** of ways
○ I aim to combine AI and UDL (see below) to **automatically** rerepresent physics word problems as diagrams drawn using **ASCII Art** and **Unicode** techniques

EXAMPLE: A picture frame hung against a wall is suspended by two wires attached to its upper corners. If the two wires make the same angle with the vertical, what must this angle be if the tension in each wire is equal to 0.75 of the weight of the picture frame?



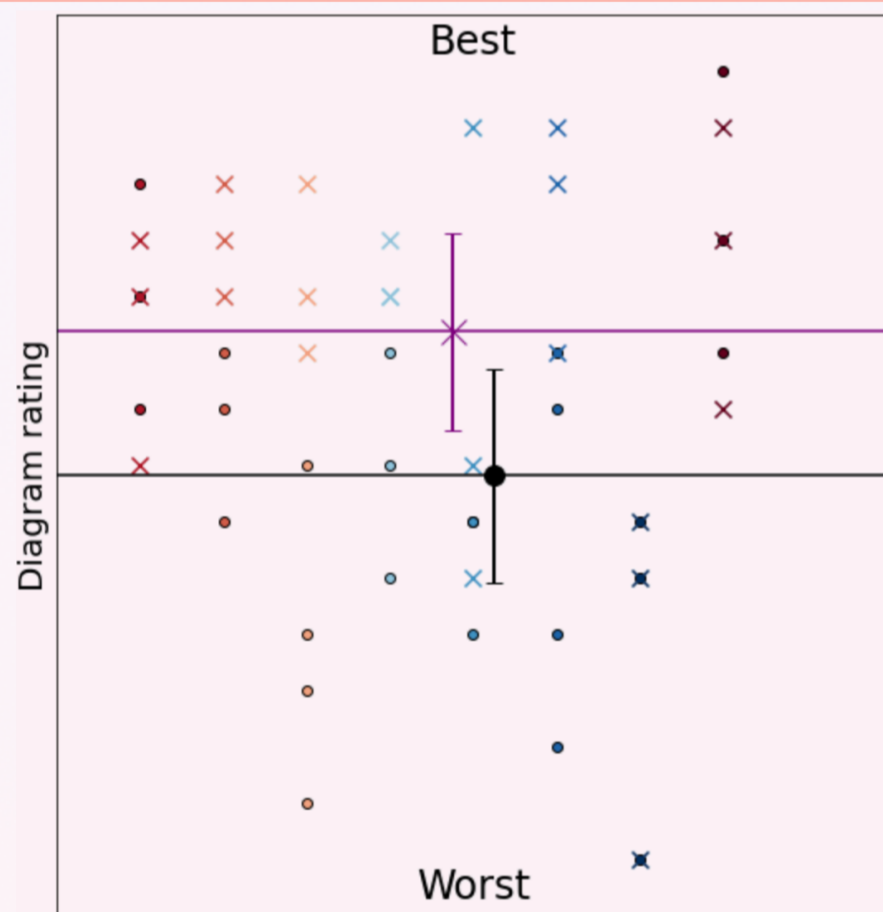
UDL

- ◆ Uses 3 principles to approach learning - not a one-size-fits-all model
- ◆ Particularly useful for those not yet formally diagnosed
- ◆ Aims to reduce anxiety and minimise ambiguity

1. Engagement - to motivate learners so they sustain interest
2. **REPRESENTATION** - give instructions in multiple ways to 'scaffold' learning
3. Action & Expression - interact with material through a variety of media

Is the PHYSUALISER EFFECTIVE?

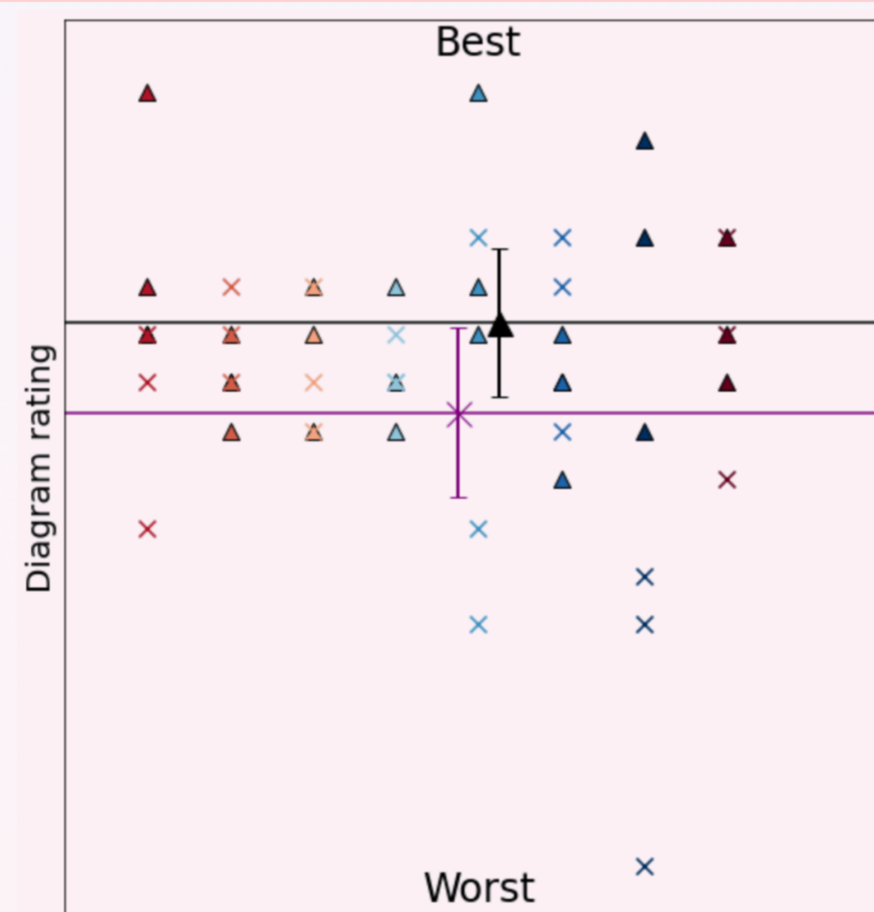
Comparing to ChatGPT



- Asked ChatGPT (black line) and **PHYSUALISER** (purple line) same questions and rated output diagram quality
- Does **PHYSUALISER** enhance learning process? **YES!**
- Spread of **PHYSUALISER** outputs higher up diagram than ChatGPT outputs
- Also, mean of **PHYSUALISER** data higher than that of ChatGPT data
- Then manually refined **PHYSUALISER** diagrams and put them into **PHYSUALISER** as input data

Is the PHYSUALISER ADAPTABLE?

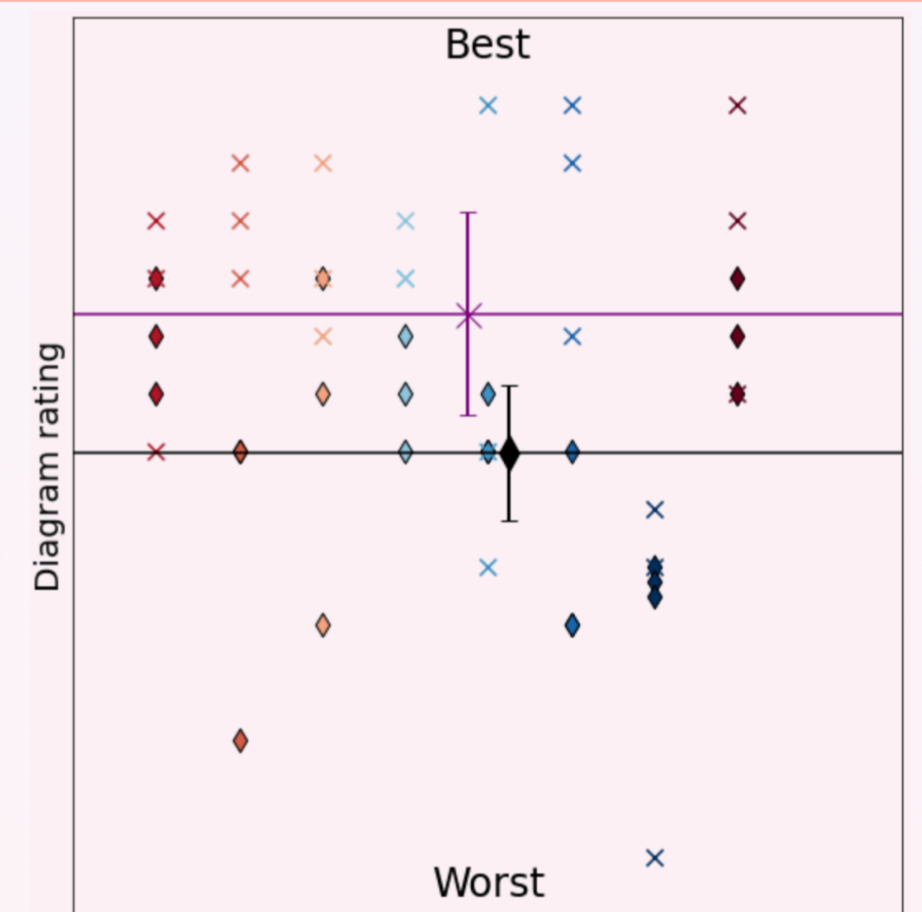
Comparing to out-distribution data



- Asked **PHYSUALISER** questions on content related to exemplar material (within mechanics) but, crucially not same topics
- Does **PHYSUALISER** function outside training capabilities? **YES!**
- Graph shows **PHYSUALISER** (purple line) actually performs better on out-distribution data (black line)
- Surprising but could be do to with suitability of subject matter to visual representation, or other intricacies

Is the PHYSUALISER EXPANDABLE?

Testing on quantum mechanics



- Asked **PHYSUALISER** questions on unrelated undergraduate content - quantum mechanics - at opposite end of the 'complexity' spectrum
- Does **PHYSUALISER** assist with unrelated concepts? **YES!** -ish
- Mean of the quantum data (black) is lower than the mechanics data (purple)
- BUT overlap in standard deviation shows that this difference is small
- Therefore, **PHYSUALISER** is effective with other data but may require further refinement for better use

● ChatGPT vectors	× Physualiser vectors	▲ Physualiser work, KE, power	◆ Physualiser Wave-Particle Duality
● ChatGPT straight line motion	× Physualiser straight line motion	▲ Physualiser gravitational & elastic potential energy	◆ Physualiser Heisenberg's Uncertainty Principle
● ChatGPT constant acceleration	× Physualiser constant acceleration	▲ Physualiser dynamics of circular motion	◆ Physualiser Models of Atoms
● ChatGPT projectiles	× Physualiser projectiles	▲ Physualiser types of forces	◆ Physualiser The Schroedinger Equation
● ChatGPT circular motion	× Physualiser circular motion	▲ Physualiser centre of mass	◆ Physualiser Particle in a Box
● ChatGPT relative motion	× Physualiser relative motion	▲ Physualiser collisions	◆ Physualiser Potential Wells
● ChatGPT newton's laws of motion	× Physualiser newton's laws of motion	▲ Physualiser momentum & impulse	◆ Physualiser Quantum Barriers & Tunnelling
● ChatGPT equilibrium & dynamics	× Physualiser equilibrium & dynamics	▲ Physualiser friction & fluid resistance	◆ Physualiser The Harmonic Oscillator

References

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Further references available in report