Automatic solving of physics word problems

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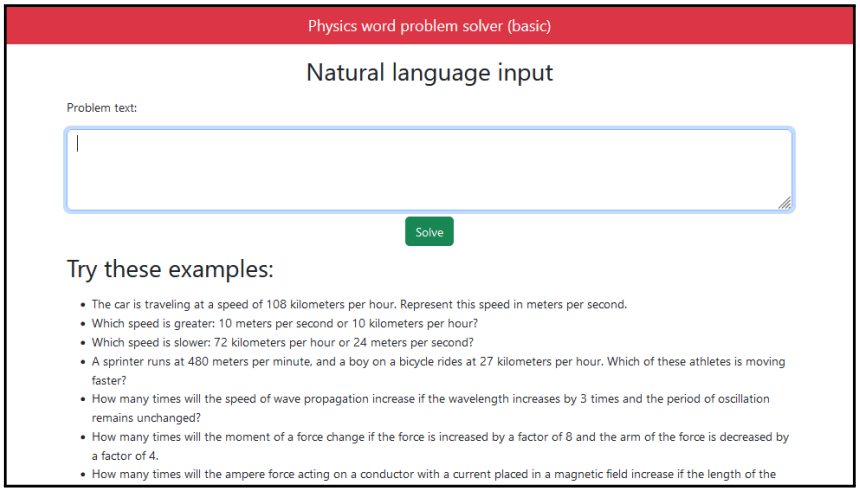
Scientific Basis of the Project

Object: automatic word problem-solving.
Subject: automatic solving of physics word problems.
Methods: developed a program and algorithms to analyze PWPs.

Link: https://inanyan.pythonanywhere.com/.

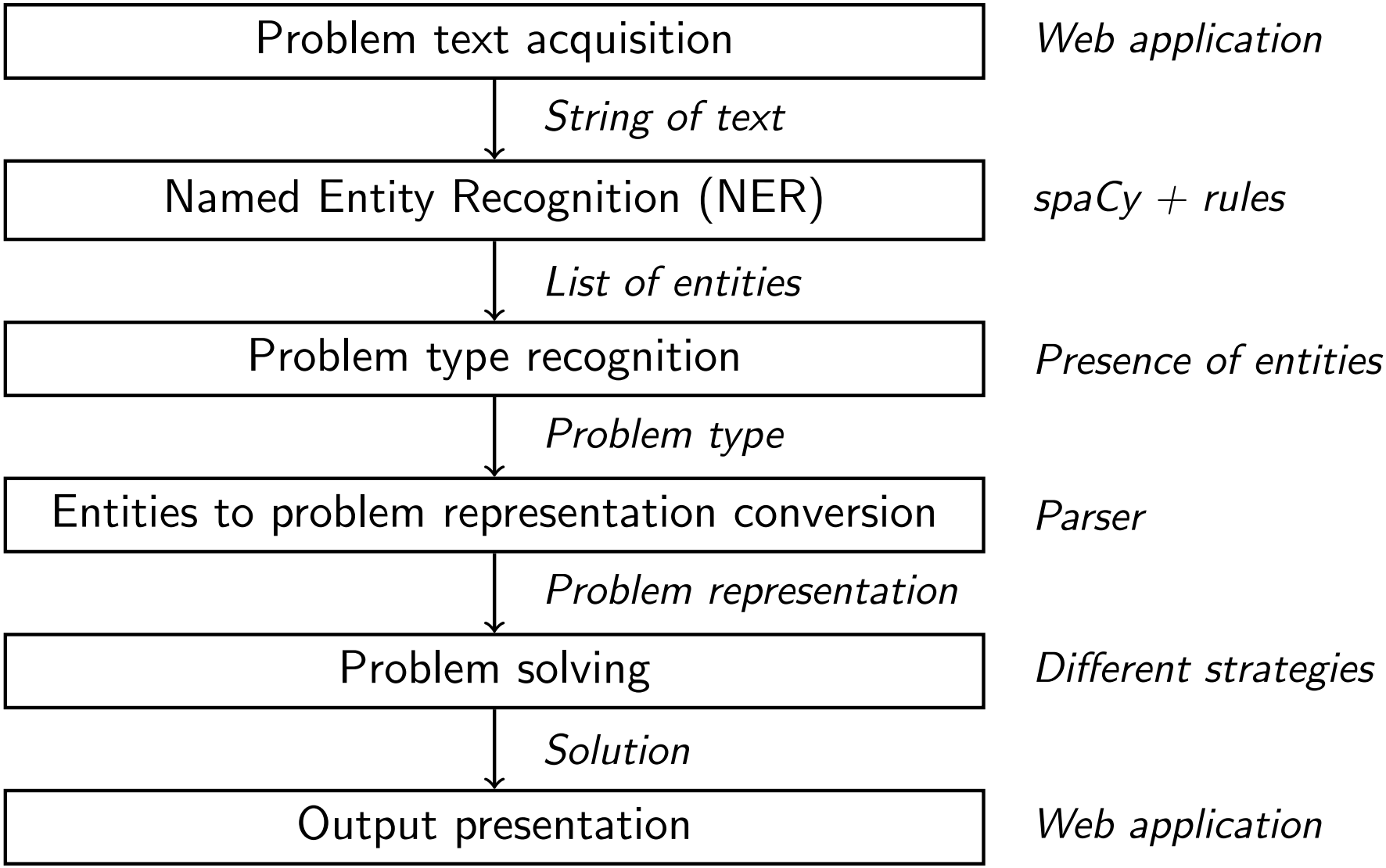
Technological stack:

- Python *(implementation)*
- spaCy *(NLP)*
- SymPy *(math)*
- Django *(web-framework)*
- MathJax *(LaTeX output)*
- Bootstrap CSS *(UI)*



Web-application

Our Algorithm: A Step-by-Step Approach



NER: The Foundation of Our Solution

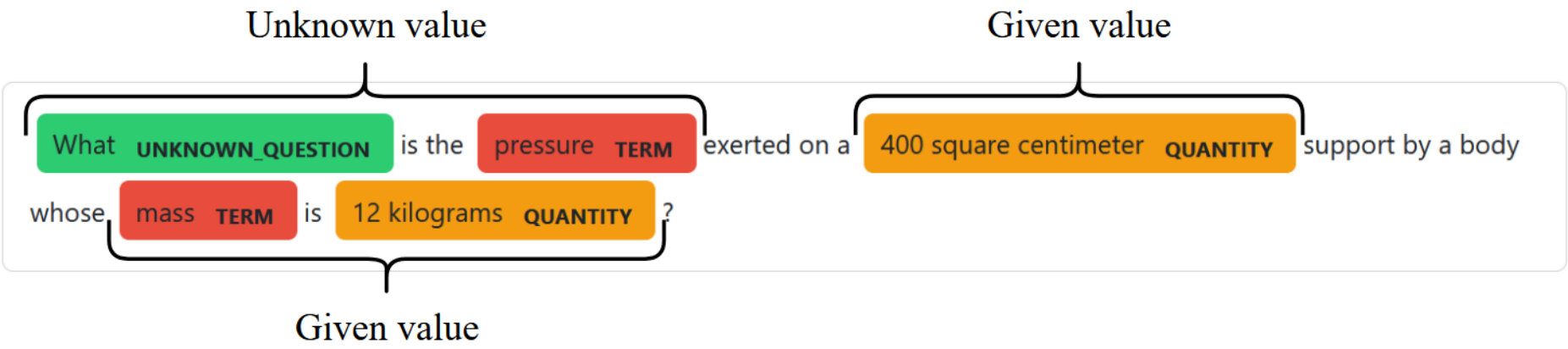
Entity Type	Examples
Units	meters, seconds, kilograms, kilometers per hour, Newtons
Quantities	10 meters, 30 seconds, 60 kilograms, 45 kilometers per hour, 100 Newtons
Terms	velocity, force, acceleration, work, energy, momentum
Question Words	what, determine, find, calculate, how much/many
...	

The car drove for 40 minutes QUANTITY at a speed TERM of 144 kilometers per hour QUANTITY . How far UNKNOWN_HOW_QUESTION did the car travel?

What UNKNOWN_QUESTION is the pressure TERM exerted on a 400 square centimeter QUANTITY support by a body whose mass TERM is 12 kilograms QUANTITY ?

What UNKNOWN_QUESTION is the optical power TERM of a collecting CONTEXT lens with a focal length TERM of 40 centimeters QUANTITY ?

Entity Conversion: Building a Problem Representation



Given values: $S = 400\ cm^2,\ m = 12\ kg$.

Unknown values: $p - ?$.

Finding the Path to the Solution: Student's POV

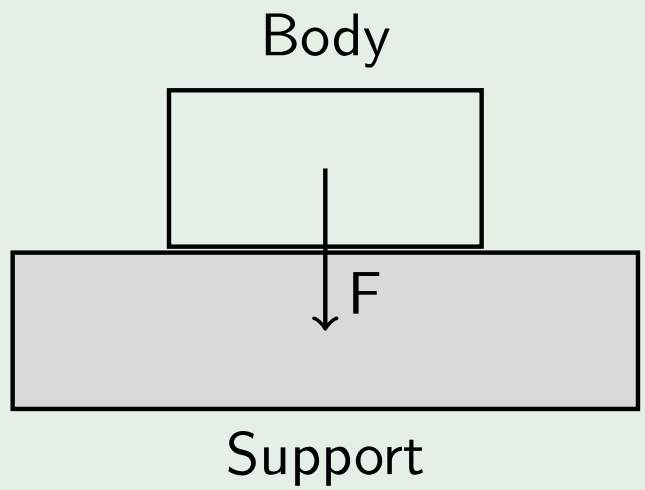
Problem

What is the *pressure* exerted on a **400 square centimeter** support by a body whose *mass* is **12 kilograms**?

Student's thought process

1. I need to find p.
2. Found a formula: $p = \frac{F}{S}$.
3. S is given.
4. F is not a given value.
5. Found a formula: $F = mg$.
6. g is a constant .
7. m is a given value
8. Now, I can apply $F = mg$!
9. Now, I can apply $p = \frac{F}{S}$!
10. Done!

Diagram



The program output

Givens:	Solution:
$S = 400\ cm^2$ $m = 12\ kg$	$F = \frac{9.8m\text{N}}{\text{kg}} = \frac{9.8 \cdot 12.0\text{kgN}}{\text{kg}} = 117.6\ N$ $p = \frac{F}{S} = 117.6\text{N}\left(400.0\text{cm}^2\right)^{-1} = 0.294\ \frac{N}{cm^2}$
$p - ?$	**Answer**: $0.294\ \frac{N}{cm^2}$.

Conclusions

End of the report

Thanks for attention!

Additional information

Source code:

- https://github.com/InAnYan/physics_solver.
- https://github.com/InAnYan/physics_solver_web.

Paper:
https://github.com/InAnYan/papers/blob/main/PhysicsSolver/Paper.pdf.

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