# Optimizing Thermal Fluids: The Role of Machine Learning in Predicting Nanofluid Heat Capacity


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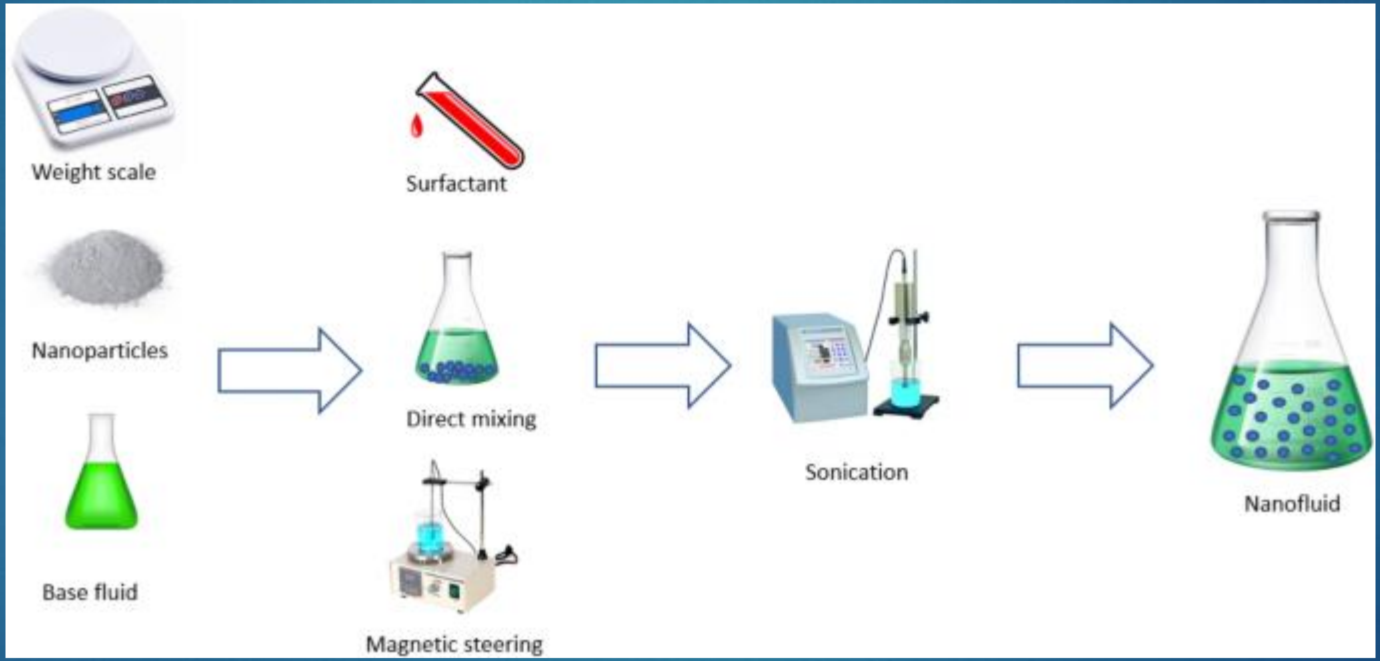
# What are Nanofluids



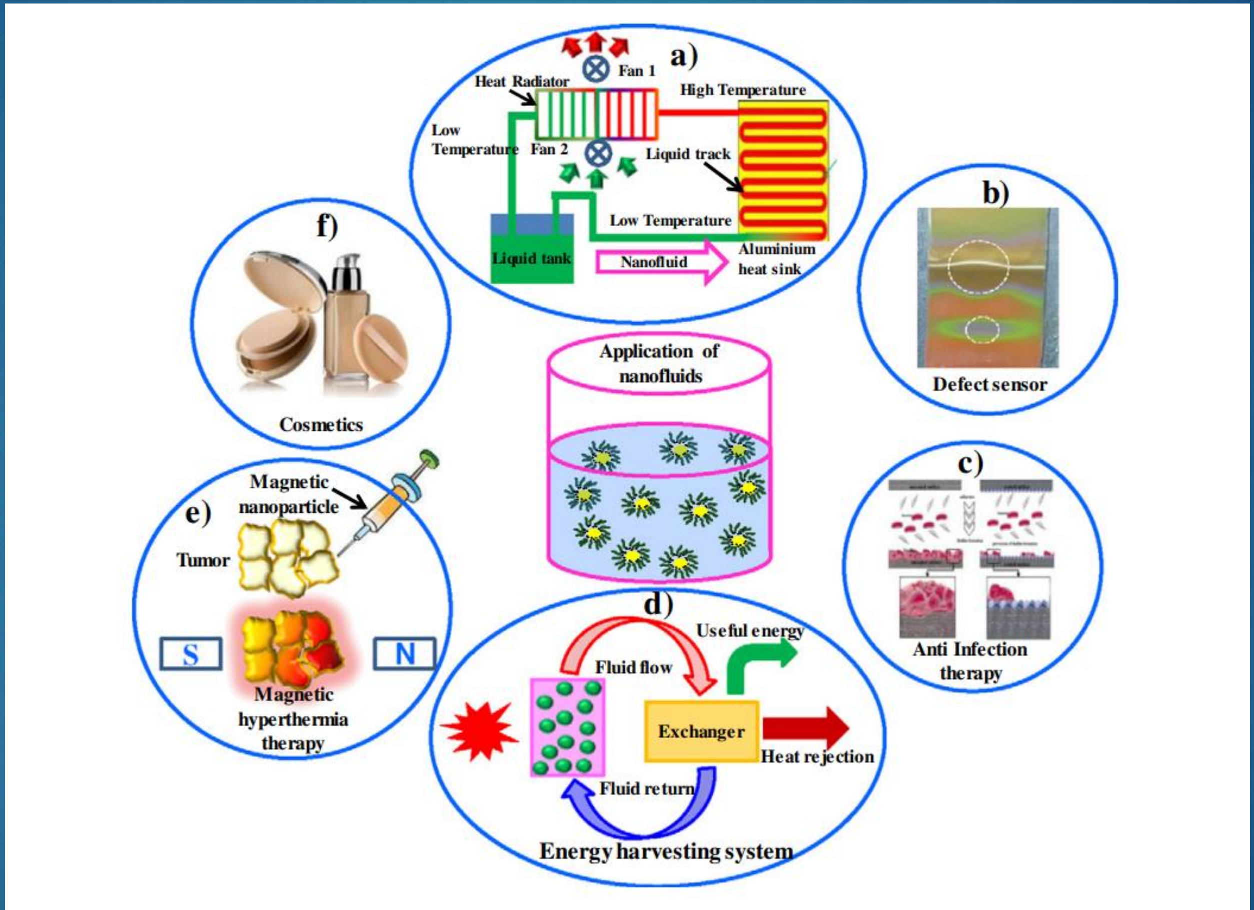
- Suspension of Nanoparticles in Base Fluid




Preparation of Nanofluids [1]

# Use of Nanofluids






Various Applications of Nanofluids [2]

# Coolant Fluids

- Absorb heat
- Protect machineries
- Increase efficiency
- Should have high SHC

# Why Specific Heat Capacity?



- High SHC leads to a more efficient coolant
- Lack of sufficient work on the subject [3,4]
- Receives less attention compared to TC and Viscosity [5-7]

# Nanofluids as Coolants



- Traditional fluids have low thermal conductivity.
- Addition of nanofluid
  - increases thermal conductivity
  - increases SHC and alters other thermophysical properties [8]
- Promising as efficient coolants.

# Objectives



- Aim - to predict SHC of Copper Oxide/Ethylene Glycol nanofluids using Machine Learning techniques
- Comparing Machine Learning models with traditional theoretical models

# Dataset

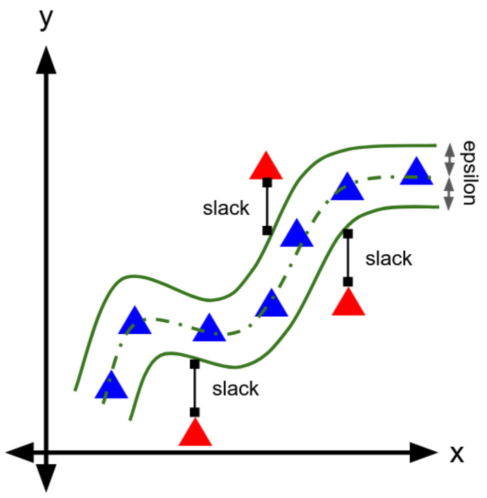
- Experimental data obtained from the work of Barbes et. al. [9] containing 84 data points
- Input Variables  - Temperature, Nanoparticle SHC and Volume Fraction
- Output Variables – Nanofluid SHC

# Methodology

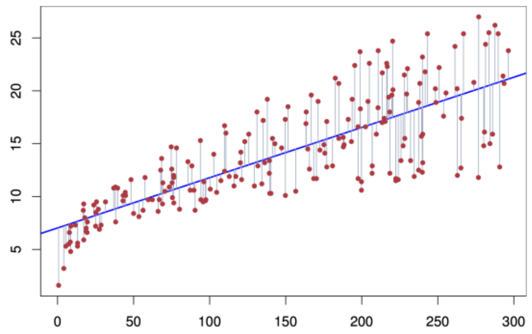


- Data preprocessing
- Using different models to predict the SHC of CuO/EG nanofluids
- ML models fine-tuned using Bayesian Hyperparameter Optimization
- Results compared with theoretical models

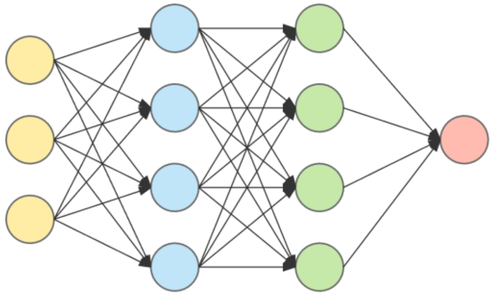
# ML Models Used



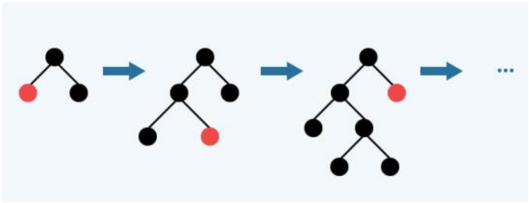

Support Vector Regression (SVR)




Linear Regression (LR)



Artificial Neural Network (ANN)



Gradient Boosting Machine (GBM)

# Theoretical Models



- MODEL 1

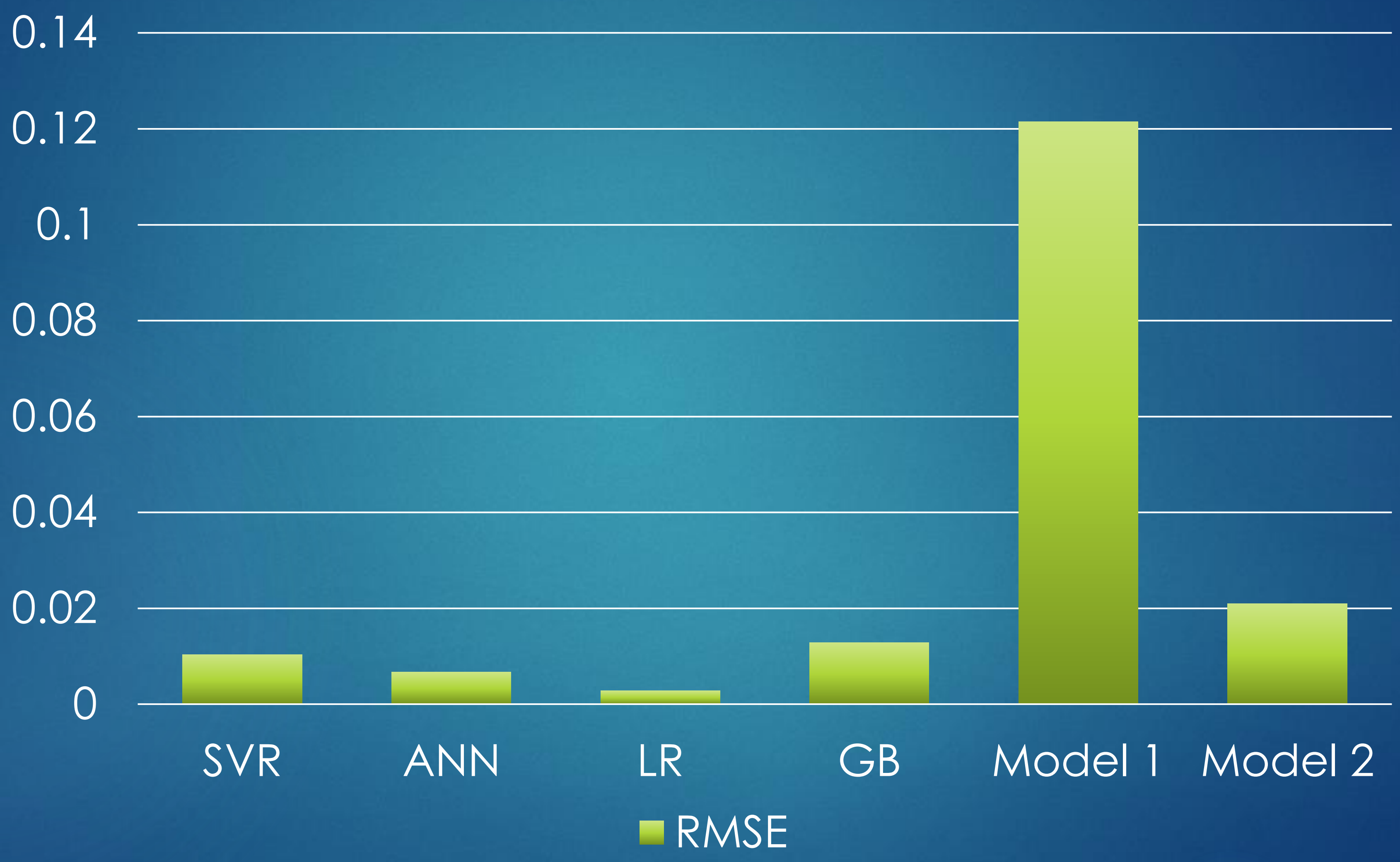
$$c_{p,nf} = \varphi c_{p,n} + (1-\varphi)c_{p,f}.$$

- MODEL 2

$$c_{p,nf} = \frac{\varphi\left(\rho c_p\right)_n + (1-\varphi)\left(\rho c_p\right)_f}{\varphi\rho_n + (1-\varphi)\rho_f}.$$

# Results





# Analysis

- All ML models perform better than theoretical models
- LR best performing among them
- Coefficients of the fitted LR model:

$$C_{p,nf} = a_1 T + a_2 C_{p,n} + a_3 \varphi + b$$

$a1$ = 0.0056, $a2$ = −0.2298, $a3$ = −0.0908 and $b$ = 0.8657

# Conclusion

- ML models are capable of learning to predict the SHC of CuO/EG nanofluids
- Can be generalized using data from different types of nanofluids
- Can  provide fast and accurate calculation of SHC

# References

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# Thank you