## Best bookseller predictor batch: 3 team members: Sahasra:2420030068 yaishaswi:2420030053 disha:2420030065 project title: BEST BOOKSELLER PREDICTOR ABSTRACT: 🔍 What Is the Research About?

The **main goal** of this research is to **predict the critical point** of **real fluids** (specifically isotopes of rubidium, sodium, and cerium: 87^{87}87Rb, 23^{23}23Na, and 133^{133}133Ce).

The **critical point** of a fluid is the temperature, pressure, and density at which the **liquid and gas phases become indistinguishable**. This property is important in industrial applications like supercritical fluid extraction, energy systems, and chemical processing.

**🧪 Methodology**

The researchers used **theoretical models** to predict critical points. The process involved the following:

**1. Imperfect Boson Gas Model**

They start by modeling the fluids as **imperfect boson gases**.

* A **boson gas** refers to a collection of particles (bosons) that obey Bose-Einstein statistics.
* An **imperfect gas** accounts for **interactions between particles**, unlike an ideal gas where no interactions exist.
* Real fluids are **not ideal**, so this model is more realistic.

**2. Virial Expansion**

They apply a **Perturbed Virial Expansion (PVE)** to describe the thermodynamic properties of the system.

* The **virial expansion** is a series that expresses the pressure of a gas in terms of powers of the density:

PkT=ρ+B2(T)ρ2+B3(T)ρ3+⋯\frac{P}{kT} = \rho + B\_2(T)\rho^2 + B\_3(T)\rho^3 + \cdotskTP​=ρ+B2​(T)ρ2+B3​(T)ρ3+⋯

Where:

* + PPP: Pressure
  + TTT: Temperature
  + ρ\rhoρ: Density
  + Bn(T)B\_n(T)Bn​(T): Virial coefficients (depend on temperature and interactions)
* **PVE** introduces corrections by using **reference fluids**.

**3. Virial Coefficients Calculated Analytically**

They calculate the virial coefficients **up to fourth order** (B4B\_4B4​) **analytically**, which means using mathematical derivation instead of just fitting to data.

* Higher-order virial coefficients allow for a more accurate representation of real gas behavior, especially near the critical point.

**4. Reference Fluids Used**

To improve the virial expansion predictions, two types of reference fluids were used:

1. **Percus–Yevick (PY)** – A model useful for hard-sphere fluids.
2. **Carnahan–Starling (CS)** – A more accurate model for hard-sphere interactions than PY.

These references serve as **starting points**, and the PVE corrects their behavior to better represent the real fluid.

**📈 Prediction of Critical Points**

Using the model and virial coefficients, the authors calculate:

* **Critical Temperature (TcT\_cTc​)**
* **Critical Pressure (PcP\_cPc​)**
* **Critical Density (ρc\rho\_cρc​)**

They compute these for:

* 87^{87}87Rb (Rubidium-87)
* 23^{23}23Na (Sodium-23)
* 133^{133}133Ce (Cerium-133)

They do this using:

* Second, third, and fourth-order virial expansions
* Both PY and CS as reference fluids

**📊 Results and Accuracy**

The results are compared with **experimental or available data**. Key findings:

* The **accuracy depends on**:
  + The **reference fluid** used
  + The **order of the virial expansion**
* Best accuracy is achieved using:
  + **Fourth-order** virial coefficients
  + **Carnahan–Starling (CS)** reference fluid

**Reported Errors:**

* **Best critical temperature**:
  + 87^{87}87Rb and 23^{23}23Na → 1% error
* **Best critical pressure**:
  + 133^{133}133Ce → 1% error
* **Best critical density**:
  + 23^{23}23Na → 1.4% error

These are **very small errors**, indicating the model is highly accurate for these cases.

**🧠 Summary of the Study’s Importance**

This research is valuable because:

* It provides a **mathematical model** to predict critical points with **high accuracy**.
* It demonstrates that **PVE with CS reference fluid** and **higher-order coefficients** gives the best results.
* It shows that **bosonic models** can be useful for describing real fluids in some conditions.

**🚀 Potential Applications**

* **Industrial design** of processes involving supercritical fluids
* **Material science** and **quantum gas studies**
* Understanding **fluid behavior under extreme conditions**