

Mock Data generation  
Synthetic

تولید داده‌های تصنعی

① Motivations → (A) Ensemble average  
متوسطگیری چندگانه

$$\langle f \rangle_{ens}$$

(B) Simulation      شبیه‌سازی  
↓

observable collection

جمع‌آوری مشاهده‌پذیرها

(C) Forecast      پیش‌بینی

② Data generation



Notes: Effective Theory      نظریه مؤثر

Ex1: Langevin Equation       $\dot{v} = -\gamma v + \eta(t)$

# Ex2: Landau-Ginzburg-Wilson theory.

For a Magnetization system (Ferromagnetism)

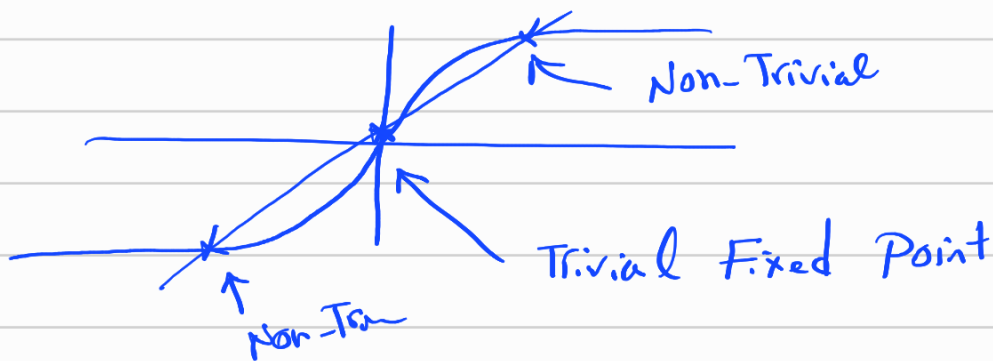
$$\mathcal{H} = -J \sum_i \vec{m}_i \cdot \vec{m}_j - \vec{B}_{\text{ext}} \cdot \sum_i \vec{m}_i$$

$J > 0 \rightarrow$  Ferromagnetism  $\uparrow \uparrow \uparrow \uparrow \uparrow \uparrow$

$J < 0 \rightarrow$  Anti Ferromagnetism  $\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow$

$B_{\text{ext}} = 0$

$$M = |\sum \vec{m}_i| = \tanh(\alpha M)$$



$$\mathcal{H} = \int d^3r \left[ a_1 (\vec{\nabla} m)^2 + a_2 m^2 + a_3 m^3 + a_4 m^4 - B_{\text{ext}} m \dots \right]$$

$$\mathcal{Z} = \text{Tr} \left( e^{-\beta \mathcal{H}} \right) = \int \frac{d\varphi d\psi}{(2\pi)^N} e^{-\beta \mathcal{H}} = \int d\Gamma e^{-\beta \mathcal{H}(\Gamma)}$$

$$= \sum_{\{m_i, \tau\}} e^{-\beta \mathcal{H}(\{m\})}$$

$$F = -k_B T \ln Z$$

تباين برمودا

↓  
Helmholtz free Energy

$$M = \left. \frac{\partial F}{\partial B_{ext}} \right|_{B_{ext}}$$

$$\chi = \left. \frac{\partial M}{\partial B_{ext}} \right|_{B=0}$$

### ③ Ex 1: Computer Random Generator

R = Call Random Number - Vanilla model.

Some Properties

$$P(R(t)) = cts$$

$$\{R(t_1), R(t_2), R(t_3), \dots, R(t_n)\}$$

$$R \in (0, 1)$$

↑  
گيرت هدهه يذو نوعي

$$C_R(\tau) = \langle R(t) R(t+\tau) \rangle = \delta_D(\tau)$$

← Weighted TPCF

Stationarity

تباين

~~Static~~

## Ex 2: Data Generation with given PDF

☆ Box-Muller

☆ PDF-Transformation  $\{\xi\} \rightarrow P(\xi) \checkmark$

$\downarrow$

$\{\eta\} \rightarrow P(\eta) \checkmark$

?

$\eta \stackrel{!}{=} g(\xi) = ?$

$$\int_{-\infty}^{\xi} d\xi' P(\xi') = \int_{-\infty}^{\eta} d\eta' P(\eta')$$

☆ Von-Neumann method

Metropolis "  $\leftarrow$

$$C_{\eta}(\tau) = \langle \eta(t) \eta(t+\tau) \rangle \propto \delta_{\eta}(\tau)$$

$$P(\eta(t)) = \text{given}$$

Ex 3: