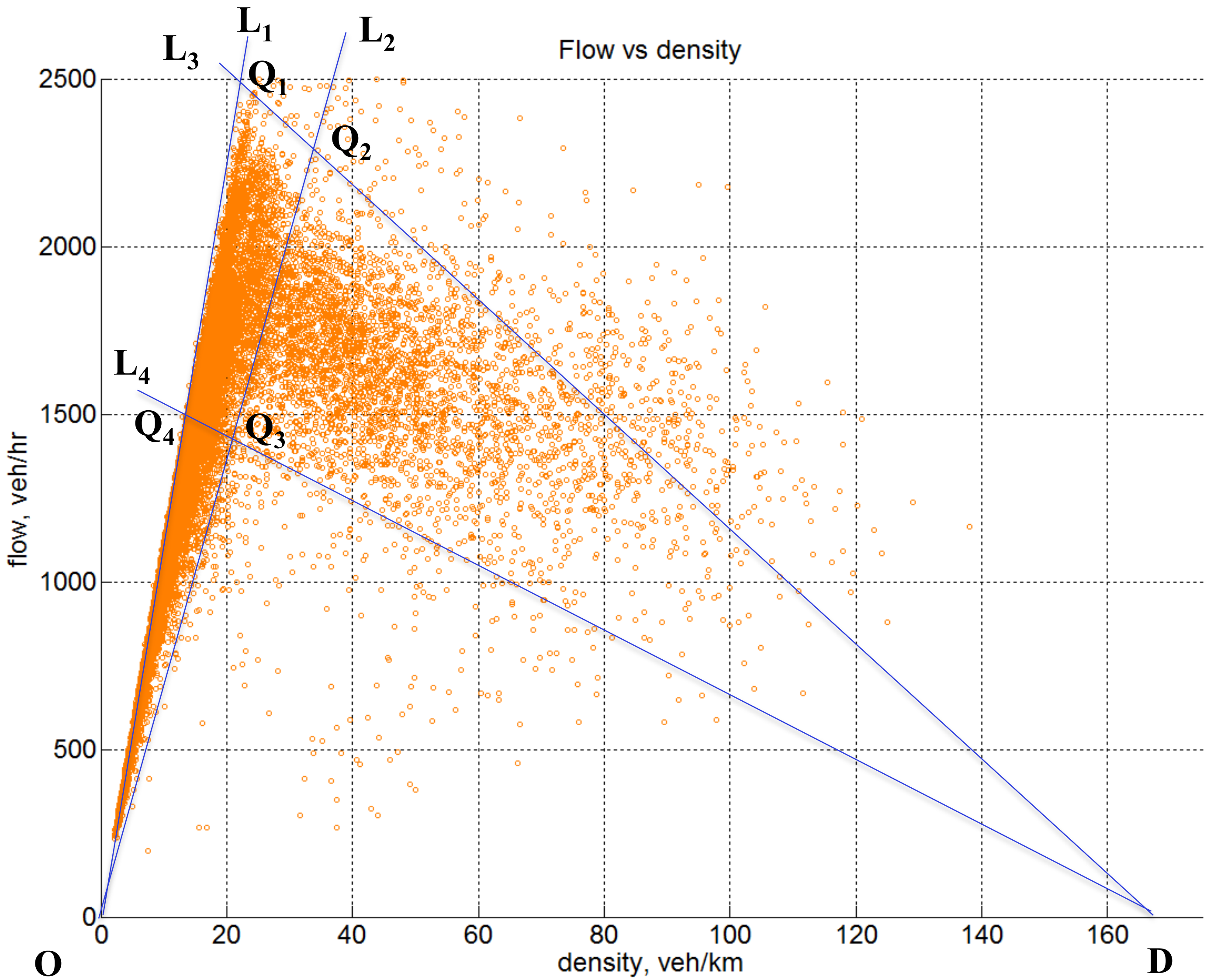
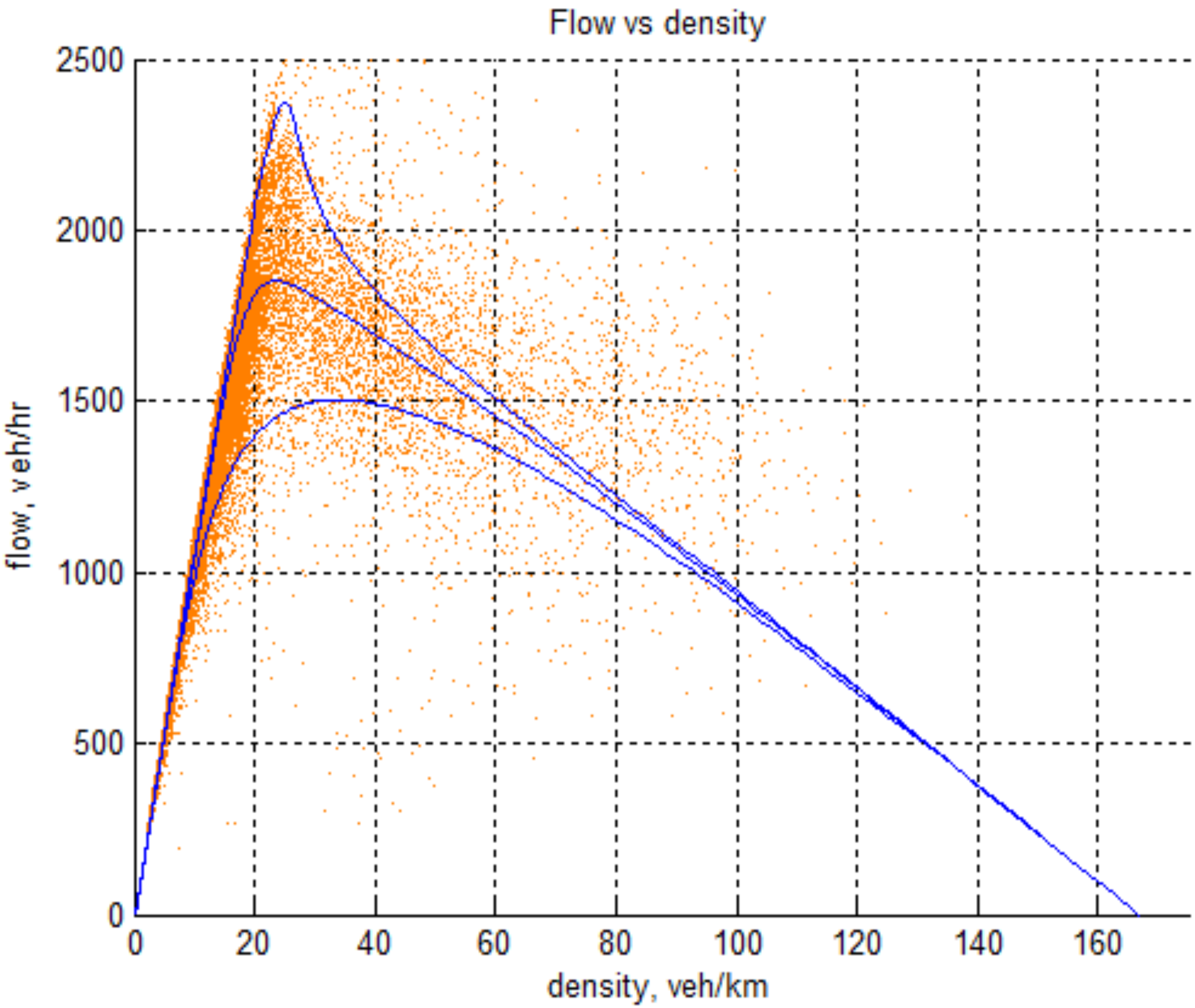
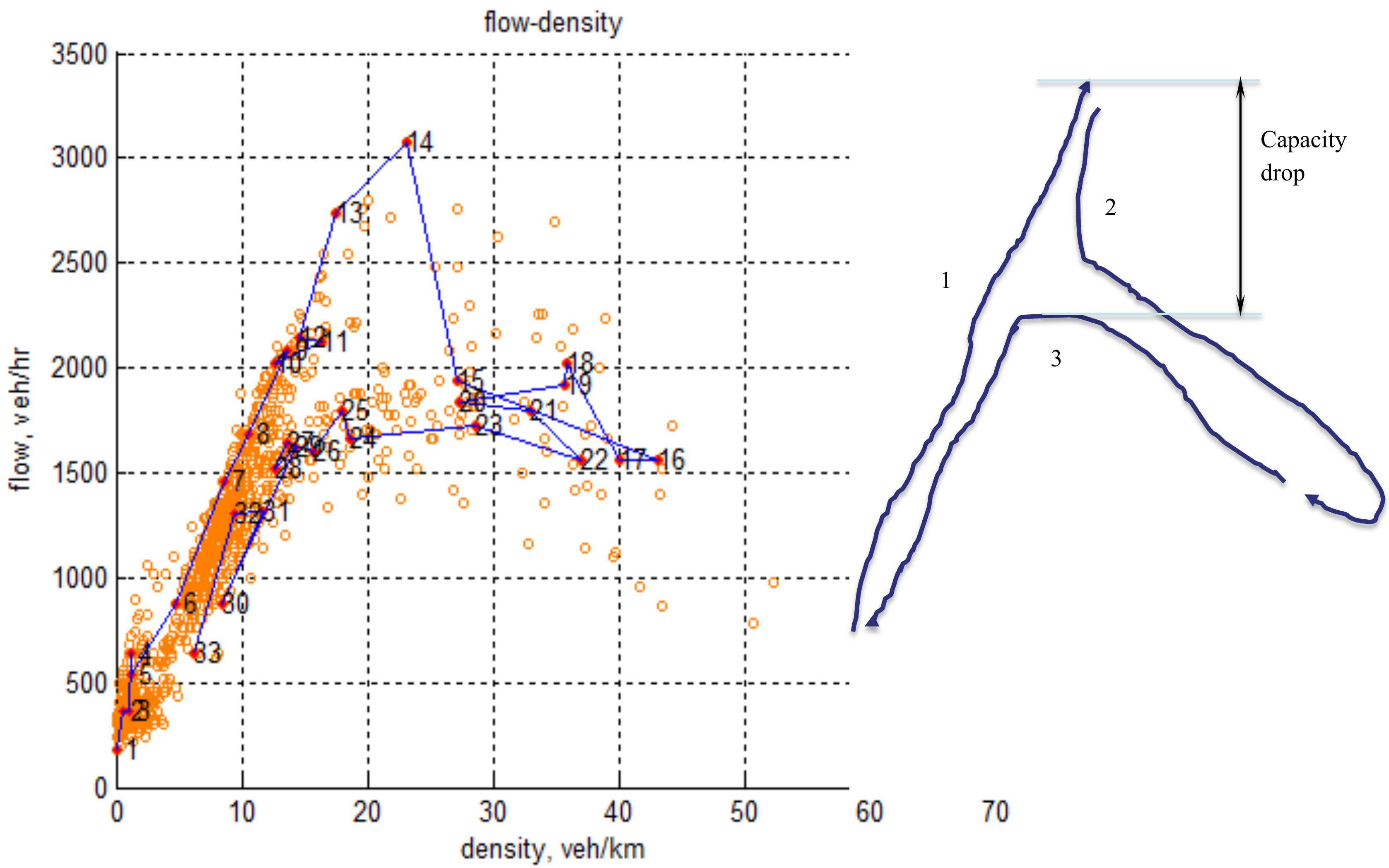
Three Influence Regions



Three Types of q-k Curves



Capacity Drop

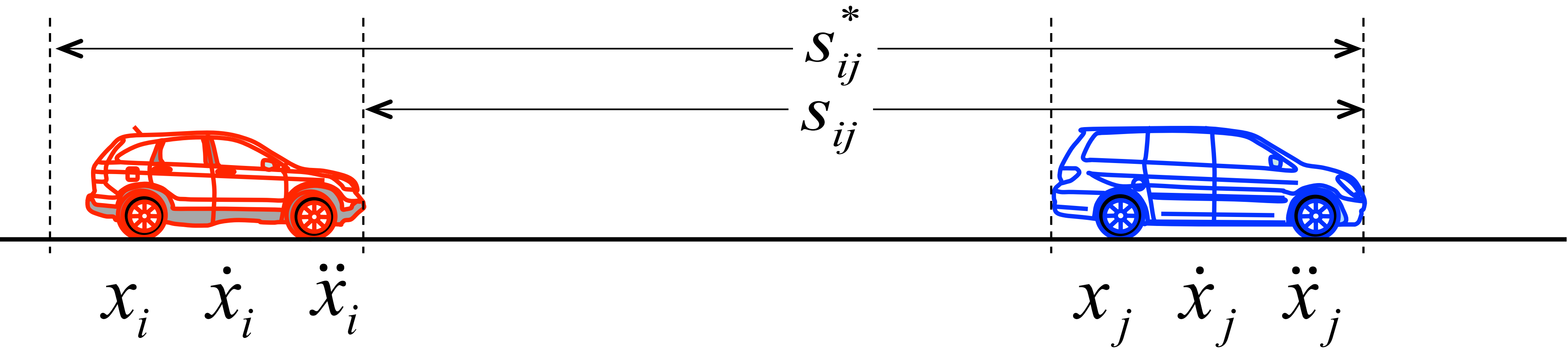


Acting Factors Behind?

Microscopic View

Good Driving Rule (GDR) $$s^*_{ij} = \tau_i \dot{x}_i + l_j$$

Safe Driving Rule (SDR) $$s^*_{ij} = \frac{\dot{x}_i^2}{2b_i} - \frac{\dot{x}_j^2}{2B_j} + \tau_i \dot{x}_i + l_j$$



SDR can be Aggressive

SDR

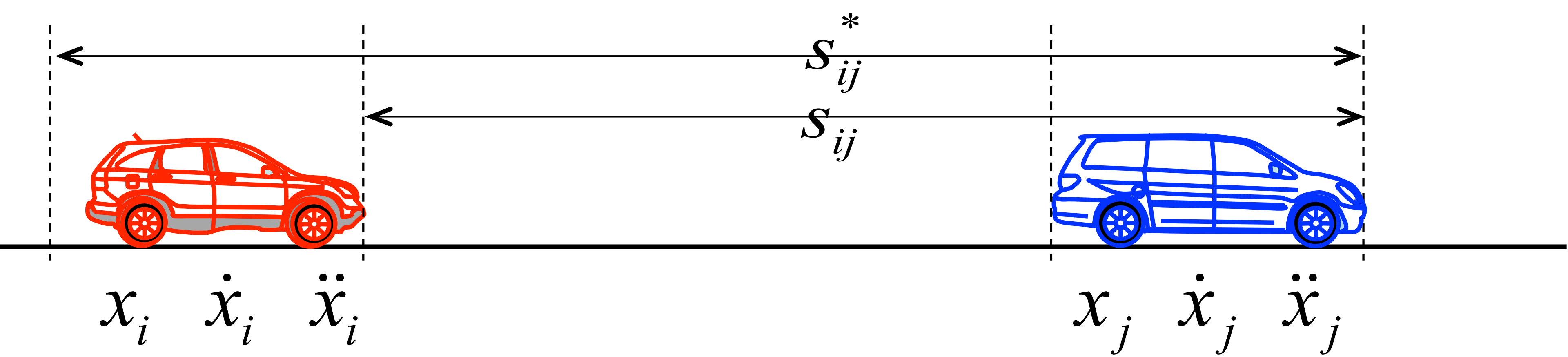
$$s_{ij}^* = \frac{\dot{x}_i^2}{2b_i} - \frac{\dot{x}_j^2}{2B_j} + \tau_i \dot{x}_i + l_j$$

$$s_{ij}^* = \gamma_i \dot{x}_i^2 + \tau_i \dot{x}_i + l_j$$

$$\gamma_i = \frac{1}{2}\left(\frac{1}{b_i} - \frac{1}{B_j}\right)$$

Aggressiveness

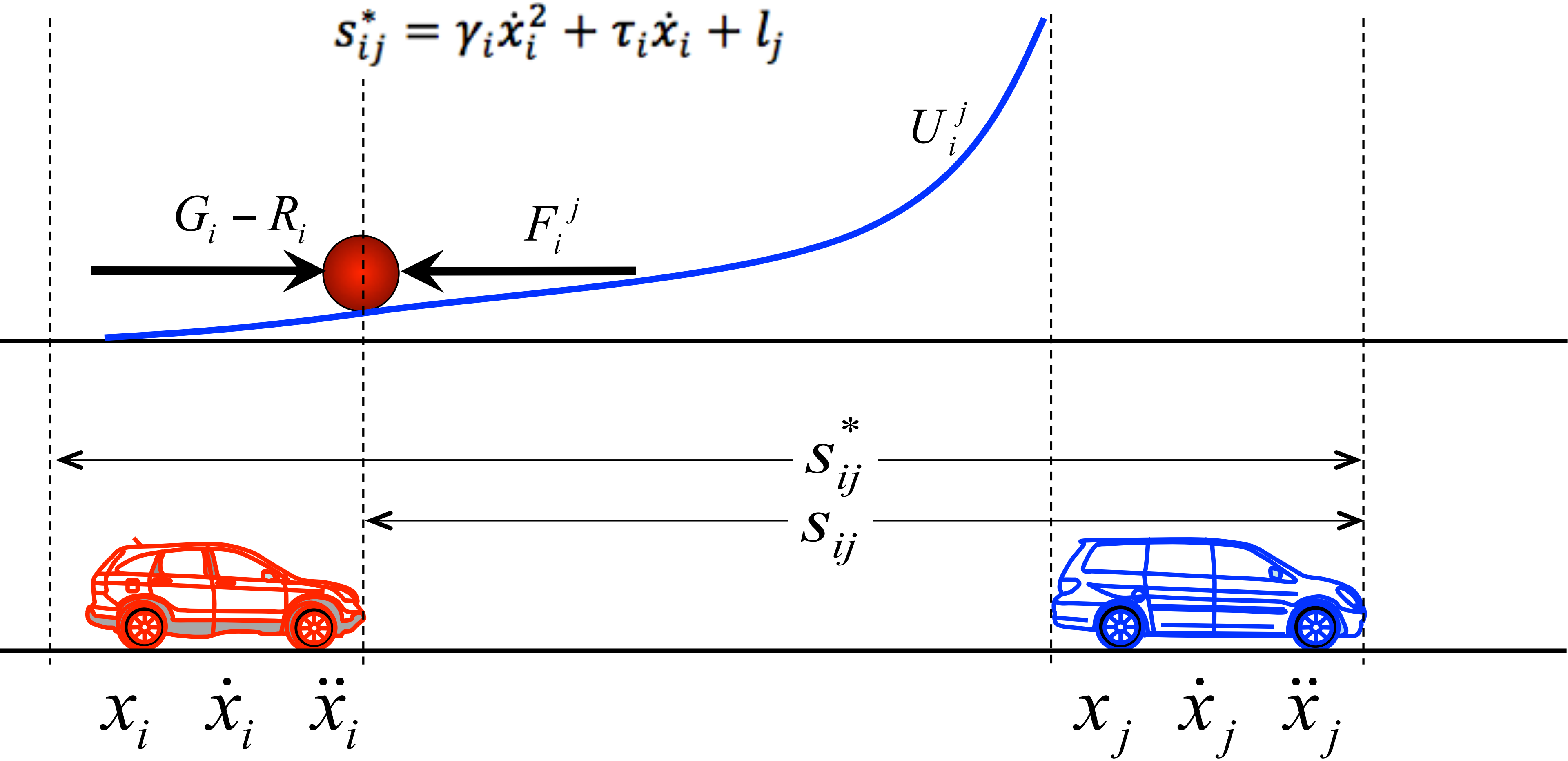
$\gamma_i > 0$	Safe Driving Rule
$\gamma_i = 0$	Good Driving Rule
$\gamma_i < 0$	Aggressive Driving Rule



Longitudinal Control Model

LCM $$\ddot{x}_i(t+\tau_i) = A_i\left[1 - \left(\frac{\dot{x}_i}{v_i}\right) - e^{1-\frac{s_{ij}}{s_{ij}^*}}\right]$$

$$s_{ij}^* = \gamma_i \dot{x}_i^2 + \tau_i \dot{x}_i + l_j$$



Acting Factors Behind?

Macroscopic View

Good Driving Rule (GDR)

$$q = \frac{1}{\tau} - \frac{l}{\tau} k$$

Safe Driving Rule (SDR)

$$q = kv \text{ and } k = \frac{1}{\gamma v^2 + \tau v + l}$$

Longitudinal Control Model (LCM)

$$q = kv \text{ and}$$

$$k = \frac{1}{(\gamma v^2 + \tau v + l)[1 - \ln\left(1 - \frac{v}{v_f}\right)]}$$

Influencing Human Factors

- **Microscopic**
  - Desired speed v_i
  - Effective length l_j
  - Response time τ_i
  - Aggressiveness γ_i
- **Macroscopic**
  - Free-flow speed v_f
  - Average length l
  - Response time τ
  - Aggressiveness γ

$$s_{ij}^* = \tau_i \dot{x}_i + l_j$$

$$s_{ij}^* = \gamma_i \dot{x}_i^2 + \tau_i \dot{x}_i + l_j$$

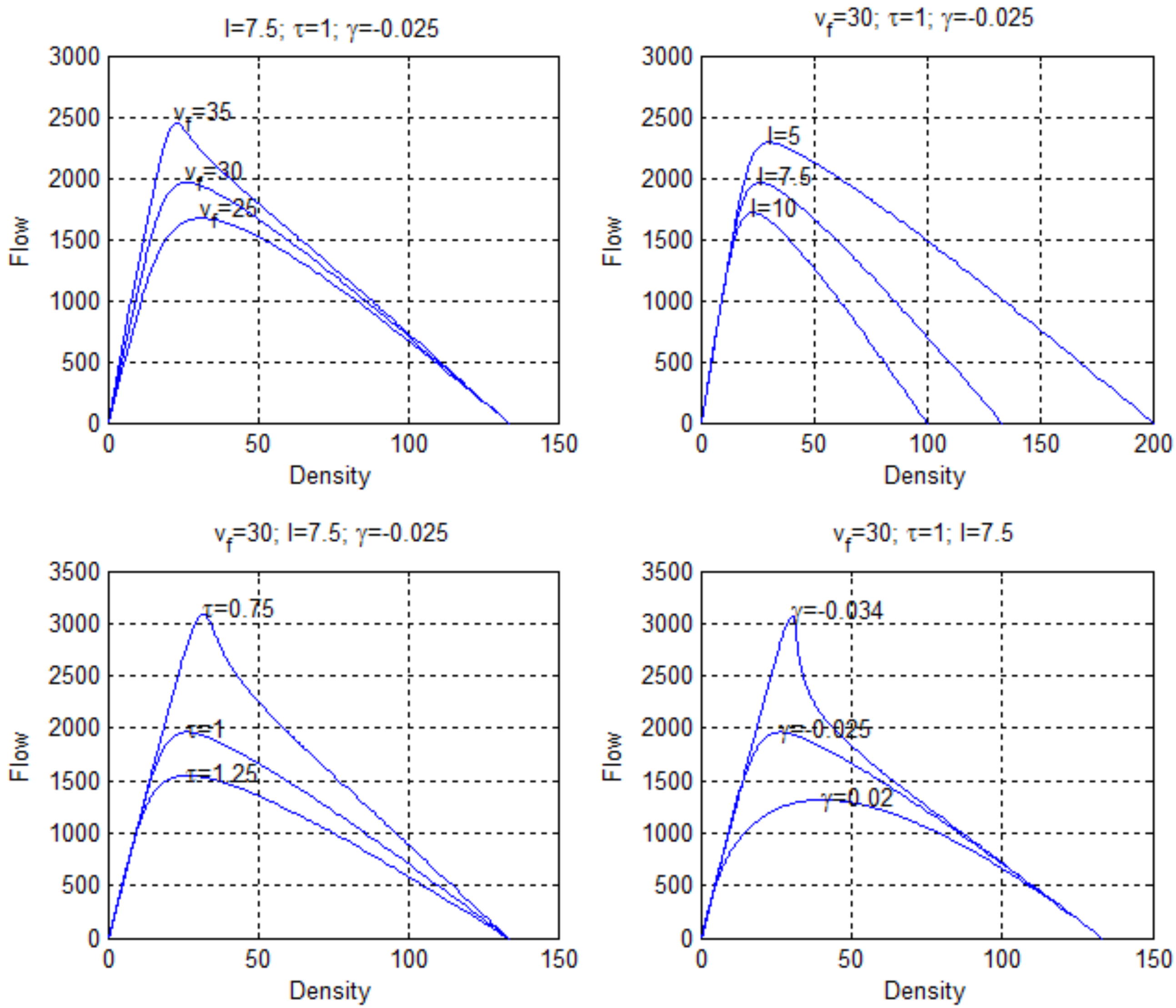
$$\ddot{x}_i(t+\tau_i) = A_i \left[1 - \left(\frac{\dot{x}_i}{v_i} \right) - e^{1 - \frac{s_{ij}}{s_{ij}^*}} \right]$$

$$q = \frac{1}{\tau} - \frac{l}{\tau} k$$

$$k = \frac{1}{\gamma v^2 + \tau v + l}$$

$$k = \frac{1}{(\gamma v^2 + \tau v + l)[1 - \ln\left(1 - \frac{v}{v_f}\right)]}$$

Influencing Human Factors



Capacity Condition

- **SDR**

$$\dot{x}_i = v_i \text{ when } s_{ij} > s_{ij}^* = \gamma_i \dot{x}_i^2 + \tau_i \dot{x}_i + l_j$$

$$q_m = \frac{1}{2\sqrt{\gamma l} + \tau} \qquad v_m = \sqrt{\frac{\gamma}{l}} \qquad k_m = \frac{l}{\gamma^2 + +\tau\sqrt{\gamma l} + l^2}$$

- **GDR**

$$\dot{x}_i = v_i \text{ when } s_{ij} > s_{ij}^* = \qquad \tau_i \dot{x}_i + l_j$$

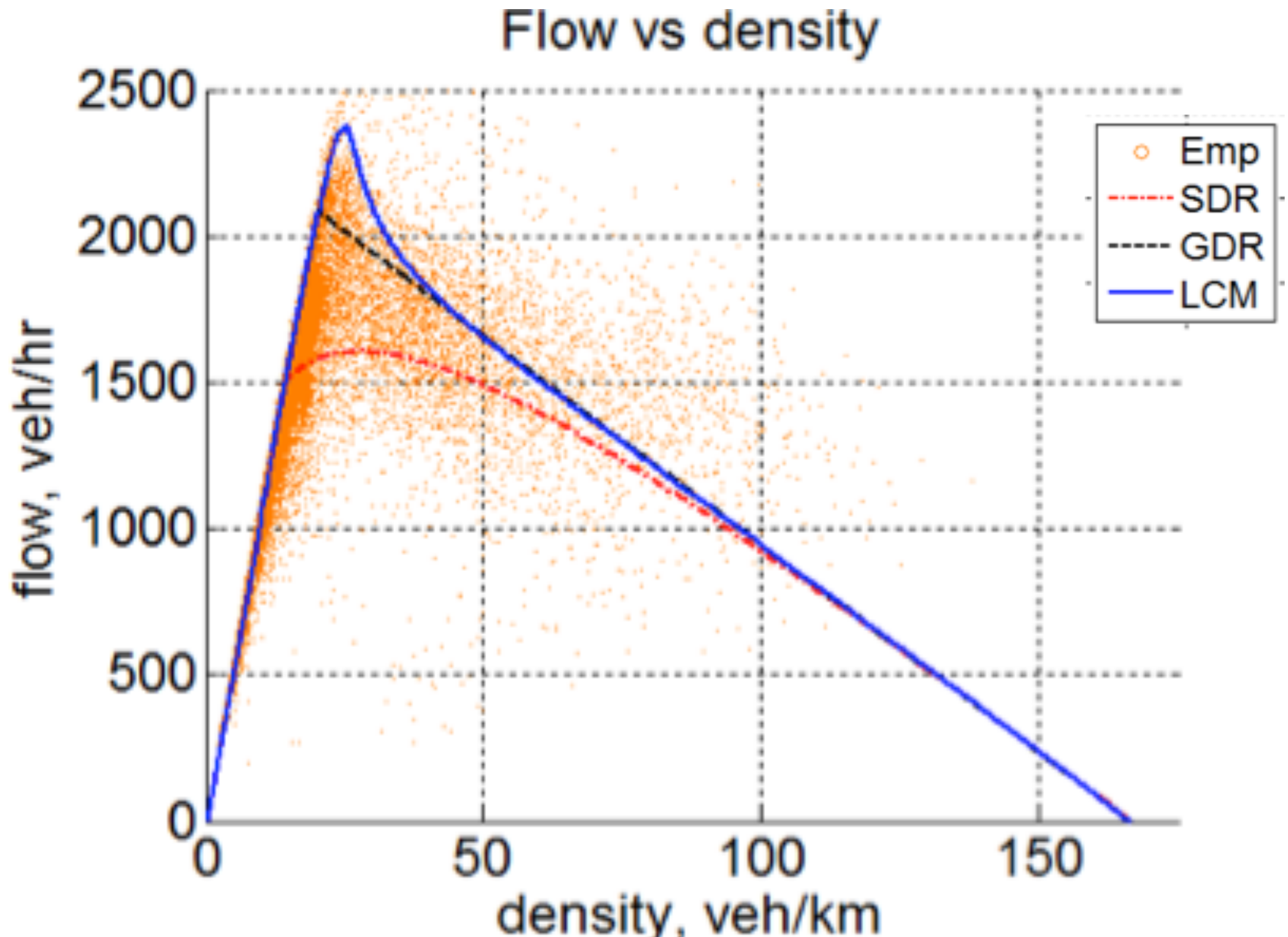
$$q_m = \frac{v_f}{\tau v_f + l} \qquad v_m = v_f \qquad k_m = \frac{1}{\tau v_f + l}$$

- **LCM**

$$\dot{x}_i = v_i \left(1 - e^{1 - \frac{s_{ij}}{s_{ij}^*}}\right) \text{ for all } s_{ij} \text{ where } \dot{x}_i \sim v_i \text{ when } s_{ij} > s_{ij}^*$$

LCM does not yield a closed form of capacity, but can be solved numerically

Capacity Drop



Backward Wave Speed

- **SDR** $$\omega_j = \frac{dq}{dk}\bigg|_{k=k_j} = \left(v - \frac{\gamma v^2 + \tau v + l}{2\gamma v + \tau}\right)_{v=0} = -\frac{l}{\tau}$$

- **GDR** $$\omega_j = \frac{dq}{dk}\bigg|_{k=k_j} = -\frac{l}{\tau}$$

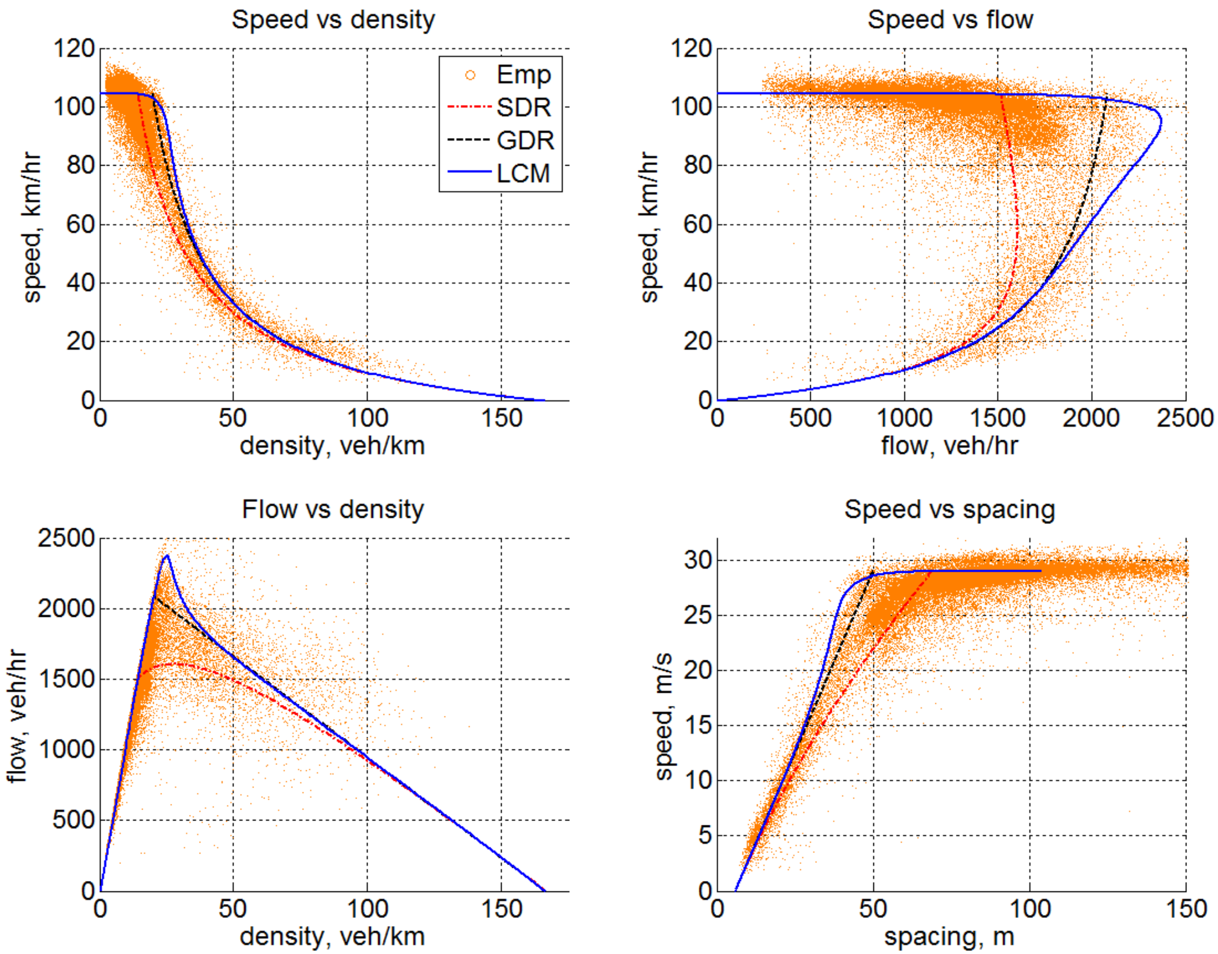
- **LCM** $$\omega_j = \frac{dq}{dk}\bigg|_{k=k_j} = -\frac{l}{\tau + l/v_f}$$

Influencing Human Factors

Human Factor Parameters		v_i	l_i	τ_i	γ_i
Free-flow speed	v_f	Y	N	N	N
Capacity – magnitude	q_m	N Y Y	Y	Y	Y N Y
Capacity – location	k_m	N Y Y	Y	Y	Y N Y
Capacity – transition		N N Y	N	N N Y	Y
Capacity – drop		N N Y	N	N N Y	N N Y
Backward wave speed at jam	ω_j	N	Y	Y	N
Jam density	k_j	N	Y	N	N

Note: Y – has influence; N – no influence. Single letter denotes that the same comment applies to the three models. Three letters (e.g., N N Y) means the comments of SDR, GDR, and LCM, respectively.

What Do Data Say?



Model	v_f (m/s)	τ (s)	l (m)	γ (s^2/m)
Safe driving rule	29	1.5	6	0.023
Good driving rule	29	1.5	6	0
LCM	29	1.3	6	-0.041

Questions? Comments?

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