

## ECS165A HW 1

**1a**

$$\text{Ans}(\text{model}) := \Pi_{\text{model}}(\sigma_{\text{city} < 50}(\text{Car}))$$

**1b**

$$\text{Ans}(\text{model}) := \Pi_{\text{model}}(\sigma_{\text{towing} > 12500 \text{ AND } \text{highway} < 20}(\text{Pickup}))$$

**1c**

$m1(\text{maker}) := \Pi_{maker}(\sigma_{msrp < 25000}(Product \bowtie Car))$

$m2(\text{maker}) := \Pi_{maker}(\sigma_{msrp > 60000}(Product \bowtie Car))$

$Ans(\text{maker}) := m1 \cap m2$

**1d**

$$v1 = \Pi_{model,msrp}(Car) \cup \Pi_{model,msrp}(Pickup) \cup \Pi_{model,msrp}(EV)$$

$$v2 = v1$$

$$Ans(msrp) := \Pi_{msrp}(\sigma_{v1.model \neq v2.model \text{ AND } v1.msrp = v2.msrp}(v1 \times v2))$$

**1e**

$v1(model, city, highway) := \Pi_{model, city, highway}(Car) \cup \Pi_{model, city, highway}(Pickup)$   
 $v2(model, city, highway) := v1$   
 $m(model) := \Pi_{model}(\sigma_{v1.city*.55+v1.highway*.45 > v2.city*.55+v2.highway*.45}(v1 \times v2))$   
 $Ans(maker) := \Pi_{maker}(Product \times m)$

**1f**

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v1(model,city,highway) :=  $\Pi_{model,city,highway}(Car) \cup \Pi_{model,city,highway}(Pickup)$ 
v2(model,city,highway) := v1
r1(model,city,highway) :=  $\sigma_{v1.city*.55+v1.highway*.45 > v2.city*.55+v2.highway*.45}(v1 \times v2)$ 
ev1(model,range,battery) :=  $\Pi_{model,range,battery}(EV)$ 
ev2(model,range,battery) := ev1
r2(model,range,battery) :=  $\sigma_{ev1.range/(ev1.battery/33.1) > ev2.range/(ev2.battery/33.1)}(ev1 \times ev2)$ 
compare1(model) :=  $\Pi_{r1.model}(\sigma_{r1.city*.55+r1.highway > r1.range/(r2.battery/33.1)}(r1 \times r2))$ 
compare2(model) :=  $\Pi_{r1.model}(\sigma_{r1.city*.55+r1.highway = r1.range/(r2.battery/33.1)}(r1 \times r2))$ 
compare3(model) :=  $\Pi_{r2.model}(\sigma_{r1.city*.55+r1.highway < r1.range/(r2.battery/33.1)}(r1 \times r2))$ 
Ans(model) := compare1  $\cup$  compare2  $\cup$  compare3
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**1g**

$c(\text{model}) := \Pi_{\text{model}}(\sigma_{\text{city} < 15}(\text{Car}))$   
 $\text{opt1}(\text{maker}) := \Pi_{\text{maker}}(\text{Product} \bowtie c)$   
 $\text{opt2}(\text{mkaer}) := \Pi_{\text{maker}}(\text{Product} \bowtie \text{EV})$   
 $\text{Ans}(\text{maker}) := \text{opt1} \cap \text{opt2}$

**1h**

$\text{join1}(\text{maker}, \text{model}, \text{volume}) := \Pi_{\text{maker}, \text{model}, \text{trunk}}(\text{Product} \bowtie \Pi_{\text{model}, \text{trunk}}(\text{Car}))$   
 $\text{join2}(\text{maker}, \text{model}, \text{volume}) := \Pi_{\text{maker}, \text{model}, \text{trunk}}(\text{Product} \bowtie \Pi_{\text{model}, \text{cargo}}(\text{Pickup}))$   
 $\text{together}(\text{maker}, \text{model}, \text{volume}) := \text{join1} \cup \text{join2}$   
 $t1(\text{maker}, \text{model}, \text{volume}) := \text{together}$   
 $t2(\text{maker}, \text{model}, \text{volume}) := \text{together}$   
 $t3(\text{maker}, \text{model}, \text{volume}) := \text{together}$   
 $\text{Ans}(\text{maker}) := \Pi_{\text{maker}}(\sigma_{t1.\text{maker}=t2.\text{maker}=t3.\text{maker} \text{ AND } t1.\text{volume} \neq t2.\text{volume} \neq t3.\text{volume}}(t1 \times t2 \times t3))$



**2a**

$$\sigma_{towing < 12000 \text{ AND } msrp > 25000}(Pickup) = \emptyset$$

**2b**

$$\sigma_{range < 105}(EV) = \emptyset$$

**2c**

$$\sigma_{city \geq 50 \text{ AND } highway < 40 \text{ AND } msrp \geq 20000}(Car) = \emptyset$$

**2d**

$$m1(\text{maker}) := \Pi_{maker}(Product \bowtie Pickup)$$

$$m2(\text{maker}) := \Pi_{maker}(Product \bowtie EV)$$

$$m1 \cap m2 = \emptyset$$

**2e**

$m1(\text{maker}, \text{year}) := \Pi_{\text{maker}, \text{year}}(\text{Product})$

$m2(\text{maker}, \text{year}) := m1$

$\sigma_{m1.\text{maker}=m2.\text{maker} \text{ AND } m1.\text{year}=m2.\text{year}}(m1 \times m2) = \emptyset$

**2f**

$$m1(\text{maker}, \text{highway}) := \Pi_{\text{maker}, \text{highway}}(\text{Product} \times \text{Car})$$

$$m2(\text{maker}, \text{highway}) := \Pi_{\text{maker}, \text{highway}}(\text{Product} \times \text{Pickup})$$

$$\sigma_{m1.\text{maker}=m2.\text{maker} \text{ AND } m1.\text{highway} \leq m2.\text{highway}}(m1 \times m2) = \emptyset$$

**2g**

$p := \Pi_{city,msrp}(Pickup)$

$c := \Pi_{city,msrp}(Car)$

$\sigma_{p.city > c.city \text{ AND } (p.msrp - c.msrp) / (c.msrp) < 0.75}(p \times c) = \emptyset$

**3a**

ID  $\rightarrow$  Px Py Pz Vx Vy Vz

Px Py Pz  $\rightarrow$  ID Vx Vy Vz



**3b**

$\{P_x, P_y, P_z\}$ ,  $\{ID\}$  are the 2 keys

**3c**

$\{P_x, P_y, P_z, V_x\}$ ,  $\{ID, P_x\}$ ,  $\{ID, V_x\}$  are 3 superkeys

**3d**

$$\begin{aligned} &6C1+6C2+6C3+6C4+6C5+6C6+3C1+3C2+3C3 \\ &= 6+15+20+15+6+1+3+3+1 \\ &= 70 \end{aligned}$$