Coo: Anomaly Cookbook

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Table 1: Data anomaly formal expression, classification, and their (Partial Order Pair) POP combinations in POP cycles.

Types of Anomalies		No	Anomalies	Formal expressions	POP Combinations
RAT	SDA	1	Dirty Read [1, 8, 12]	$W_i[x_m]\dots R_j[x_m]\dots A_i$	$W_iR_j[x]-R_jA_i[x]$
	SDA	2	Non-repeatable Read [8]	$R_i[x_m]\dots W_j[x_{m+1}]\dots R_i[x_{m+1}]$	$R_iW_j[x]-W_jR_i[x]$
	SDA	3	Intermediate Read [1, 12]	$W_i[x_m]\dots R_j[x_m]\dots W_i[x_{m+1}]$	$W_iR_j[x]-R_jW_i[x]$
	SDA	4	**Intermediate Read Committed**	$W_i[x_m]\dots R_j[x_m]\dots C_j\dots W_i[x_{m+1}]$	$W_iR_j[x]-R_jC_jW_i[x]$
	SDA	5	**Lost Self Update**	$W_i[x_m]\dots W_j[x_{m+1}]\dots R_i[x_{m+1}]$	$W_iW_j[x]-W_jR_i[x]$
	DDA	6	**Write-read Skew**	$W_i[x_m]\dots R_j[x_m]\dots W_j[y_n]\dots R_i[y_n]$	$W_iR_j[x]-W_jR_i[y]$
	DDA	7	**Write-read Skew Committed**	$W_i[x_m]\dots R_j[x_m]\dots W_j[y_n]\dots C_j\dots R_i[y_n]$	$W_iR_j[x]-W_jC_jR_i[y]$
	DDA	8	**Double-write Skew 1**	$W_i[x_m]\dots R_j[x_m]\dots W_j[y_n]\dots W_i[y_{n+1}]$	$W_iR_j[x]-W_jW_i[y]$
	DDA	9	**Double-write Skew 1 Committed**	$W_i[x_m]\dots R_j[x_m]\dots W_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$W_iR_j[x]-W_jC_jW_i[y]$
	DDA	10	**Double-write Skew 2**	$W_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots R_i[y_n]$	$W_iW_j[x]-W_jR_i[y]$
	DDA	11	Read Skew [2]	$R_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots R_i[y_n]$	$R_iW_j[x]-W_jR_i[y]$
	DDA	12	**Read Skew 2**	$W_i[x_m]\dots R_j[x_m]\dots R_j[y_n]\dots W_i[y_{n+1}]$	$W_iR_j[x]-R_jW_i[y]$
	DDA	13	**Read Skew 2 Committed**	$W_i[x_m]\dots R_j[x_m]\dots R_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$W_iR_j[x]-R_jC_jW_i[y]$
	MDA	14	**Step RAT** [5, 6]	$\dots W_i[x_m]\dots R_j[x_m]\dots$, and $N_{obj}\geq 2, N_T\geq 3$	$\dots W_iR_j[x]\dots$
WAT	SDA	15	Dirty Write [8]	$W_i[x_m]\dots W_j[x_{m+1}]\dots A_i/C_i$	$W_iW_j[x]-W_jA_i/C_i[x]$
	SDA	16	**Full Write**	$W_i[x_m]\dots W_j[x_{m+1}]\dots W_i[x_{m+2}]$	$W_iW_j[x]-W_jW_i[x]$
	SDA	17	**Full Write Committed**	$W_i[x_m]\dots W_j[x_{m+1}]\dots C_j\dots W_i[x_{m+2}]$	$W_iW_j[x]-W_jC_jW_i[x]$
	SDA	18	Lost Update [2]	$R_i[x_m]\dots W_j[x_{m+1}]\dots W_i[x_{m+2}]$	$R_iW_j[x]-W_jW_i[x]$
	SDA	19	**Lost Self Update Committed**	$W_i[x_m]\dots W_j[x_{m+1}]\dots C_j\dots R_i[x_{m+1}]$	$W_iW_j[x]-W_jC_jR_i[x]$
	DDA	20	**Double-write Skew 2 Committed**	$W_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots C_j\dots R_i[y_n]$	$W_iW_j[x]-W_jC_jR_i[y]$
	DDA	21	Full-write Skew [9]	$W_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots W_i[y_{n+1}]$	$W_iW_j[x]-W_jW_i[y]$
	DDA	22	**Full-write Skew Committed**	$W_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$W_iW_j[x]-W_jC_jW_i[y]$
	DDA	23	**Read-write Skew 1**	$R_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots W_i[y_{n+1}]$	$R_iW_j[x]-W_jW_i[y]$
	DDA	24	**Read-write Skew 2**	$W_i[x_m]\dots W_j[x_{m+1}]\dots R_j[y_n]\dots W_i[y_{n+1}]$	$W_iW_j[x]-R_jW_i[y]$
	DDA	25	**Read-write Skew 2 Committed**	$W_i[x_m]\dots W_j[x_{m+1}]\dots R_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$W_iW_j[x]-R_jC_jW_i[y]$
	MDA	26	**Step WAT**	$\dots W_i[x_m]\dots W_j[x_{m+1}]\dots$, and $N_{obj}\geq 2, N_T\geq 3$, and not include $(\dots W_{i1}[y_n]\dots R_{j1}[y_n]\dots)$	$\dots W_iW_j[x]\dots$
IAT	SDA	27	Non-repeatable Read Committed [8]	$R_i[x_m]\dots W_j[x_{m+1}]\dots C_j\dots R_i[x_{m+1}]$	$R_iW_j[x]-W_jC_jR_i[x]$
	SDA	28	**Lost Update Committed**	$R_i[x_m]\dots W_j[x_{m+1}]\dots C_j\dots W_i[x_{m+2}]$	$R_iW_j[x]-W_jC_jW_i[x]$
	DDA	29	Read Skew Committed [2]	$R_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots C_j\dots R_i[y_n]$	$R_iW_j[x]-W_jC_jR_i[y]$
	DDA	30	**Read-write Skew 1 Committed**	$R_i[x_m]\dots W_j[x_{m+1}]\dots W_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$R_iW_j[x]-W_jC_jW_i[y]$
	DDA	31	Write Skew [3]	$R_i[x_m]\dots W_j[x_{m+1}]\dots R_j[y_n]\dots W_i[y_{n+1}]$	$R_iW_j[x]-R_jW_i[y]$
	DDA	32	**Write Skew Committed**	$R_i[x_m]\dots W_j[x_{m+1}]\dots R_j[y_n]\dots C_j\dots W_i[y_{n+1}]$	$R_iW_j[x]-R_jC_jW_i[y]$
	MDA	33	**Step IAT** [4, 6, 7, 10, 11]	Not include $(\dots W_{i1}[x_m]\dots R_{j1}[x_m]\dots$ and $\dots W_{i2}[y_n]\dots W_{j2}[y_{n+1}]\dots)$, $N_{obj}\geq 2, N_T\geq 3$	$\dots R_iW_j[x]\dots$