SCRUM Delivery Optimization Model

Generated from Entities/Relations/Goals/Conditions/DecisionVariables

September 5, 2025

Contents

Notation preface

We reconcile two minor naming inconsistencies from the relationship list: (i) "Employee" is taken to mean **Worker**; (ii) "Sprint Review" without space corresponds to entity **SprintReview**. All sets and parameters below are induced by the provided CSVs.

1 1. Sets (Entities)

- P : Projects (`Project`)
- T : Teams (`Team`)
- W : Workers (`Worker`)
- F : Features (`Feature`)
- S : Skills (`Skill`)
- R : Roles (`Role`)
- PO : Product Owners (`ProductOwner`)
- SM : Scrum Masters (`ScrumMaster`)
- PB : Product Backlogs (`ProductBacklog`)
- SP : Sprints (`Sprint`)
- SPP : Sprint Planning meetings (`SprintPlanning`)
- DS : Daily Scrums (`DailyScrum`)
- SR : Sprint Reviews (`SprintReview`)
- SRE : Sprint Retrospectives (`SprintRetrospective`)
- SBL : Sprint Backlogs (`SprintBacklog`)
- SG : Sprint Goals (`SprintGoal`)
- E : Epics (`Epic`)
- US : User Stories (`UserStory`)
- TS : Tasks (`Task`)
- DEV : Development Snapshots (`DevelopmentSnapshot`)
- BL : Blockers (`Blocker`)
- SH : Stakeholders (`Stakeholder`)
- V : Velocity records (`Velocity`)
- REP : Release Plans (`ReleasePlan`)
- RM : Roadmaps (`Roadmap`)
- SCB : Scrum Boards (`ScrumBoard`)
- FED : Feature Documentation (`FeatureDocumentation`)

2 2. Indices

- $p \in P,\ t \in T,\ w \in W,\ f \in F,\ s \in S,\ r \in R,\ po \in PO,\ sm \in SM$
- $pb \in PB,\ sp \in SP,\ sbl \in SBL,\ sg \in SG,\ e \in E,\ u \in US,\ k \in TS$
- $bl \in BL,\ v \in V,\ rep \in REP,\ rm \in RM,\ sh \in SH,\ scb \in SCB,\ dev \in DEV$

Parameters from entity attributes (All are taken from the corresponding entity attributes.)

- story_points$[u] \in \mathbb{Z}_{\geq 0}$ from `UserStory.story_points`
- effort$[k] \in \mathbb{R}_{\geq 0}$ from `Task.effort`
- severity$[bl] \in \mathbb{R}_{\geq 0}$ from `Blocker.severity`
- achievement_of_goal$[sp] \in \{0, 1\}$ from `Sprint.achievement_of_goal`
- team_satisfaction$[sre] \in \mathbb{R}$ from `SprintRetrospective.team_satisfaction`
- number_of_entries$[pb] \in \mathbb{Z}_{\geq 0}$ from `ProductBacklog.number_of_entries`
- avgV$[v] \in \mathbb{R}_{\geq 0}$, maxV$[v] \in \mathbb{R}_{\geq 0}$ from `Velocity.(avg_story_points,max_velocity)`
- benefit$[sg] \in \mathbb{R}$ from `SprintGoal.benefit`
- priorityF$[f] \in \mathbb{R}$ from `Feature.priority`
- durationDS$[d] \in \mathbb{R}_{\geq 0}$ from `DailyScrum.duration` for $d \in DS$
- durationSPP$[m] \in \mathbb{R}_{\geq 0}$ from `SprintPlanning.duration_(min)` for $m \in SPP$
- attend$[sr] \in \mathbb{Z}_{\geq 0}$ from `SprintReview.attendees_count` for $sr \in SR$

Decision variables (from DecisionVariables.csv) All binaries take values in $\{0, 1\}$.

$$
\begin{aligned}
x_{t,p}^{TP} &:= \texttt{team\_assigned\_to\_project (DV0)} \\
x_{w,t}^{WT} &:= \texttt{worker\_belongs\_to\_team (DV1)} \\
x_{w,s}^{WS} &:= \texttt{worker\_has\_skill (DV2)} \\
x_{w,r}^{WR} &:= \texttt{worker\_takes\_role (DV3)} \\
x_{po,pb}^{PO\text{–}PB} &:= \texttt{po\_manages\_product\_backlog (DV4)} \\
x_{sm,t}^{SMT} &:= \texttt{scrum\_master\_supports\_team (DV5)} \\
x_{pb,f}^{PBF} &:= \texttt{product\_backlog\_contains\_feature (DV6)} \\
x_{pb,e}^{PBE} &:= \texttt{product\_backlog\_contains\_epic (DV7)} \\
x_{e,u}^{EUS} &:= \texttt{epic\_contains\_user\_story (DV8)} \\
x_{u,k}^{UST} &:= \texttt{user\_story\_consists\_of\_task (DV9)} \\
x_{u,sbl}^{USSBL} &:= \texttt{user\_story\_in\_sprint\_backlog (DV10)} \\
x_{sbl,sp}^{SBLSP} &:= \texttt{sprint\_backlog\_in\_sprint (DV11)} \\
x_{sp,sg}^{SPSG} &:= \texttt{sprint\_pursues\_goal (DV12)} \\
x_{k,bl}^{TBL} &:= \texttt{task\_blocked\_by\_blocker (DV13)} \\
x_{v,t}^{VT} &:= \texttt{velocity\_refers\_to\_team (DV14)}
\end{aligned}
$$

3 3. Goals

- **G0 (maximize_delivered_story_points)**:

$$\max\ Z_0\ =\ \sum_{u\in US}\sum_{sbl\in SBL}\sum_{sp\in SP}\text{story\_points}[u]\ x_{u,sbl}^{USSBL}\ x_{sbl,sp}^{SBLSP}.$$

- **G1 (minimize_unresolved_blocker_severity)**:

$$\min\ Z_1\ =\ \sum_{k\in TS}\sum_{bl\in BL}\text{severity}[bl]\ x_{k,bl}^{TBL}.$$

- **G2 (maximize_sprint_goal_achievement)**:

$$\max\ Z_2\ =\ \sum_{sp\in SP}\sum_{sg\in SG}\text{achievement\_of\_goal}[sp]\ x_{sp,sg}^{SPSG}.$$

- **G3 (minimize_open_task_effort)**:

$$\min\ Z_3\ =\ \sum_{u\in US}\sum_{k\in TS}\text{effort}[k]\ x_{u,k}^{UST}.$$

- **G4 (maximize_team_satisfaction)**:

$$\max\ Z_4\ =\ \sum_{sre\in SRE}\text{team\_satisfaction}[sre].$$

- **G5 (minimize_product_backlog_size)**:

$$\min\ Z_5\ =\ \sum_{pb\in PB}\text{number\_of\_entries}[pb].$$

- **G6 (maximize_velocity_avg)**:

$$\max\ Z_6\ =\ \sum_{v\in V}\sum_{t\in T}\text{avgV}[v]\ x_{v,t}^{VT}.$$

- **G7 (maximize_sprint_goal_benefit)**:

$$\max\ Z_7\ =\ \sum_{sp\in SP}\sum_{sg\in SG}\text{benefit}[sg]\ x_{sp,sg}^{SPSG}.$$

- **G8 (maximize_feature_priority_delivered)**:

$$\max\ Z_8\ =\ \sum_{pb\in PB}\sum_{f\in F}\text{priorityF}[f]\ x_{pb,f}^{PBF}.$$

- **G9 (minimize_daily_scrum_duration)**:

$$\min\ Z_9\ =\ \sum_{d\in DS}\text{durationDS}[d].$$

- **G10 (minimize_sprint_planning_duration)**:

$$\min\ Z_{10}\ =\ \sum_{m\in SPP}\text{durationSPP}[m].$$

- **G11 (maximize_stakeholder_participation)**:

$$\max\ Z_{11}\ =\ \sum_{sr\in SR}\text{attend}[sr].$$

4 4. Conditions

- **C0 (user_story_must_have_acceptance_criteria)**: For all $u \in US$, acceptance criteria exists:
$$\mathbf{1}\{\text{acceptance\_criteria}[u] \text{ defined}\} = 1.$$
- **C1 (user_story_status_cannot_be_done_if_not_in_sprint)**: Let $\text{done}[u] \in \{0, 1\}$ flag if status is "done". Then
$$\sum_{sbl \in SBL} x_{u,sbl}^{USSBL} \geq \text{done}[u], \quad \forall u \in US.$$
- **C2 (task_type_may_match_bug_or_chore)**: Soft-preference only (no hard inequality).
- **C3 (sprint_end_after_start)**: For all $sp \in SP$,
$$\text{end\_date}[sp] - \text{start\_date}[sp] > 0.$$
- **C4 (sprint_backlog_status_active)**: Status consistency for $sbl \in SBL$ (parameter-level requirement).
- **C5 (sprint_goal_achievement_status_defined)**: $\mathbf{1}\{\text{achievement\_status}[sg] \text{ defined}\} = 1, \ \forall sg \in SG$.
- **C6 (scrum_board_columns_defined)**: $\mathbf{1}\{\text{columns}[scb] \text{ defined}\} = 1, \ \forall scb \in SCB$.
- **C7 (worker_availability_positive)**: $\text{availability}[w] > 0, \ \forall w \in W$.
- **C8 (product_backlog_status_defined)**: $\mathbf{1}\{\text{status}[pb] \text{ defined}\} = 1, \ \forall pb \in PB$.
- **C9 (role_area_of_responsibility_defined)**: $\mathbf{1}\{\text{area\_of\_responsibility}[r] \text{ defined}\} = 1, \ \forall r \in R$.
- **C10 (skill_certified_preferred)**: Soft-preference (used in scoring/weighting), no hard inequality.
- **C11 (blocker_status_cannot_match_done_without_task)**: If a blocker is marked done, it must be linked to at least one task:
$$\text{done}[bl] \leq \sum_{k \in TS} x_{k,bl}^{TBL}, \quad \forall bl \in BL.$$
- **C12 (release_plan_planned_date_defined)**: $\mathbf{1}\{\text{planned\_date}[rep] \text{ defined}\} = 1, \ \forall rep \in REP$.

- **Relational cardinalities (from Relationships.csv):**

$$\sum_{p \in P} x_{t,p}^{TP} = 1, \qquad \forall t \in T \quad \text{(R1: team} \rightarrow \text{exactly one project)}$$

$$\sum_{t \in T} x_{w,t}^{WT} = 1, \qquad \forall w \in W \quad \text{(R2: worker} \rightarrow \text{team)}$$

$$\sum_{r \in R} x_{w,r}^{WR} \leq 1, \qquad \forall w \in W \quad \text{(R4: at most one role)}$$

$$\sum_{pb \in PB} x_{po,pb}^{PO\text{–}PB} = 1, \qquad \forall po \in PO \quad \text{(R5)}$$

$$\sum_{po \in PO} x_{po,pb}^{PO\text{–}PB} = 1, \qquad \forall pb \in PB \quad \text{(R5 bijection)}$$

$$\sum_{sm \in SM} x_{sm,t}^{SMT} = 1, \qquad \forall t \in T \quad \text{(R6: one SM per team)}$$

$$\sum_{pb \in PB} x_{pb,f}^{PBF} = 1, \qquad \forall f \in F \quad \text{(R7: feature in exactly one PB)}$$

$$\sum_{pb \in PB} x_{pb,e}^{PBE} = 1, \qquad \forall e \in E \quad \text{(R8: epic in exactly one PB)}$$

$$\sum_{e \in E} x_{e,u}^{EUS} = 1, \qquad \forall u \in US \quad \text{(R9: US in exactly one epic)}$$

$$\sum_{u \in US} x_{u,k}^{UST} = 1, \qquad \forall k \in TS \quad \text{(R10: task in exactly one US)}$$

$$\sum_{sbl \in SBL} x_{u,sbl}^{USSBL} \leq 1, \qquad \forall u \in US \quad \text{(R11: US in} \leq 1 \text{ sprint backlog)}$$

$$\sum_{sp \in SP} x_{sbl,sp}^{SBLSP} = 1, \qquad \forall sbl \in SBL \quad \text{(R12: each SBL in exactly one sprint)}$$

$$\sum_{sg \in SG} x_{sp,sg}^{SPSG} = 1, \qquad \forall sp \in SP \quad \text{(R13: each sprint pursues 1 goal)}$$

- **Capacity (velocity) coupling (loose upper bound)**:

$$\sum_{u \in US} \sum_{sbl \in SBL} \text{story\_points}[u]\; x_{u,sbl}^{USSBL}\; x_{sbl,sp}^{SBLSP} \;\leq\; \sum_{v \in V} \text{maxV}[v], \quad \forall sp \in SP.$$

5 5. DecisionVariables

- DV0: `team_assigned_to_project` ($x_{t,p}^{TP} \in \{0,1\}$)
- DV1: `worker_belongs_to_team` ($x_{w,t}^{WT} \in \{0,1\}$)
- DV2: `worker_has_skill` ($x_{w,s}^{WS} \in \{0,1\}$)
- DV3: `worker_takes_role` ($x_{w,r}^{WR} \in \{0,1\}$)
- DV4: `po_manages_product_backlog` ($x_{po,pb}^{PO\text{–}PB} \in \{0,1\}$)
- DV5: `scrum_master_supports_team` ($x_{sm,t}^{SMT} \in \{0,1\}$)
- DV6: `product_backlog_contains_feature` ($x_{pb,f}^{PBF} \in \{0,1\}$)

- DV7: `product_backlog_contains_epic` ($x_{pb,e}^{PBE} \in \{0,1\}$)
- DV8: `epic_contains_user_story` ($x_{e,u}^{EUS} \in \{0,1\}$)
- DV9: `user_story_consists_of_task` ($x_{u,k}^{UST} \in \{0,1\}$)
- DV10: `user_story_in_sprint_backlog` ($x_{u,sbl}^{USSBL} \in \{0,1\}$)
- DV11: `sprint_backlog_in_sprint` ($x_{sbl,sp}^{SBLSP} \in \{0,1\}$)
- DV12: `sprint_pursues_goal` ($x_{sp,sg}^{SPSG} \in \{0,1\}$)
- DV13: `task_blocked_by_blocker` ($x_{k,bl}^{TBL} \in \{0,1\}$)
- DV14: `velocity_refers_to_team` ($x_{v,t}^{VT} \in \{0,1\}$)