SCRUM Domain Optimization Model

Generated Assistant

August 11, 2025

Contents

Introduction

This document formulates a mathematical optimization model over a SCRUM-oriented software development domain. It instantiates *Sets (Entities)*, *Indices*, *Goals* (objectives), *Conditions* (constraints), and *Decision Variables*, using the previously provided CSVs: `Entities.csv`, `Relationships.csv`, `Goals.csv`, `Conditions.csv`, and `DecisionVariables.csv`. Attributes from entities are represented as parameters; selections and planning choices are represented as decision variables.

1 1. Sets (Entities)

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

2 2. Indices

- $p \in \mathcal{P},\ t \in \mathcal{T},\ w \in \mathcal{W},\ f \in \mathcal{F},\ s \in \mathcal{S},\ r \in \mathcal{R},$
- $po \in \mathcal{PO},\ sm \in \mathcal{SM},\ pb \in \mathcal{PB},\ sp \in \mathcal{SP},\ spp \in \mathcal{SPP},\ ds \in \mathcal{DS},$
- $sr \in \mathcal{SR},\ sre \in \mathcal{SRE},\ sbl \in \mathcal{SBL},\ sg \in \mathcal{SG},\ e \in \mathcal{E},\ us \in \mathcal{US},$
- $tsk \in \mathcal{TSK},\ dev \in \mathcal{DEV},\ bl \in \mathcal{BL},\ sh \in \mathcal{SH},\ vel \in \mathcal{VEL},$
- $rep \in \mathcal{REP},\ rm \in \mathcal{RM},\ scb \in \mathcal{SCB},\ fed \in \mathcal{FED}.$

3 3. Goals

Objective aggregation. We scalarize multiple goals using a weighted max–min formulation. Let w_i be the weight of goal i and $g_i(\cdot)$ its expression. Define:

$$\max Z \;=\; \sum_{i\in\mathcal{G}_{\max}} w_i\, g_i \;-\; \sum_{i\in\mathcal{G}_{\min}} w_i\, g_i,$$

where $\mathcal{G}_{\max}$ collects "max" goals and $\mathcal{G}_{\min}$ collects "min" goals. Below each goal lists its ID, name, and mathematical expression (the w_i correspond to the CSV `Weight` column).

Parameters (from entity attributes). For brevity we denote attributes as parameters:

$\texttt{max\_velocity}[vel]$, $\texttt{severity}[bl]$, $\texttt{effort}[tsk]$, $\texttt{achievement\_of\_goal}[sp]$, $\texttt{number\_of\_entries}[pb]$, $\texttt{budget}[p]$, $\texttt{estimated\_effort}[f]$, $\texttt{story\_points}[us]$, $\texttt{relevance\_to\_feature}[sh]$, $\texttt{attendees\_count}[sr]$, $\texttt{availability}[w]$, $\texttt{benefit}[sg]$, $\texttt{status}[\cdot]$, $\texttt{acceptance\_criteria}[us]$, $\texttt{experience}[sm]$, $\texttt{planned\_date}[rep]$, $\texttt{objectives}[rm]$, $\texttt{linked\_requirements}[fed]$, $\texttt{last\_updated}[pb]$.

Decision variables (used by goals). Binary/real/integer variables are defined in Section 5; we reference: $x_F[f]$, $x_{US}[us]$, $x_{TSK}[tsk]$, $\alpha_W[w]$, $r_{SR}[sr]$, $b_P[p]$, $y_{SG}[sg]$, etc.

- **G0 maximize_team_velocity (max).**
  $$g_0 \;=\; \sum_{vel\in\mathcal{VEL}} \texttt{max\_velocity}[vel].$$
- **G1 minimize_blocker_severity (min).**
  $$g_1 \;=\; \sum_{bl\in\mathcal{BL}} \texttt{severity}[bl]\,(1 - \texttt{fix\_BL}[bl]).$$
- **G2 minimize_task_effort (min).**
  $$g_2 \;=\; \sum_{tsk\in\mathcal{TSK}} \texttt{effort}[tsk]\; x_{TSK}[tsk].$$
- **G3 maximize_sprint_goal_achievement (max).**
  $$g_3 \;=\; \sum_{sp\in\mathcal{SP}} \texttt{achievement\_of\_goal}[sp].$$
- **G4 minimize_backlog_size (min).**
  $$g_4 \;=\; \sum_{pb\in\mathcal{PB}} \texttt{number\_of\_entries}[pb] \;-\; \sum_{pb\in\mathcal{PB}} \texttt{limit\_PB}[pb].$$
- **G5 minimize_project_budget (min).**
  $$g_5 \;=\; \sum_{p\in\mathcal{P}} b_P[p].$$

- **G6 minimize_feature_effort (min).**
$g_6 = \sum_{f \in \mathcal{F}} \texttt{estimated\_effort}[f]\, x_F[f].$

- **G7 maximize_user_story_points_done (max).**
$g_7 = \sum_{us \in \mathcal{US}} \texttt{story\_points}[us]\, x_{US}[us].$

- **G8 maximize_stakeholder_relevance (max).**
$g_8 = \sum_{sh \in \mathcal{SH}} \texttt{relevance\_to\_feature}[sh].$

- **G9 maximize_review_attendance (max).**
$g_9 = \sum_{sr \in \mathcal{SR}} r_{SR}[sr] \quad (\text{with } 0 \leq r_{SR}[sr] \leq \texttt{attendees\_count}[sr]).$

- **G10 maximize_team_availability (max).**
$g_{10} = \sum_{w \in \mathcal{W}} \alpha_W[w] \cdot \texttt{availability}[w].$

- **G11 maximize_benefit_of_sprint_goal (max).**
$g_{11} = \sum_{sg \in \mathcal{SG}} \texttt{benefit}[sg]\, \mathbb{I}[y_{SG}[sg] \text{ selected}].$

- **G12 minimize_cycle_instability (min).**
$g_{12} = \sum_{sp \in \mathcal{SP}} \big(1 - \mathbb{I}[\texttt{status}[sp] \text{ stable}]\big).$

4 4. Conditions

Each condition Cj appears as a logical rule and its mathematical constraint.

- **C0 capacity_respected.** (Must-Match)
Logical: Total selected task effort must not exceed reserved team capacity.
Mathematical: $\sum_{tsk \in \mathcal{TSK}} \texttt{effort}[tsk]\, x_{TSK}[tsk] \leq \sum_{t \in \mathcal{T}} \texttt{cap\_T}[t].$

- **C1 mandatory_high_severity_blockers_addressed.** (Must-Match)
Logical: All high-severity blockers must be fixed.
Mathematical: For all $bl \in \mathcal{BL}$ with $\texttt{severity}[bl] \geq \theta^{\text{sev}}$: $\texttt{fix\_BL}[bl] = 1.$

- **C2 stories_have_acceptance_criteria.** (Must-Match)
Logical: Only stories with acceptance criteria can be selected.
Mathematical: $\forall us \in \mathcal{US} : \; x_{US}[us] \leq \mathbb{I}[\texttt{acceptance\_criteria}[us] \text{ present}].$

- **C3 team_is_active.** (Must-Match)
Logical: Inactive teams cannot carry capacity.
Mathematical: $\forall t \in \mathcal{T} : \; \texttt{cap\_T}[t] \leq M \cdot \mathbb{I}[\texttt{team\_status}[t] = \text{active}].$

- **C4 po_available_for_planning.** (Must-Match)
Logical: If PO is unavailable, no new user stories are selected.
Mathematical: $\sum_{us \in \mathcal{US}} x_{US}[us] \leq M \cdot \mathbb{I}[\texttt{availability}[po] \geq \theta^{po}].$

- **C5 sm_experienced_threshold.** (May-Match)
Logical: Prefer sprints moderated by sufficiently experienced SM.
Mathematical: $\mathbb{I}[\texttt{experience}[sm] \geq \theta^{sm}] = 1$ (soft; can be enforced or rewarded).

- **C6 feature_status_ready.** (Must-Match)
  Logical: Only "ready" features can be selected for release.
  Mathematical: $\forall f \in \mathcal{F}: \; x_F[f] \le \mathbb{I}[\texttt{status}[f] = \text{ready}]$.

- **C7 sprint_dates_valid.** (Must-Match)
  Logical: Each sprint must have *end_date* > *start_date*.
  Mathematical: $\forall sp \in \mathcal{SP}: \; \texttt{end\_date}[sp] - \texttt{start\_date}[sp] \ge 1$.

- **C8 backlog_is_current.** (May-Match)
  Logical: Prefer backlogs updated recently; visibility cap cannot exceed entries.
  Mathematical: $\forall pb \in \mathcal{PB}: \; \texttt{limit\_PB}[pb] \le \texttt{number\_of\_entries}[pb]$.

- **C9 release_has_planned_date.** (Must-Match)
  Logical: Release batch size is defined only if a planned date exists.
  Mathematical: $\forall rep \in \mathcal{REP}: \; \texttt{batch\_REP}[rep] \le M \cdot \mathbb{I}[\texttt{planned\_date}[rep] \text{ set}]$.

- **C10 roadmap_has_objectives.** (May-Match)
  Logical: Roadmap should specify objectives if release plans are scheduled.
  Mathematical: $\sum_{rep \in \mathcal{REP}} \texttt{batch\_REP}[rep] \le M \cdot \mathbb{I}[\texttt{objectives}[rm] \text{ present}]$.

- **C11 doc_linked_to_feature.** (Must-Match)
  Logical: Selected features must have linked documentation.
  Mathematical: $\forall f \in \mathcal{F}: \; x_F[f] \le \mathbb{I}[\exists\, fed \in \mathcal{FED}: \; \texttt{linked\_requirements}[fed] \ni f]$.

- **C12 team_size_within_bounds.** (May-Match)
  Logical: Capacity per team proportional to team size (through velocity-per-person ν).
  Mathematical: $\forall t \in \mathcal{T}: \; \texttt{cap\_T}[t] \le \nu \cdot \texttt{team\_size}[t]$.

5 5. DecisionVariables

Let M be a sufficiently large constant, $\mathbb{Z}$ integers, $\mathbb{Z}_+$ nonnegative integers, and $[a, b]$ a real interval.

- **DV0 select_feature_for_release**: $x_F[f] \in \{0, 1\} \;\; \forall f \in \mathcal{F}$.
- **DV1 assign_user_story_to_sprint**: $x_{US}[us] \in \{0, 1\} \;\; \forall us \in \mathcal{US}$.
- **DV2 activate_task**: $x_{TSK}[tsk] \in \{0, 1\} \;\; \forall tsk \in \mathcal{TSK}$.
- **DV3 allocate_budget_project**: $b_P[p] \in [0, 10^8] \subset \mathbb{R} \;\; \forall p \in \mathcal{P}$.
- **DV4 set_story_priority_adjustment**: $\Delta\pi_{US}[us] \in \{-5, \ldots, 5\} \subset \mathbb{Z} \;\; \forall us \in \mathcal{US}$.
- **DV5 team_capacity_reserved_points**: $\texttt{cap\_T}[t] \in \mathbb{Z}_+, \; 0 \le \texttt{cap\_T}[t] \le 500 \;\; \forall t \in \mathcal{T}$.
- **DV6 set_sprint_goal_focus**: $y_{SG}[sg] \in \{0, 1, 2, 3\} \subset \mathbb{Z} \;\; \forall sg \in \mathcal{SG}$.
- **DV7 staff_availability_override**: $\alpha_W[w] \in [0, 1] \subset \mathbb{R} \;\; \forall w \in \mathcal{W}$.
- **DV8 select_blocker_fix_now**: $\texttt{fix\_BL}[bl] \in \{0, 1\} \;\; \forall bl \in \mathcal{BL}$.
- **DV9 enable_ci_stage_deploy**: $\texttt{deploy\_DEV}[dev] \in \{0, 1\} \;\; \forall dev \in \mathcal{DEV}$.
- **DV10 number_of_review_attendees_target**: $r_{SR}[sr] \in \mathbb{Z}_+, \; 0 \le r_{SR}[sr] \le 200 \;\; \forall sr \in \mathcal{SR}$.
- **DV11 set_release_batch_size**: $\texttt{batch\_REP}[rep] \in \mathbb{Z}_+, \; 0 \le \texttt{batch\_REP}[rep] \le 200 \;\; \forall rep \in \mathcal{REP}$.

- **DV12 limit_backlog_entries_visible**: $\texttt{limit\_PB}[pb] \in \mathbb{Z}_+,\ 0 \leq \texttt{limit\_PB}[pb] \leq 1000\ \ \forall pb \in \mathcal{PB}$.

Full scalarized objective (with weights). Let W_i be the CSV weights of G_i (e.g., W_0=1.0, W_1=1.0, W_2=1.0, W_3=1.2, W_4=0.6, W_5=1.5, W_6=1.0, W_7=0.9, W_8=0.7, W_9=0.5, W_{10}=1.1, W_{11}=0.8, W_{12}=0.3). Then:

$$\max Z \;=\; W_0\, g_0 \;-\; W_1\, g_1 \;-\; W_2\, g_2 \;+\; W_3\, g_3 \;-\; W_4\, g_4 \;-\; W_5\, g_5 \;-\; W_6\, g_6 \;+\; W_7\, g_7 \;+\; W_8\, g_8 \;+\; W_9\, g_9 \;+\; W$$