SCRUM Company Optimization Model

From Entities, Relationships, Goals, Conditions, and Decision Variables

Generated Model

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Contents

1 1. Sets (Entities)

- **Entity Sets (from `Entities.csv`):**
  - P (Project): projects.
  - T (Team): teams.
  - W (Worker): workers (note: Relationships used "Employee"; here, *Employee* $\equiv$ *Worker*).
  - F (Feature): features.
  - S (Skill): skills.
  - R (Role): roles.
  - PO (ProductOwner): product owners.
  - SM (ScrumMaster): scrum masters.
  - PB (ProductBacklog): product backlogs.
  - SP (Sprint): sprints.
  - SPP (SprintPlanning): sprint planning events.
  - DS (DailyScrum): daily scrums.
  - SR (SprintReview): sprint reviews.
  - SRE (SprintRetrospective): sprint retrospectives.
  - SBL (SprintBacklog): sprint backlogs.
  - SG (SprintGoal): sprint goals.
  - E (Epic): epics.
  - US (UserStory): user stories.
  - TSK (Task): tasks.
  - DEV (DevelopmentSnapshot): development snapshots.
  - BL (Blocker): blockers.
  - SH (Stakeholder): stakeholders.
  - VEL (Velocity): velocity records (per team).
  - REP (ReleasePlan): release plans.
  - RM (Roadmap): roadmaps.
  - SCB (ScrumBoard): scrum boards.
  - FED (FeatureDocumentation): feature documentation entries.
- **Relationship Sets (from `Relationships.csv`; normalized names):**
  - $R_T^P \subseteq T \times P$ (is_assigned_to_project)
  - $R_W^T \subseteq W \times T$ (belongs_to_team)
  - $R_W^S \subseteq W \times S$ (has_skill)
  - $R_W^R \subseteq W \times R$ (takes_on_role)
  - $R_{PO}^{PB} \subseteq PO \times PB$ (manages_backlog)
  - $R_T^{SM} \subseteq T \times SM$ (is_supported_by)
  - $R_{PB}^F \subseteq PB \times F$ (contains_feature)
  - $R_{PB}^E \subseteq PB \times E$ (contains_epic)
  - $R_E^{US} \subseteq E \times US$ (contains_user_story)

- $R_{US}^{TSK} \subseteq US \times TSK$ (consists_of_tasks)
- $R_{US}^{SBL} \subseteq US \times SBL$ (is_in_sprint_backlog)
- $R_{SBL}^{SP} \subseteq SBL \times SP$ (belongs_to_sprint)
- $R_{SP}^{SG} \subseteq SP \times SG$ (pursues_goal)
- $R_{SCB}^{TSK} \subseteq SCB \times TSK$ (contains_tasks)
- $R_{FED}^{F} \subseteq FED \times F$ (documents_feature)
- $R_{TSK}^{BL} \subseteq TSK \times BL$ (is_blocked_by)
- $R_{SH}^{SR} \subseteq SH \times SR$ (participates_in)
- $R_{SM}^{SRE} \subseteq SM \times SRE$ (moderates_retrospective)
- $R_{T}^{VEL} \subseteq VEL \times T$ (refers_to_team)
- $R_{REP}^{F} \subseteq REP \times F$ (plans_release)
- $R_{REP}^{RM} \subseteq REP \times RM$ (is_part_of_roadmap)
- $R_{SP}^{DEV} \subseteq SP \times DEV$ (generates_snapshot)

- **Parameters (from entity attributes; treated as given data):**
  - $budget(p) \in \mathbb{R}_+$ for $p \in P$.
  - $priority(f) \in \mathbb{R}_+$, $eff\_est(f) \in \mathbb{R}_+$ for $f \in F$.
  - $totalEff(sbl) \in \mathbb{R}_+$, $numTasks(sbl) \in \mathbb{N}$ for $sbl \in SBL$.
  - $ag(sp) \in \{0,1\}$ ($achievement\_of\_goal$) for $sp \in SP$.
  - $sev(bl) \in \mathbb{R}_+$, $activeBL(bl) \in \{0,1\}$ for $bl \in BL$.
  - $avail(w) \in \mathbb{R}_+$, $activeW(w) \in \{0,1\}$ for $w \in W$.
  - $cards(scb) \in \mathbb{N}$ for $scb \in SCB$.
  - $rel(sh) \in \mathbb{R}_+$ for $sh \in SH$.
  - $vel\_avg(t) \in \mathbb{R}_+$ for $t \in T$ (via VEL).
  - $included(rep) \in \mathbb{N}$ for $rep \in REP$.
  - Indicator $hasDoc(f) \in \{0,1\}$ from FED linking (via R_{FED}^{F}).

- **Global policy parameters (model constants):**
  - $B^{\max}$ (budget cap), $PR^{\min}$ (minimum epic priority), $EXP^{\min}$ (min SM experience indicator), $E^{\max}$ (task effort cap), $ENT^{\max}$ (max backlog entries), $DUR^{\max}$ (max sprint planning duration).

2 2. Indices

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

3 3. Goals

We employ a weighted multi-objective approach with weights $w_i > 0$ from `Goals.csv`. The composite objective is

$$\max \sum_{i \in \mathcal{G}^{max}} w_i \, \Phi_i \; - \sum_{j \in \mathcal{G}^{min}} w_j \, \Phi_j,$$

where each Φ term corresponds to an item below. Logical intent is stated alongside the mathematical form.

- **G0: maximize_average_velocity**
  Logical: Maximize the team's average story points per sprint.
  Mathematical: $\Phi_0 = \sum_{t \in T} vel\_avg(t)$.
- **G1: minimize_blocker_severity**
  Logical: Minimize cumulative severity of all *active* blockers.
  Mathematical: $\Phi_1 = \sum_{bl \in BL} activeBL(bl) \cdot sev(bl)$.
- **G2: minimize_feature_effort**
  Logical: Prefer features with lower estimated effort among those selected into releases.
  Mathematical: $\Phi_2 = \sum_{rep \in REP} \sum_{f \in F} eff\_est(f) \cdot u_{f,rep}$.
- **G3: maximize_feature_priority**
  Logical: Emphasize higher-priority features selected into releases.
  Mathematical: $\Phi_3 = \sum_{rep \in REP} \sum_{f \in F} priority(f) \cdot u_{f,rep}$.
- **G4: minimize_sprint_backlog_total_effort**
  Logical: Keep total sprint effort manageable across all sprint backlogs.
  Mathematical: $\Phi_4 = \sum_{sbl \in SBL} totalEff(sbl)$.
- **G5: maximize_sprint_goal_achievement**
  Logical: Maximize rate of sprint goal achievement.
  Mathematical: $\Phi_5 = \sum_{sp \in SP} ag(sp)$.
- **G6: minimize_task_effort**
  Logical: Prefer smaller tasks to improve flow.
  Mathematical: $\Phi_6 = \sum_{tsk \in TSK} e_{tsk}$.
- **G7: maximize_worker_availability**
  Logical: Maximize usable capacity through assignments to teams.
  Mathematical: $\Phi_7 = \sum_{w \in W} \sum_{t \in T} avail(w) \cdot y_{w,t}$.
- **G8: minimize_number_of_tasks**
  Logical: Reduce number of tasks in the sprint backlogs overall.
  Mathematical: $\Phi_8 = \sum_{sbl \in SBL} numTasks(sbl)$.
- **G9: maximize_release_plan_coverage**
  Logical: Maximize the number of features covered by release plans.
  Mathematical: $\Phi_9 = \sum_{rep \in REP} \sum_{f \in F} u_{f,rep}$.

- **G10: minimize_wip_on_board**
  Logical: Reduce work-in-progress on scrum boards.
  Mathematical: $\Phi_{10} = \sum_{scb \in SCB} cards(scb)$.
- **G11: maximize_stakeholder_relevance**
  Logical: Maximize focus on what is relevant to stakeholders.
  Mathematical: $\Phi_{11} = \sum_{sh \in SH} rel(sh)$.

4 4. Conditions

Each condition Ck from `Conditions.csv` is given with logic and mathematical form. Unless otherwise stated, $\Rightarrow$ implications are linearized via big-M/binary gating using parameter indicators provided by data (so the right-hand side is effectively enforced only when the left-hand side is relevant).

- **C0: limit_total_budget**
  Logical: The sum of allocated project budgets must not exceed the cap.
  Mathematical: $\sum_{p \in P} b_p \ \leq \ B^{\max}$.
- **C1: require_active_backlog**
  Logical: Any backlog that is managed must be active/usable.
  Mathematical: $o_{po,pb} \ \leq \ activePB(pb) \quad \forall po \in PO, \ pb \in PB$, where $activePB(pb) \in \{0,1\}$ is derived from backlog *status*.
- **C2: require_high_priority_epics**
  Logical: Epics under consideration must meet a minimum priority.
  Mathematical: $priority(e) \ \geq \ PR^{\min} \quad \forall e \in E$.
- **C3: exclude_resolved_blockers**
  Logical: Resolved blockers do not count as active scope.
  Mathematical: $activeBL(bl) \in \{0,1\}, \quad activeBL(bl) = 0$ if status = "resolved", $\forall bl \in BL$.
- **C4: require_scrum_master_experience**
  Logical: A team can be supported by a SM only if the SM meets minimum experience.
  Mathematical: $m_{sm,t} \ \leq \ eligibleSM(sm) \quad \forall sm \in SM, \ t \in T$, where $eligibleSM(sm) = \mathbb{I}[\text{experience}(sm) \geq EXP^{\min}]$.
- **C5: team_size_within_bounds**
  Logical: Configured team size bounds and assignment consistency.
  Mathematical: $3 \leq sz_t \leq 15, \ \sum_{w \in W} y_{w,t} = sz_t \quad \forall t \in T$.
- **C6: workers_must_be_active**
  Logical: Only active workers are assignable to a team.
  Mathematical: $y_{w,t} \ \leq \ activeW(w) \quad \forall w \in W, \ t \in T$.
- **C7: limit_task_effort**
  Logical: Each task's effort must not exceed the threshold.
  Mathematical: $e_{tsk} \ \leq \ E^{\max} \quad \forall tsk \in TSK$.
- **C8: require_sprint_goal**
  Logical: Each sprint must pursue exactly one defined sprint goal (per R_{SP}^{SG}).
  Mathematical: $\sum_{sg \in SG} \mathbb{I}[(sp, sg) \in R_{SP}^{SG}] \ = \ 1 \quad \forall sp \in SP$.

- **C9: cap_backlog_entries**
  Logical: The entries in a product backlog must not exceed a maximum.
  Mathematical: $entries(pb) \leq ENT^{\max} \quad \forall pb \in PB$.

- **C10: require_feature_documentation**
  Logical: Features included in any release plan must have documentation.
  Mathematical: $u_{f,rep} \leq hasDoc(f) \quad \forall f \in F,\ rep \in REP$.

- **C11: limit_sprint_planning_duration**
  Logical: Sprint Planning duration must stay within its timebox.
  Mathematical: $duration(spp) \leq DUR^{\max} \quad \forall spp \in SPP$.

- *Relationship cardinalities (reference):*
  - Team–Project (R1): each t may map to multiple p but each $(t, p) \in R_T^P$ is at most one assignment: encoded via binary $x_{t,p} \in \{0, 1\}$; many-to-one/one-to-many respected by sums.
  - Worker–Team (R2): $\sum_{t \in T} y_{w,t} \leq 1$ (*at most one* team per worker).
  - SprintBacklog–Sprint (R12): each sbl belongs to exactly one sp: $\sum_{sp \in SP} \mathbb{I}[(sbl, sp) \in R_{SBL}^{SP}] = 1$ (data linkage).

5 5. DecisionVariables

- **DV0: assign_team_to_project**
  $x_{t,p} \in \{0, 1\}$ indicates whether team t is assigned to project p.

- **DV1: assign_worker_to_team**
  $y_{w,t} \in \{0, 1\}$ indicates whether worker w is assigned to team t.

- **DV2: assign_user_story_to_sprint_backlog**
  $z_{us,sbl} \in \{0, 1\}$ indicates whether user story us is in sprint backlog sbl.

- **DV3: select_feature_for_release**
  $u_{f,rep} \in \{0, 1\}$ indicates whether feature f is included in release plan rep.

- **DV4: choose_scrum_master_for_team**
  $m_{sm,t} \in \{0, 1\}$ indicates whether scrum master sm is linked to team t.

- **DV5: choose_product_owner_for_backlog**
  $o_{po,pb} \in \{0, 1\}$ indicates whether product owner po manages backlog pb.

- **DV6: prioritize_user_story**
  $p_{us} \in \{1, 2, 3, 4, 5\}$ is the discrete priority assigned to user story us.

- **DV7: allocate_budget_to_project**
  $b_p \in [0, 1{,}000{,}000]$ is the budget allocated to project p.

- **DV8: set_task_effort**
  $e_{tsk} \in \{1, 2, 3, 5, 8, 13, 21\}$ is the estimated effort for task tsk.

- **DV9: set_sprint_number**
  $sn_{sp} \in \{1, 2, \ldots, 100\}$ is the identifier for sprint sp.

- **DV10: set_team_size**
  $sz_t \in \{3, 4, \ldots, 15\}$ is the configured size for team t.

- **DV11: set_story_points**
  $sp_{us} \in \{1, 2, 3, 5, 8, 13\}$ are the story points for user story us.