SCRUM Planning Optimization Model (Derived from Entities, Relationships, Goals, Conditions, Decision Variables)

Auto-generated from CSV specifications

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Contents

1 1. Sets (Entities)

- $\mathcal{P}$ (Project) — products/initiatives; attributes: id, name, project_start, project_end, description, budget, status, target_audience, priority.
- $\mathcal{T}$ (Team) — Scrum teams; attributes: id, name, team_size, team_start, team_status, location, team_type.
- $\mathcal{W}$ (Worker) — individual members; attributes: id, name, first_name, email, start_date, status, availability.
- $\mathcal{F}$ (Feature) — mid-sized functionality; attributes: id, title, description, status, priority, estimated_effort.
- $\mathcal{S}$ (Skill) — competencies; attributes: id, label, description, level, certified, category.
- $\mathcal{R}$ (Role) — responsibilities; attributes: id, role_name, description, area_of_responsibility.
- $\mathcal{PO}$ (ProductOwner) — product leadership; attributes: id, name, email, availability.
- $\mathcal{SM}$ (ScrumMaster) — process coach; attributes: id, name, email, experience.
- $\mathcal{PB}$ (ProductBacklog) — ordered requirements; attributes: id, created_on, last_updated, number_of_entries, status.
- $\mathcal{SP}$ (Sprint) — timebox; attributes: id, sprint_number, start_date, end_date, status, achievement_of_goal.
- $\mathcal{SPP}$ (SprintPlanning) — kickoff; attributes: id, date, duration, moderation, outcome_documentation.
- $\mathcal{DS}$ (DailyScrum) — daily; attributes: id, date, time, duration, moderation.
- $\mathcal{SR}$ (SprintReview) — review; attributes: id, date, duration, feedback_documentation, attendees_count.
- $\mathcal{SRE}$ (SprintRetrospective) — retro; attributes: id, date, duration, improvement_actions, team_satisfaction, moderation.
- $\mathcal{SBL}$ (SprintBacklog) — selected items/plan; attributes: id, number_of_tasks, last_updated, status, total_effort.
- $\mathcal{SG}$ (SprintGoal) — objective; attributes: id, objective_description, achievement_status, benefit.
- $\mathcal{E}$ (Epic) — large requirement; attributes: id, title, description, priority, status, estimated_effort.
- $\mathcal{US}$ (UserStory) — user-centric requirement; attributes: id, title, description, acceptance_criteria, priority, story_points, status.
- $\mathcal{TSK}$ (Task) — smallest work unit; attributes: id, title, description, status, effort, type.
- $\mathcal{DEV}$ (DevelopmentSnapshot) — increment; attributes: id, version_number, creation_date, test_status, deployment_target, documentation.
- $\mathcal{BL}$ (Blocker) — impediment; attributes: id, title, description, severity, status, detected_on, resolved_on.

- $\mathcal{SH}$ (Stakeholder) — interested party; attributes: id, name, organization, role, email, area_of_interest, influence_level, relevance_to_feature.
- $\mathcal{VEL}$ (Velocity) — throughput measure; attributes: id, number_of_sprints_used, avg_story_points, max_velocity, min_velocity, trend.
- $\mathcal{REP}$ (ReleasePlan) — planned releases; attributes: id, version, planned_date, included_features, status.
- $\mathcal{RM}$ (Roadmap) — long-term view; attributes: id, start_date, end_date, milestones, objectives, versions.
- $\mathcal{SCB}$ (ScrumBoard) — task board; attributes: id, board_type, columns, number_of_cards, last_updated.
- $\mathcal{FED}$ (FeatureDocumentation) — docs; attributes: id, title, description, creation_date, change_log, linked_requirements, author.

Relationship Incidence (from Relationships.csv). We encode each relationship Rk as a binary incidence matrix over the corresponding sets, respecting cardinalities:

- $R1$: `is_assigned_to_project` $\Rightarrow$ $A^{T,P}_{t,p} \in \{0,1\}$.
- $R2$: `belongs_to_team` $\Rightarrow$ $A^{W,T}_{w,t} \in \{0,1\}$.
- $R3$: `has_skill` $\Rightarrow$ $A^{W,S}_{w,s} \in \{0,1\}$.
- $R4$: `takes_on_role` $\Rightarrow$ $A^{W,R}_{w,r} \in \{0,1\}$.
- $R5$: `manages_backlog` $\Rightarrow$ $A^{PO,PB}_{po,pb} \in \{0,1\}$.
- $R6$: `is_supported_by` $\Rightarrow$ $A^{T,SM}_{t,sm} \in \{0,1\}$.
- $R7$: `contains_feature` $\Rightarrow$ $A^{PB,F}_{pb,f} \in \{0,1\}$.
- $R8$: `contains_epic` $\Rightarrow$ $A^{PB,E}_{pb,e} \in \{0,1\}$.
- $R9$: `contains_user_story` $\Rightarrow$ $A^{E,US}_{e,u} \in \{0,1\}$.
- $R10$: `consists_of_tasks` $\Rightarrow$ $A^{US,TSK}_{u,t} \in \{0,1\}$.
- $R11$: `is_in_sprint_backlog` $\Rightarrow$ $A^{US,SBL}_{u,sbl} \in \{0,1\}$.
- $R12$: `belongs_to_sprint` $\Rightarrow$ $A^{SBL,SP}_{sbl,sp} \in \{0,1\}$.
- $R13$: `pursues_goal` $\Rightarrow$ $A^{SP,SG}_{sp,sg} \in \{0,1\}$.
- $R14$: `contains_tasks` $\Rightarrow$ $A^{SCB,TSK}_{scb,t} \in \{0,1\}$.
- $R15$: `documents_feature` $\Rightarrow$ $A^{FED,F}_{fd,f} \in \{0,1\}$.
- $R16$: `is_blocked_by` $\Rightarrow$ $A^{TSK,BL}_{t,b} \in \{0,1\}$.
- $R17$: `participates_in` $\Rightarrow$ $A^{SH,SR}_{sh,sr} \in \{0,1\}$.
- $R18$: `moderates_retrospective` $\Rightarrow$ $A^{SM,SRE}_{sm,sre} \in \{0,1\}$.

- $R19:$ `refers_to_team` $\Rightarrow$ $A^{VEL,T}_{vel,t} \in \{0,1\}$.
- $R20:$ `plans_release` $\Rightarrow$ $A^{REP,F}_{rep,f} \in \{0,1\}$.
- $R21:$ `is_part_of_roadmap` $\Rightarrow$ $A^{REP,RM}_{rep,rm} \in \{0,1\}$.
- $R22:$ `generates_snapshot` $\Rightarrow$ $A^{SP,DEV}_{sp,dev} \in \{0,1\}$.

2 2. Indices

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

Attribute Parameters (examples). For attributes used by goals/conditions we define parameters:

- spoints_u (US.story_points), uprio_u (US.priority), ustatus_u (indicator for status=Ready).
- teffort_{tsk} (TSK.effort), $\text{ttype\_unplanned}_{tsk} \in \{0,1\}$, tstatus_{tsk}.
- bsev_b (BL.severity), $\text{bcrit}_b \in \{0,1\}$, $\text{bopen}_b \in \{0,1\}$.
- $\text{wavail}_w \in [0,1]$ (WORKER.availability), wstatus_w.
- sbl_tot_{sbl} (SBL.total_effort), sblstatus_{sbl}.
- vavg_{vel} (VEL.avg_story_points), $\text{vtrend}^{+}_{vel} \in \{0,1\}$.
- sgbenefit_{sg}, $\text{sgaligned}_{sg} \in \{0,1\}$.
- fest_f (FEATURE.estimated_effort), fprio_f, $\text{frefined}_f \in \{0,1\}$.
- pbudget_p (PROJECT.budget).
- repdate_{rep} (REP.planned_date), $\text{repapproved}_{rep} \in \{0,1\}$.
- shrel_{sh} (SH.relevance_to_feature), sratt_{sr} (SR.attendees_count), $\text{srquorum} \in \mathbb{Z}_+$.
- $\text{spactive}_{sp} \in \{0,1\}$ (SPRINT.status=Active).

Decision Variables (from DecisionVariables.csv). We model the planning choices as:

$x_{u,sp} \in \{0,1\}$	(DV0) assign_user_story_to_sprint
$y_{f,rep} \in \{0,1\}$	(DV1) select_feature_for_release
$a_{tsk,w} \in \{0,1\}$	(DV2) assign_task_to_worker
$h_{tsk} \in [0,40]$	(DV3) set_task_effort_hours
$n_u^{\text{sprint}} \in \{1,\ldots,99\}$	(DV4) choose_sprint_for_user_story
$\text{cap}_{sp} \in [0,200]$	(DV5) decide_team_capacity_story_points
$z_b^{\text{res}} \in \{0,1\}$	(DV6) approve_blocker_resolution
$d_{sp}^{\text{start}} \in \{1,\ldots,31\}$	(DV7) schedule_sprint_start_day
$r_f^{\text{rank}} \in \{1,\ldots,100\}$	(DV8) prioritize_feature_rank
$\beta_p \in [0,10^6]$	(DV9) budget_allocation_to_project
$g_{sp}^{\text{target}} \in [0,100]$	(DV10) set_sprint_goal_benefit_target
$N_{sbl}^{\text{tasks}} \in \{0,\ldots,300\}$	(DV11) decide_number_of_tasks_in_sprintbacklog
$i_{sh,sr}^{\text{inv}} \in \{0,1\}$	(DV12) select_stakeholder_for_review

3 3. Goals

We scalarize the multi-objective using weights w_k from `Goals.csv`. Each goal Gk is shown with its logical intent and mathematical term. The overall objective is:

$$\max \sum_{k:\text{maximize}} w_k \cdot \text{Term}_k \; - \sum_{k:\text{minimize}} w_k \cdot \text{Term}_k.$$

- **G0 maximize_total_story_points** (IsSum=True, GoalType=max, Weight=1.0)
  Logical: Prefer plans that include higher total story points.
  Math term: $\text{Term}_{G0} = \sum_{u \in \mathcal{US}} \sum_{sp \in \mathcal{SP}} \text{spoints}_u \, x_{u,sp}$.

- **G1 minimize_total_task_effort** (IsSum=True, GoalType=min, Weight=1.0)
  Logical: Reduce total planned task effort.
  Math term: $\text{Term}_{G1} = \sum_{tsk \in \mathcal{TSK}} h_{tsk}$.

- **G2 minimize_open_blocker_severity** (IsSum=True, GoalType=min, Weight=2.0)
  Logical: Reduce impact from open blockers.
  Math term: $\text{Term}_{G2} = \sum_{b \in \mathcal{BL}} \text{bsev}_b \, (1 - z_b^{\text{res}}) \, \text{bopen}_b$.

- **G3 maximize_team_availability** (IsSum=True, GoalType=max, Weight=1.0)
  Logical: Prefer allocations to more available workers.
  Math term: $\text{Term}_{G3} = \sum_{tsk \in \mathcal{TSK}} \sum_{w \in \mathcal{W}} \text{wavail}_w \, a_{tsk,w}$.

- **G4 minimize_sprint_backlog_total_effort** (IsSum=True, GoalType=min, Weight=1.5)
  Logical: Keep sprint backlog effort low.
  Math term: $\text{Term}_{G4} = \sum_{sbl \in \mathcal{SBL}} \text{sbl\_tot}_{sbl}$.

- **G5 maximize_velocity_avg_story_points** (IsSum=True, GoalType=max, Weight=1.0)
  Logical: Favor teams/sprints with higher historical velocity.
  Math term: $\text{Term}_{G5} = \sum_{vel \in \mathcal{VEL}} \text{vavg}_{vel}$.

- **G6 maximize_sprint_goal_benefit** (IsSum=True, GoalType=max, Weight=1.0)
  Logical: Increase delivered benefit vs. target.
  Math term: $\text{Term}_{G6} = \sum_{sp \in \mathcal{SP}} \sum_{sg \in \mathcal{SG}} A^{SP,SG}_{sp,sg} \cdot \min\{\text{sgbenefit}_{sg},\, g^{\text{target}}_{sp}\}$.

- **G7 minimize_feature_estimated_effort** (IsSum=True, GoalType=min, Weight=1.0)
  Logical: Prefer lower-effort features in the plan.
  Math term: $\text{Term}_{G7} = \sum_{f \in \mathcal{F}} \sum_{rep \in \mathcal{REP}} \text{fest}_f \, y_{f,rep}$.

- **G8 maximize_feature_priority** (IsSum=True, GoalType=max, Weight=0.8)
  Logical: Prefer higher-priority features.
  Math term: $\text{Term}_{G8} = \sum_{f \in \mathcal{F}} \sum_{rep \in \mathcal{REP}} \text{fprio}_f \, y_{f,rep}$.

- **G9 minimize_project_budget** (IsSum=True, GoalType=min, Weight=1.2)
  Logical: Minimize allocated budget.
  Math term: $\text{Term}_{G9} = \sum_{p \in \mathcal{P}} \beta_p$.

- **G10 minimize_release_planned_date** (IsSum=False, GoalType=min, Weight=0.7)
  Logical: Release as early as possible.
  Math term: $\text{Term}_{G10} = \max_{rep \in \mathcal{REP}} \text{repdate}_{rep} \cdot \left[\sum_{f \in \mathcal{F}} y_{f,rep} \geq 1 \right]$ (or surrogate $\sum_{rep} \text{repdate}_{rep} \sum_f y_{f,rep}$).

- **G11 maximize_stakeholder_relevance** (IsSum=True, GoalType=max, Weight=0.9)
  Logical: Invite more relevant stakeholders to reviews.
  Math term: $\text{Term}_{G11} = \sum_{sr \in \mathcal{SR}} \sum_{sh \in \mathcal{SH}} \text{shrel}_{sh} \, i^{\text{inv}}_{sh,sr}$.

4 4. Conditions

Each condition from `Conditions.csv` is shown with ID, name, logic, and a mathematical constraint. "Must-Match" (CriteriaType = 2) are hard constraints; "Cannot-Match" (= 0) forbidding constraints; "May-Match" (= 1) are soft and can be modeled via penalties or left to goals.

- **C0 must_match_user_story_status_ready** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only *Ready* user stories can be selected into sprints.
  Constraint: $x_{u,sp} \leq \text{ustatus}_u \quad \forall u \in \mathcal{US}, \forall sp \in \mathcal{SP}$.

- **C1 must_match_feature_status_refined** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only *Refined* features can be chosen for a release.
  Constraint: $y_{f,rep} \leq \text{frefined}_f \quad \forall f \in \mathcal{F}, \forall rep \in \mathcal{REP}$.

- **C2 cannot_match_task_type_unplanned** (IsSum=False, GoalType=min, CriteriaType=0, Weight=1.5)
  Logical: Unplanned tasks cannot be assigned.
  Constraint: $a_{tsk,w} \leq 1 - \text{ttype\_unplanned}_{tsk} \quad \forall tsk \in \mathcal{TSK}, \forall w \in \mathcal{W}$.

- **C3 must_match_sprint_status_active** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)

Logical: Assignments only into *Active* sprints.
Constraint: $x_{u,sp} \le \text{spactive}_{sp} \quad \forall u, sp.$

- **C4 must_match_product_backlog_status_ordered** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only items from an *Ordered* Product Backlog can be planned.
  Constraint: $x_{u,sp} \le \sum_{pb \in \mathcal{PB}} \text{pb\_ordered}_{pb} \Big(\sum_{e \in \mathcal{E}} A^{PB,E}_{pb,e} \, A^{E,US}_{e,u} \Big),$ with $\text{pb\_ordered}_{pb} \in \{0,1\}$.

- **C5 may_match_worker_availability_high** (IsSum=True, GoalType=min, CriteriaType=1, Weight=0.8)
  Logical: Prefer workers with availability ≥ 0.8.
  Soft constraint (example): $\sum_{tsk,w} a_{tsk,w} \, \max\{0,\, 0.8 - \text{wavail}_w\} \le \epsilon.$

- **C6 must_match_team_type_cross_functional** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only cross-functional teams can receive work.
  Constraint (team capacity binding): $\sum_{u} \text{spoints}_u \, x_{u,sp} \;\le\; \sum_{t \in \mathcal{T}} \text{cap}_{sp} \, \text{isXFunc}_t \, A^{T,P}_{t,p} \quad \forall sp,$
  with $\text{isXFunc}_t \in \{0,1\}$.

- **C7 cannot_match_blocker_severity_critical** (IsSum=False, GoalType=min, CriteriaType=0, Weight=2.0)
  Logical: Tasks blocked by critical blockers must not be planned.
  Constraint: $\sum_{w} a_{tsk,w} \le 1 - \max_{b \in \mathcal{BL}} \{ A^{TSK,BL}_{tsk,b} \cdot \text{bcrit}_b \} \quad \forall tsk.$

- **C8 must_match_sprint_goal_achievement_status_aligned** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only sprints whose goal is aligned may be populated.
  Constraint: $\sum_{u} x_{u,sp} \le M \cdot \sum_{sg} A^{SP,SG}_{sp,sg} \, \text{sgaligned}_{sg} \quad \forall sp.$

- **C9 may_match_sprint_review_attendees_sufficient** (IsSum=True, GoalType=min, CriteriaType=1, Weight=0.5)
  Logical: Prefer reviews with quorum.
  Soft constraint: $\sum_{sr} \max\{0,\, \text{srquorum} - \text{sratt}_{sr} - \sum_{sh} i^{\text{inv}}_{sh,sr}\} \le \epsilon.$

- **C10 must_match_release_plan_status_approved** (IsSum=False, GoalType=min, CriteriaType=2, Weight=1.0)
  Logical: Only *Approved* release plans may contain features.
  Constraint: $y_{f,rep} \le \text{repapproved}_{rep} \quad \forall f, rep.$

- **C11 may_match_velocity_trend_positive** (IsSum=False, GoalType=min, CriteriaType=1, Weight=0.6)
  Logical: Prefer teams with increasing velocity.
  Soft constraint: $\sum_{vel} (1 - \text{vtrend}^{+}_{vel}) \le \epsilon$ (or encode via objective $G5$).

Additional Feasibility (structural) Constraints (from Relationships).

- Story–Sprint consistency: $\sum_{sp} x_{u,sp} \le 1 \quad \forall u.$

- Story–Task linking: if any task of u is assigned then u must be scheduled: $\sum_{w} a_{tsk,w} \leq \sum_{sp} x_{u,sp} \quad \forall u,\ \forall tsk$ with $A^{US,TSK}_{u,tsk} = 1$.
- Release inclusion via plan: $y_{f,rep} \leq A^{REP,F}_{rep,f} \quad \forall f, rep.$
- SprintBacklog linkage: $\sum_{u} A^{US,SBL}_{u,sbl} \leq N^{\text{tasks}}_{sbl} \quad \forall sbl.$
- Capacity limit (illustrative): $\sum_{u} \text{spoints}_u \, x_{u,sp} \leq \text{cap}_{sp} \quad \forall sp.$
- Budget guard: $\sum_{f,rep} \text{fest}_f \, y_{f,rep} \leq \sum_{p} \beta_p.$

5 5. DecisionVariables

- **DV0 assign_user_story_to_sprint**: Binary, Domain $\{0, 1\}$, Min 0, Max 1.
- **DV1 select_feature_for_release**: Binary, Domain $\{0, 1\}$, Min 0, Max 1.
- **DV2 assign_task_to_worker**: Binary, Domain $\{0, 1\}$, Min 0, Max 1.
- **DV3 set_task_effort_hours**: Real, Domain $\mathbb{R}^+$, Min 0, Max 40.
- **DV4 choose_sprint_for_user_story**: Integer, Domain $\mathbb{Z}^+$, Min 1, Max 99.
- **DV5 decide_team_capacity_story_points**: Real, Domain $\mathbb{R}^+$, Min 0, Max 200.
- **DV6 approve_blocker_resolution**: Binary, Domain $\{0, 1\}$, Min 0, Max 1.
- **DV7 schedule_sprint_start_day**: Integer, Domain $\mathbb{Z}$, Min 1, Max 31.
- **DV8 prioritize_feature_rank**: Integer, Domain $\mathbb{Z}^+$, Min 1, Max 100.
- **DV9 budget_allocation_to_project**: Real, Domain $\mathbb{R}^+$, Min 0, Max 1,000,000.
- **DV10 set_sprint_goal_benefit_target**: Real, Domain $\mathbb{R}^+$, Min 0, Max 100.
- **DV11 decide_number_of_tasks_in_sprintbacklog**: Integer, Domain $\mathbb{Z}^+$, Min 0, Max 300.
- **DV12 select_stakeholder_for_review**: Binary, Domain $\{0, 1\}$, Min 0, Max 1.