

# Optimization Model for SCRUM-Based Software Development

Based on Domain Entities and Relationships

AI Assistant  
Knowledge-Based Modeling System

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## 1. Sets (Entities)

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$\mathcal{P}$ : Set of Projects,  $P \in \mathcal{P}$ , with attributes: id, name, project\_start, project\_end, description, budget, status, target\_audience, priority.

$\mathcal{T}$ : Set of Teams,  $T \in \mathcal{T}$ , with attributes: id, name, team\_size, team\_start, team\_status, location, team\_type.

$\mathcal{W}$ : Set of Workers,  $W \in \mathcal{W}$ , with attributes: id, name, first\_name, email, start\_date, status, availability.

$\mathcal{F}$ : Set of Features,  $F \in \mathcal{F}$ , with attributes: id, title, description, status, priority, estimated\_effort.

$\mathcal{S}$ : Set of Skills,  $S \in \mathcal{S}$ , with attributes: id, label, description, level, certified, category.

$\mathcal{R}$ : Set of Roles,  $R \in \mathcal{R}$ , with attributes: id, role\_name, description, area\_of\_responsibility.

$\mathcal{PO}$ : Set of Product Owners,  $PO \in \mathcal{PO}$ , with attributes: id, name, email, availability.

$\mathcal{SM}$ : Set of Scrum Masters,  $SM \in \mathcal{SM}$ , with attributes: id, name, email, experience.

$\mathcal{PB}$ : Set of Product Backlogs,  $PB \in \mathcal{PB}$ , with attributes: id, created\_on, last\_updated, number\_of\_entries, status.

$\mathcal{SP}$ : Set of Sprints,  $SP \in \mathcal{SP}$ , with attributes: id, sprint\_number, start\_date, end\_date, status, achievement\_of\_goal.

$\mathcal{SPP}$ : Set of Sprint Plannings,  $SPP \in \mathcal{SPP}$ , with attributes: id, date, duration\_(min), moderation, outcome\_documentation.

$\mathcal{DS}$ : Set of Daily Scrums,  $DS \in \mathcal{DS}$ , with attributes: id, date, time, duration, moderation.

$\mathcal{SR}$ : Set of Sprint Reviews,  $SR \in \mathcal{SR}$ , with attributes: id, date, duration, feedback\_documentation, attendees\_count.

$\mathcal{SRE}$ : Set of Sprint Retrospectives,  $SRE \in \mathcal{SRE}$ , with attributes: id, date, duration, improvement\_actions, team\_satisfaction, moderation.

$\mathcal{SBL}$ : Set of Sprint Backlogs,  $SBL \in \mathcal{SBL}$ , with attributes: id, number\_of\_tasks, last\_updated, status, total\_effort.

$\mathcal{SG}$ : Set of Sprint Goals,  $SG \in \mathcal{SG}$ , with attributes: id, objective\_description, achievement\_status, benefit.

$\mathcal{E}$ : Set of Epics,  $E \in \mathcal{E}$ , with attributes: id, title, description, priority, status, estimated\_effort.

$\mathcal{US}$ : Set of User Stories,  $US \in \mathcal{US}$ , with attributes: id, title, description, acceptance\_criteria, priority, story\_points, status.

$\mathcal{TSK}$ : Set of Tasks,  $TSK \in \mathcal{TSK}$ , with attributes: id, title, description, status, effort, type.

$\mathcal{DEV}$ : Set of Development Snapshots,  $DEV \in \mathcal{DEV}$ , with attributes: id, version\_number, creation\_date, test\_status, deployment\_target, documentation.

$\mathcal{BL}$ : Set of Blockers,  $BL \in \mathcal{BL}$ , with attributes: id, title, description, severity, status, detected\_on, resolved\_on.

$\mathcal{SH}$ : Set of Stakeholders,  $SH \in \mathcal{SH}$ , with attributes: id, name, organization, role, email, area\_of\_interest, influence\_level, relevance\_to\_feature.

$\mathcal{VEL}$ : Set of Velocity Records,  $VEL \in \mathcal{VEL}$ , with attributes: id, number\_of\_sprints\_used, avg\_story\_points, max\_velocity, min\_velocity, trend.

$\mathcal{REP}$ : Set of Release Plans,  $REP \in \mathcal{REP}$ , with attributes: id, version, planned\_date, included\_features, status.

$\mathcal{RM}$ : Set of Roadmaps,  $RM \in \mathcal{RM}$ , with attributes: id, start\_date, end\_date, milestones, objectives, versions.

$\mathcal{SCB}$ : Set of Scrum Boards,  $SCB \in \mathcal{SCB}$ , with attributes: id, board\_type, columns\_(todo/done...), number\_of\_cards, last\_updated.

$\mathcal{FED}$ : Set of Feature Documentations,  $FED \in \mathcal{FED}$ , with attributes: id, title, description, creation\_date, change\_log, linked\_requirements, author.

## 2. Indices

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$p \in \mathcal{P}$ : Index for Projects.

$t \in \mathcal{T}$ : Index for Teams.

$w \in \mathcal{W}$ : Index for Workers.

$f \in \mathcal{F}$ : Index for Features.

$s \in \mathcal{S}$ : Index for Skills.

$r \in \mathcal{R}$ : Index for Roles.

$sp \in \mathcal{SP}$ : Index for Sprints.

$us \in \mathcal{US}$ : Index for User Stories.

$tk \in \mathcal{TSK}$ : Index for Tasks.

$bl \in \mathcal{BL}$ : Index for Blockers.

$sh \in \mathcal{SH}$ : Index for Stakeholders.

$v \in \mathcal{VEL}$ : Index for Velocity records.

$rp \in \mathcal{REP}$ : Index for Release Plans.

$rm \in \mathcal{RM}$ : Index for Roadmaps.

## 3. Goals

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### **G0: maximize\_project\_budget**

Maximize total budget across selected projects:

$$\max \sum_{p \in \mathcal{P}} x_p \cdot \text{budget}(p)$$

### **G1: minimize\_project\_duration**

Minimize total project duration:

$$\min \sum_{p \in \mathcal{P}} x_p \cdot (\text{project\_end}(p) - \text{project\_start}(p))$$

### **G2: maximize\_team\_size**

Maximize cumulative team size:

$$\max \sum_{t \in \mathcal{T}} y_t \cdot \text{team\_size}(t)$$

**G3: minimize\_worker\_start\_date**

Prefer earlier-starting workers:

$$\min \sum_{w \in \mathcal{W}} z_w \cdot \text{start\_date}(w)$$

**G4: maximize\_worker\_availability**

Maximize total worker availability:

$$\max \sum_{w \in \mathcal{W}} z_w \cdot \text{availability}(w)$$

**G5: maximize\_feature\_priority**

Maximize sum of feature priorities:

$$\max \sum_{f \in \mathcal{F}} u_f \cdot \text{priority}(f)$$

**G6: minimize\_task\_effort**

Minimize total task effort:

$$\min \sum_{tk \in \mathcal{TSK}} v_{tk} \cdot \text{effort}(tk)$$

**G7: maximize\_story\_points**

Maximize completed story points:

$$\max \sum_{us \in \mathcal{US}} v_{us} \cdot \text{story\_points}(us)$$

**G8: minimize\_sprint\_duration**

Minimize sprint length:

$$\min \sum_{sp \in \mathcal{SP}} w_{sp} \cdot (\text{end\_date}(sp) - \text{start\_date}(sp))$$

**G9: maximize\_sprint\_achievement**

Maximize sprint goal achievement:

$$\max \sum_{sp \in \mathcal{SP}} w_{sp} \cdot \text{achievement\_of\_goal}(sp)$$

**G10: minimize\_blocker\_resolution\_time**

Minimize average blocker resolution time:

$$\min \sum_{bl \in \mathcal{BL}} b_{bl} \cdot (\text{resolved\_on}(bl) - \text{detected\_on}(bl))$$

**G11: maximize\_velocity\_trend**

Maximize velocity trend:

$$\max \sum_{v \in \mathcal{VEL}} a_v \cdot \text{trend}(v)$$

**G12: maximize\_stakeholder\_influence**

Maximize influence of involved stakeholders:

$$\max \sum_{sh \in \mathcal{SH}} c_{sh} \cdot \text{influence\_level}(sh)$$

**G13: minimize\_release\_plan\_delay**

Minimize release plan dates:

$$\min \sum_{rp \in \mathcal{REP}} d_{rp} \cdot \text{planned\_date}(rp)$$

**G14: maximize\_epic\_effort\_estimate**

Maximize effort allocated to epics:

$$\max \sum_{e \in \mathcal{E}} e_e \cdot \text{estimated\_effort}(e)$$

## 4. Conditions

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**C0: require\_project\_status\_active**

Only active projects are allowed:

$$x_p = 1 \implies \text{status}(p) = \text{"active"}, \quad \forall p \in \mathcal{P}$$

**C1: require\_team\_status\_active**

Only active teams can be assigned:

$$y_t = 1 \implies \text{team\_status}(t) = \text{"active"}, \quad \forall t \in \mathcal{T}$$

**C2: require\_worker\_status\_active**

Only active workers can be allocated:

$$z_w = 1 \implies \text{status}(w) = \text{"active"}, \quad \forall w \in \mathcal{W}$$

**C3: require\_feature\_status\_completed**

Only completed features contribute:

$$u_f > 0 \implies \text{status}(f) = \text{"completed"}, \quad \forall f \in \mathcal{F}$$

**C4: require\_task\_status\_done**

Only done tasks are considered:

$$v_{tk} = 1 \implies \text{status}(tk) = \text{"done"}, \quad \forall tk \in \mathcal{TSK}$$

**C5: require\_sprint\_status\_completed**

Only completed sprints count:

$$w_{sp} = 1 \implies \text{status}(sp) = \text{"completed"}, \quad \forall sp \in \mathcal{SP}$$

**C6: require\_valid\_role\_assignment**

Worker must have at least one valid role:

$$z_w = 1 \implies \exists r \in \mathcal{R} : \text{takes\_on\_role}(w, r), \quad \forall w \in \mathcal{W}$$

**C7: require\_certified\_skills**

Only certified skills are used:

$$\text{has\_skill}(w, s) \implies \text{certified}(s) = \text{true}, \quad \forall w \in \mathcal{W}, s \in \mathcal{S}$$

**C8: require\_non\_zero\_story\_points**

Exclude zero-point stories:

$$v_{us} = 1 \implies \text{story\_points}(us) > 0, \quad \forall us \in \mathcal{US}$$

**C9: require\_positive\_effort**

Task effort must be positive:

$$v_{tk} = 1 \implies \text{effort}(tk) > 0, \quad \forall tk \in \mathcal{TSK}$$

**C10: require\_valid\_sprint\_goal**

Sprint must have defined goal:

$$w_{sp} = 1 \implies \exists sg \in \mathcal{SG} : \text{pursues\_goal}(sp, sg) \wedge \text{objective\_description}(sg) \neq \emptyset$$

**C11: require\_documented\_feature**

Feature must have documentation:

$$u_f = 1 \implies \exists fed \in \mathcal{FED} : \text{documents\_feature}(fed, f), \quad \forall f \in \mathcal{F}$$

**C12: require\_planned\_release\_status**

Release must be planned or released:

$$d_{rp} = 1 \implies \text{status}(rp) \in \{\text{"planned"}, \text{"released"}\}, \quad \forall rp \in \mathcal{REP}$$

**C13: require\_roadmap\_milestone\_defined**

Roadmap must have at least one milestone:

$$\text{is\_part\_of\_roadmap}(rp, rm) \implies \text{milestones}(rm) \neq \emptyset, \quad \forall rp \in \mathcal{REP}, rm \in \mathcal{RM}$$

**C14: require\_non\_empty\_backlog**

Product Backlog must contain items:

$$\text{contains\_feature}(pb, f) \vee \text{contains\_epic}(pb, e) \implies \text{number\_of\_entries}(pb) > 0, \quad \forall pb \in \mathcal{PB}$$

## 5. Decision Variables

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$x_p \in \{0, 1\}$ : Project selection variable for  $p \in \mathcal{P}$

$y_t \in [1, 10]$ : Number of teams assigned to a project (continuous)

$z_w \in [0, 1]$ : Worker allocation level for  $w \in \mathcal{W}$

$s_{tk,s} \in \{1, 2, 3, 4, 5\}$ : Minimum required skill level for task  $tk$

$r_w \in [1, 3]$ : Number of roles assigned to worker  $w$

$u_f \in [1, 10]$ : Priority score for feature  $f$

$d_{sp} \in [5, 30]$ : Duration (in days) of sprint  $sp$

$v_{tk} \in \{0, 1\}$ : Task completion status (1 if done)

$v_{us} \in [1, 20]$ : Estimated story points for user story  $us$

$b_{bl} \in \{1, 2, 3\}$ : Blocker severity level for  $bl \in \mathcal{BL}$

$c_{sh} \in [0, 1]$ : Stakeholder influence weight

$m_v \in [0.5, 2.0]$ : Velocity multiplier for team performance prediction

$v_{rp} \in [1.0, 10.0]$ : Release version number

$f_{fed} \in [0, 100]$ : Documentation completeness percentage

$n_{scb} \in [3, 7]$ : Number of columns on Scrum Board  $scb$