**Objective**

Obtain a correct design for a system that is more preferred than any other correct design.

- Correct design: a set of goals & tasks that provide the system's required functionality
- Preference analysis quickly becomes difficult as systems become more complex
- Analysis needs to be able to handle tradeoffs between sets of optional goals
- Qualitative preference valuations allow effective reasoning without false “accuracy”

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**Goal-Oriented Requirements Engineering**

Defines a system's requirements in terms of a goal model [Yu and Mylopoulos, ICSE 1994]

- **Root goal**: overall purpose or functionality of system
- **Required goals**: conditions, outcomes, or world states to achieve
- **Tasks**: partially or fully realize a goal
- **Optional goals**: desirable but not required (e.g., non-functional properties).

An optional goal is satisfied if it has both:
1. No BREAK (−−) links from satisfied goals
2. ≥ 1 MAKE (++) link from a satisfied goal

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**Finding the Most Preferred Correct System Design(s)**

1. **Optional Goal Tradeoffs**
   - Consider the following preferences from the proposed system's users:
     1. **If robust documentation** is used, payment traceability is more important than reducing transaction costs.
     2. **If transaction costs** are reduced at the expense of customer satisfaction, then using robust documentation takes precedence over ensuring payment traceability.
     3. **If robust documentation** is not provided, **payments should be traceable** even at the expense of reduced customer satisfaction and increased transaction cost.

2. **Translate Tradeoffs into CI-Nets**
   - A conditional importance network or CI-net [Bouveret et al., IJCAI 2009] consists of statements of the form:
     \[ S_i \succ S_j \]
   - In English:
     “If all propositions in \( S_i \) are true and all propositions in \( S_j \) are false, then the set of propositions \( S_i \) is preferred to the set \( S_j \).”
   - A set of optional goals \( \gamma_1 \) is preferred to another set \( \gamma_2 \) if one of the following is true:
     1. **Monotonicity**: \( \gamma_1 \) has at least one more optional goal than \( \gamma_2 \)
     2. **Importance**: The goals in \( \gamma_1 \) are preferred to those in \( \gamma_2 \) according to a CI-net statement
   - Several sets of optional goals, arranged in order so that each successive set is preferred to the previous set, form an **improving flipping sequence**.

3. **Compute Total Order over Sets of Optional Goals**
   - No need to perform all pairwise comparisons! Instead:
     1. Transform CI-net into induced preference graph
     2. Use NuSMV (http://nusmv.fbk.eu) to verify that
     IPG is cycle-free and compute total order over all sets of optional goals

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**Related Work**

- Liaskos et al., RE 2010
  - Supports precedence constraints & optional subgoals of required goals
  - Quantitative, not qualitative, preference valuations
- Sebastani et al., CAiSE 2004; Ernst et al., ER 2010
  - Ernst et al. use HELP/HURT labels for partial support/denial of optional goals
  - Both express simple qualitative preferences between pairs of goals (\( a \succ b \))
- Methods based on Analytic Hierarchy Process (AHP)
  - Quantity preferences & rank relative importance of single options
  - Do not represent conditional preferences

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**Future Directions**

- Test our approach on industrial-scale goal models
- Add support for precedence constraints
- Add support for partial satisfaction of optional goals (HELP/HURT links)
- Integrate preferences of multiple stakeholders
- Apply framework to related problems, e.g., software product line engineering