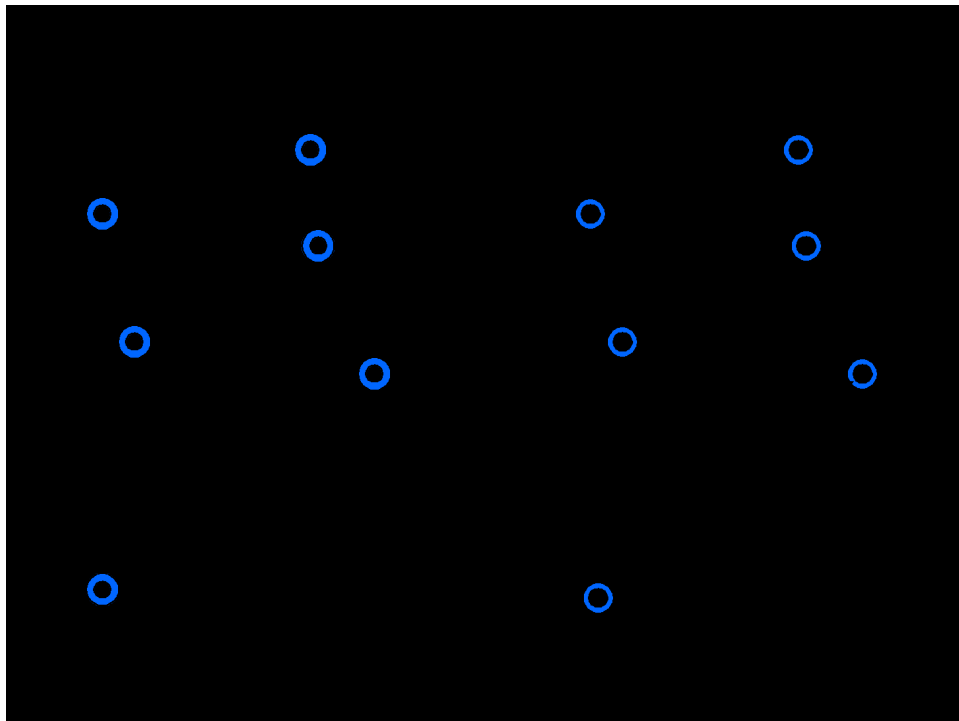
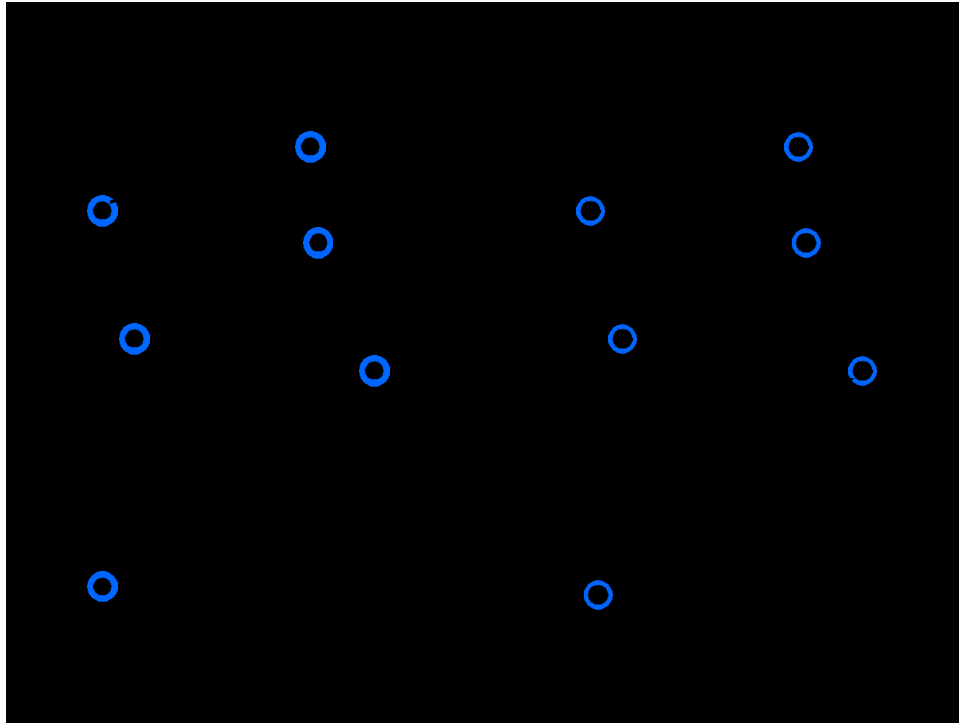


Underlying ideas

- Graph1 refinement Graph2
- Graphs can play the following roles:
 - interface class graph
 - (application) class graph
 - positive strategy graph
 - have a source and a target

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Roles graphs play in OOD under refinement relations

- Small graph

- G
- PSG
- PSG

- Big graph

- G
- PSG
- G

G: class graph (CG) or interface class graph (ICG).

ICG is a view on a class graph.

PSG: positive strategy graph.

Roles graphs play in OOD under refinement relations

SMALL	BIG	INTENT
CG	CG	evolution
ICG	CG	view (abstr.)
CG	ICG	view (roles)
ICG	ICG	layering
PSG	CG	AP
PSG	ICG	improved AP
PSG	PSG	subtraversal

Roles graphs play in OOD under refinement relations

<i>application</i>	<i>PSG()</i>
<i>CG</i>	AP
<i>ICG</i>	Better AP, class graph views
<i>PSG</i>	Meta strategy

Applications of strategy graphs

- Specify mapping between graphs (adaptors)
 - Advantage: mapping does not have to refer to details of lower level graph → robustness
- Specify traversals through graphs
 - Specification does not have to refer to details of traversed graph → robustness
- Specify function compositions
 - without referring to detail of API → robustness

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Applications of strategy graphs

- Specify range of generic operations such as comparing, copying, printing, etc.
 - without referring to details of class graph → robustness. Used in Demeter/Java. Used in distributed computing: marshalling, D, AspectJ, Xerox PARC

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Theory of Strategy Graphs

- Palsberg/Xiao/Lieberherr: TOPLAS '95
- Palsberg/Patt-Shamir/Lieberherr: Science of Computer Programming 1997
- Lieberherr/Patt-Shamir: Strategy graphs, 1997 NU TR
- Lieberherr/Patt-Shamir: Dagstuhl '98 Workshop on Generic Programming (LNCS)

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Strategy graph and base graph are directed graphs

Key concepts

- Strategy graph S with source s and target t of a base graph G . $Nodes(S)$ subset $Nodes(G)$ (Embedded strategy graph).
- A path p is an *expansion* of path p' if p' can be obtained by deleting some elements from p .
- S defines *path set* in G as follows:
 $PathSet_{st}(G,S)$ is the set of all $s-t$ paths in G that are expansions of any $s-t$ path in S .

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Key concepts

- A path p in G is an *expansion* of path p' in S if $OrderedNodes(p')$ can be obtained by deleting some elements from $OrderedNodes(p)$.
- $OrderedNodes(p)$ is the ordered sequence of nodes in p in the order the nodes appear in p .
- **Recall:** $Nodes(S) \hat{=} Nodes(G)$

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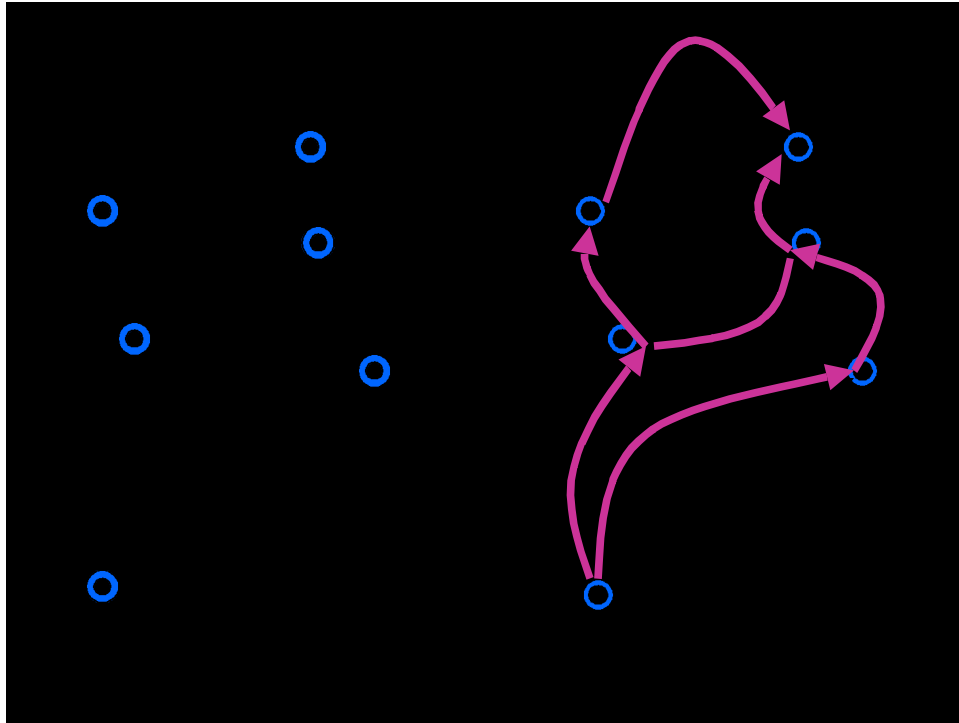
Strategies, constraint map

- Let S be a strategy graph, let G be a base graph with $Nodes(S) \hat{=} Nodes(G)$. Given a strategy-graph path $p = \langle a_0 a_1 \dots a_n \rangle$, we say that a path p' in G is an expansion of p if there exist paths p_1, \dots, p_n in G such that $p' = p_1 \cdot p_2 \dots p_n$ and: For all $0 < i < n+1$, $Source(p_i) = a_{i-1}$ and $Target(p_i) = a_i$.

10/15/98

AOO/Demeter

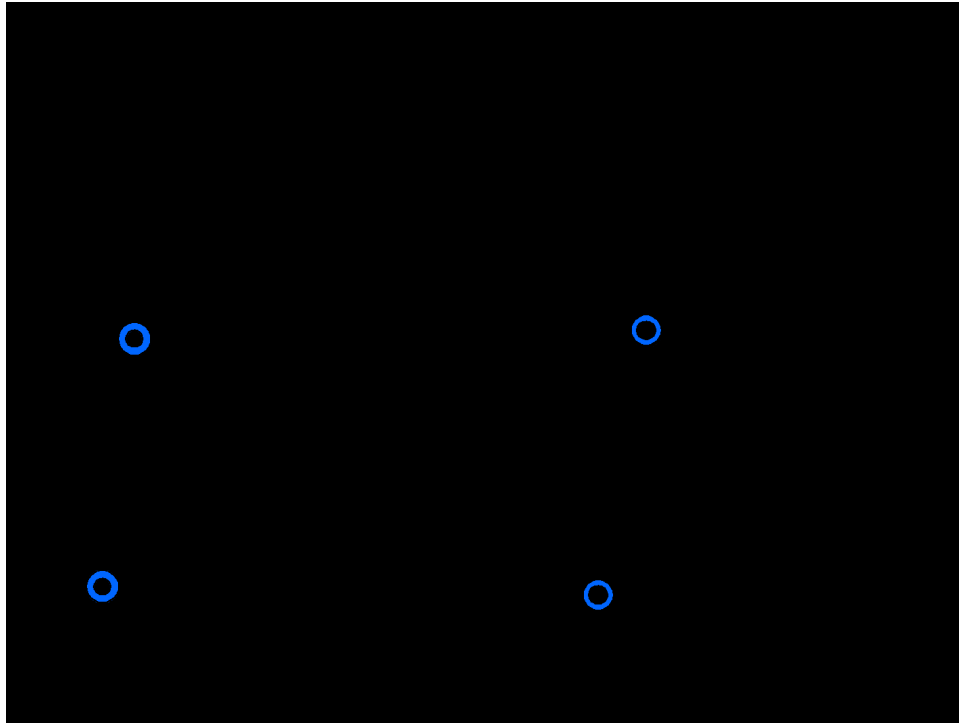
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Strategy graph and base graph are directed graphs

Key concepts

- A strategy graph G_1 is a *path-set-refinement* of a strategy graph G_2 if for all base graphs G_3 : $PathSet(G_3, G_1) \subseteq PathSet(G_3, G_2)$.
- Surprise?: co-NP-complete



Strategy graph and base graph are directed graphs

Key concepts

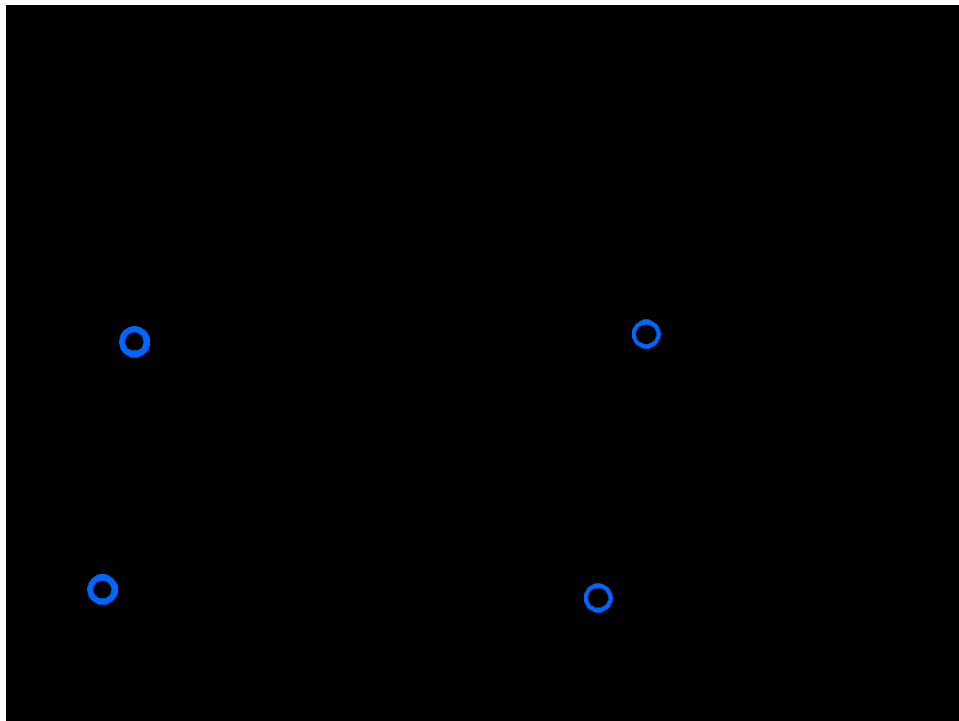
- A strategy graph G_1 is an *expansion* of a strategy graph G_2 if for any path p_1 (from s to t) in G_1 there exists a path p_2 (from s to t) in G_2 such that p_1 is an expansion of p_2 .
- Surprise? Co-NP-complete. Equivalent to path-set-refinement

Strategy graph and base graph are directed graphs

Key concepts

- A strategy graph G_1 is a *dual-expansion* of a strategy graph G_2 if for any path p_2 (from s to t) in G_2 there exists a path p_1 (from s to t) in G_1 such that p_1 is an expansion of p_2 .

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Key concepts

- Let $G_1=(V_1,E_1)$ and $G_2=(V_2,E_2)$ be directed graphs with V_2 a subset of V_1 . Graph G_1 is a **refinement** of G_2 if for all u,v in V_2 we have that $(u,v) \in E_2$ if and only if there exists a path in G_1 between u and v which does not use in its interior a node in V_2 .
- Polynomial. Implies path-set-refinement and expansion

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