An Abstract Argumentation Framework for Supporting Agreements in Agent Societies

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Index

- Motivation
- Background
- Abstract Argumentation Framework
- Agent Society
- AFs in Agent Societies (AFAS)
- AFAS objective
- Acceptability Semantics
- Water-rights transfer example

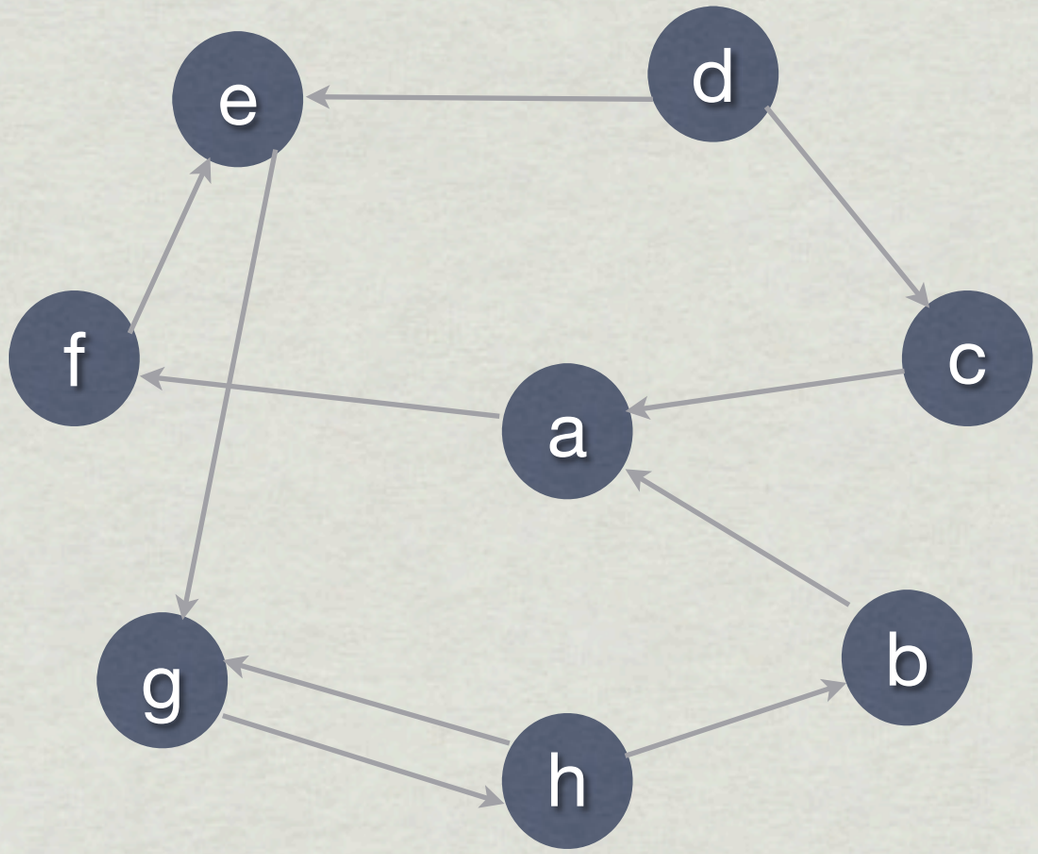
Motivation

- MAS require agents to have a way of reaching agreements that **harmonise conflicts**.
- Agents in MAS can form societies that link them via **dependency relations.**
- Agents' **social context** influences the way agents can argue:
  - Dependency relations.
  - Agents' values (e.g. solidarity, environmentalism)

Background

- Argumentation theory can be applied as a mechanism to reach agreements between agents.
- Current argumentation frameworks do not consider the social context of agents.
- Dung's Argumentation framework can be extended and adapted to agent societies:
  - AF = <A, R>
  - Acceptability Semantics.

Abstract Argumentation Framework



- AF = <A, R>
- A ={a, b, c, d, e f, g, h}
- R = {attacks(a,f), attacks(b,a), attacks(c,a), attacks(d,e), attacks(e,g), attacks(f,e), attacks(g,h), attacks(h,b), attacks(h,g)}

Agent Society

S_t = < Ag, RI, D, G, N, V, Role, $Dependency_{St}$, Group, Values,$Valpref_q$ >

- Ag = {ag_1, ag_2, ..., ag_I}
- RI = {rl_1, rl_2, ..., rl_I}
- D = {d_1, d_2, ..., d_K}
- G = {g_1, g_2, ..., g_L} / g_I = {ag_1, ag_2, ..., ag_M}
- N = normative context of S_t
- V = {v_1, v_2, ..., v_P}

- Role: Ag -> 2^R
- $Dependency_{St}$: $<_D^{S_t} \subseteq$ R x R
  - e.g. farmer $<_d^{S_t}$ administrator
- Group: Ag -> 2^G
- Values: Ag -> 2^V
- $ValPref_q$: $<_q^{S_t} \subseteq$ V x V / q = ag $\vee$ gr
  - e.g. economy $<_{ag_1}^{S_t}$ solidarity

AFs in Agent Societies

- Argumentation Framework for an Agent Society:
  - AFAS = <A, R, S_t>
- Audience: specific preference order over values.
- Agents form part of a specific audience.
- Agent-specific Argumentation Framework in an Agent Society:
  - AAFAS = <Ag, Rl, D, G, N, A, R, V, Role, $Dependency_{st}$, Group, Values, val, $Vapref_{agi}$>
    - val(ag,a): Ag x A -> 2^V
    - $Valpref_{agi}$: $<^{S_t}_{ag_i} \subseteq$ V x V

AFAS objective

- Aim of the AFAS: determine which agent's arguments attack other agent's argument and which will win the attack (defeat the other).
  - Values
  - Value preference relations
  - Dependency relations:
    - Power
    - Authorisation
    - Charity

Acceptability Semantics

- Assuming that agent ag_1 has put forward argument a_1 and agent ag_2 has put forward argument a_2 in the society S_t:

- **defeats$_{ag1}$(a_1, a_2)** iff attacks(a_1, a_2) $\wedge$

  (val(ag_1, a_1) $<^{S_t}_{ag_1}$ val(ag_1, a_2) $\notin$ ValPref$_{ag1}$) $\wedge$

  (Role(ag_1) $<^{S_t}_{Pow}$ Role(ag_2) $\vee$ Role(ag_1) $<^{S_t}_{Aut}$ Role (ag_2))

  $\notin$ Dependency$_{St}$

Acceptability Semantics

- **Conflict-free:** a set of arguments ARG is conflict-free for an agent ag_1 in the society S_t iff

  $\nexists a_1, a_2 \in ARG / (attacks(a_1,a_2) \vee attacks(a_2,a_1)) \vee$

  $(val(ag_1, a_1) <^{S_t}_{ag_1} val(ag_1, a_2) \notin ValPref_{ag1}) \wedge$

  $(Role(ag_1) <^{S_t}_{Pow} Role(ag_2) \vee Role(ag_1) <^{S_t}_{Aut} Role\ (ag_2))$

  $\notin Dependency_{St}$

- **Acceptability:** an argument $a_1 \in A$ is acceptable in S_t wrt the set of arguments $ARG \in A$ iff

  $\forall\ a_2 \in A \wedge defeats_{ag1}(a_2, a_1) \rightarrow \exists\ a_3 \in ARG \wedge defeats_{ag1}(a_3, a_2)$

Acceptability Semantics

- **Admissibility:** a conflict-free set of argument ARG $\in$ A is admissible for an agent ag iff

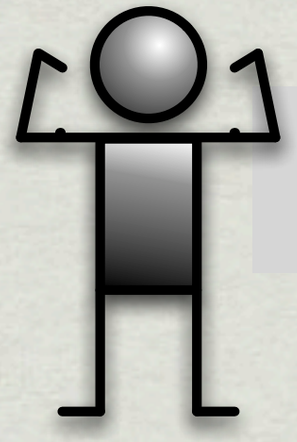
  $\forall$ a $\in$ ARG -> acceptable_{ag}

- **Preferred extension:** a set of arguments ARG $\in$ A is a $\text{preferred-extension}_{ag}$ for an agent ag if it is a maximal (wrt set inclusion) admissible_{ag} subset of A

Water-rights transfer Example

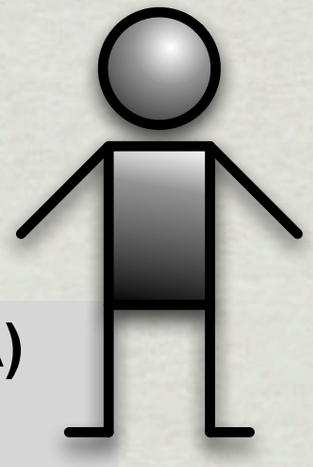
Farmer 1 (F1)

ValPref: SO < J < EC



Farmer 2 (F2)

ValPref: J < EC < SO



Basin Administrator (BA)

ValPref: EC < SO < J

- Water-right: contract that establishes the use of water that a user can do (volume,price,district...).
- Farmer $<^{RB}_{Ch}$ Farmer; Farmer $<^{RB}_{Pow}$ Basin Administrator

Water-rights transfer Example

F1 -> A1 (F1w): F1 should be the beneficiary of the transfer because its land is closer to the offered water-right and thus promote economy.

F1 -> A2 (F2nw): F1 should not be the beneficiary of the transfer to help F2 and thus promote solidarity.

F2 -> A3 (F2w): F2 should be the beneficiary of the transfer because its land is dry and needs an urgent irrigation, which promotes solidarity.

F2 -> A4 (F2nw): F2 should not be the beneficiary of the transfer to help F1 and thus promote economy.

F1 -> A5 (F1w&F2nw): F2 should allow F1 to be the beneficiary of the transfer to avoid the intervention of a jury.

F2,BA -> A6 (F1nw&F2w): F1 should allow F2 to be the beneficiary of the transfer to avoid the intervention of a jury.

Water-rights transfer Example

A3
F2w
SO

A1
F1w
EC

A5
F1w&F2nw
J

A6
F1nw&F2w
J

A2
F1nw
SO

A4
F2nw
EC

AFAS

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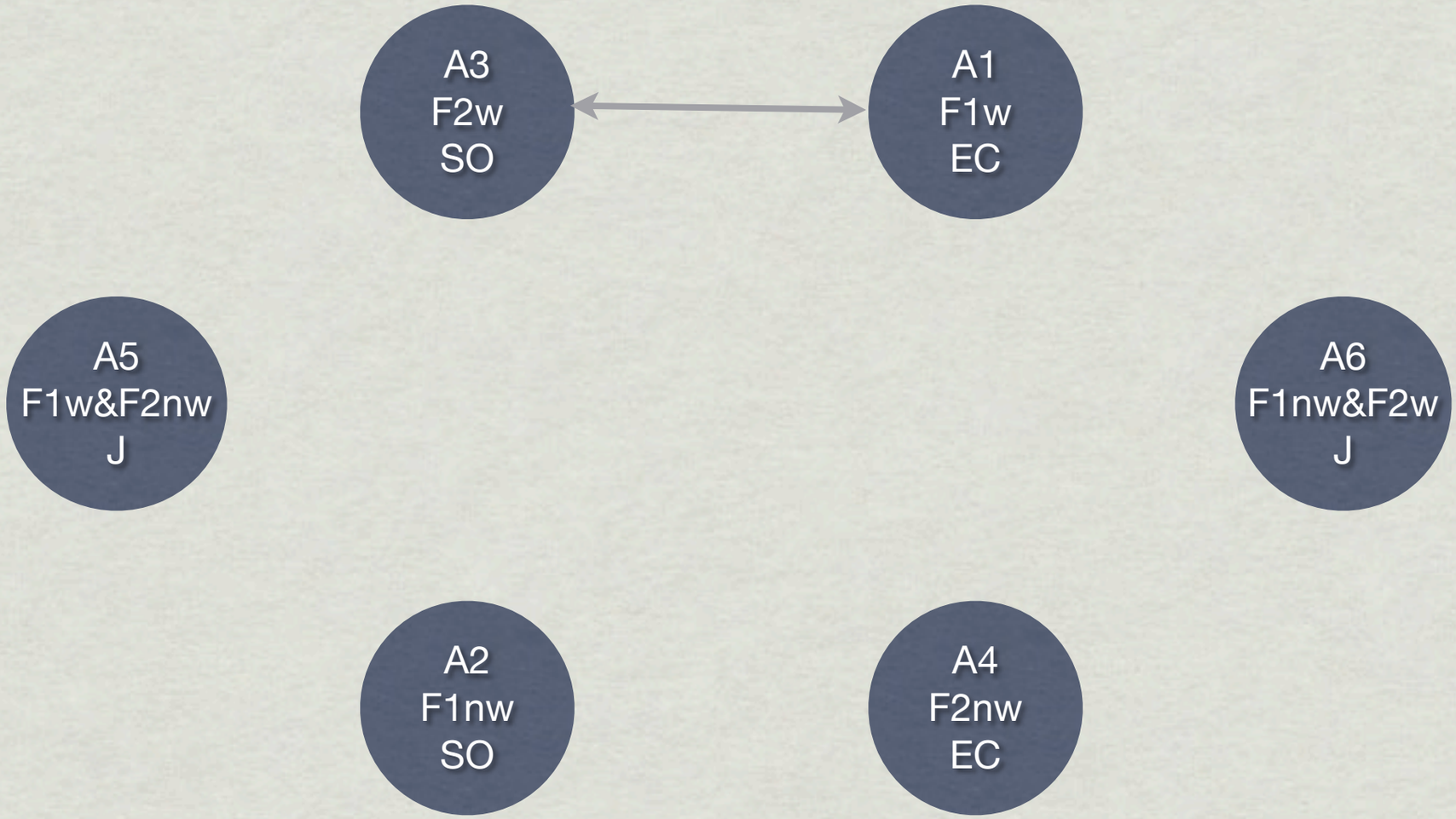

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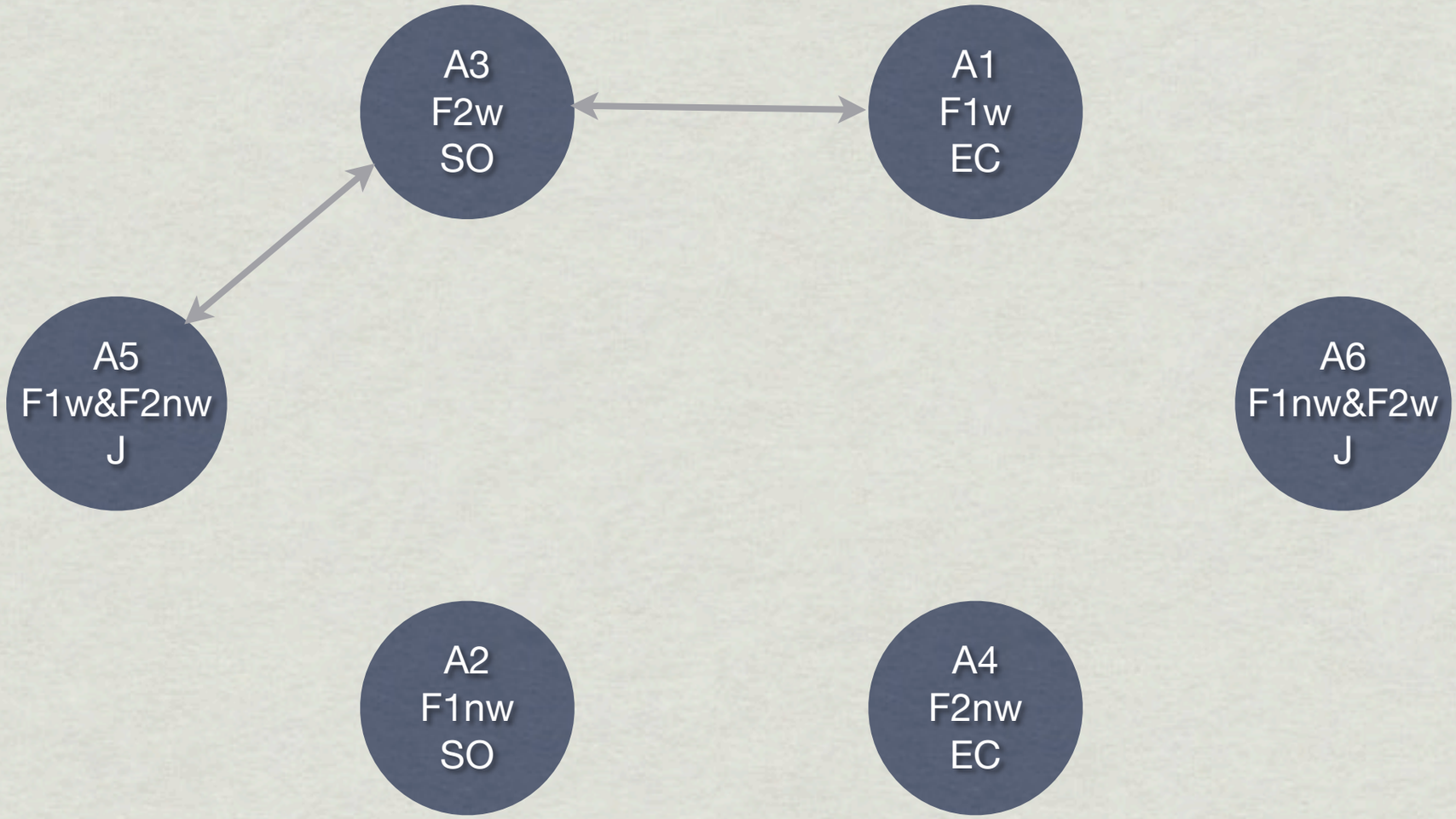

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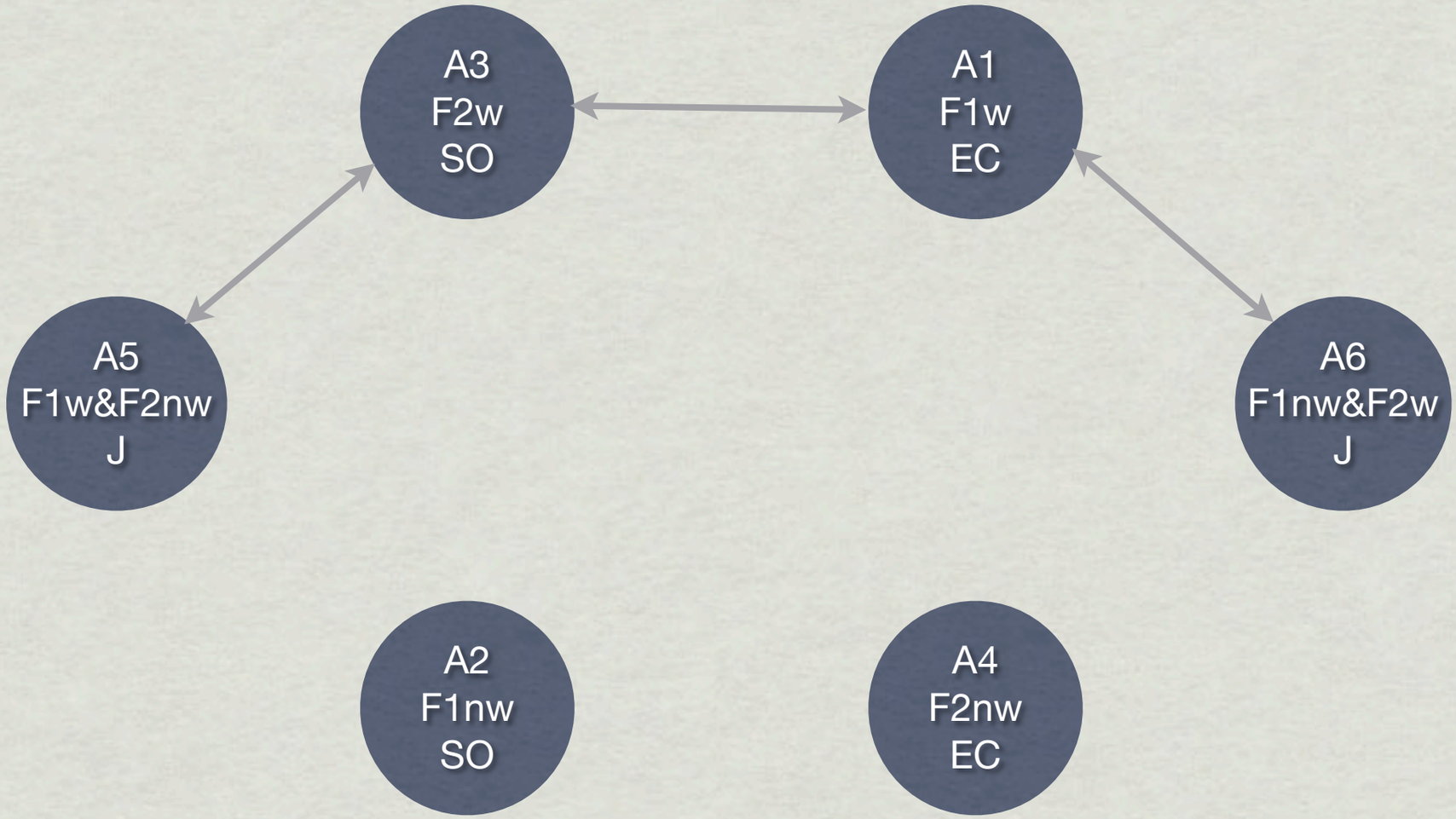

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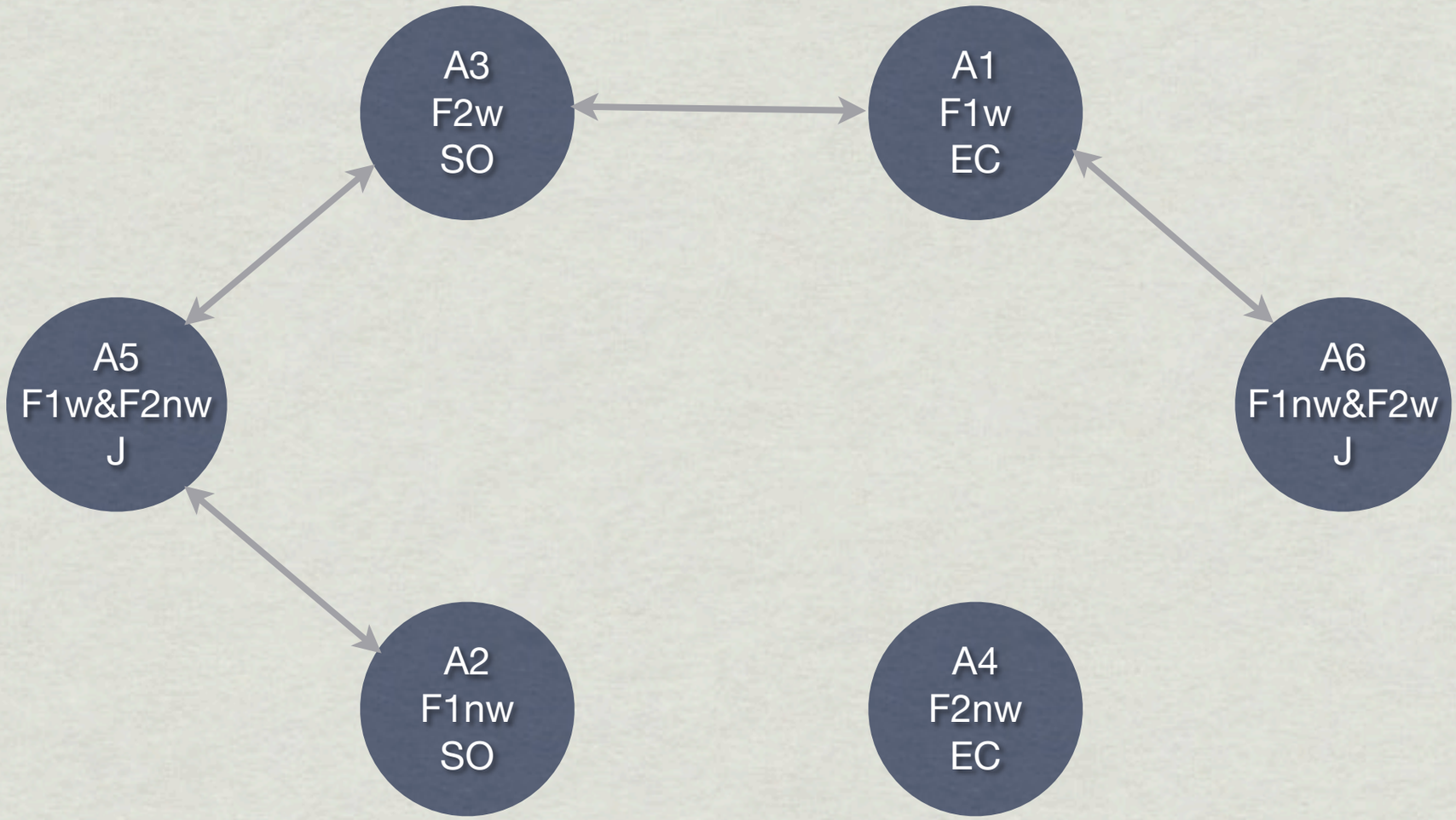

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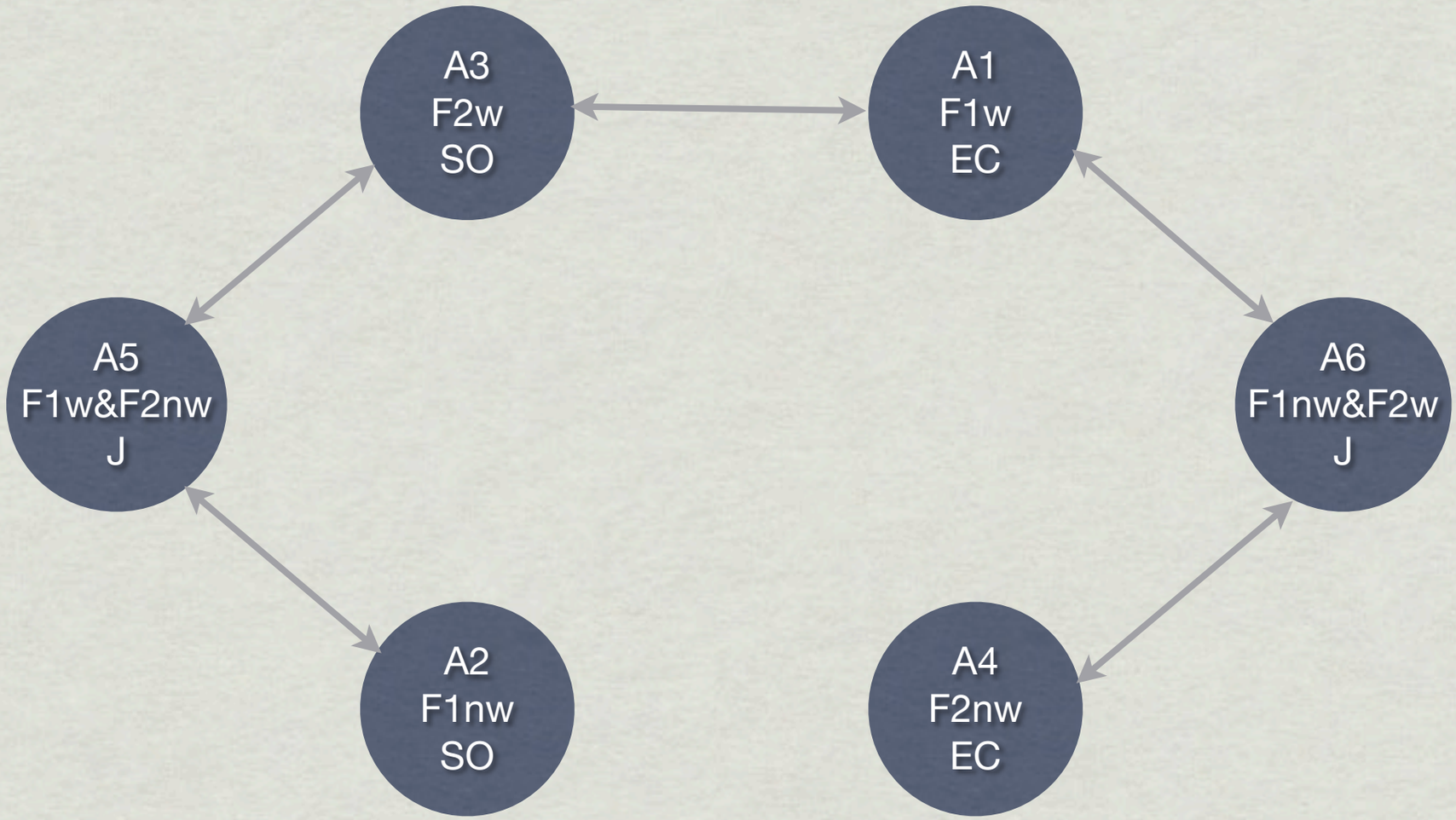

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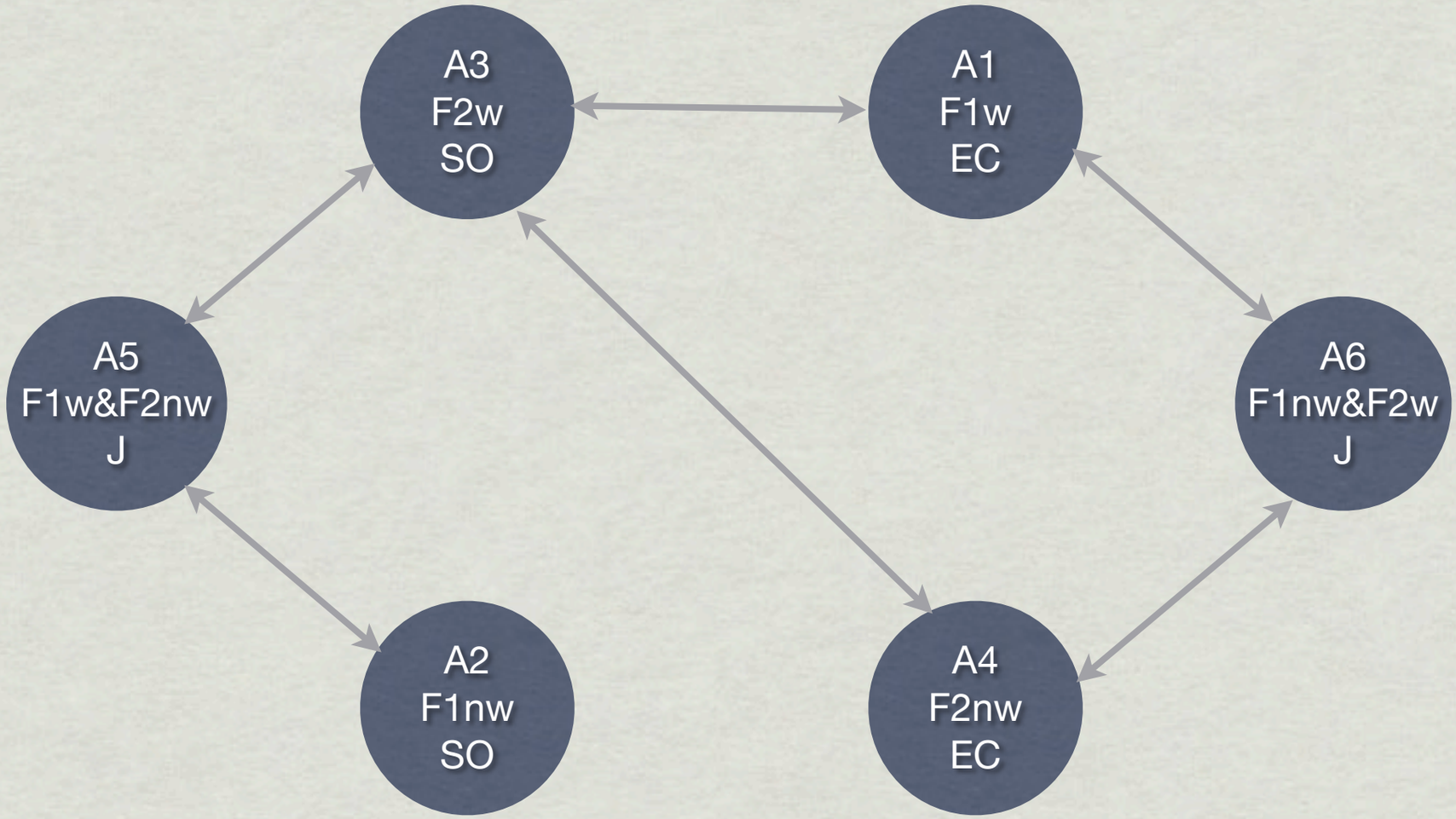

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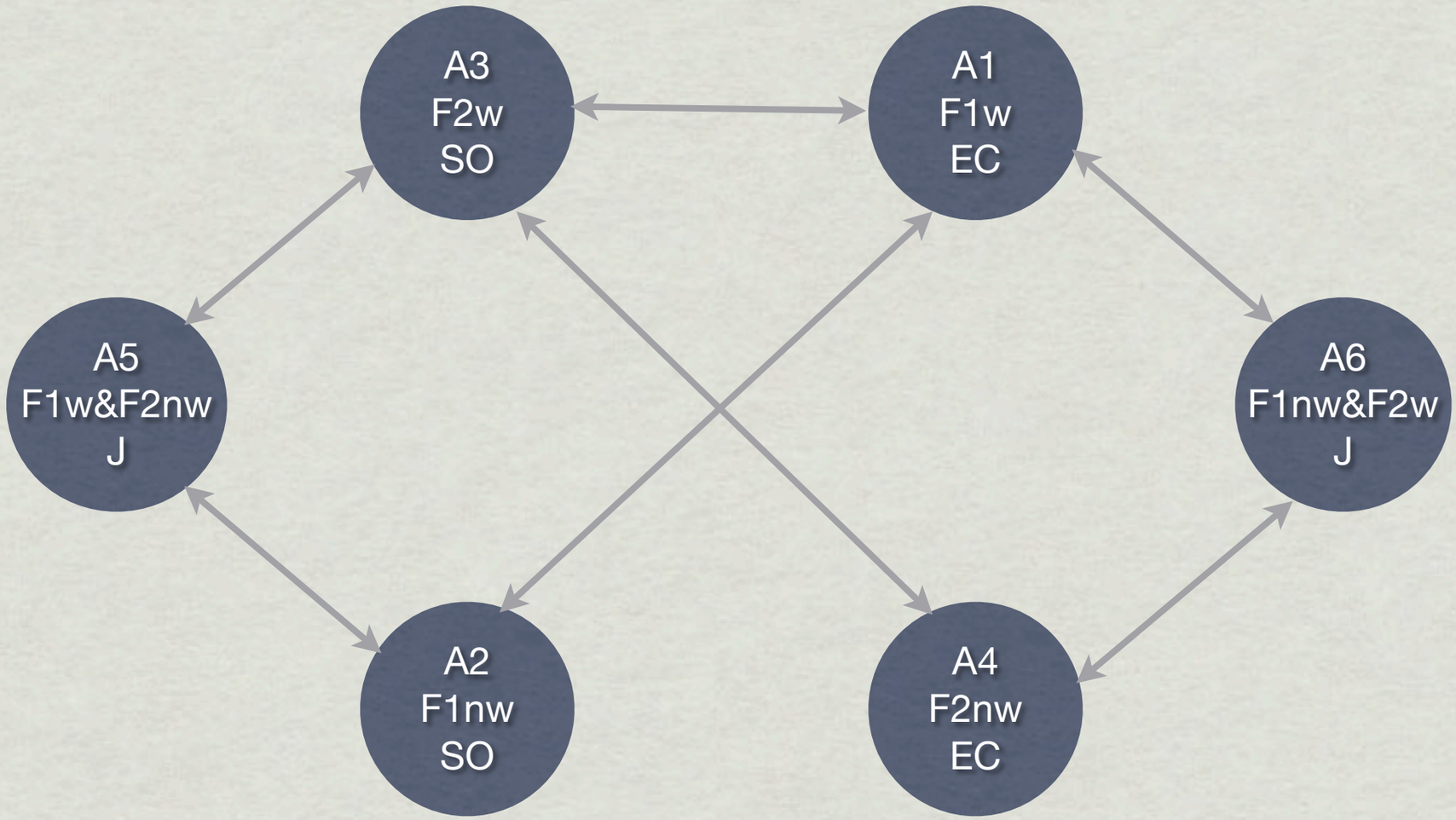

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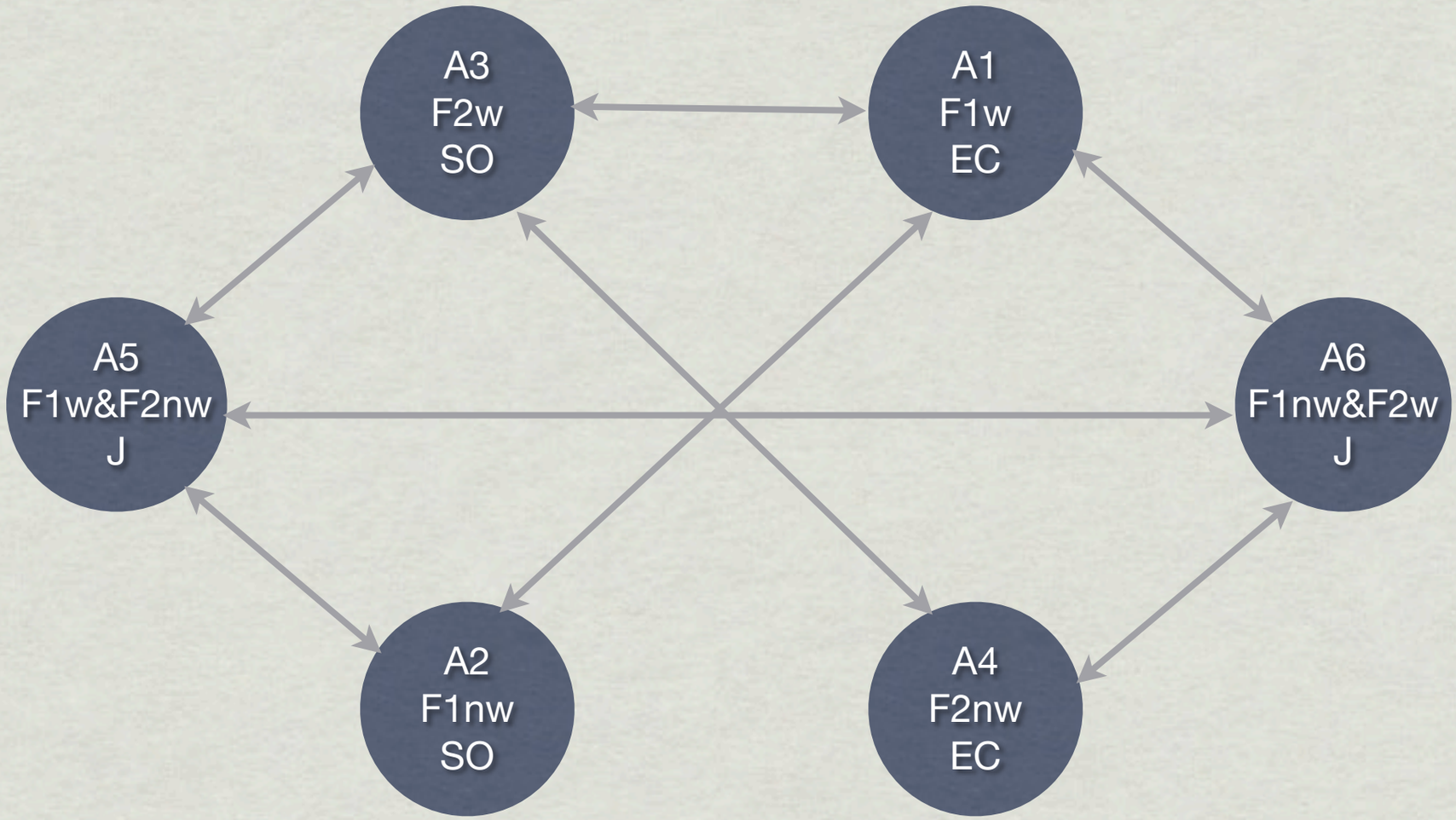

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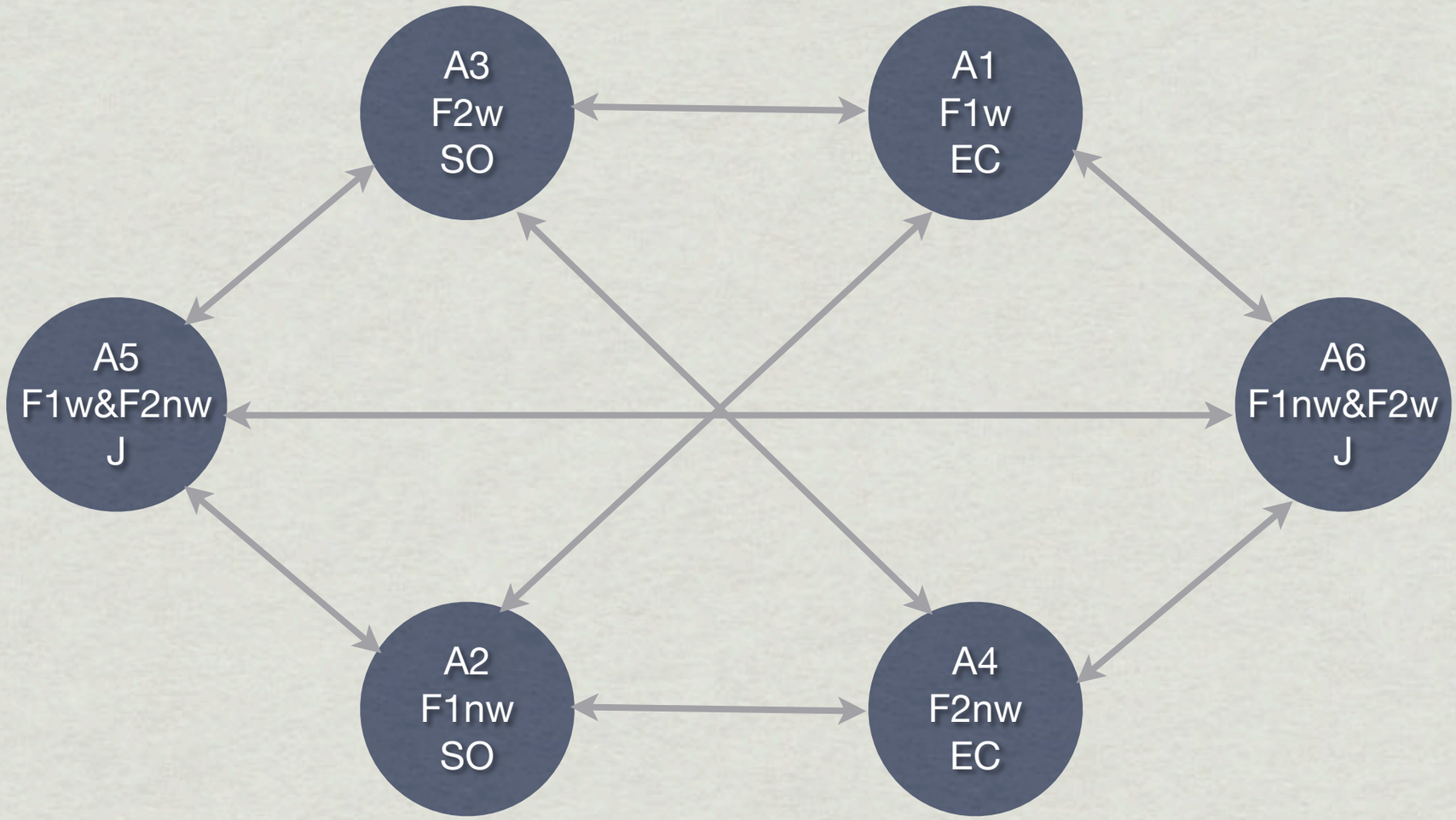

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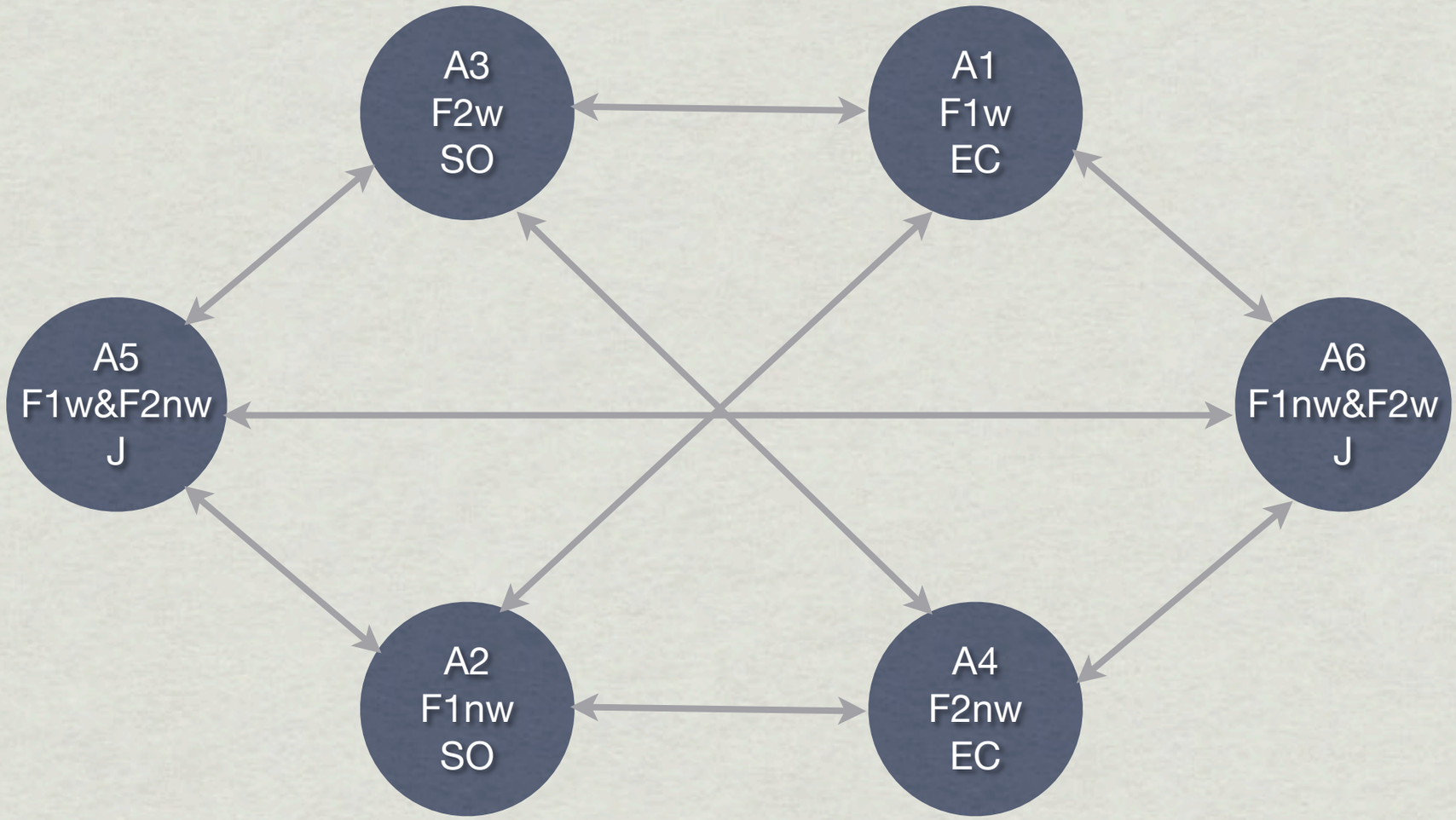
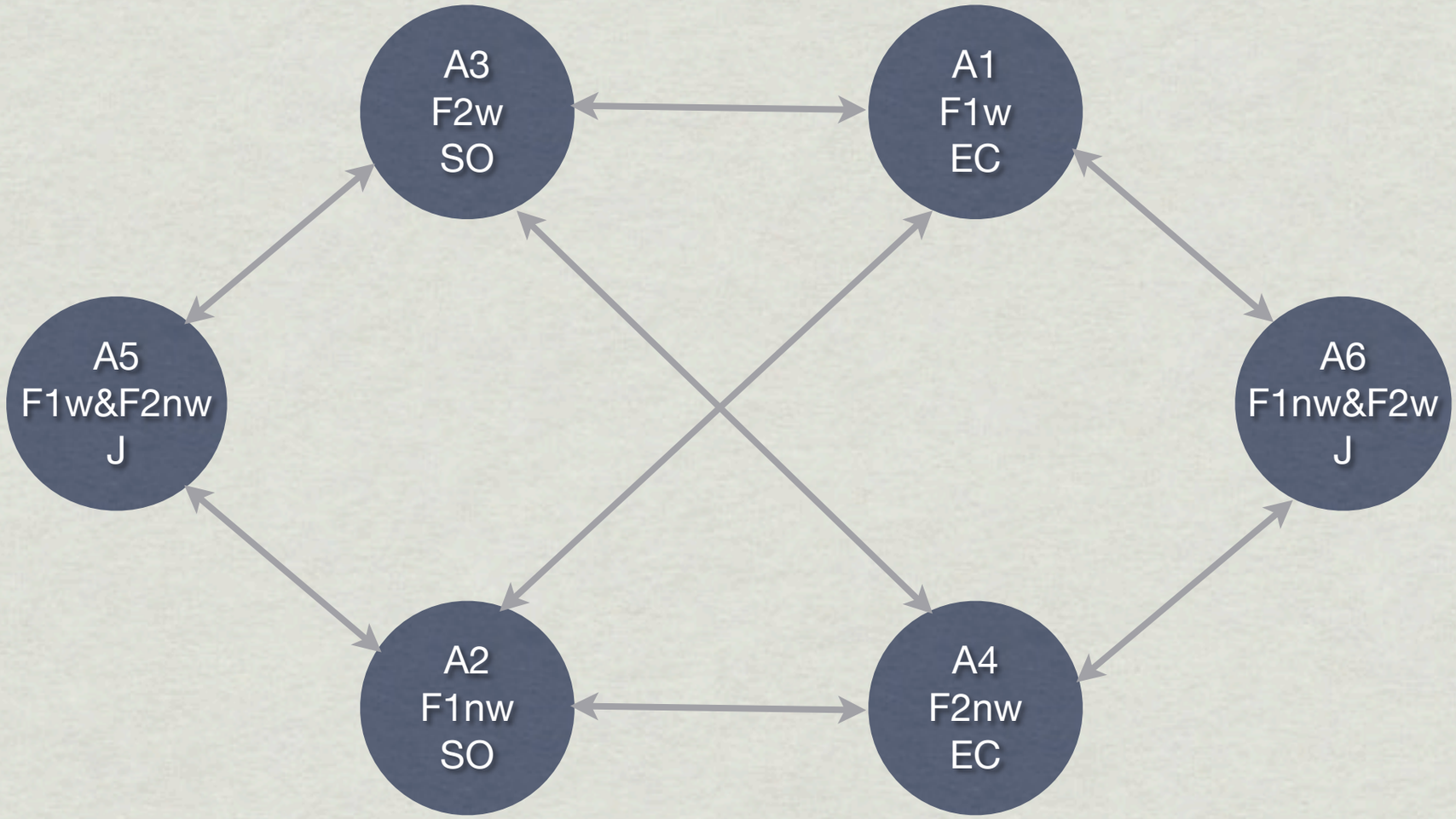


AFAS$_{F1}$

- **F1:** SO < J < EC

- Farmer $<^{RB}_{Ch}$ Farmer
- Farmer $<^{RB}_{Pow}$ Basin Administrator

Water-rights transfer Example



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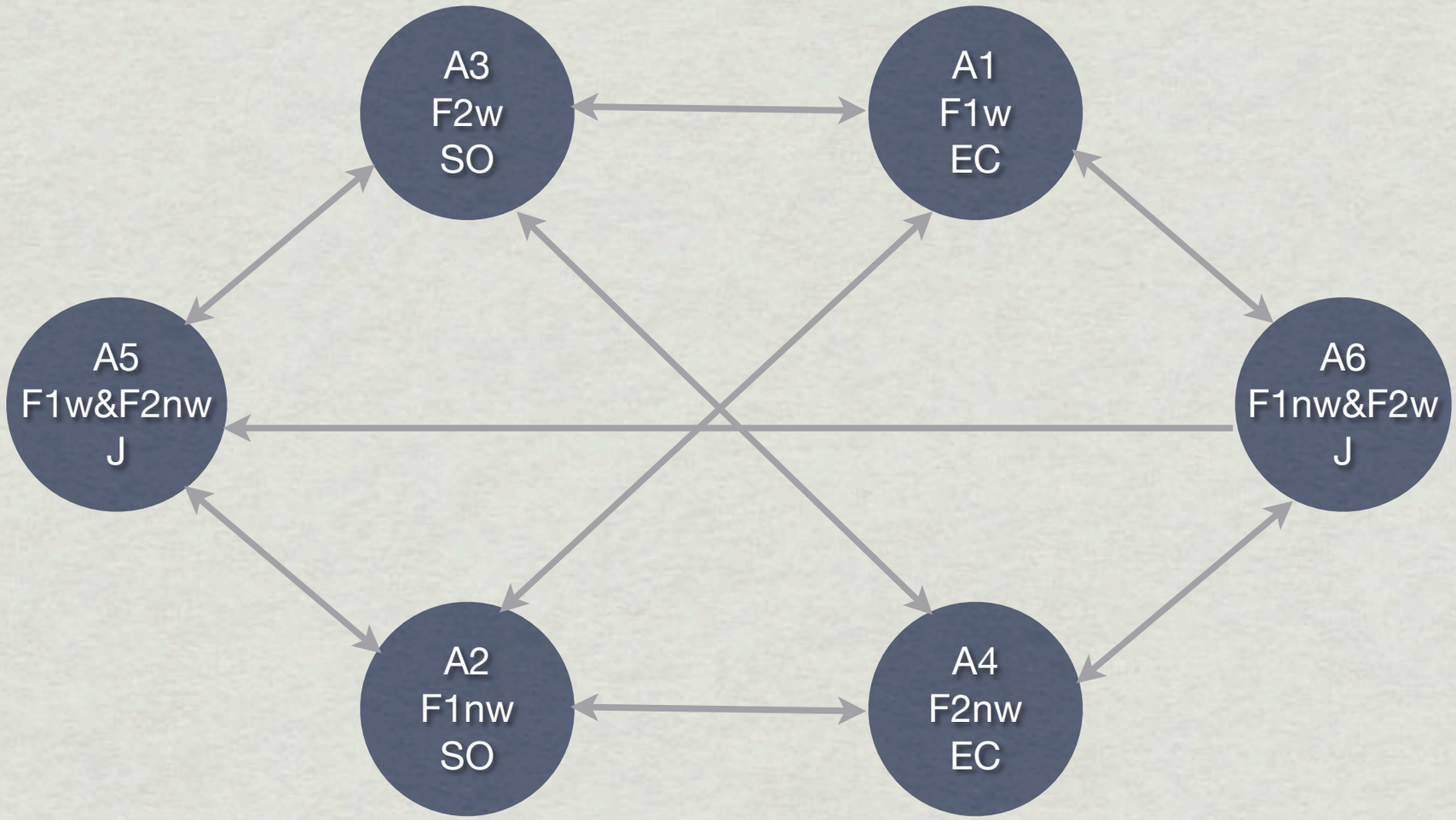

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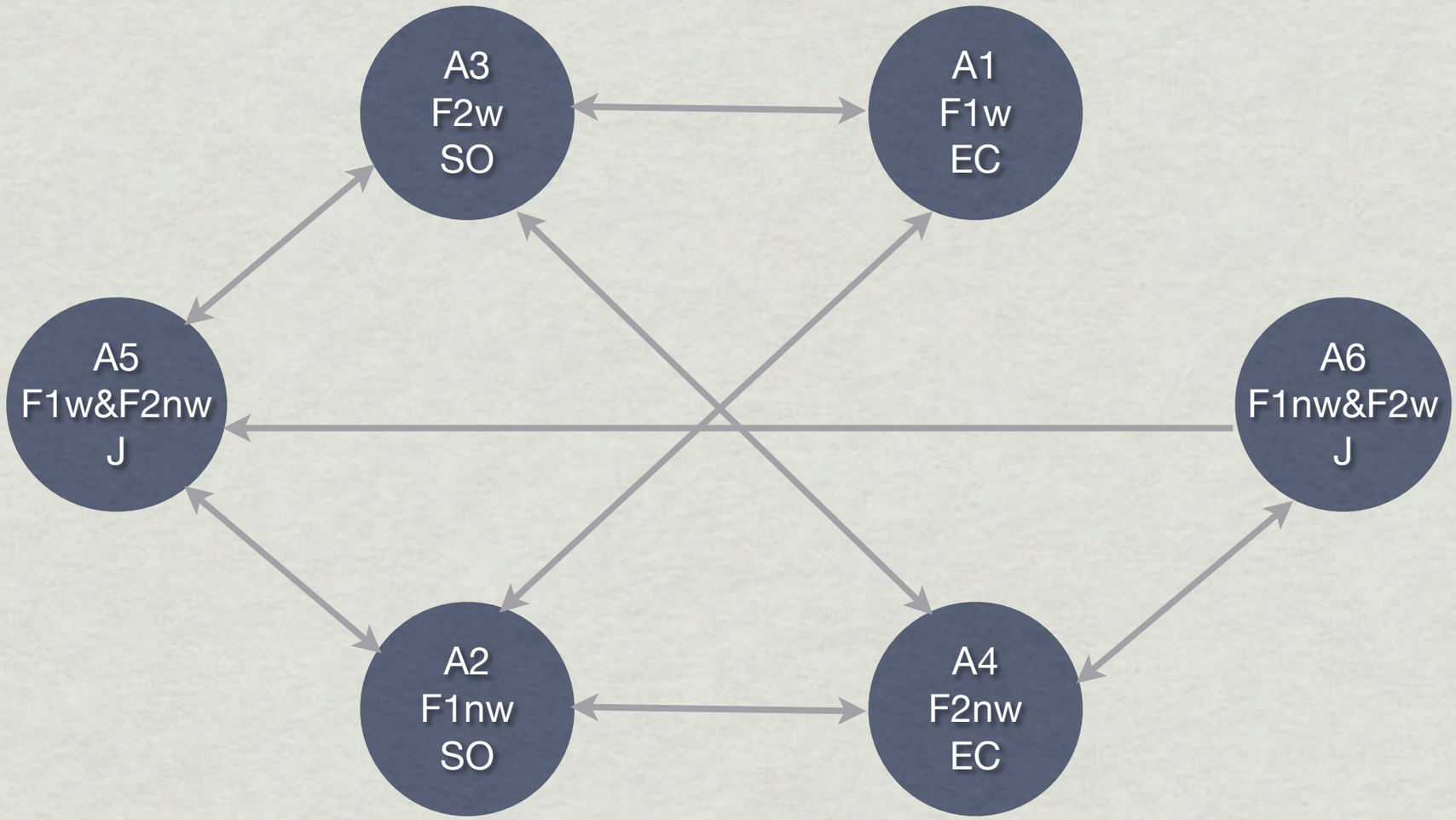

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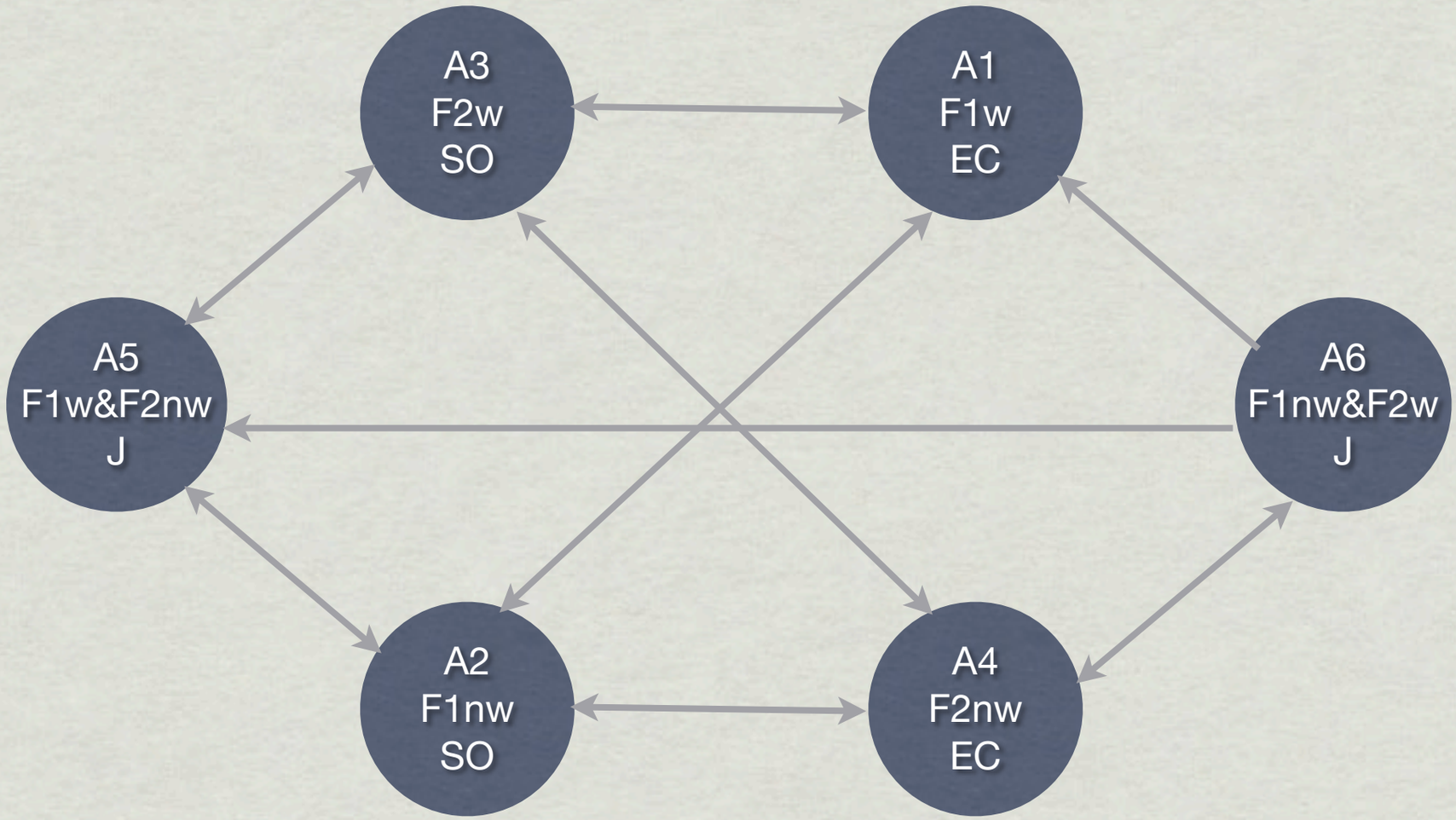

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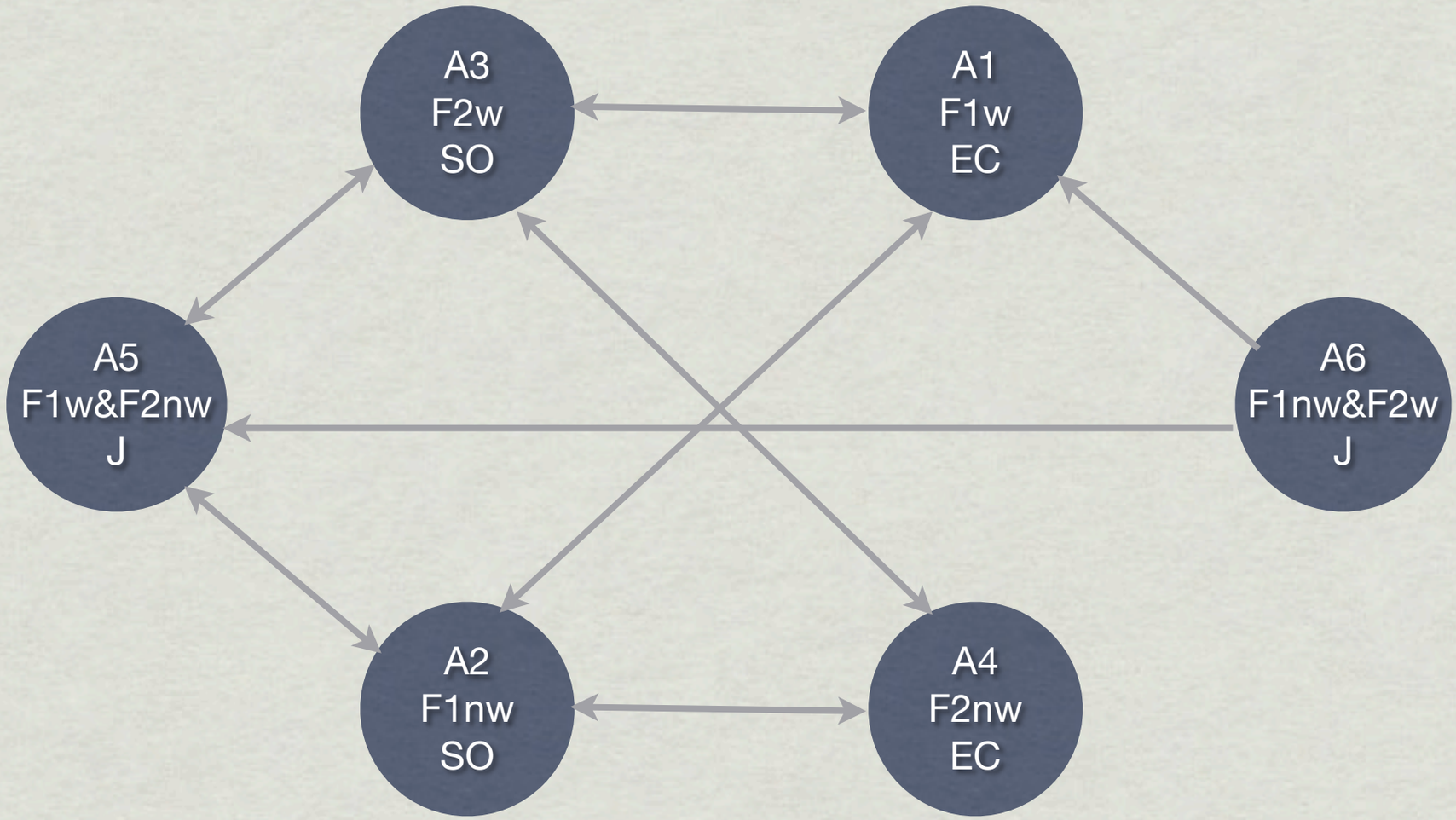

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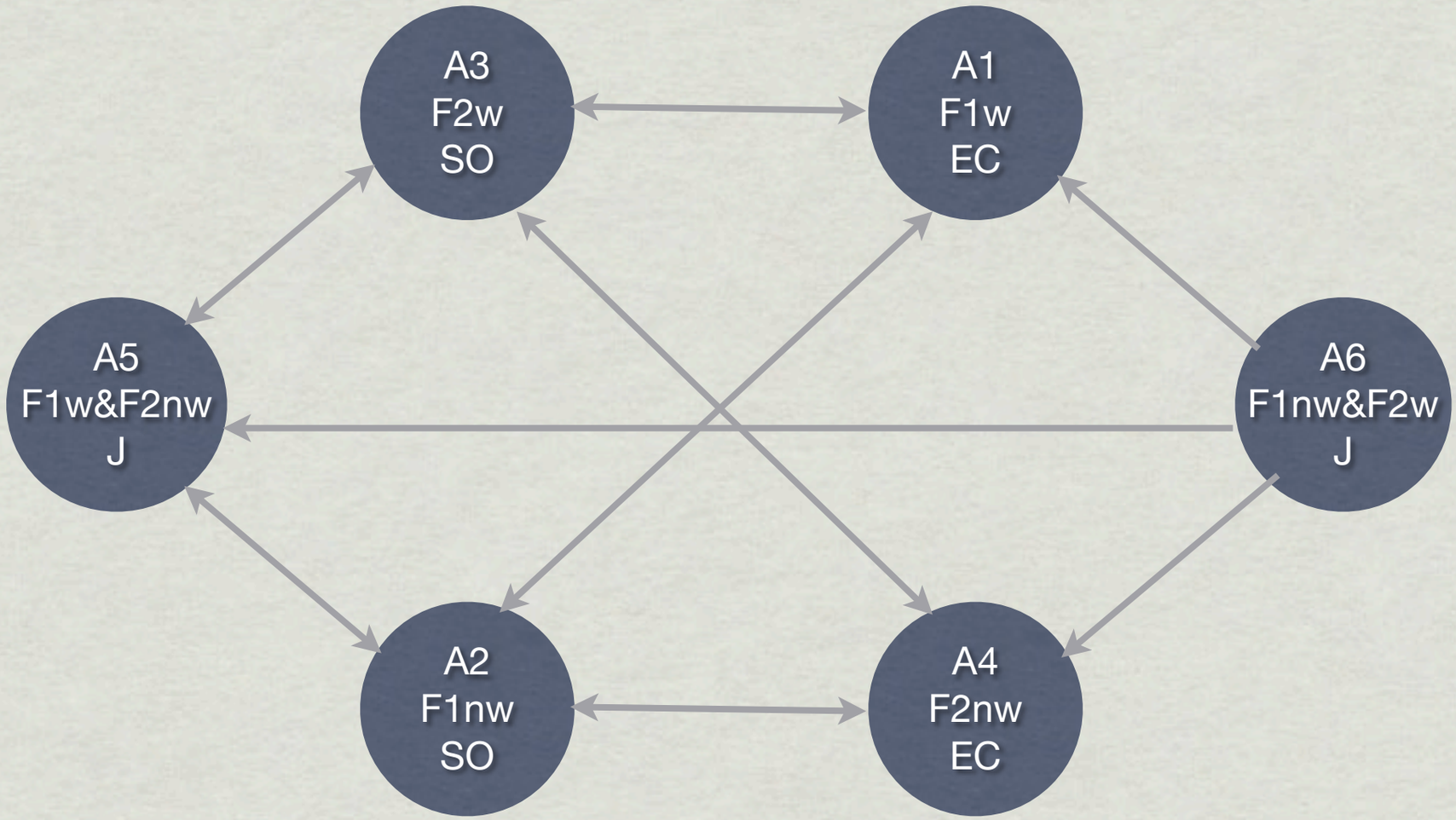

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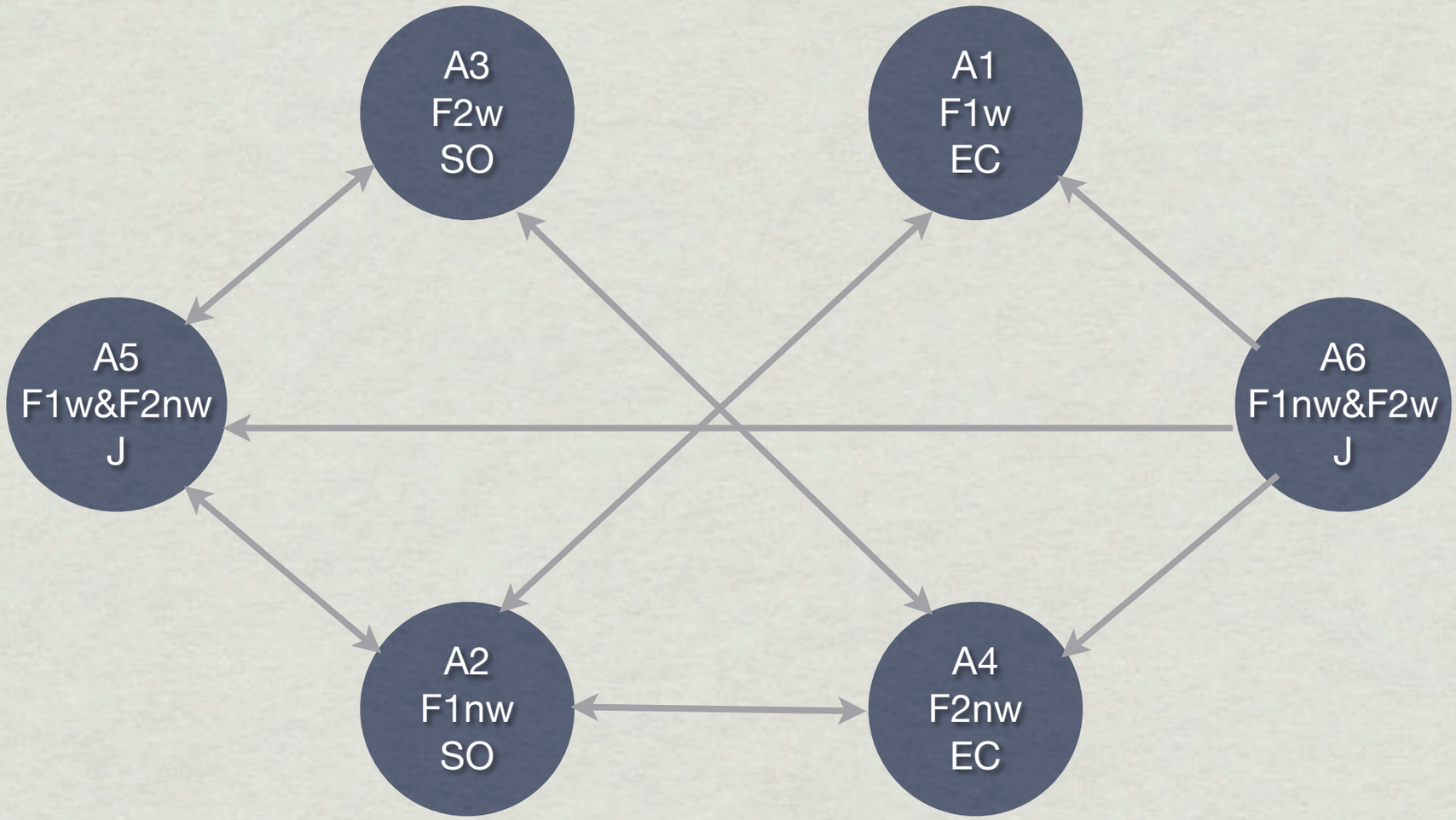

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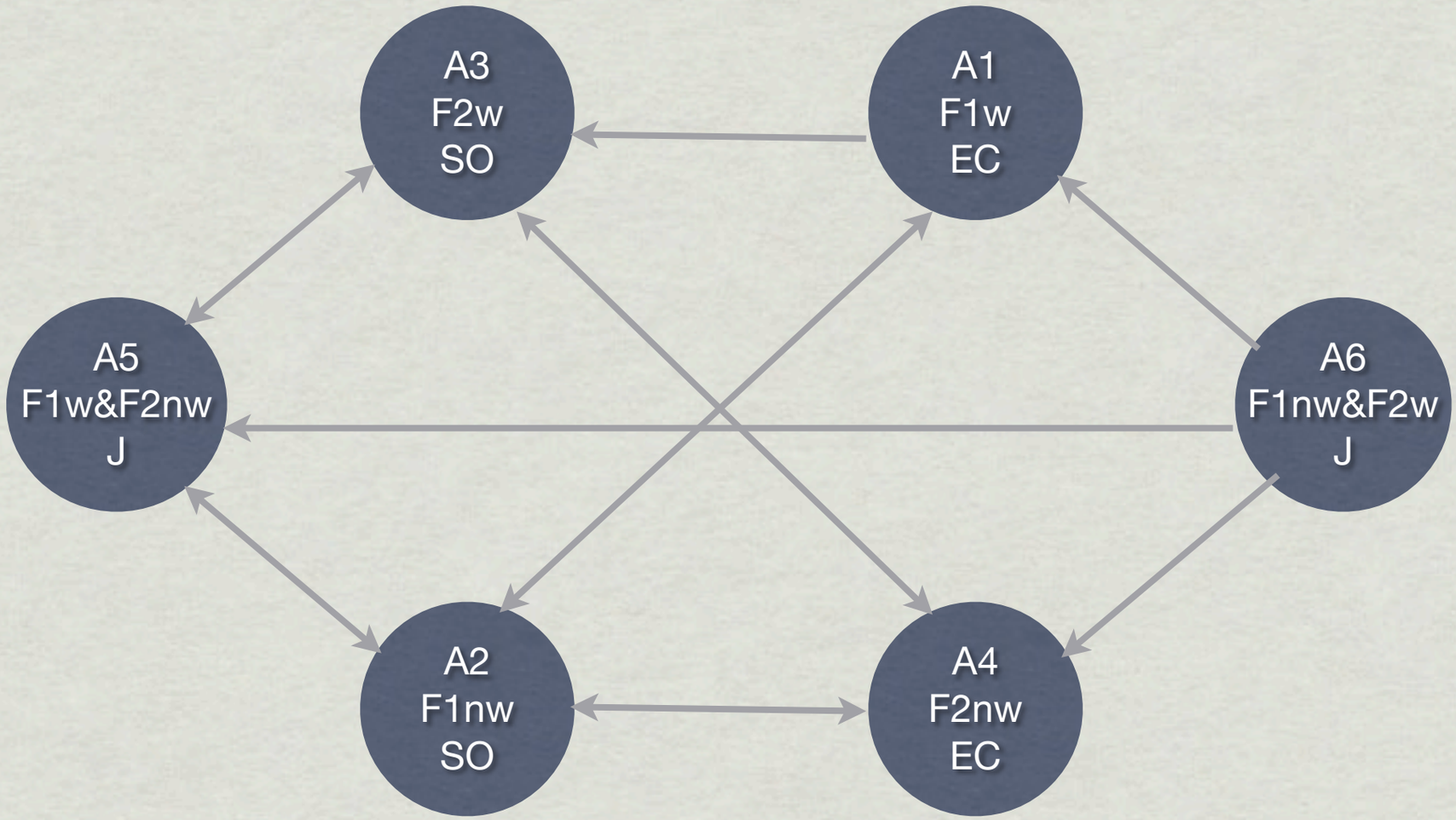

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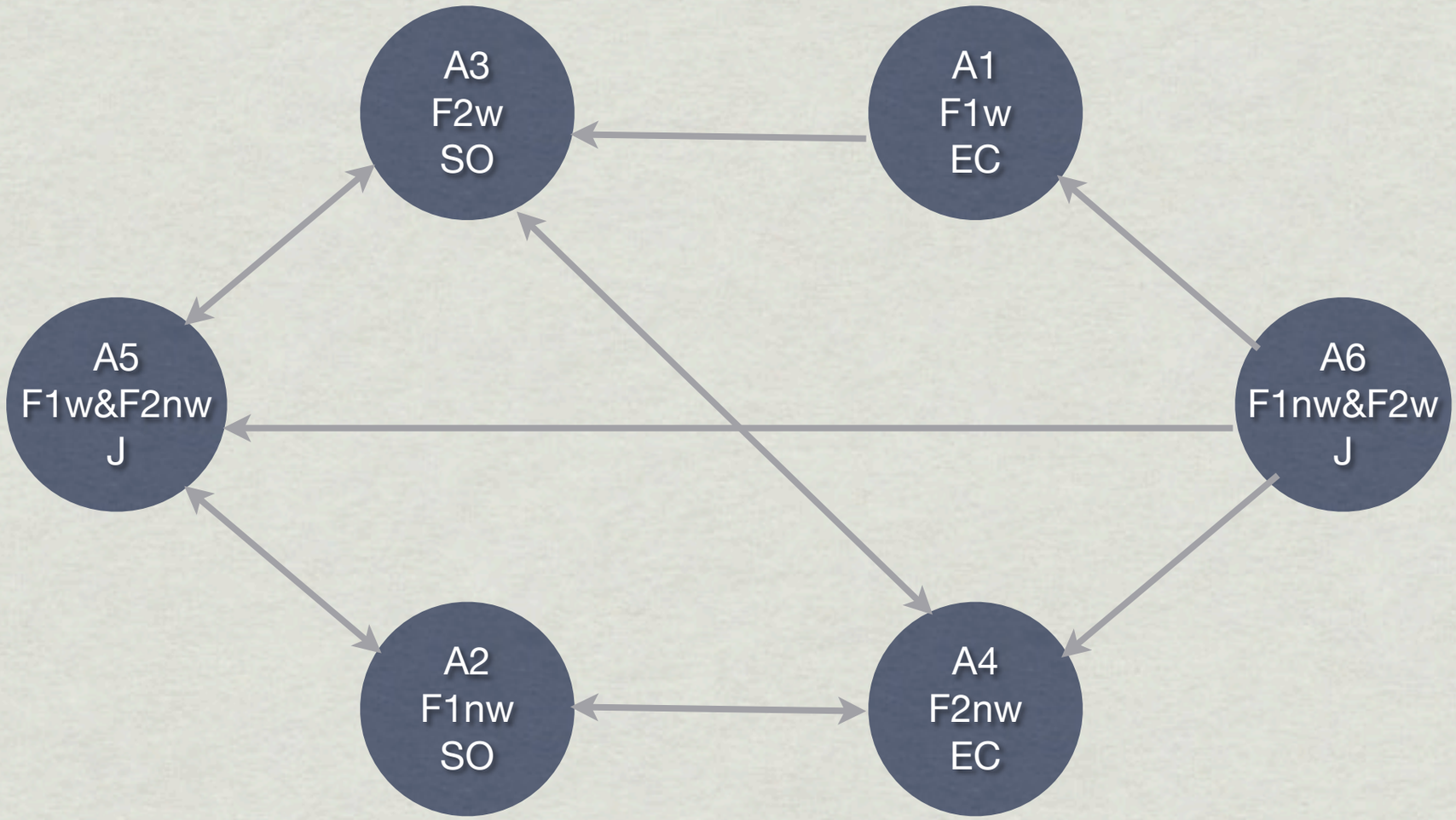

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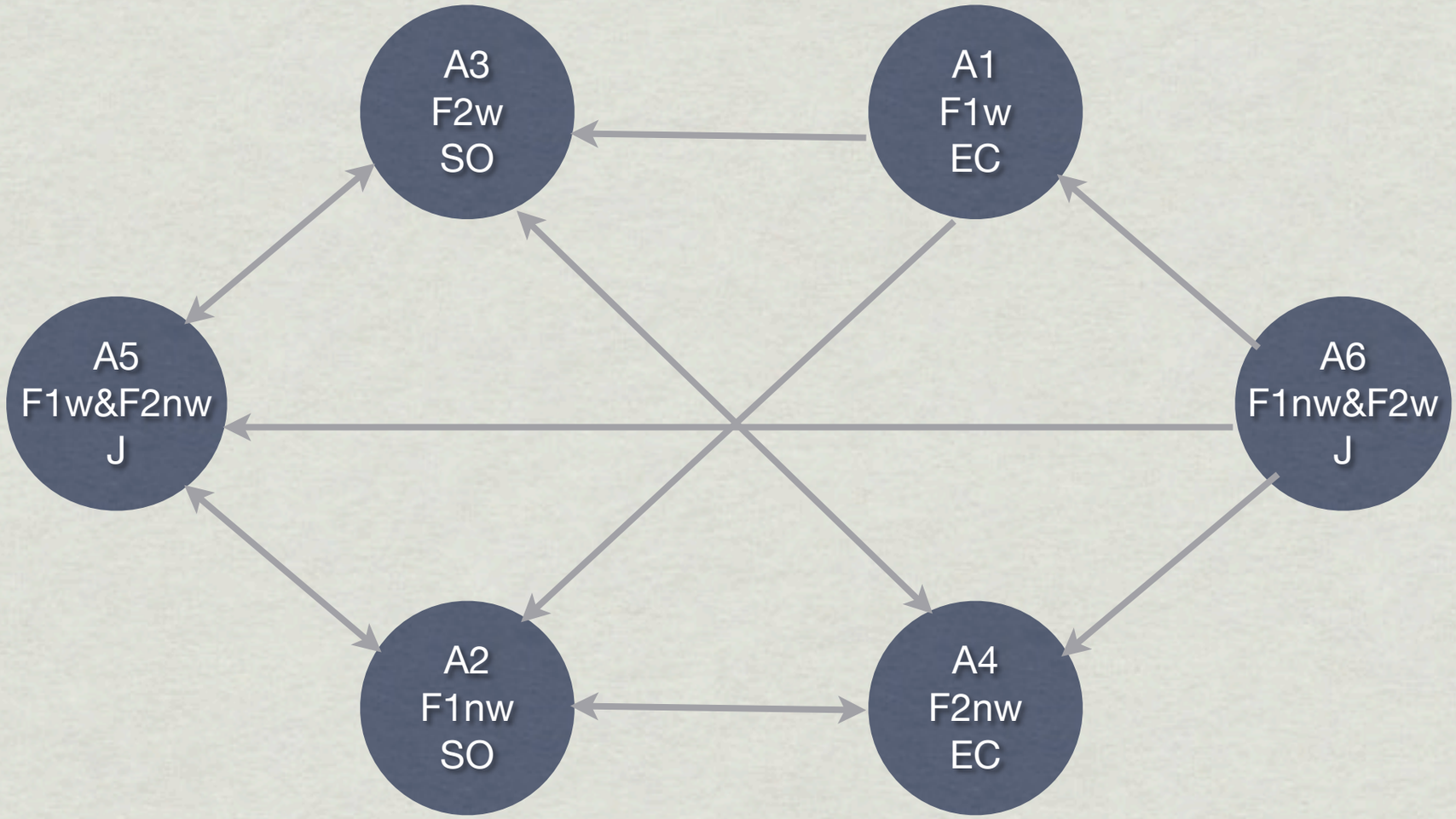

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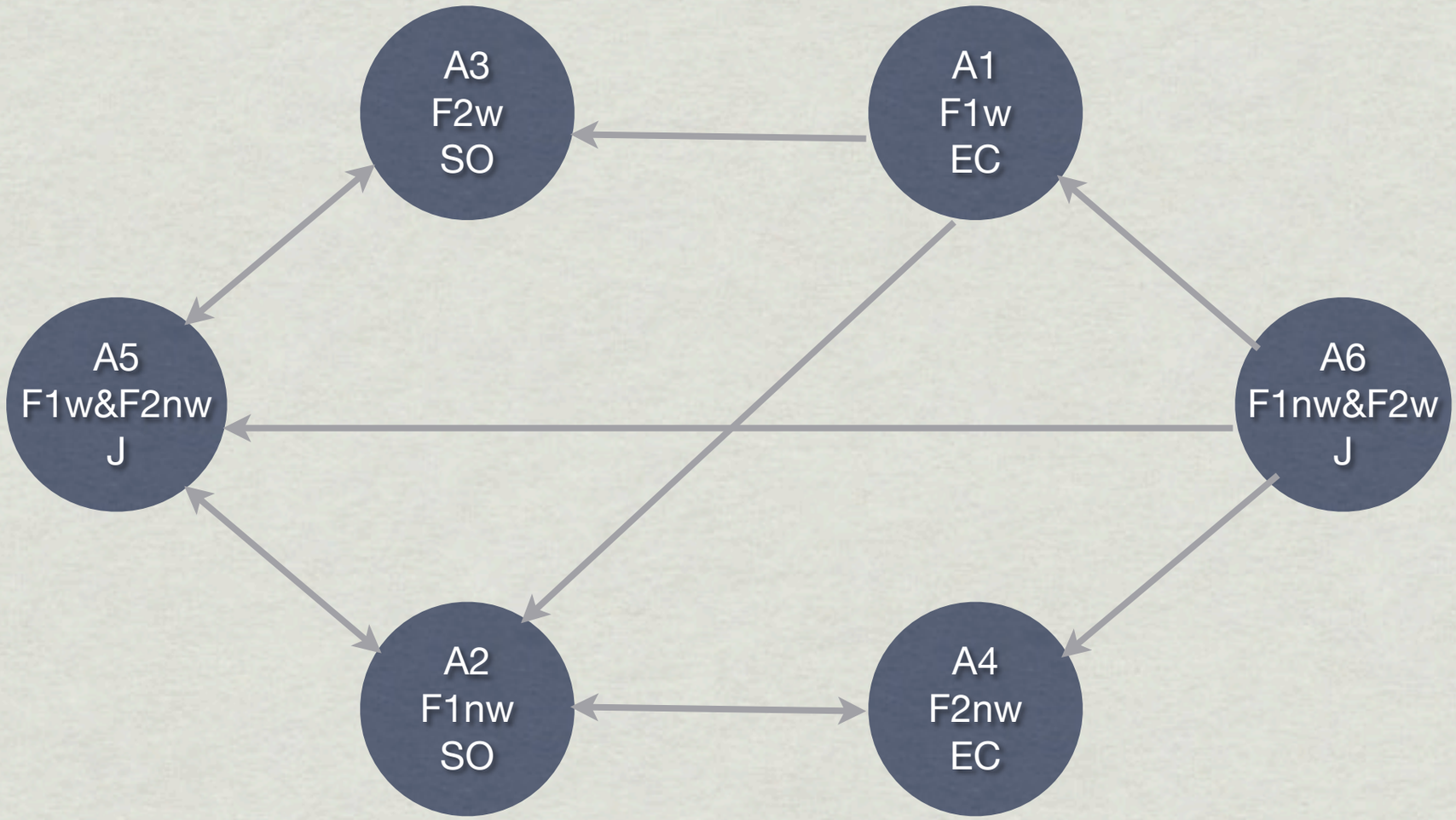

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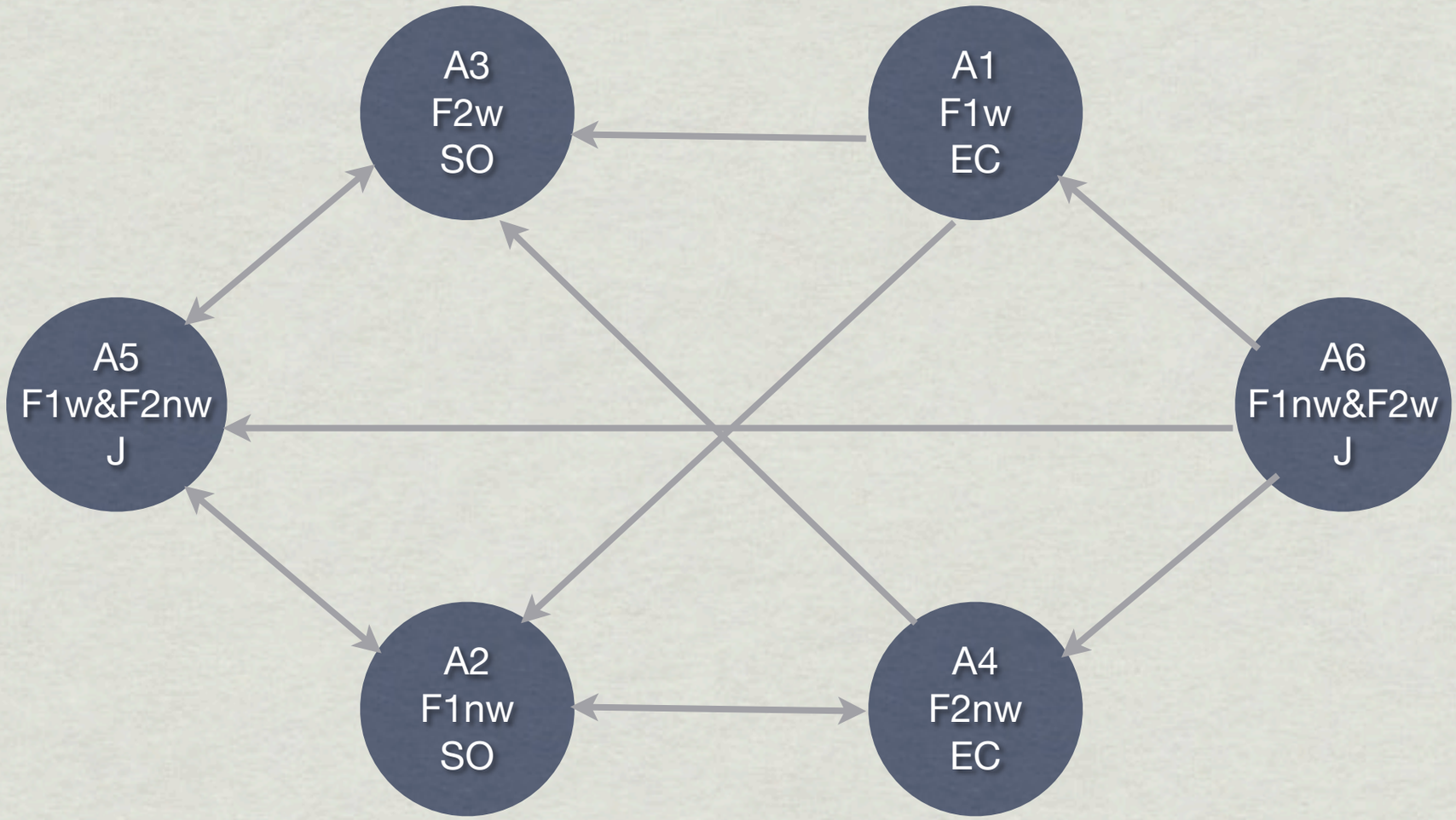

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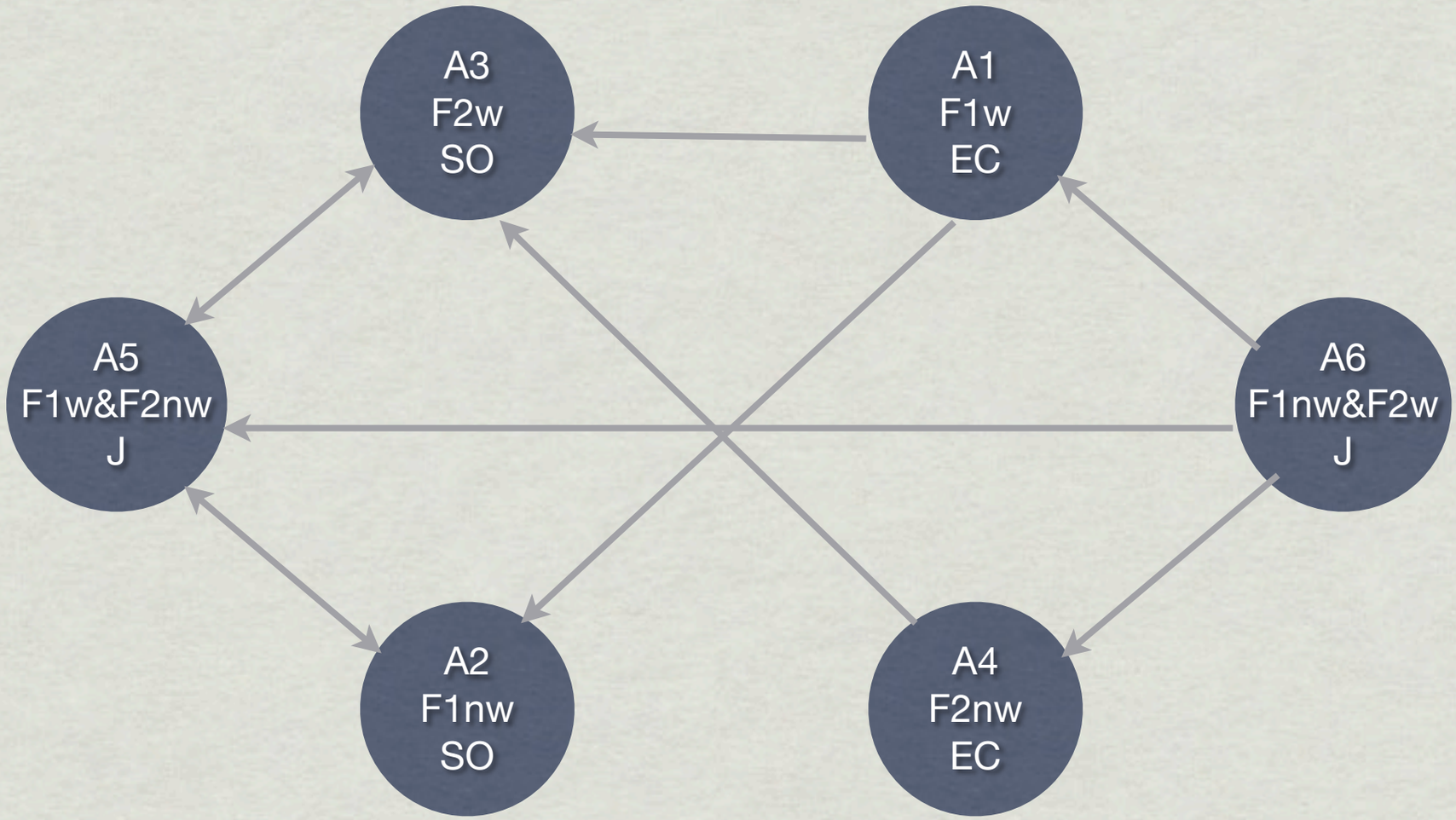

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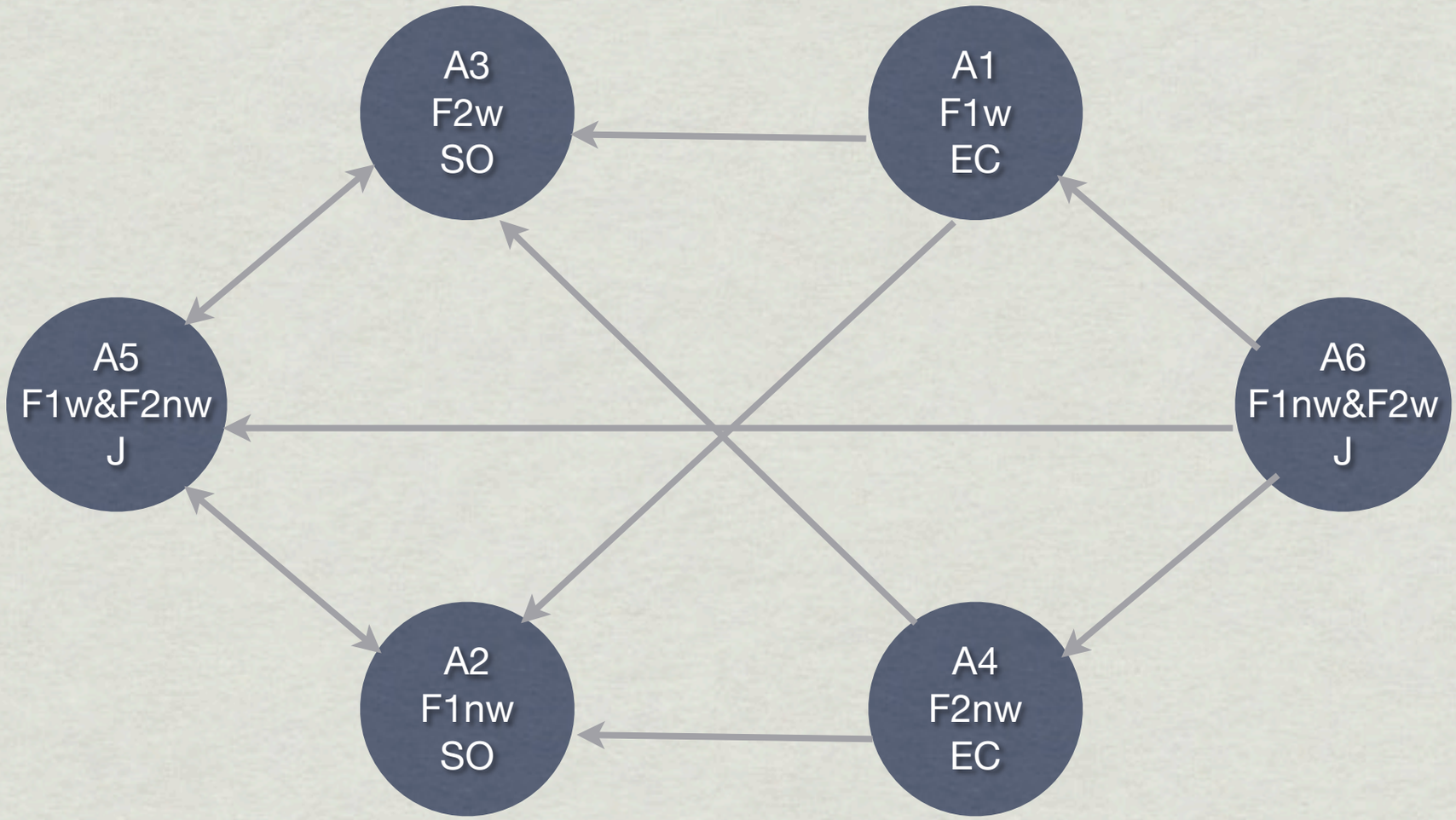

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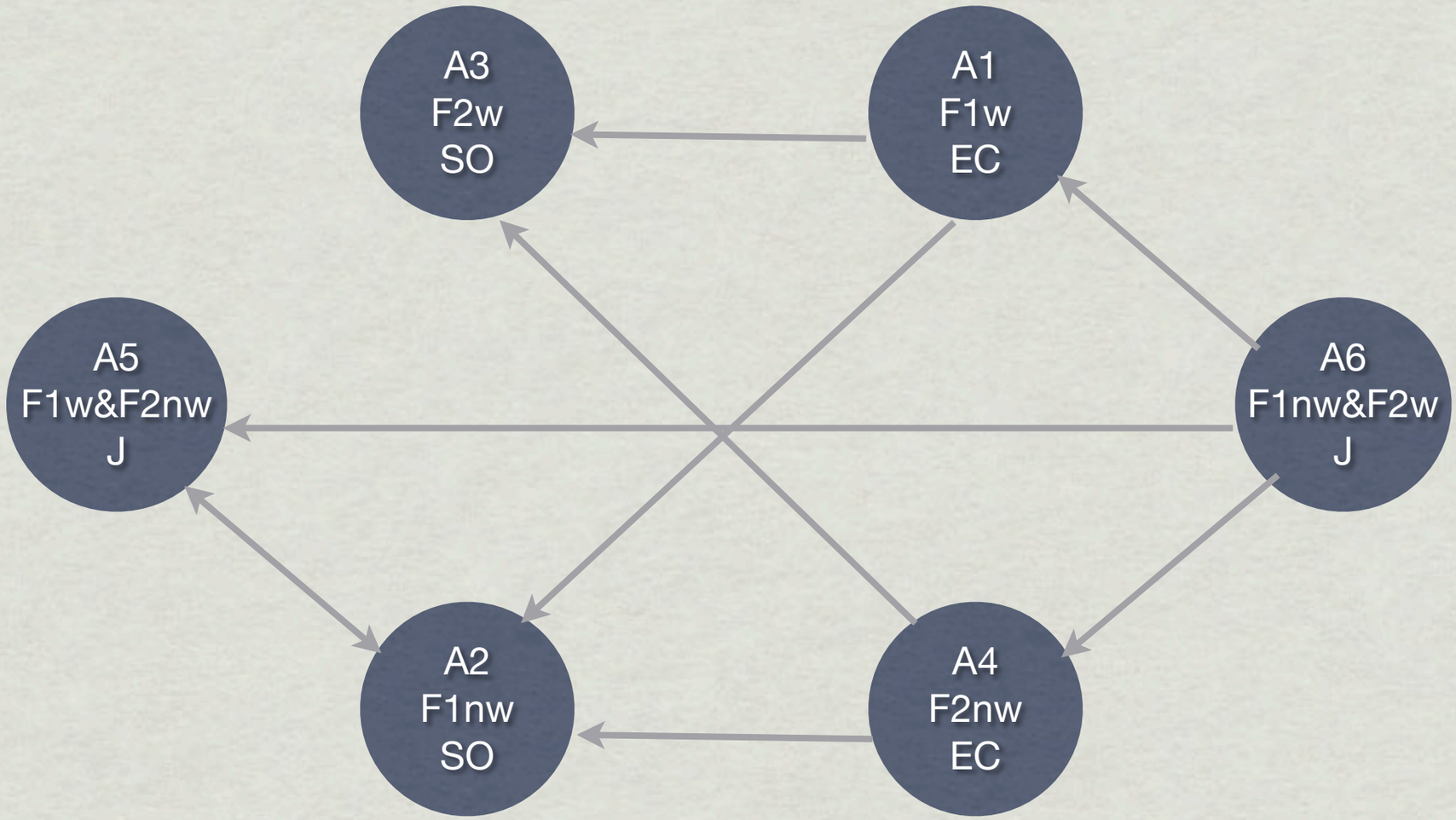

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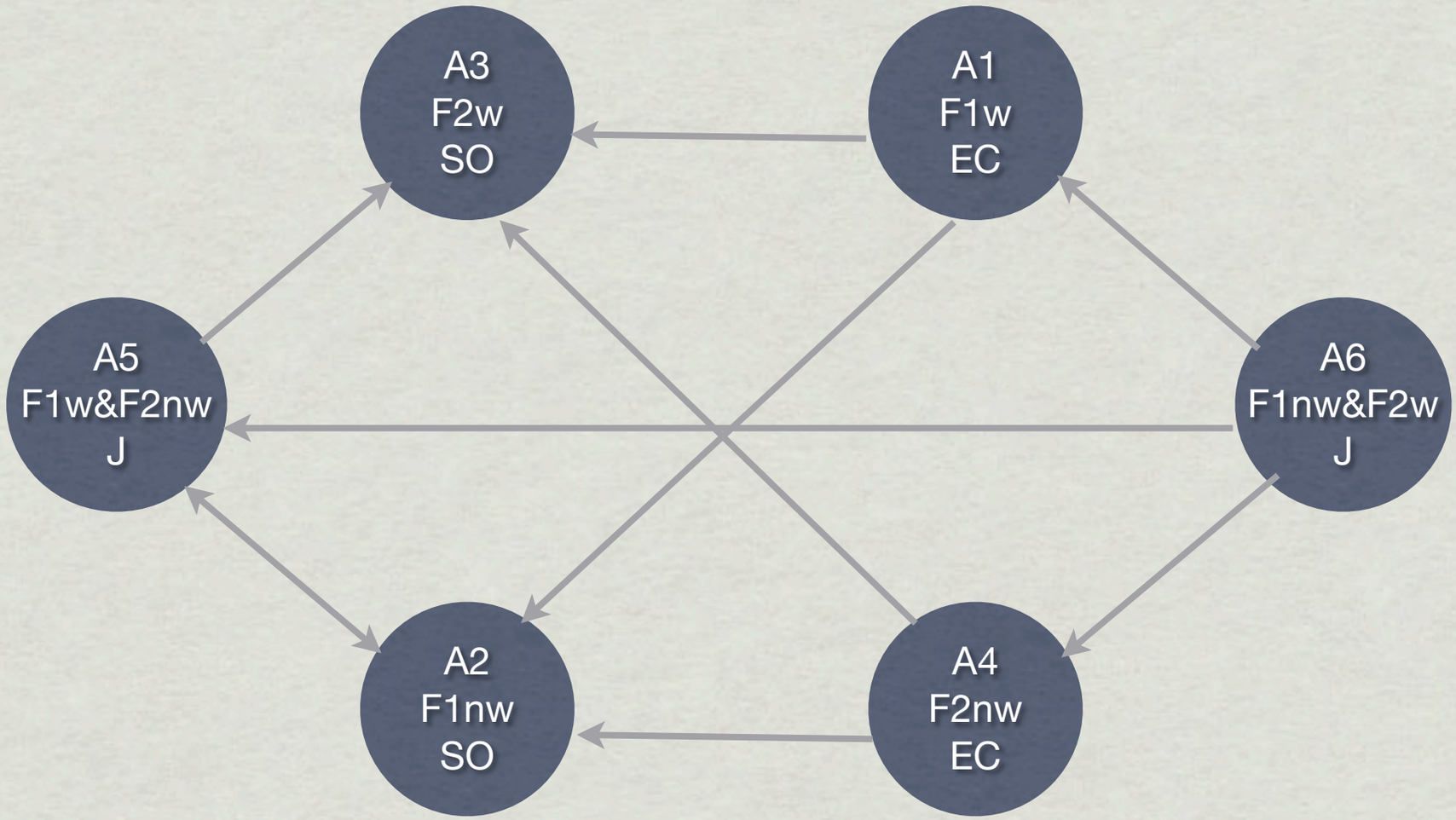

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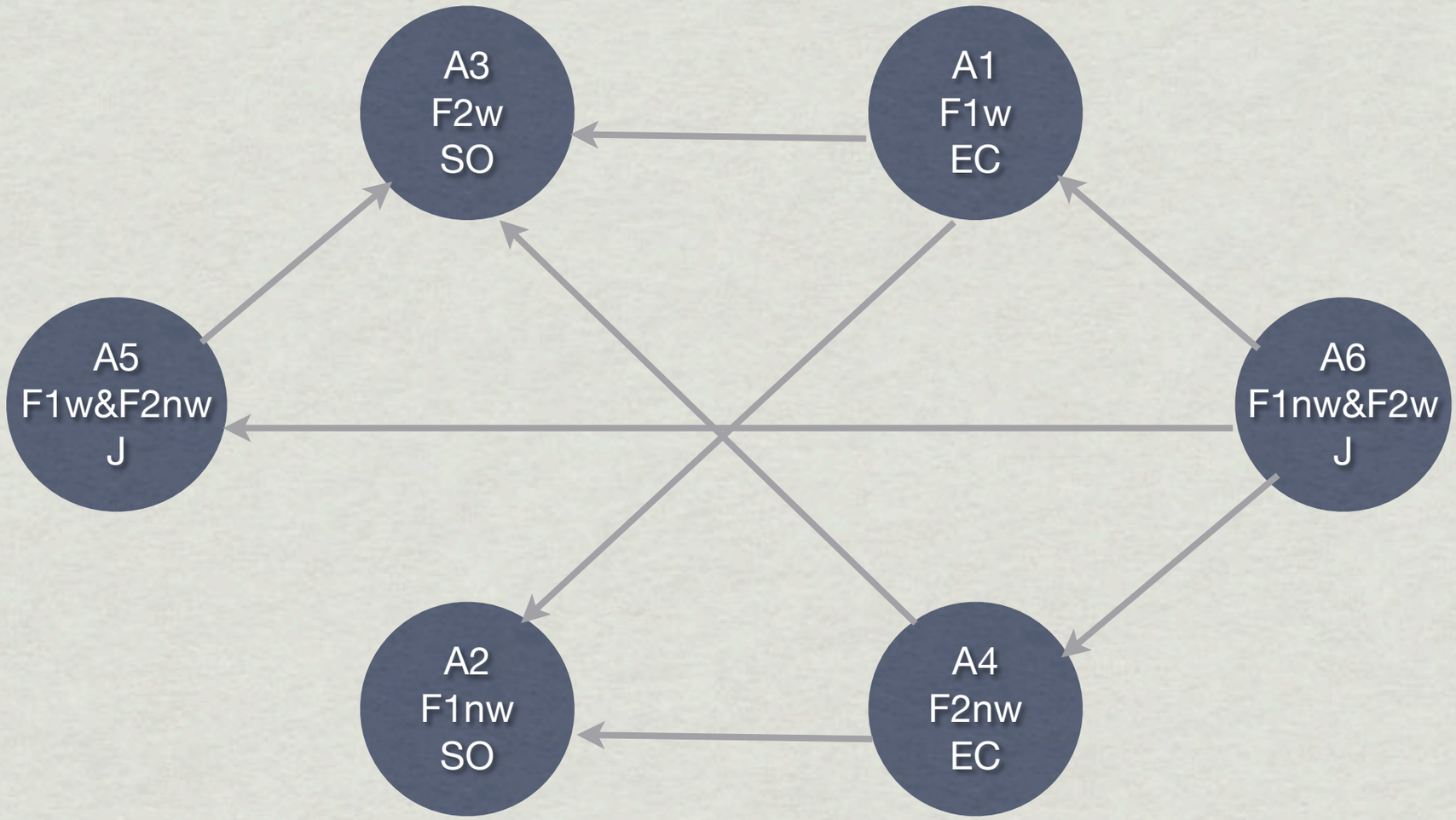

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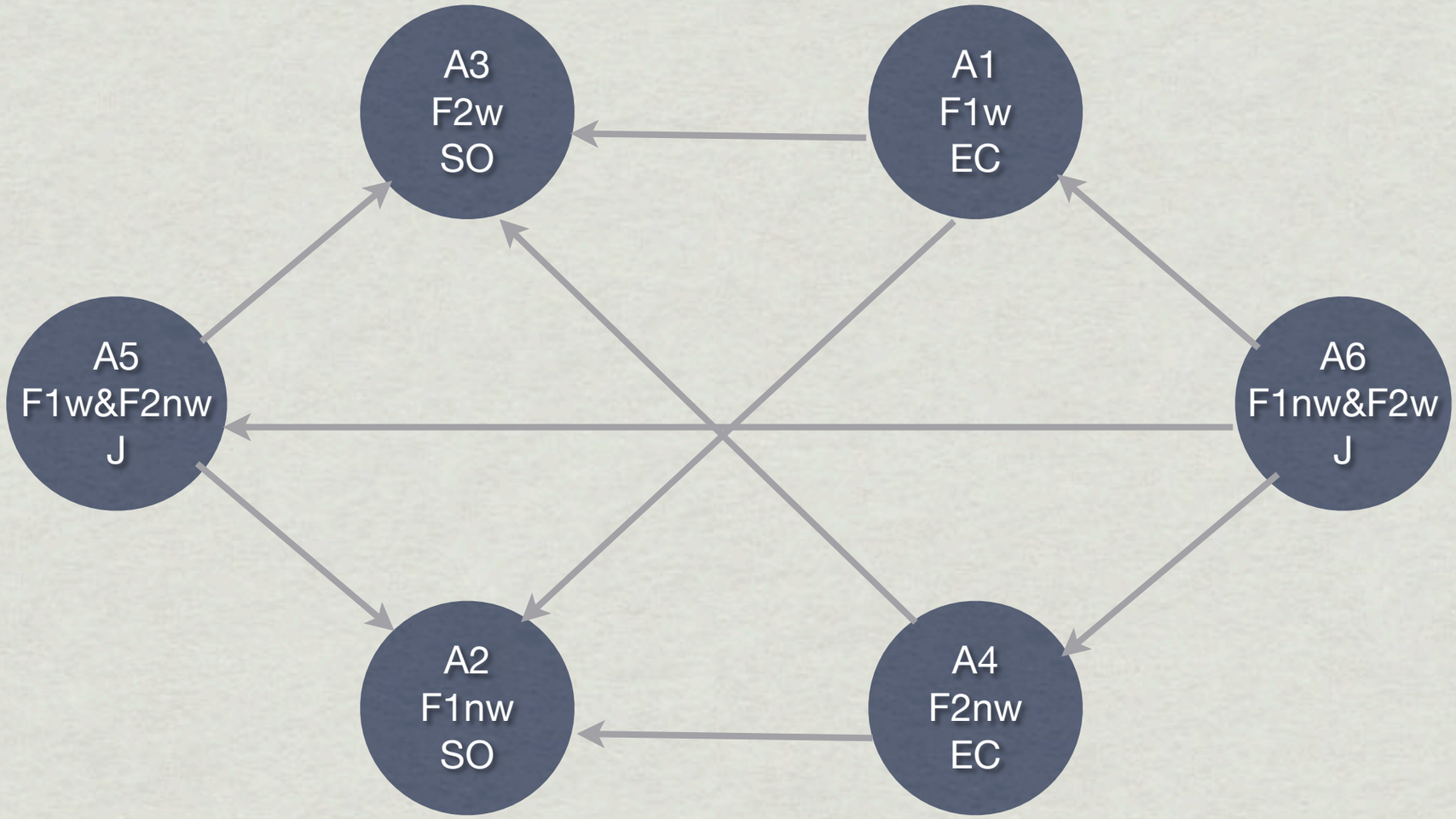

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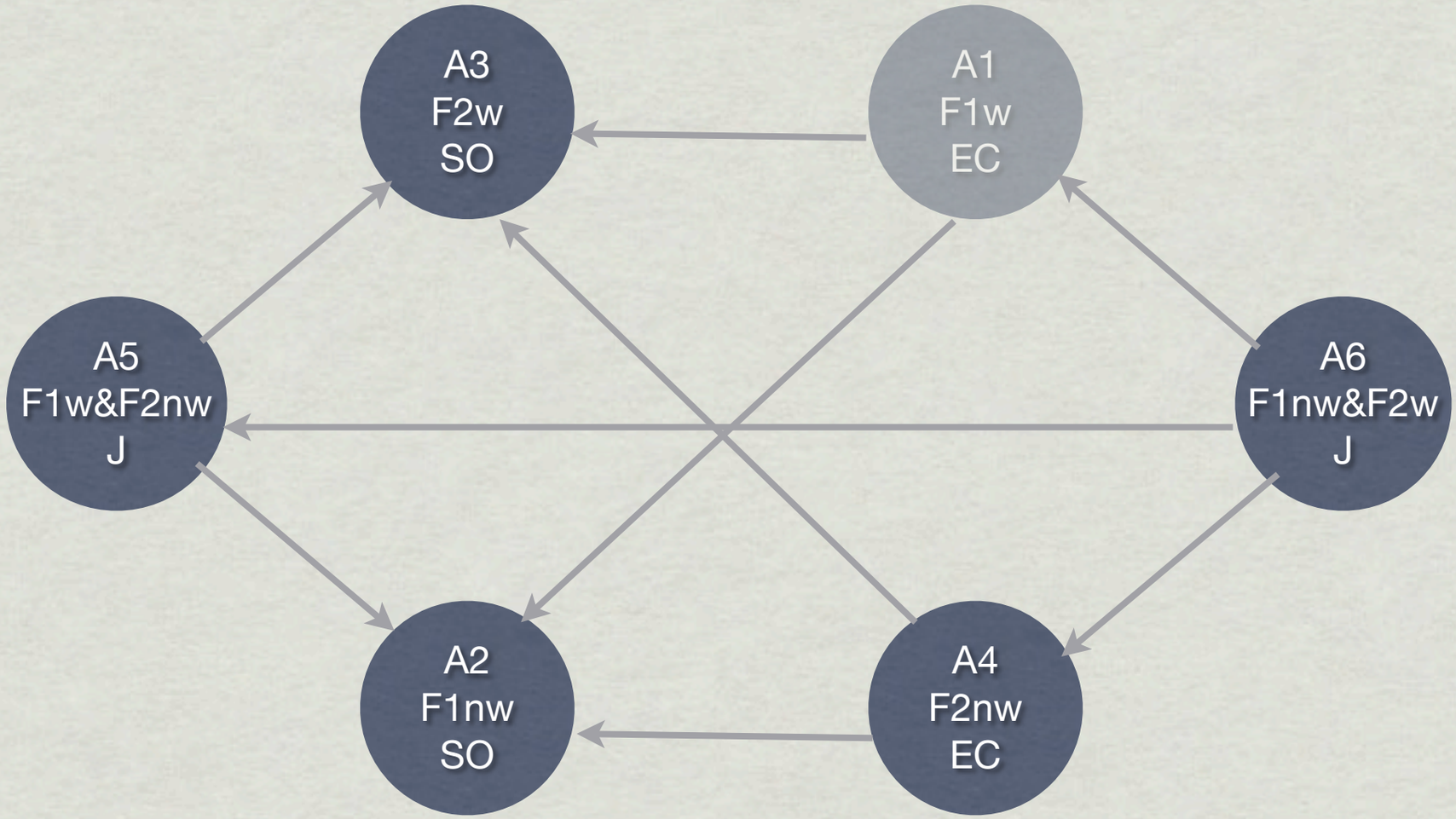

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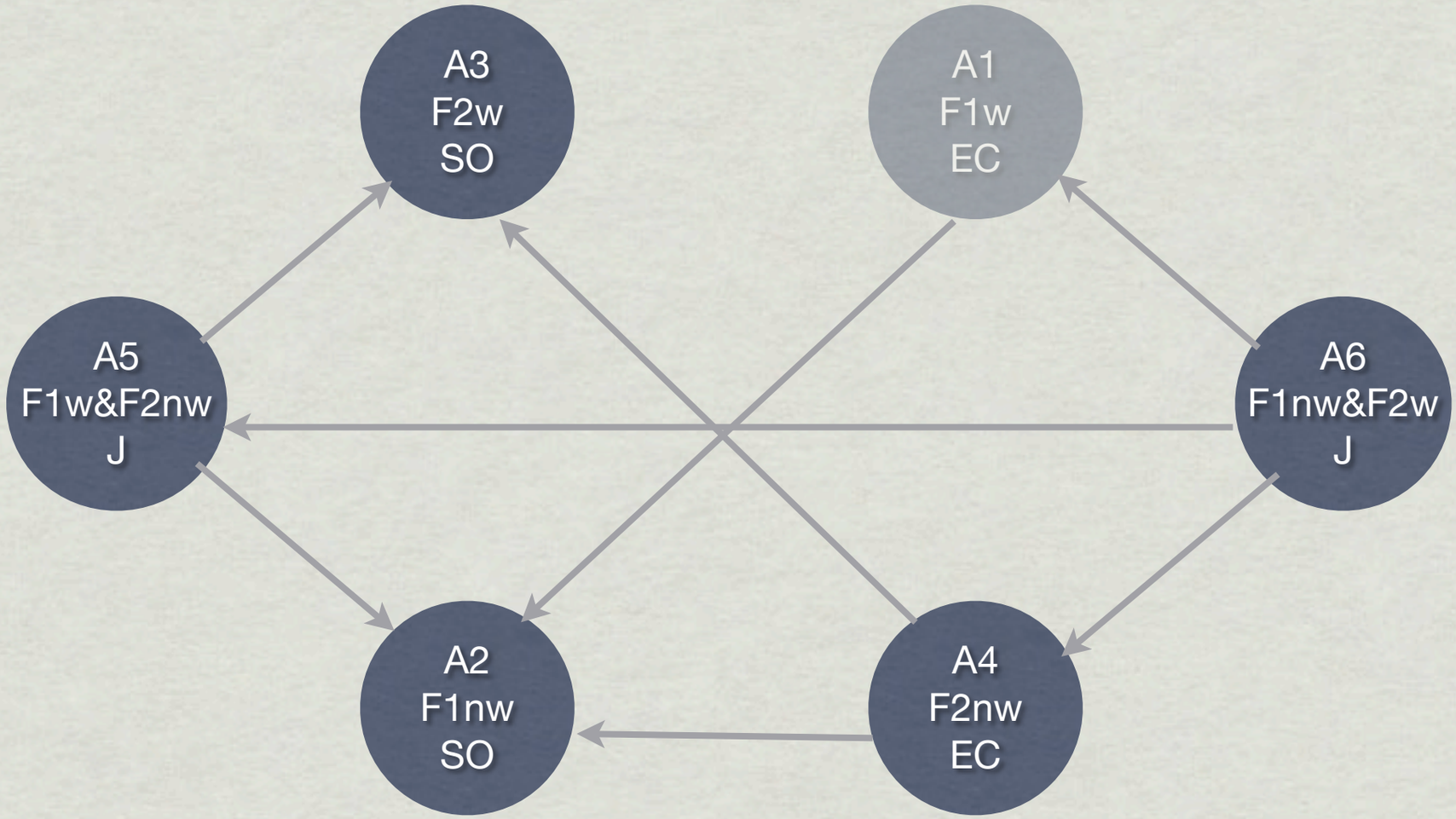

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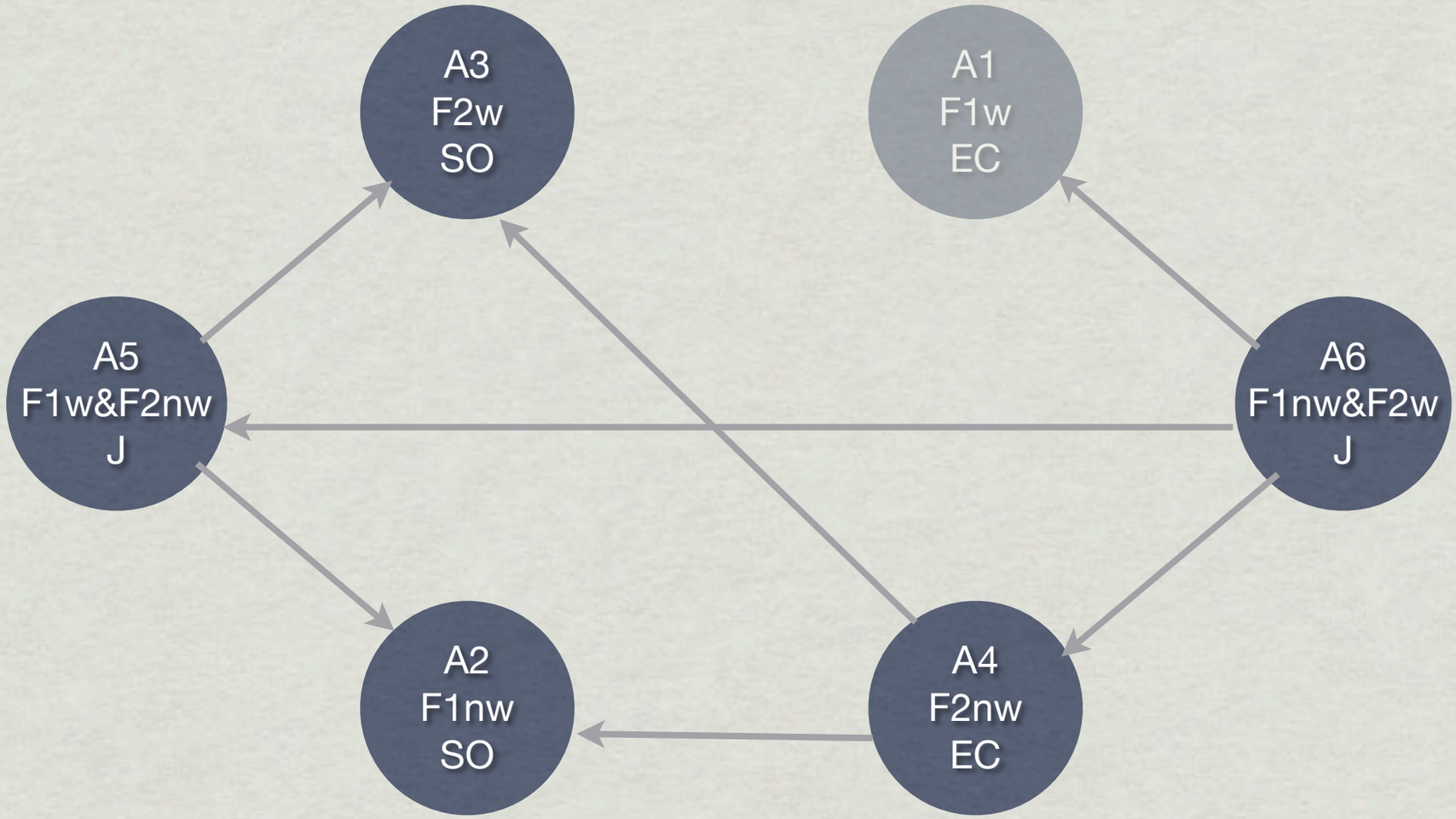

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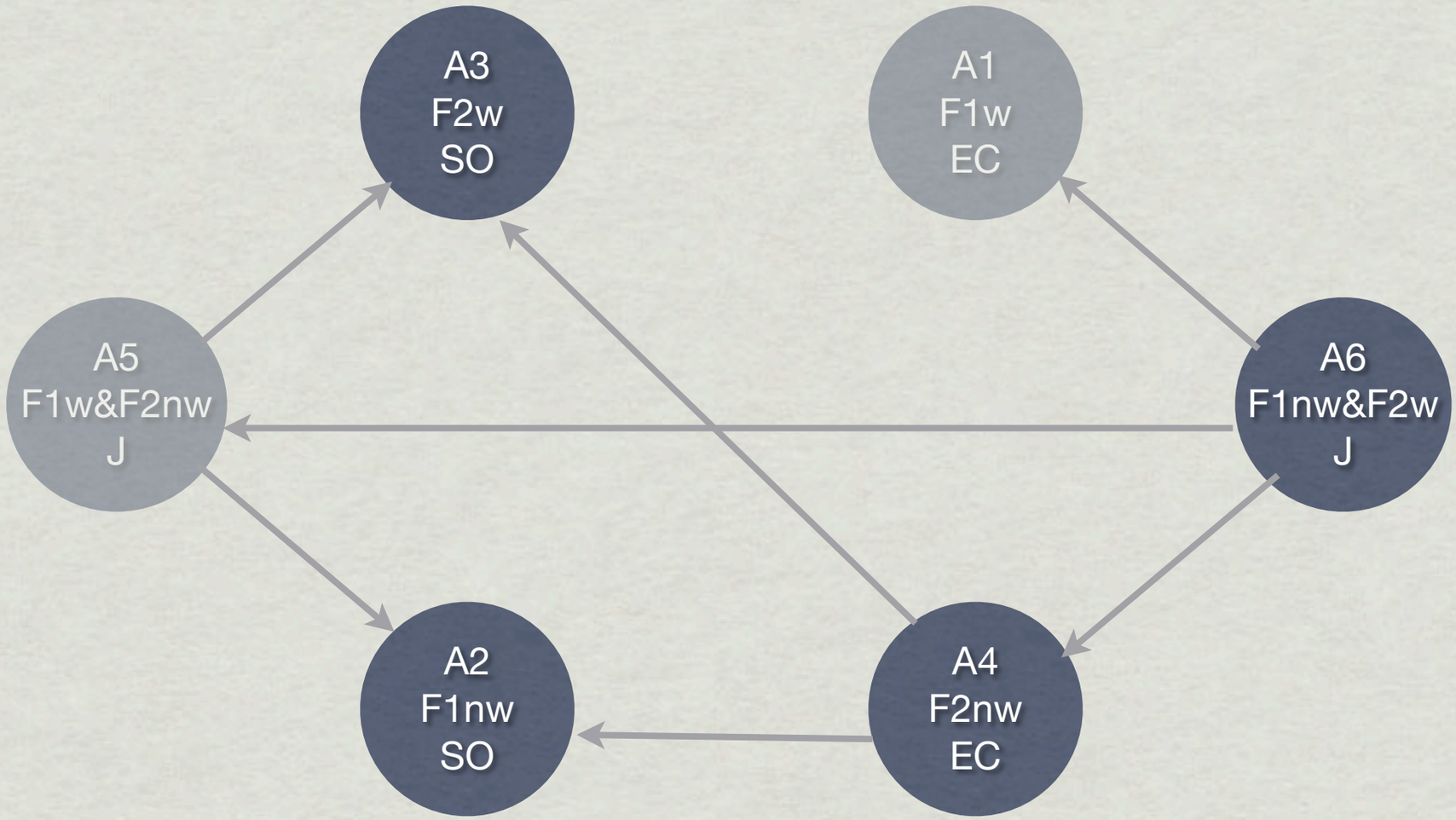

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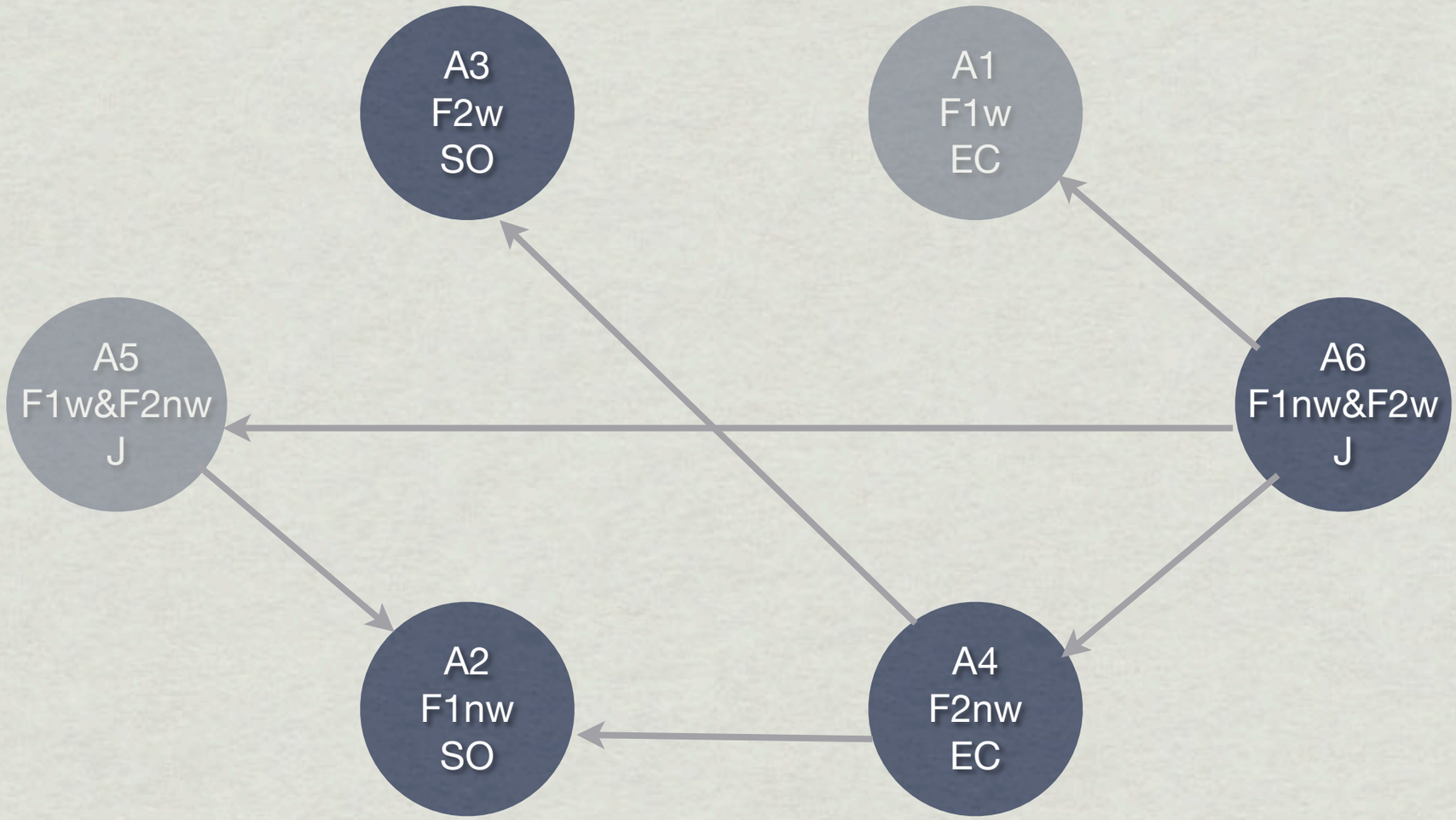

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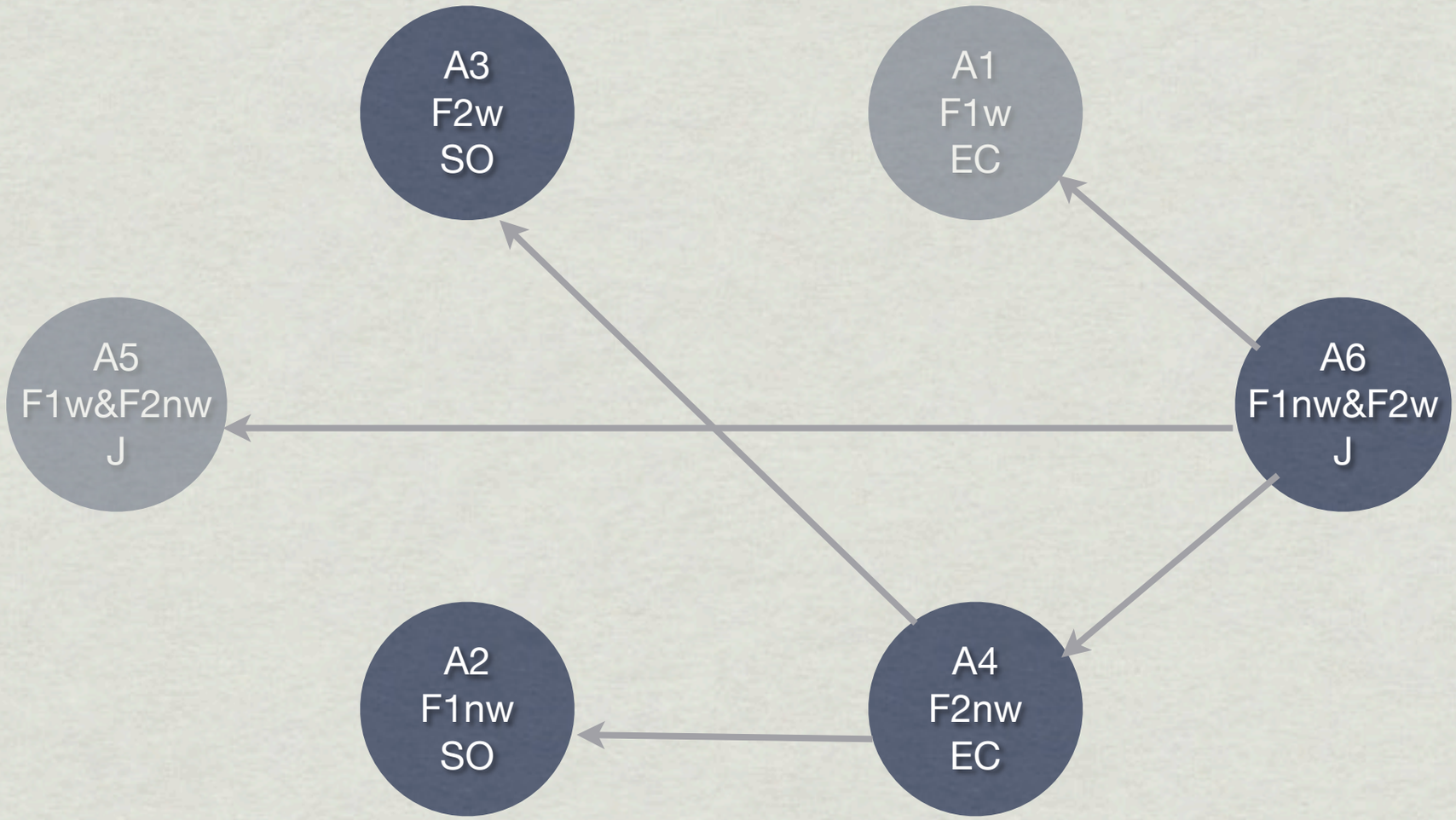

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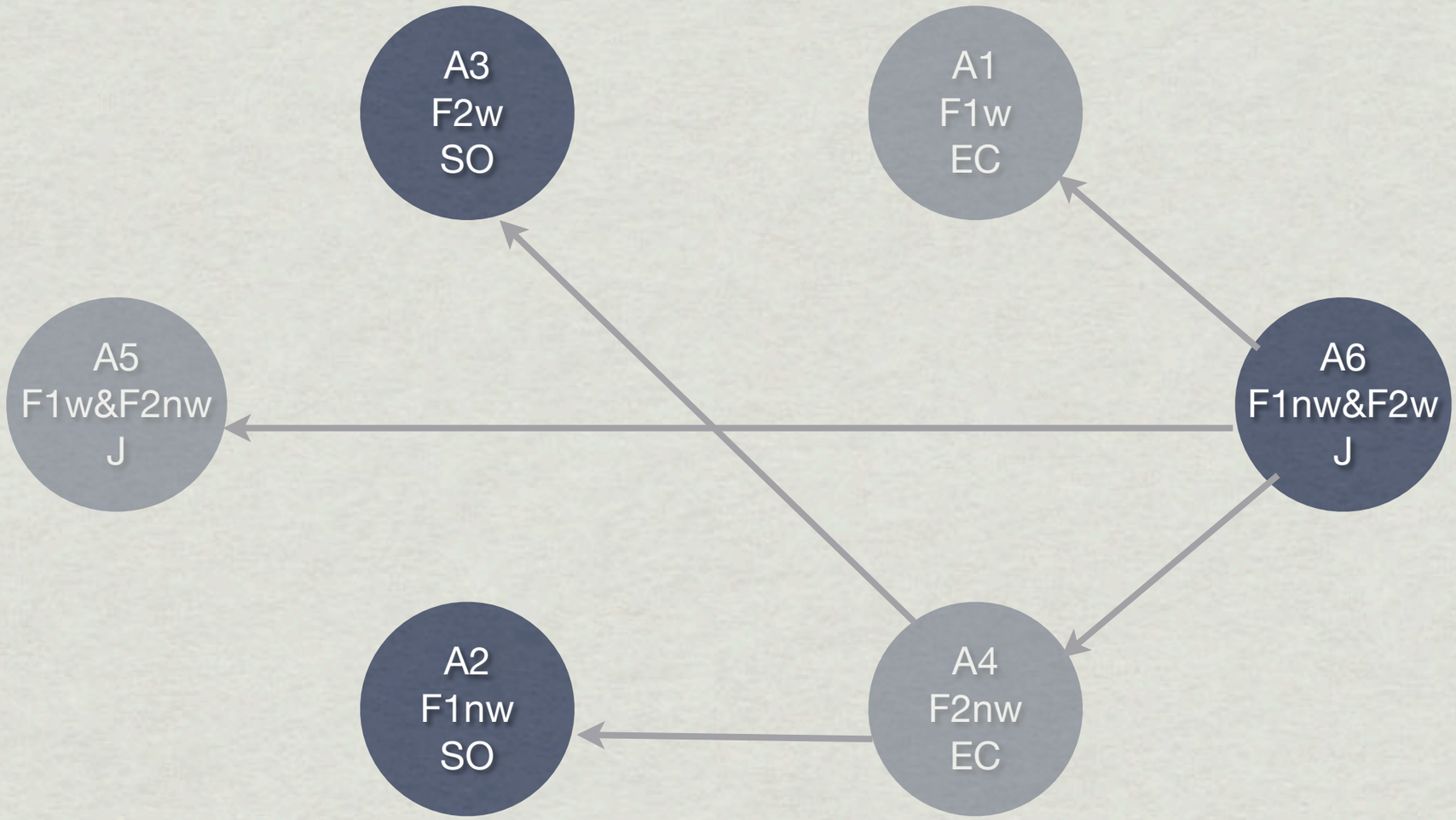

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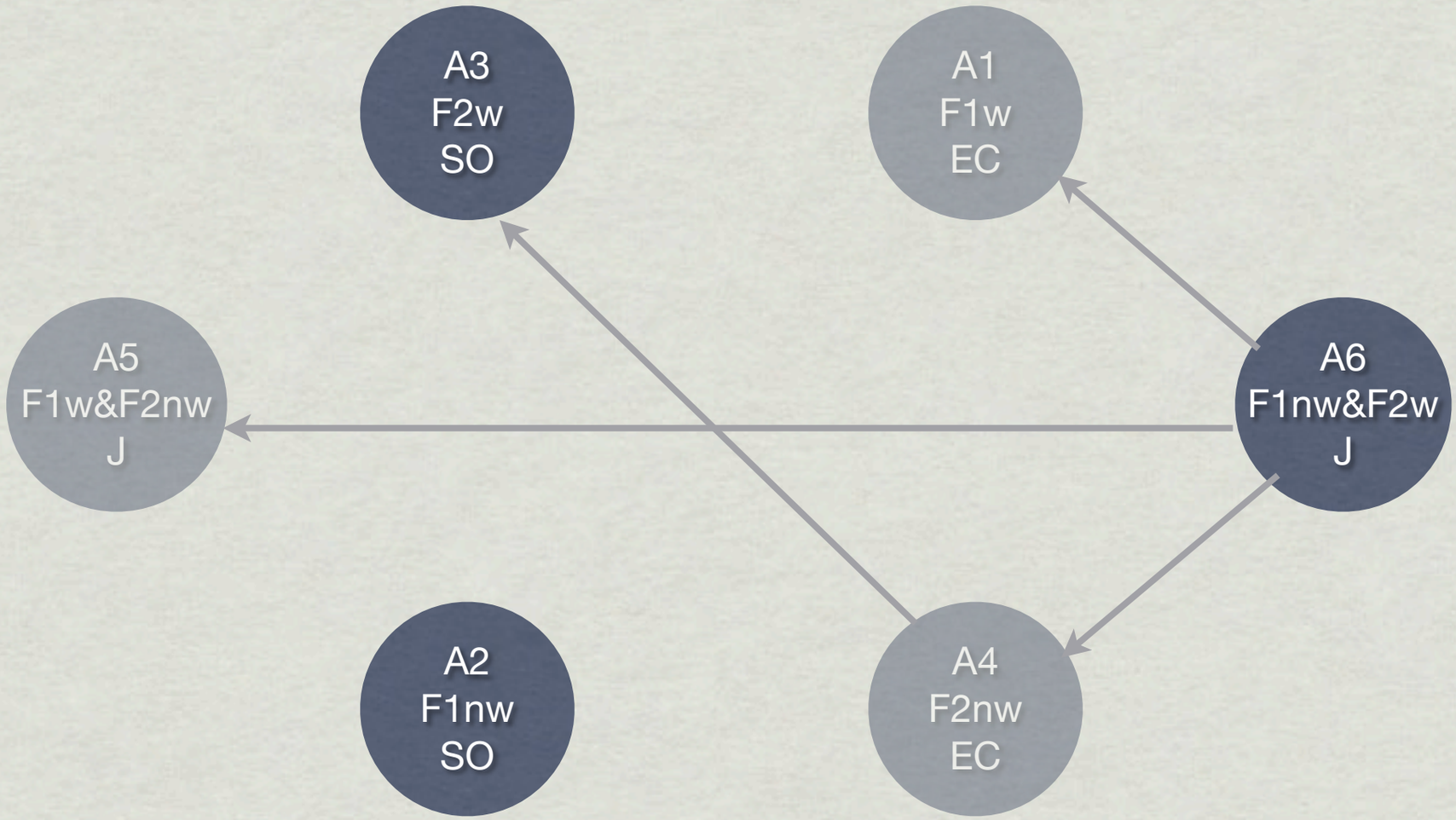
- Farmer $<^{RB}_{Pow}$ Basin Administrator

Water-rights transfer Example



AFAS$_{F1}$

- **F1:** SO < J < EC

- Farmer $<^{RB}_{Ch}$ Farmer
- Farmer $<^{RB}_{Pow}$ Basin Administrator

Water-rights transfer Example

AFAS$_{F1}$

- **F1:** SO < J < EC

- Farmer $<^{RB}_{Ch}$ Farmer
- Farmer $<^{RB}_{Pow}$ Basin Administrator

Conclusions

- Abstract Argumentation Framework to help agents to reach agreements in agent societies.
- Takes into account the social dependencies between agents.
- Also considers the agents' preferences over values.

Thanks!