

Collaborative multi-agent IVUS image segmentation



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Outline



- System design
- Agent design
- Conflict resolution
- Examples and Results
- Future work.

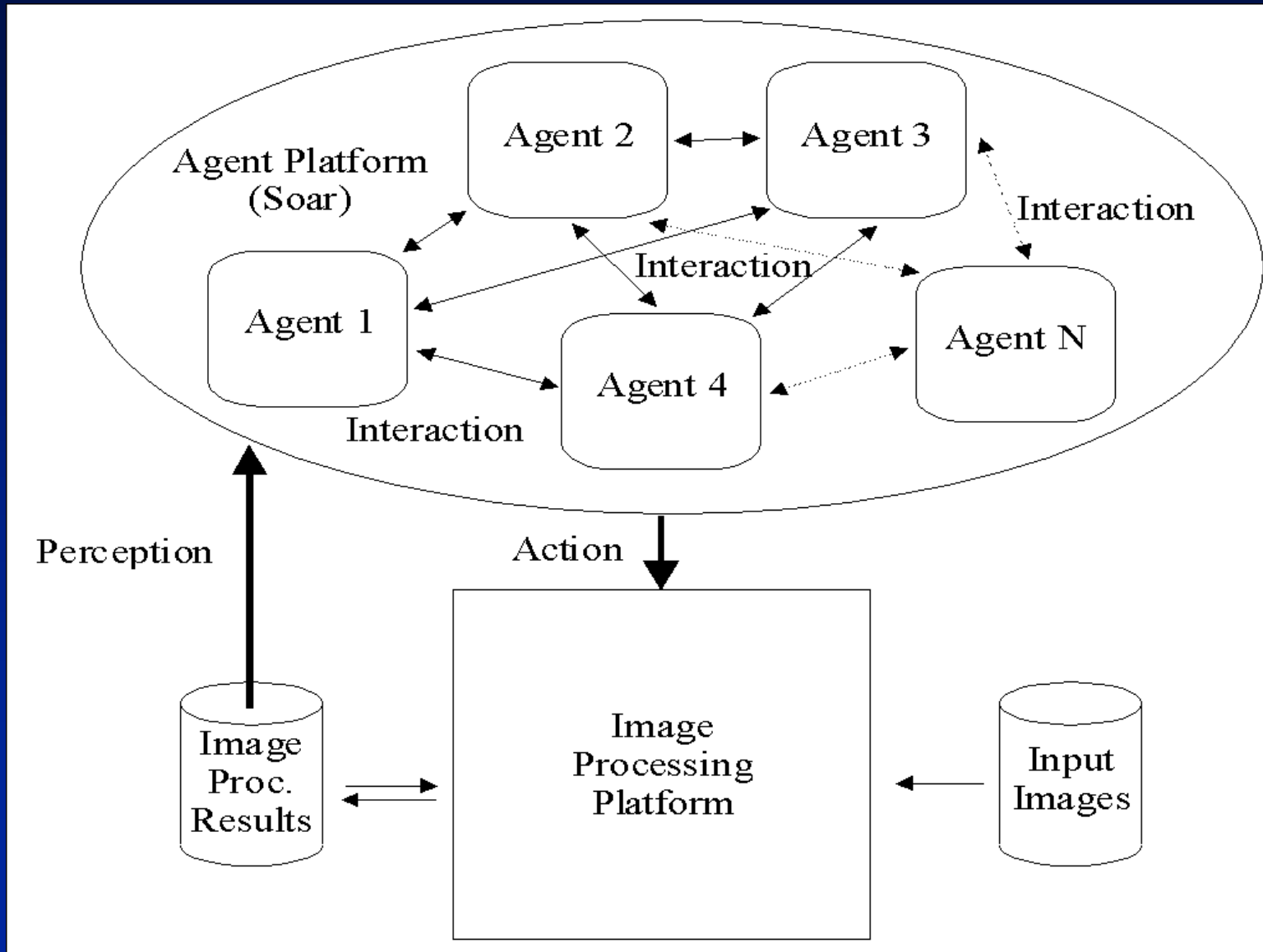
Multi-agent IVUS image interpretation



- Modular approach:
One or more agents for each possible image object.
- Currently: lumen, vessel, shadow, calcified plaque, side-branch, and status agent.
- Agents establish interrelations through communication and exchange interests and capabilities.



System design





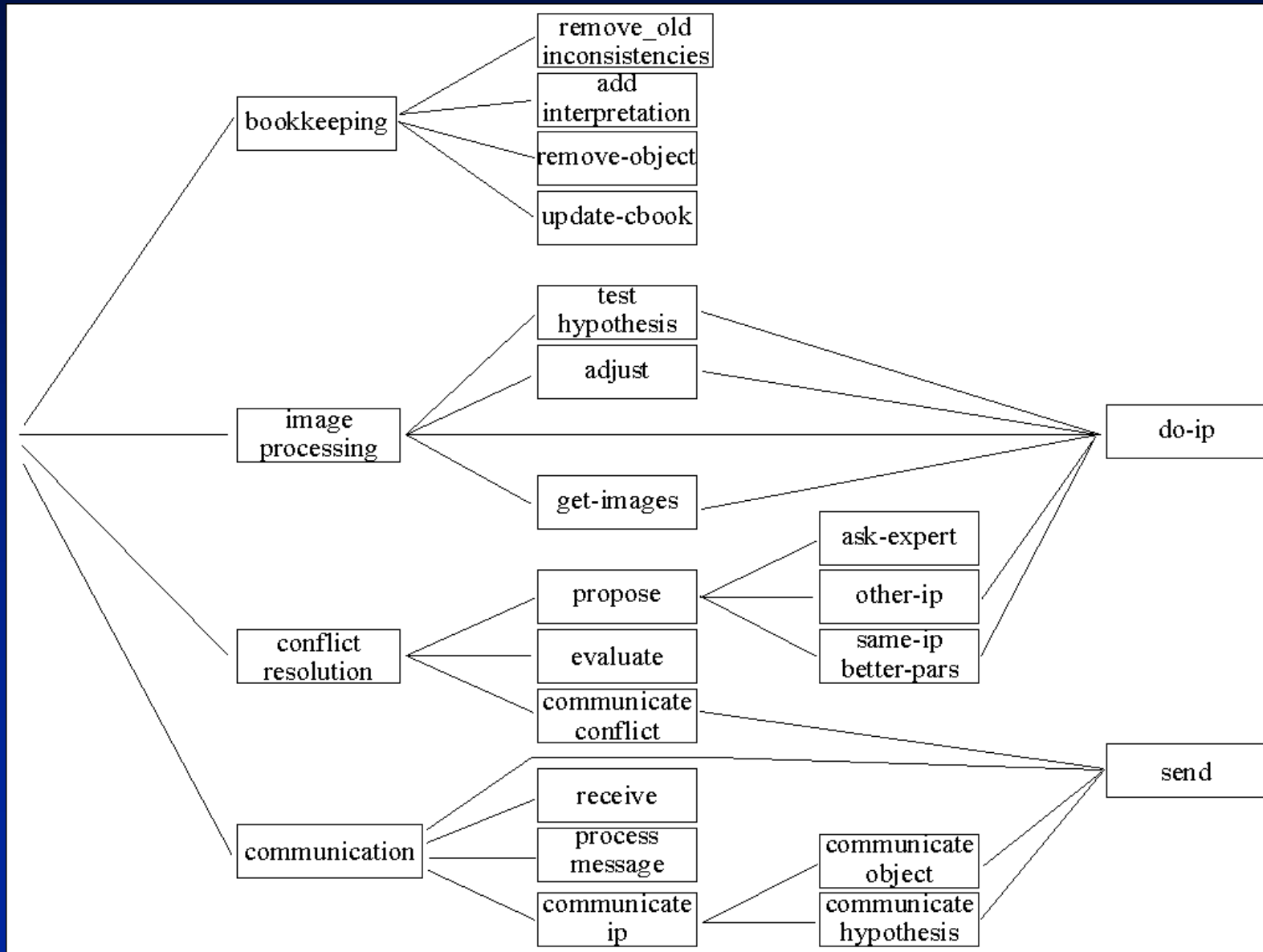
Agent design: productions

- Typical agent model:
 - ◆ 37 communication rules
 - ◆ 189 image processing rules
 - ◆ 112 conflict resolution rules
 - ◆ 26 utilities and default rules
 - ◆ 9 agent specific rules

373 productions

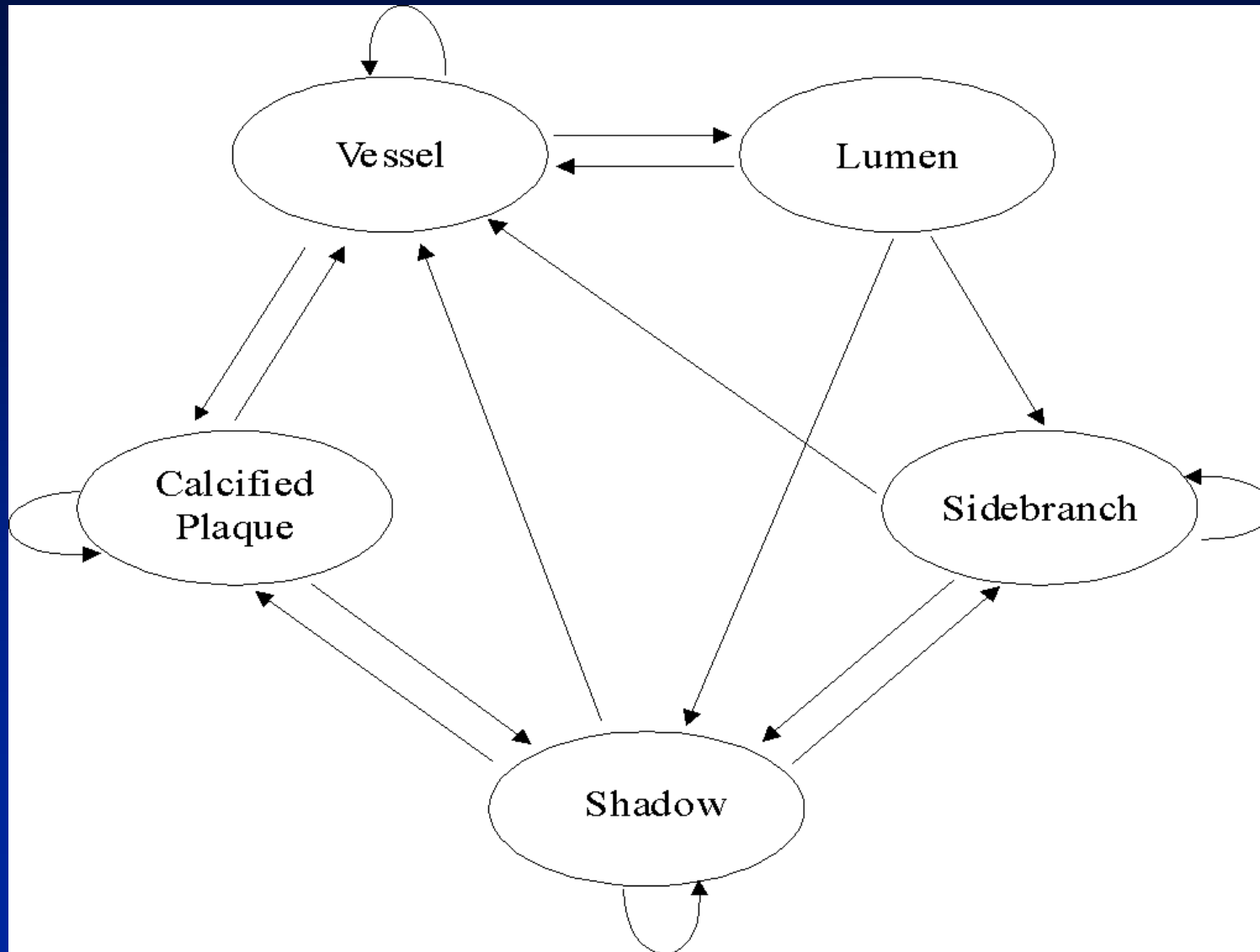


Agent design: operator relations



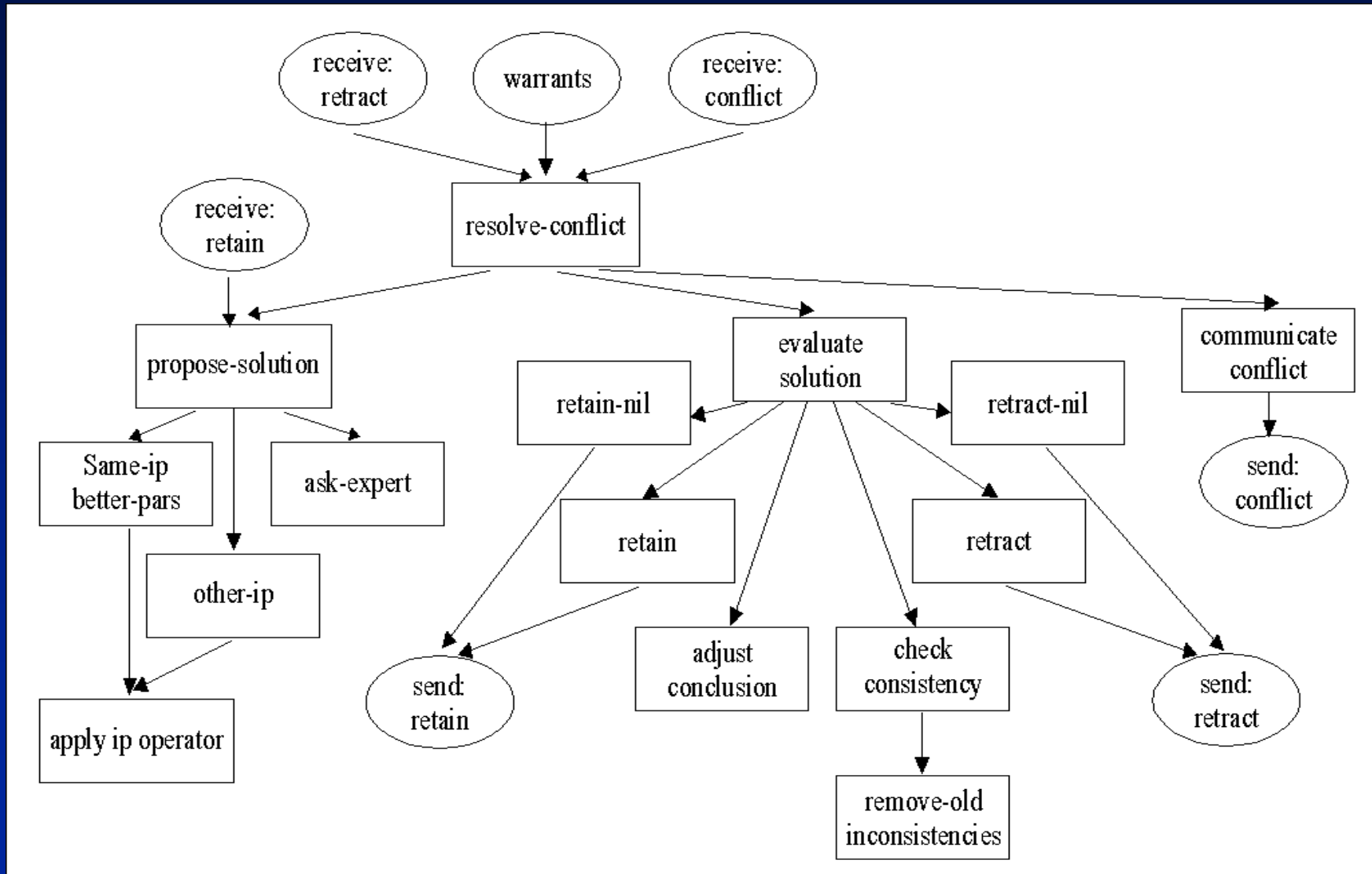


Agent design: agent relations





Conflict resolution: design





Conflict resolution: snapshot

ivus-shadow-old

```
100:  O: 0135 (propose-solution)
      101:   ==>S: S27 (operator no-change)

102:  O: 0138 (same-ip-better-pars)
      Improving selectivity. Adjusting mindist: 30 --> 31
103:  ==>S: S28 (operator no-change)

104:  O: 0143 (send)
      2875115: Sending message to <agent-status>

105:  O: 0141 (detect-shadow-old)
      Detecting shadow contours ....
      Sensitivity (mindist = 31, mu = 0.66, fuzzy-set = [20 25 29 35] )
      Selectivity (mindist = 31, mu = 0.33, fuzzy-set = [29 35 99 100] )

106:  O: 0145 (evaluate-solution)
      107:   ==>S: S31 (operator no-change)

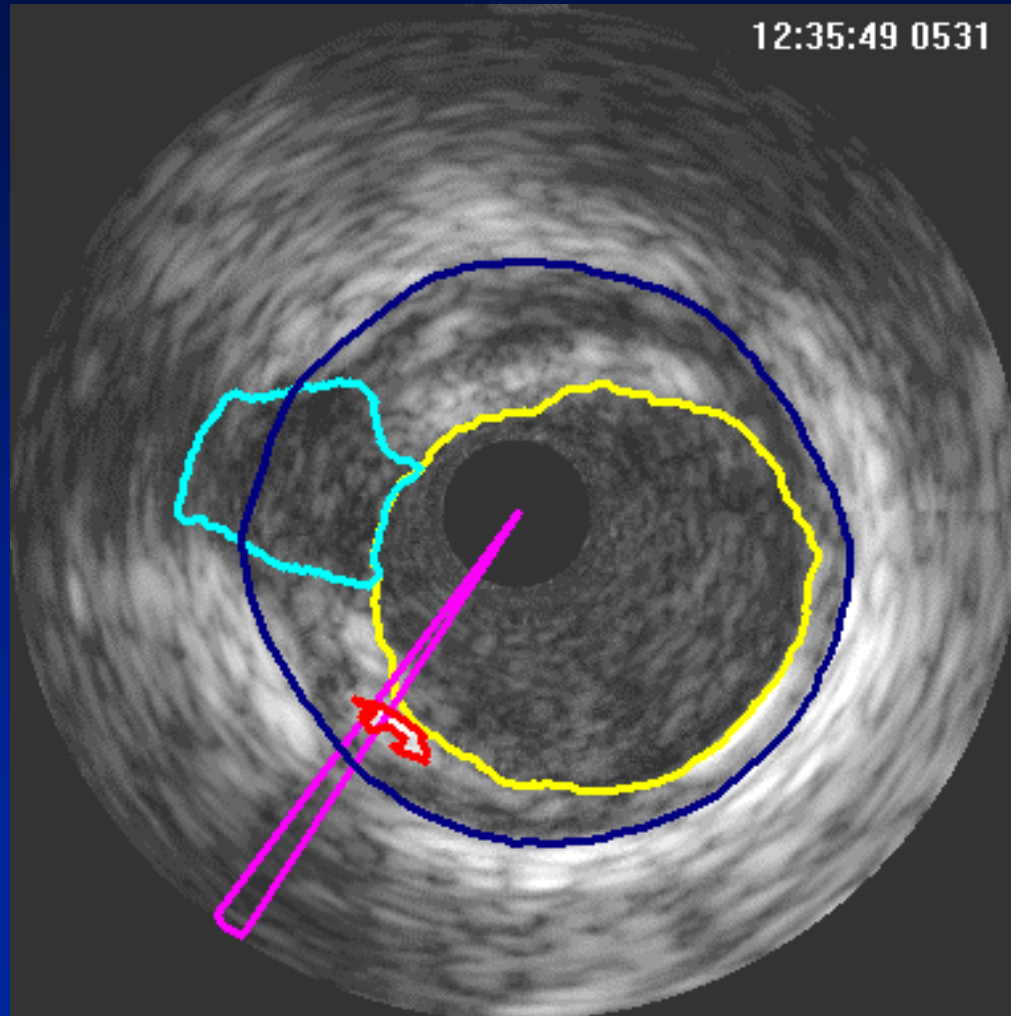
108:  O: 0148 (retain-object)
      109:   ==>S: S32 (operator no-change)
```

Step
Stop
Run
Init
Learn
Watch
Excise
Productions
Save
Print

Command >

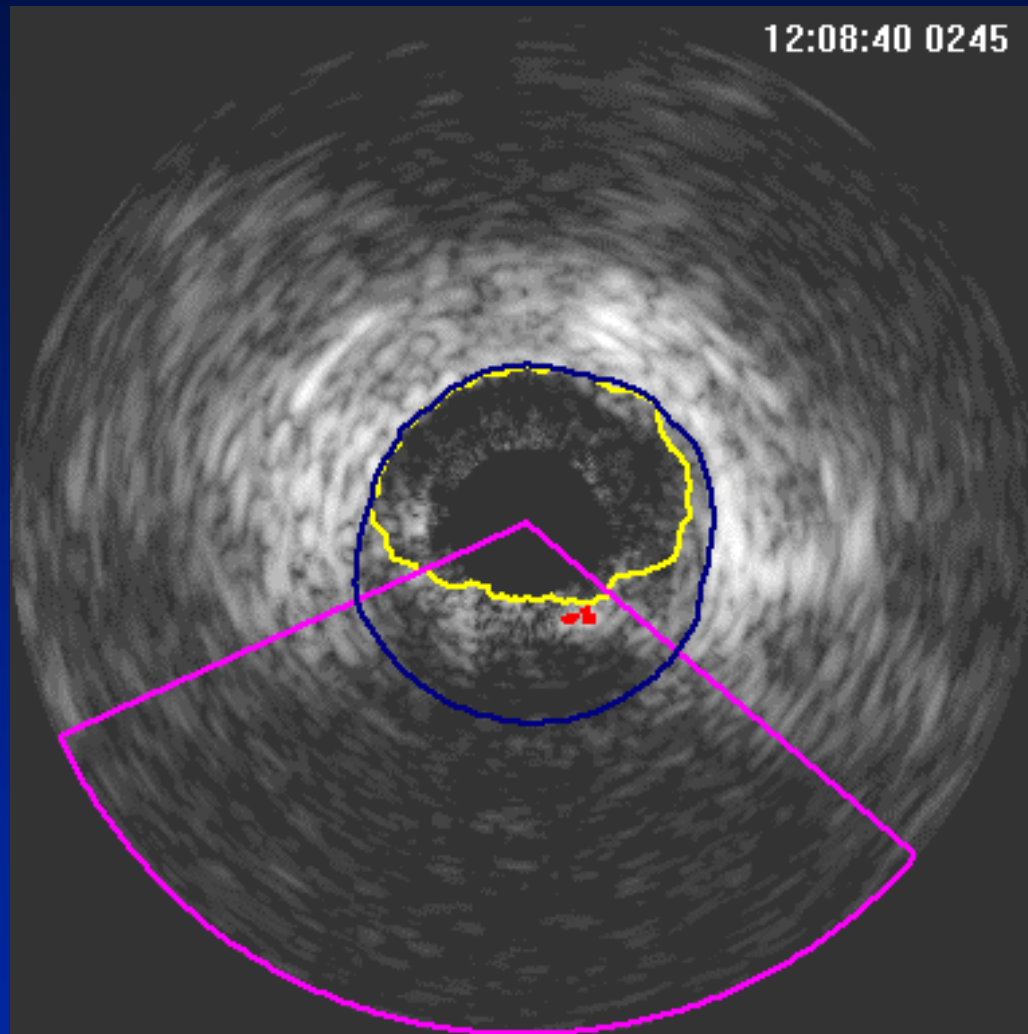


Conflict resolution: example

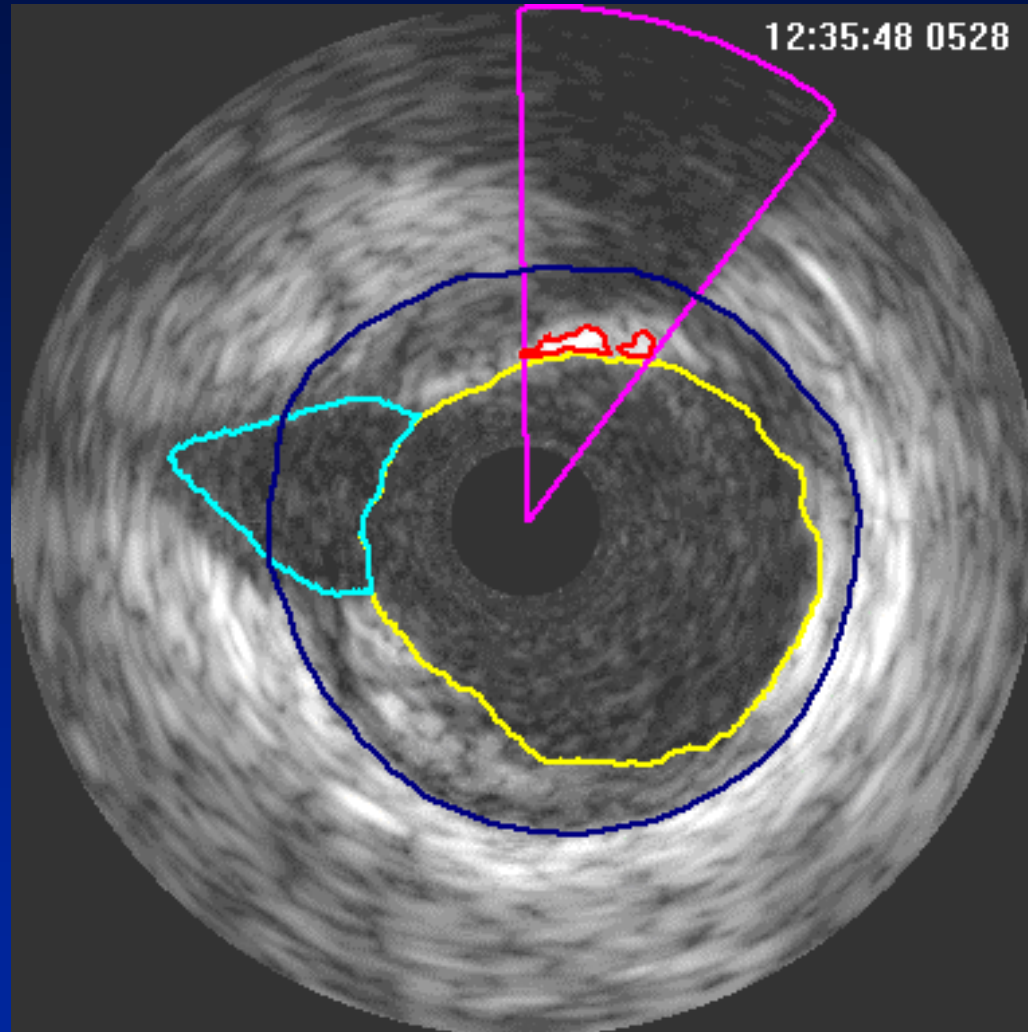




Test-hypothesis: example



Results: patient1





Standalone (sa) vs multi-agent (ma)

- All conflicts resolved.
- Considerable improvement of detectors.
- Still some room for improvement.

Result	<i>lumen</i>		<i>vessel</i>		<i>sidebranch</i>		<i>shadow</i>	
	<i>sa</i>	<i>ma</i>	<i>sa</i>	<i>ma</i>	<i>sa</i>	<i>ma</i>	<i>sa</i>	<i>ma</i>
<i>optimal</i>	30	30	18	27	26	32	12	12
<i>suboptimal</i>	2	2	2	5	0	0	1	1
<i>false</i>	0	0	12	0	6	0	10	0



Future work

- Validation of complete imageruns.
- Publication of results.
- Inclusion of new agents (CSG, stent).
- Learning image processing from the user.

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