

Analyzing Team C2 Behaviour using Games and Agents

Paper 006

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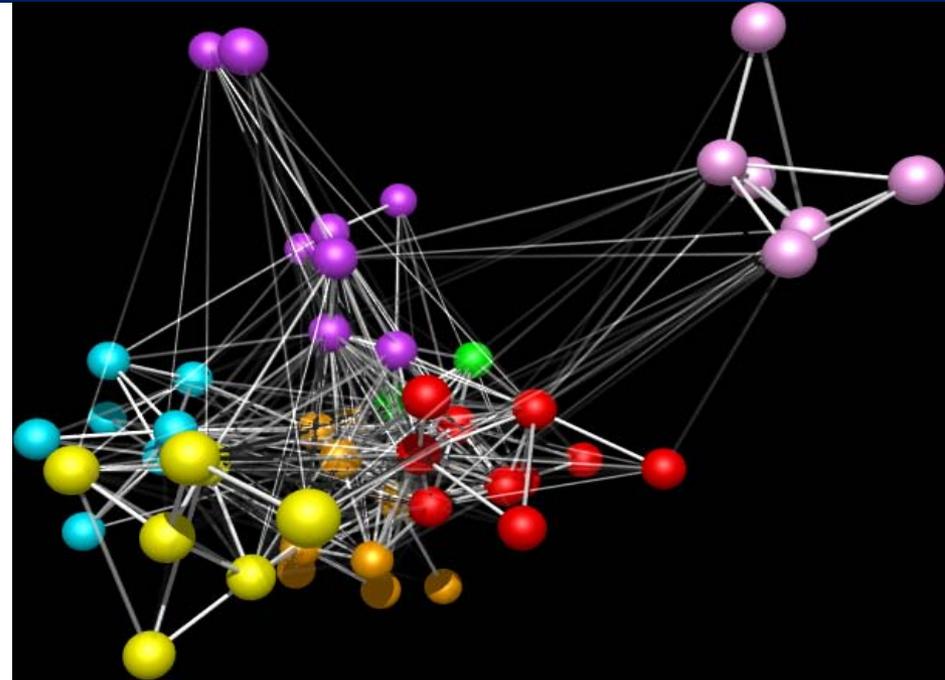
Australian Government

Department of Defence

Defence Science and
Technology Organisation

Presented
by Alex Kalloniatis

Some background: Network Models of C2



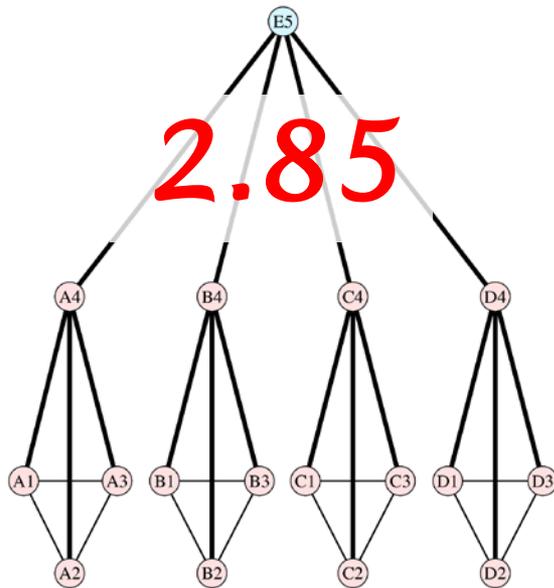
<http://www.navy.mil>



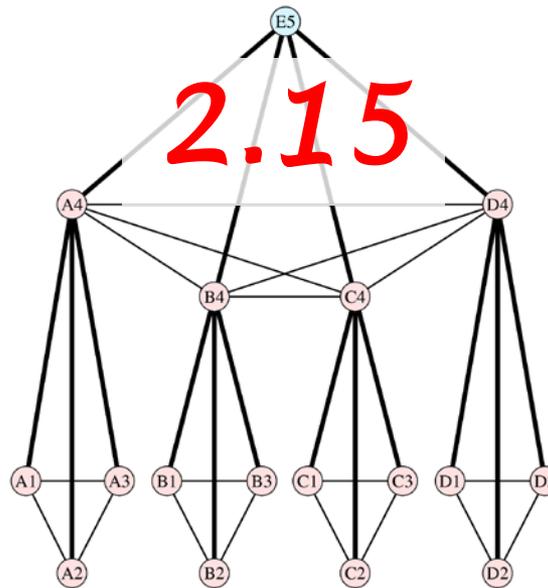
<http://video.defence.gov.au>

ELICIT Experiments ...

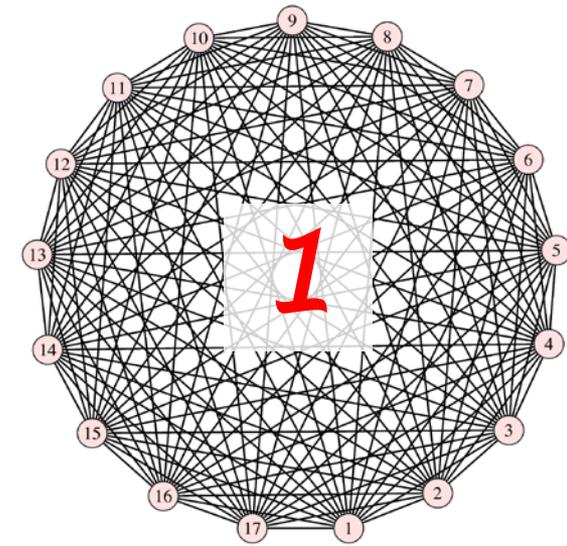
... when we consider how the **team decision time** varies with the **average distance** in team structures ...



(a) Traditional Hierarchy



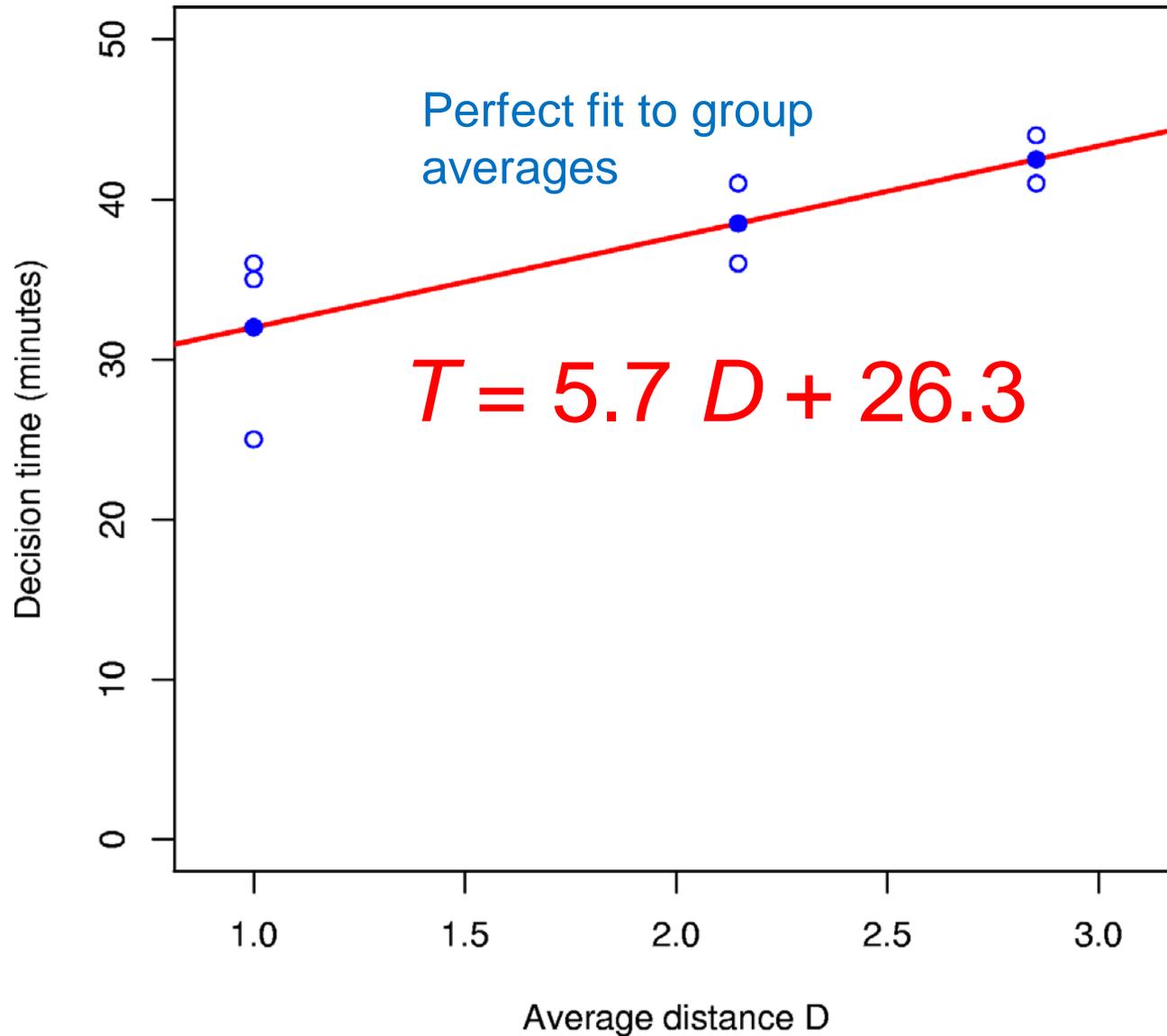
(b) Hybrid Organization



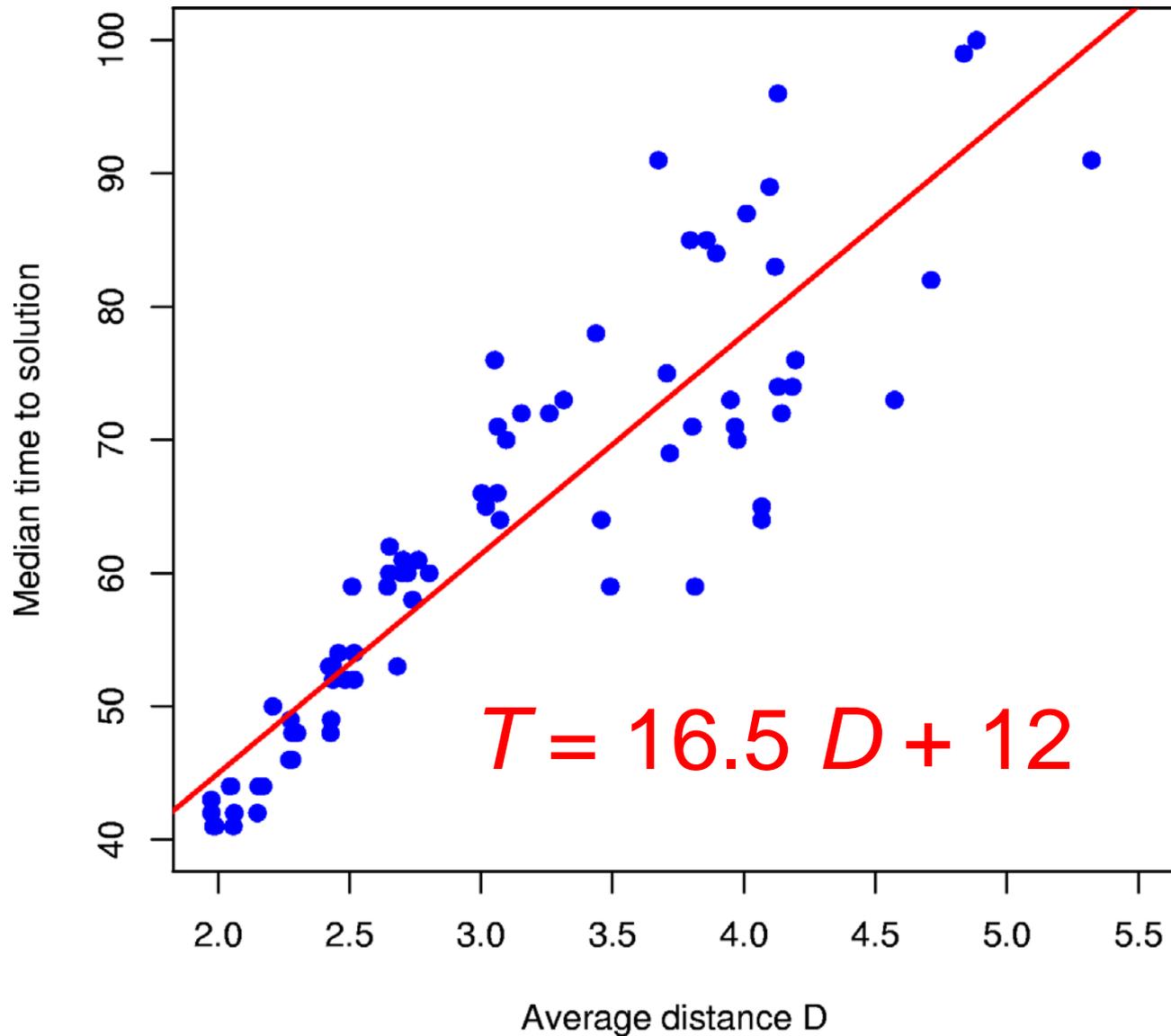
(c) Edge Organization

See P. Thunholm, E.-C. Ng, M. Cheah, K.-Y. Tan, N. Chua, and C.-L. Chua, "Exploring Alternative Edge versus Hierarchy C2 Organizations using the ELICIT Platform with Configurable Chat System." *International C2 Journal*. 3(2), 2009, www.dodccrp.org/files/IC2J_v3n2_04_Thunholm.pdf

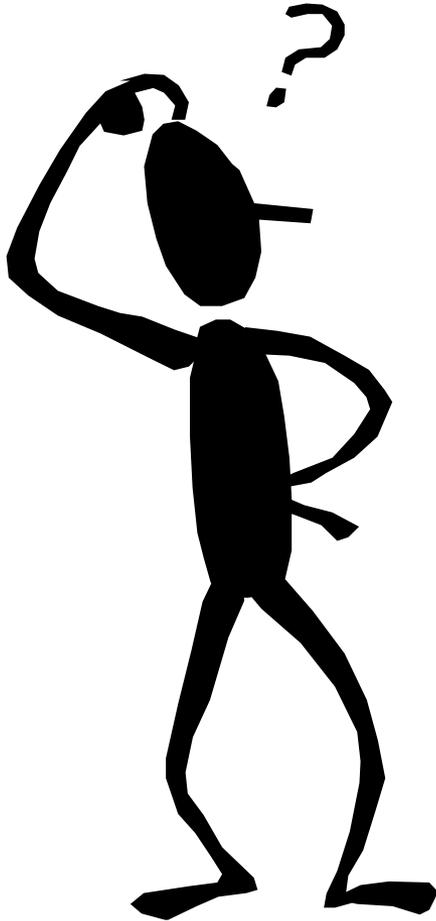
... show a linear relationship



Simulations presented in 2011 show the same thing



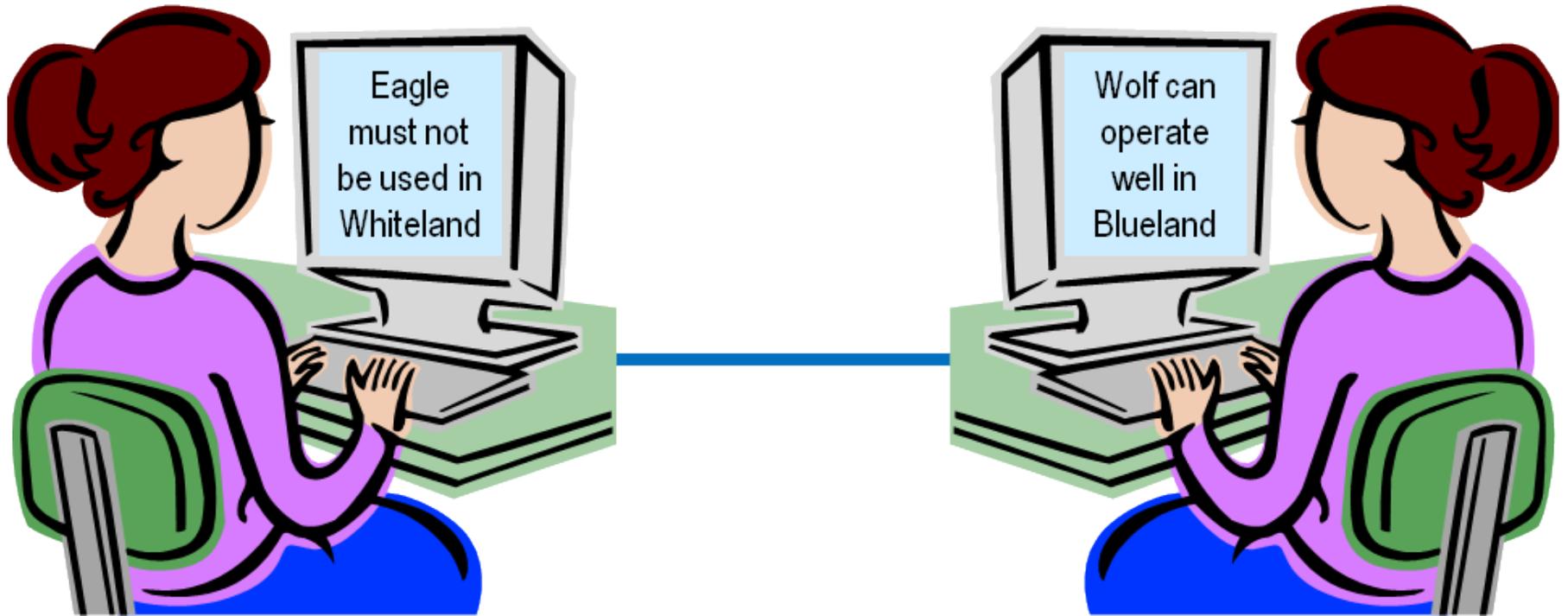
Is the linear relationship a general rule?



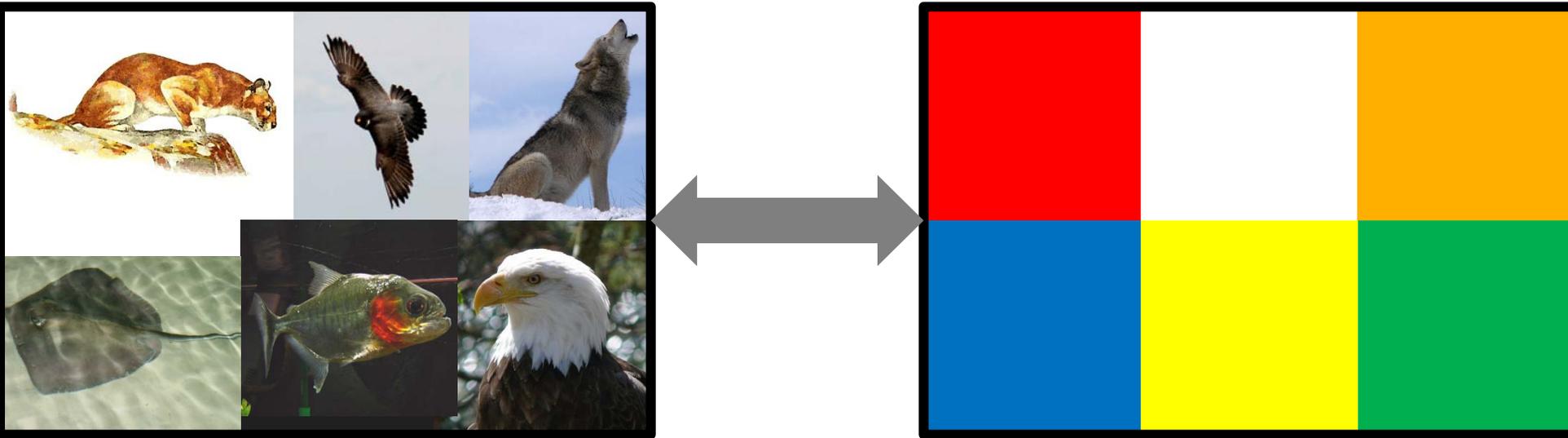
Some other models show power-law relationships.

To study this, we built a tool ...

A simple tool for networked C2 experiments



Task: assignment of 6 platforms to 6 regions



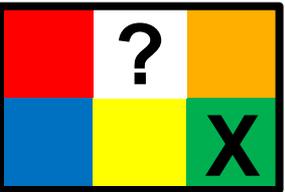
Puma should, if possible, be used in Scarlet City
Falcon is not ideally suited to conditions in Orangeland
Stingray can operate well in Blueland
Wolf must not be used in Whiteland
Falcon must be used in Greenland
etc. ...

Why is this problem interesting?

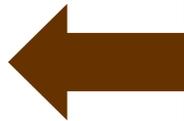
| | Orange | Green | | Yellow | Red | Blue |
|---|------------|-------------|-------------|-----------|-------------|------------|
|  | | Avoid | Works well | Avoid | Use if poss | |
|  | Not ideal | Must use | Use if poss | | Use if poss | Works well |
|  | | Not ideal | | | Not ideal | |
|  | Works well | Works well | | Not ideal | | Works well |
|  | | | Works well | | Not ideal | Not ideal |
|  | | Use if poss | Not allowed | Not ideal | Works well | Works well |

- Simple but non-trivial problem
- Relevant information distributed among team members
- Coordinated decision-making needed (one person per row)

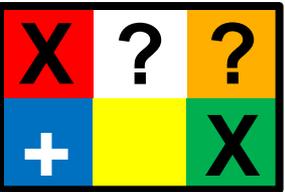
A sample conversation for “Stingray”



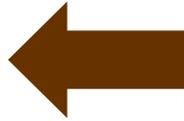
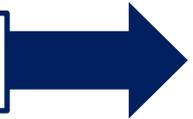
Piranha is not ideally suited to conditions in Whiteland
Stingray should, if possible, not be used in Whiteland
Stingray must not be used in Greenland
Wolf should, if possible, not be used in Yellowland



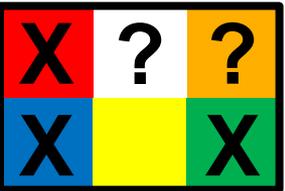
Stingray is not ideally suited to conditions in Orangeland
Stingray should, if possible, be used in Blueland
Falcon must be used in Scarlet City



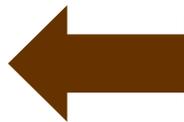
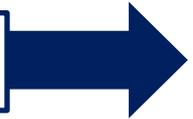
Bob likes Blueland for Stingray



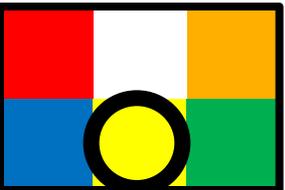
Alice has locked in Blueland for Eagle



Bob wants Yellowland for Stingray



More discussion...



Bob has locked in Yellowland for Stingray



We have developed experimental & chat tools for this

FACT SUBSET #1:

Puma should, if possible, be used in Scarlet City

Falcon is not ideally suited to conditions in Orangeland

Stingray can operate well in Blueland

Wolf can operate well in Blueland

Puma is assigned to

Orangeland ▼

Please make your selection and click 'Go'

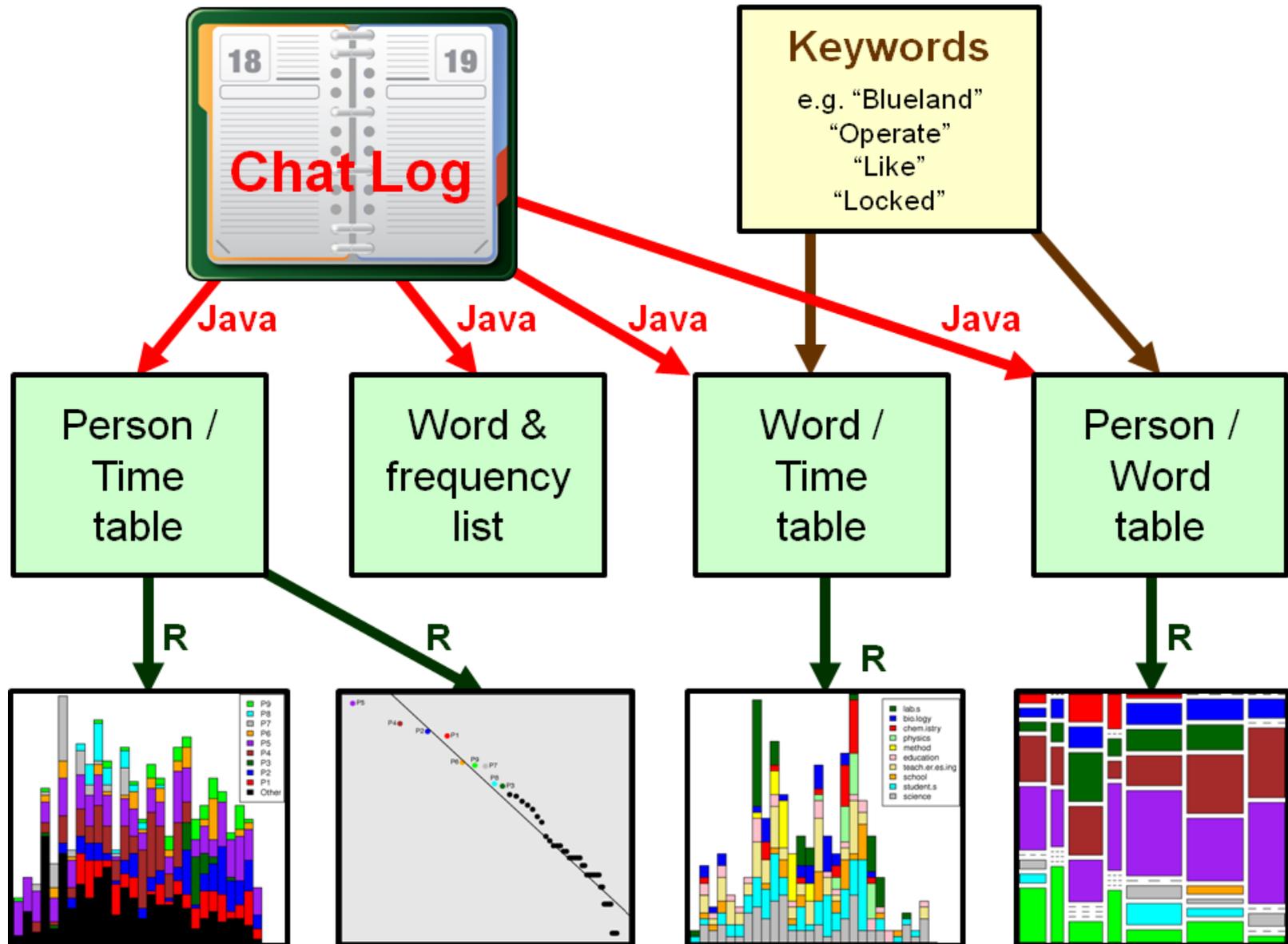
Go

This chat panel is for Alice to communicate with Bob

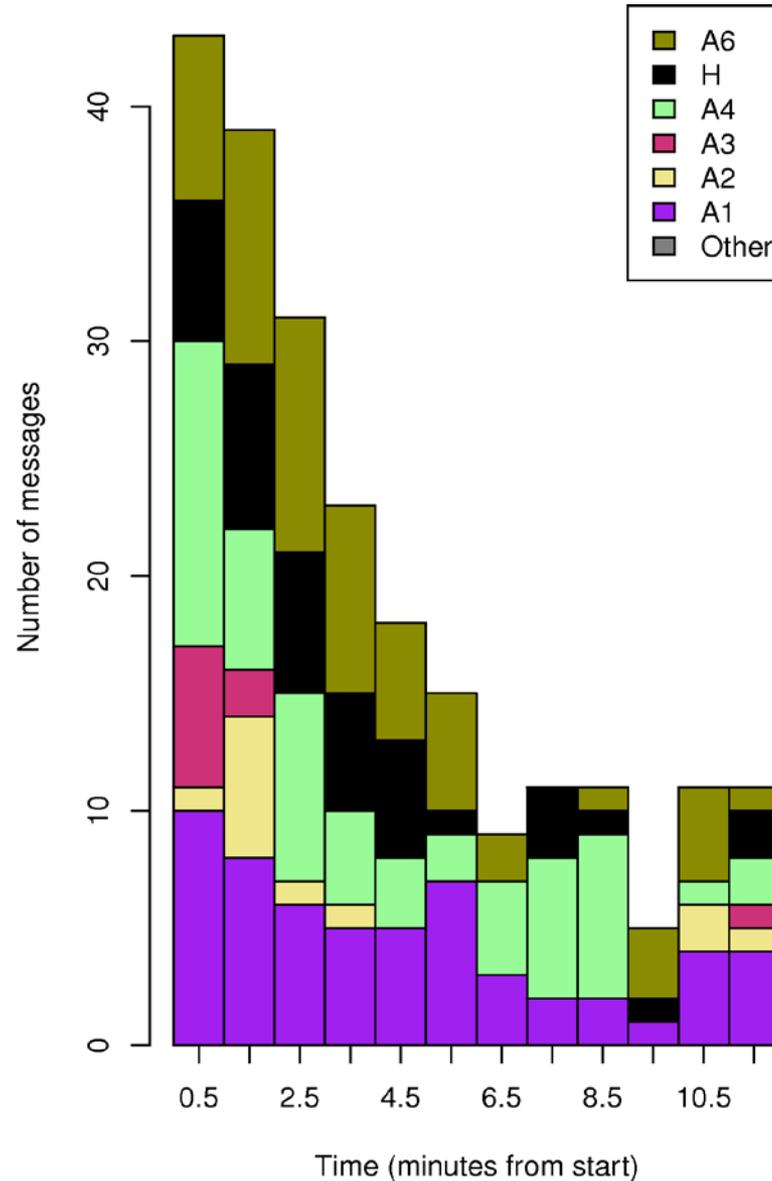
WELCOME! Mon Jan 17 18:35:11 EST 2011

Alice: Hello (18:35:11)

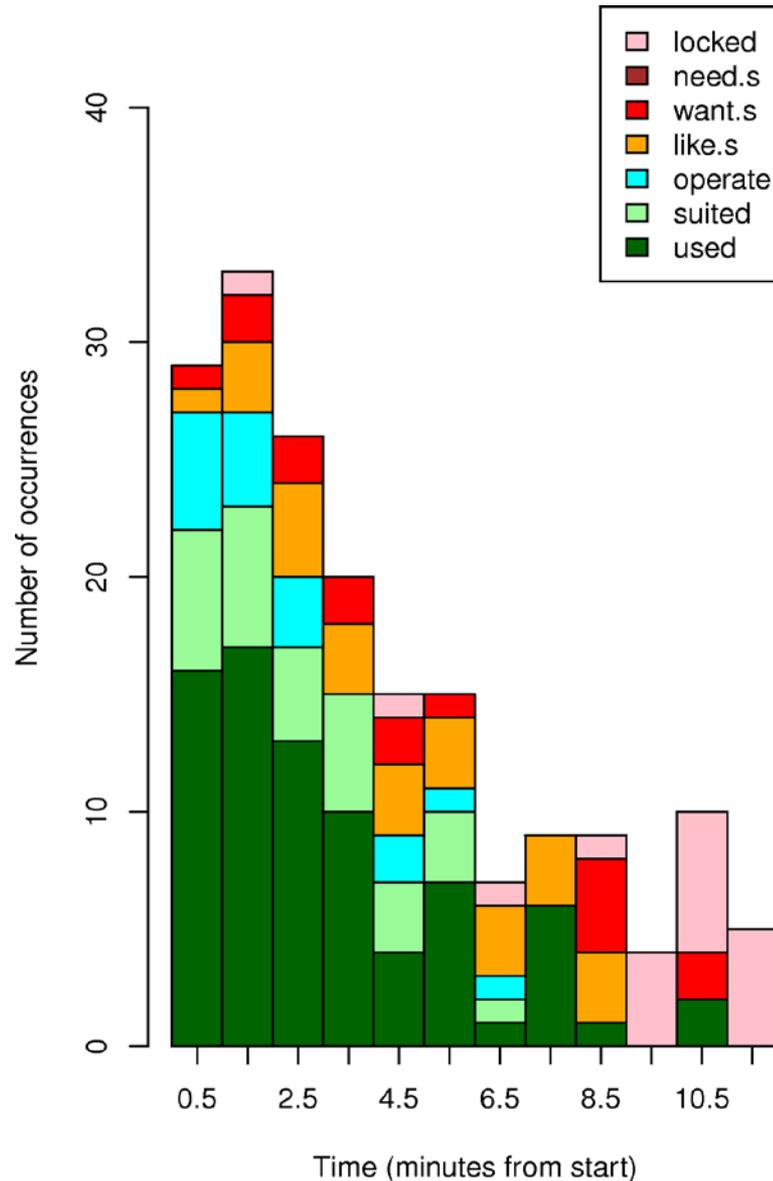
Analysis Tools



Analysis: Person/Time Histogram



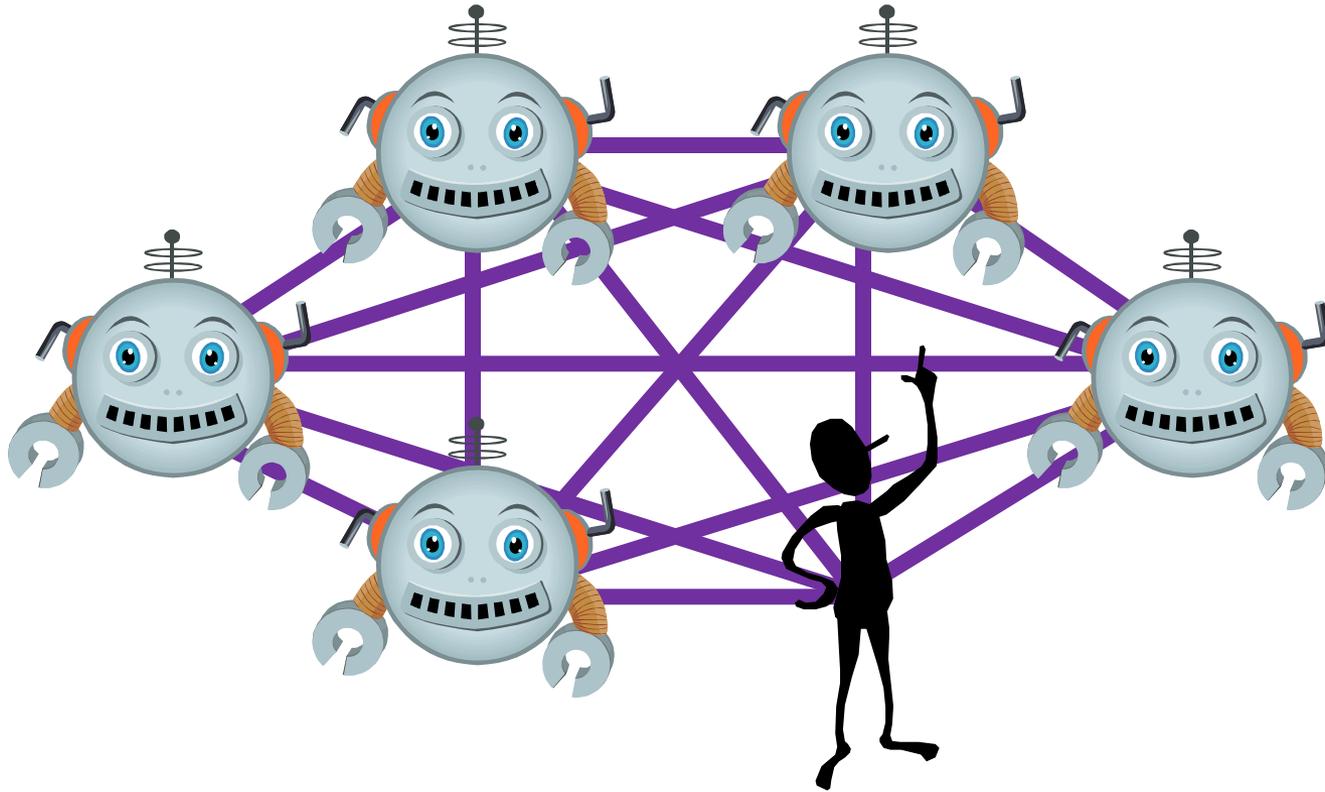
Analysis: Person/Word Histogram



**Manual suffixing
of keywords:**

like.s = like + likes

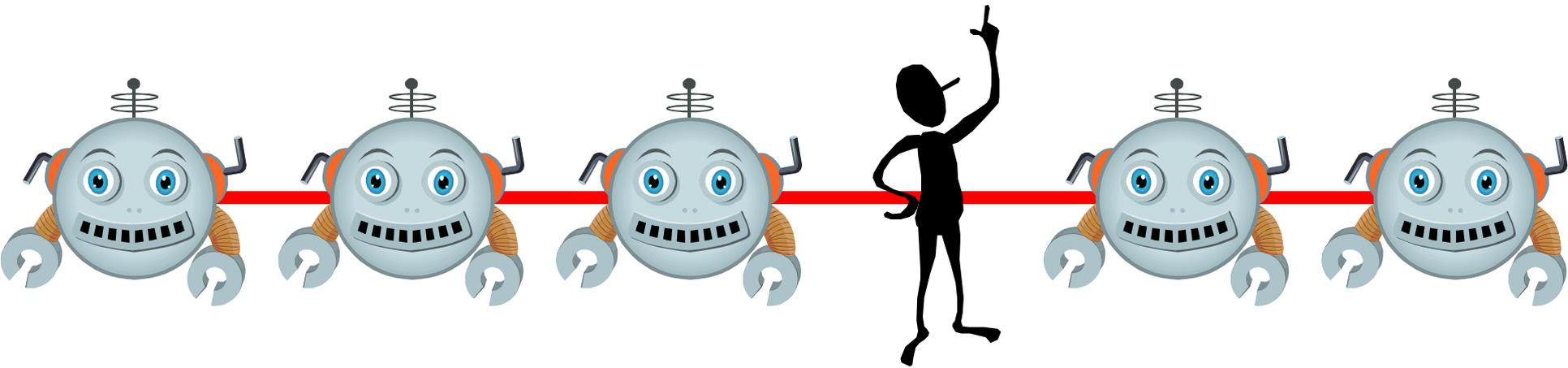
Hybrid human–agent team: Fully Connected



Participants (human and agent) use a shared chat log to distribute facts like “Stingray *can operate well* in Blueland.”

This is followed by discussion of preferences, and final “locked in” decisions, using scripted messages.

Hybrid human-agent team: Chain

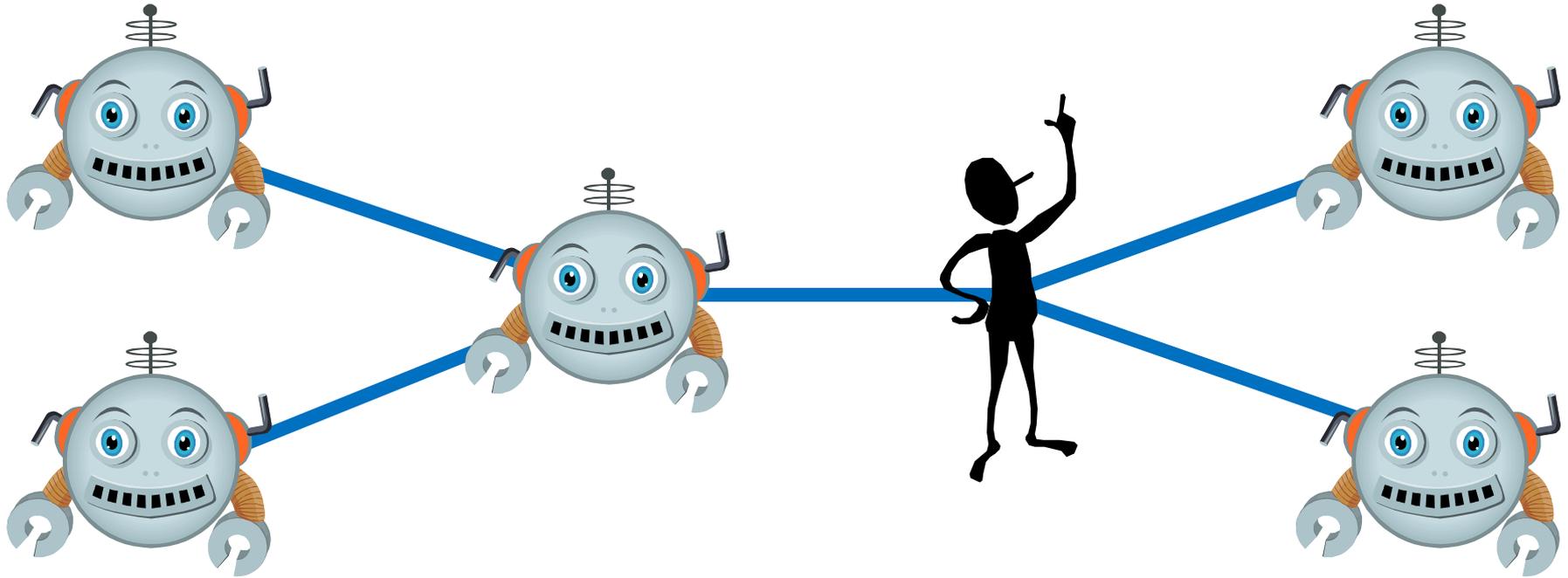


Topologies like this are enforced by the chat tool.

Except at the two ends, participants here must pass on messages by rebroadcasting.

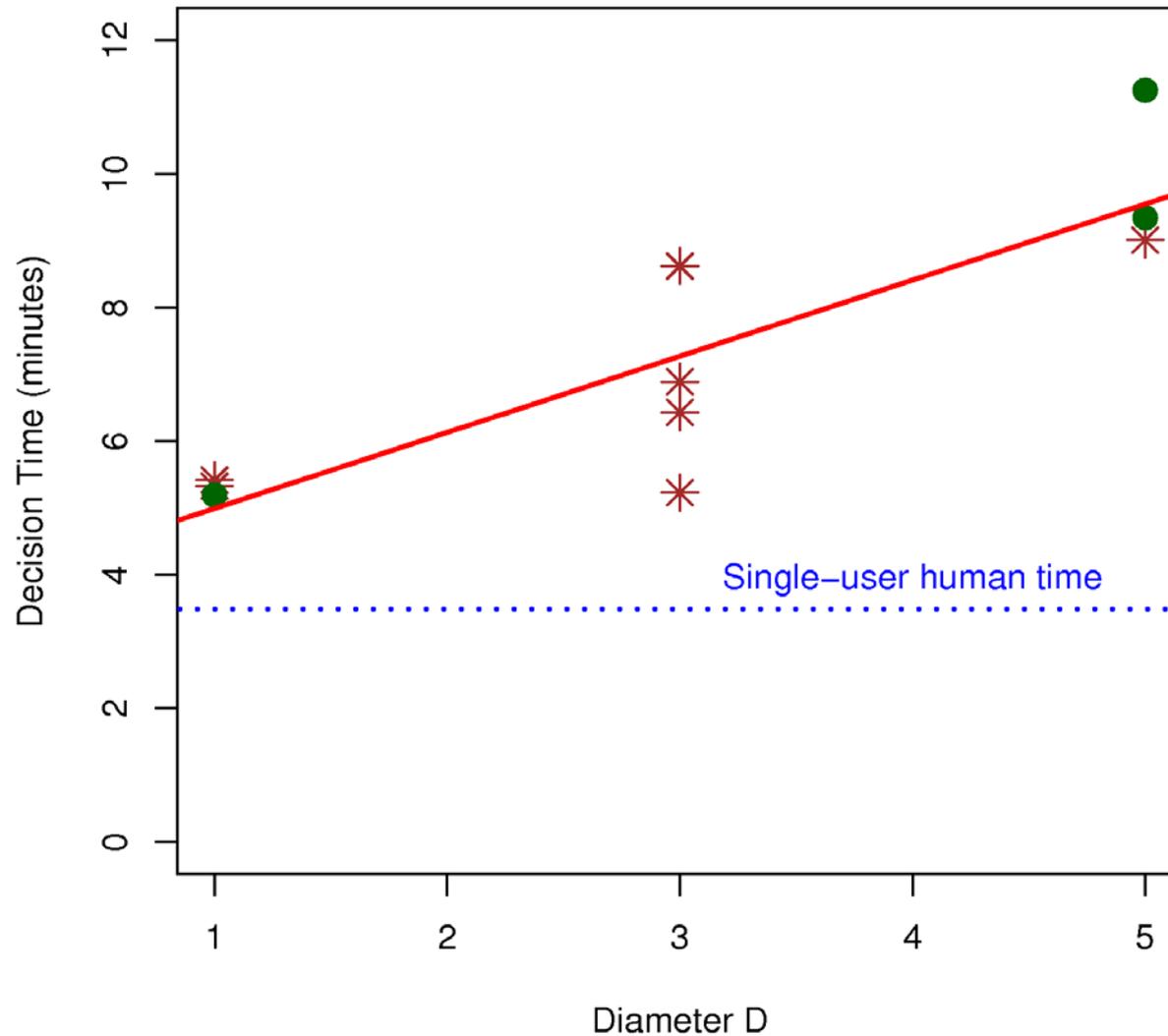
Messages from one end must be rebroadcast 4 times to reach the other end (diameter = 5).

Hybrid human-agent team: Tree



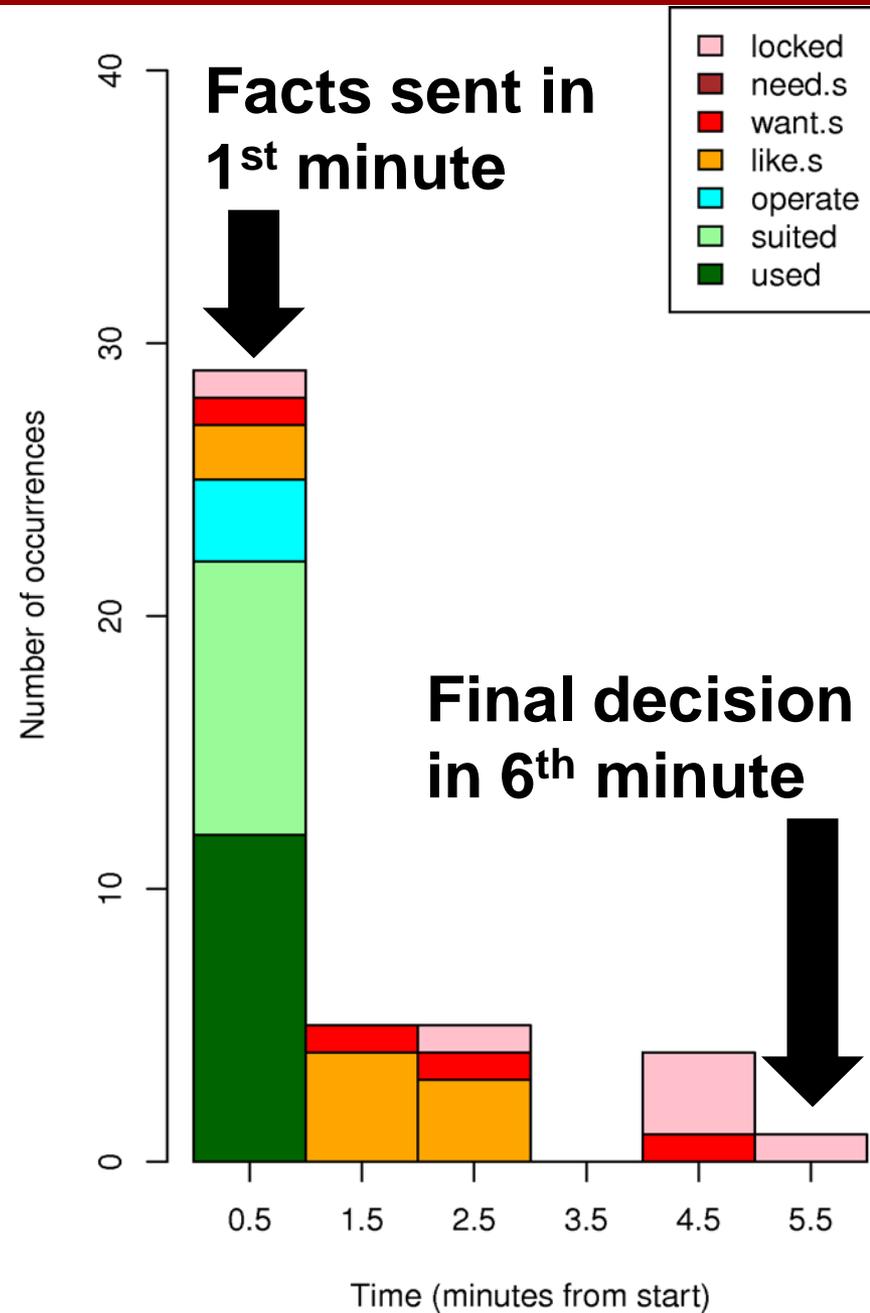
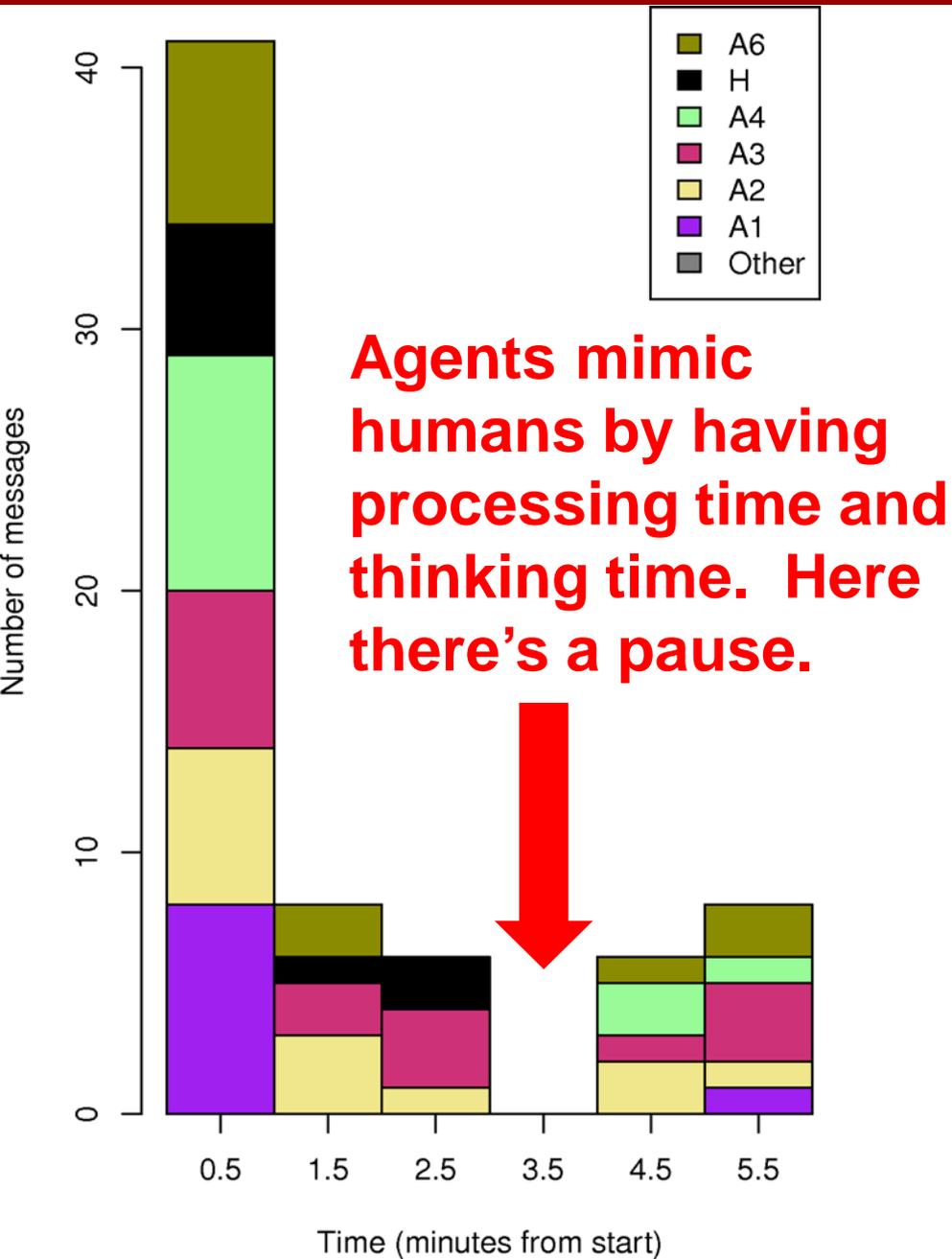
Rebroadcasting is also needed here, but at most twice (diameter = 3).

Hybrid human-agent teams

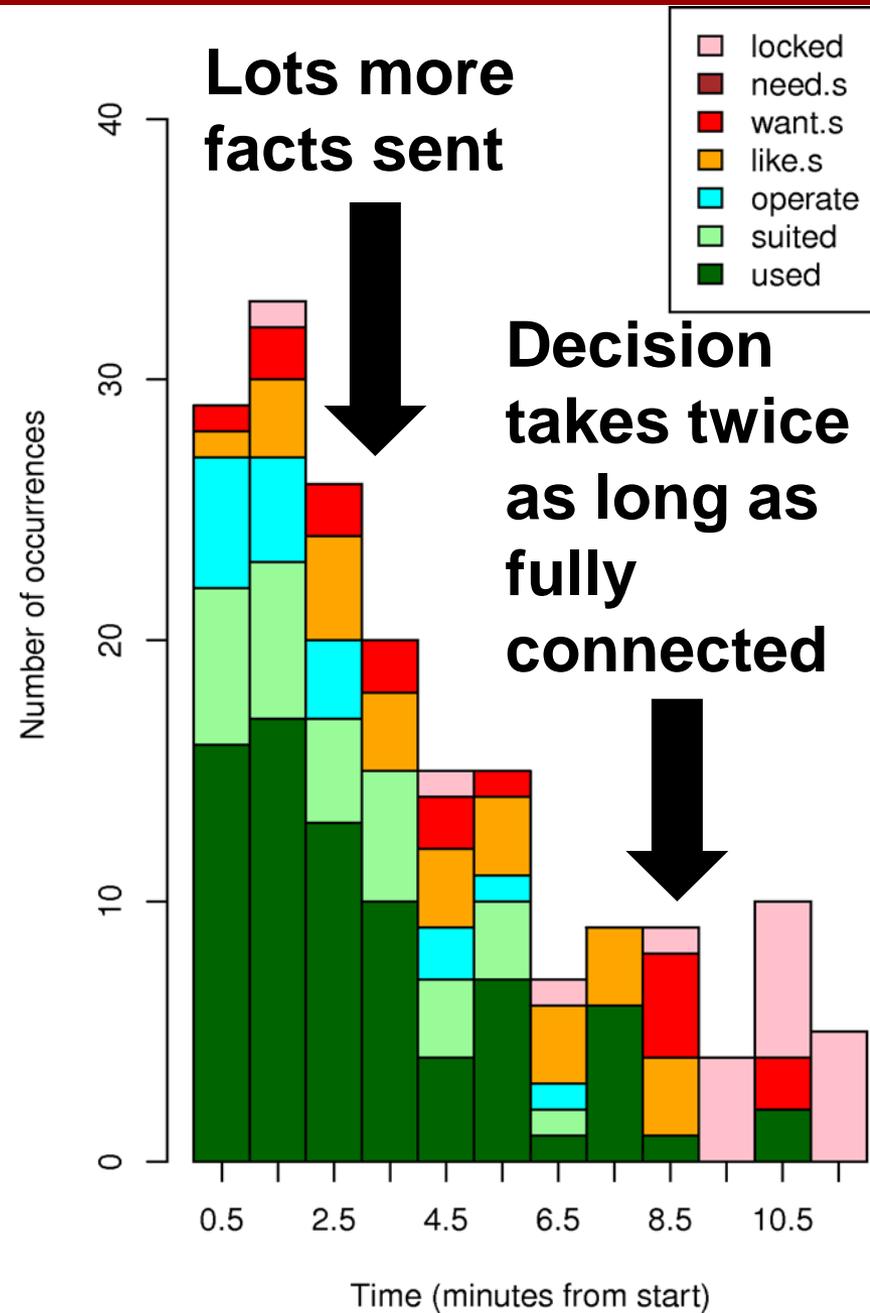
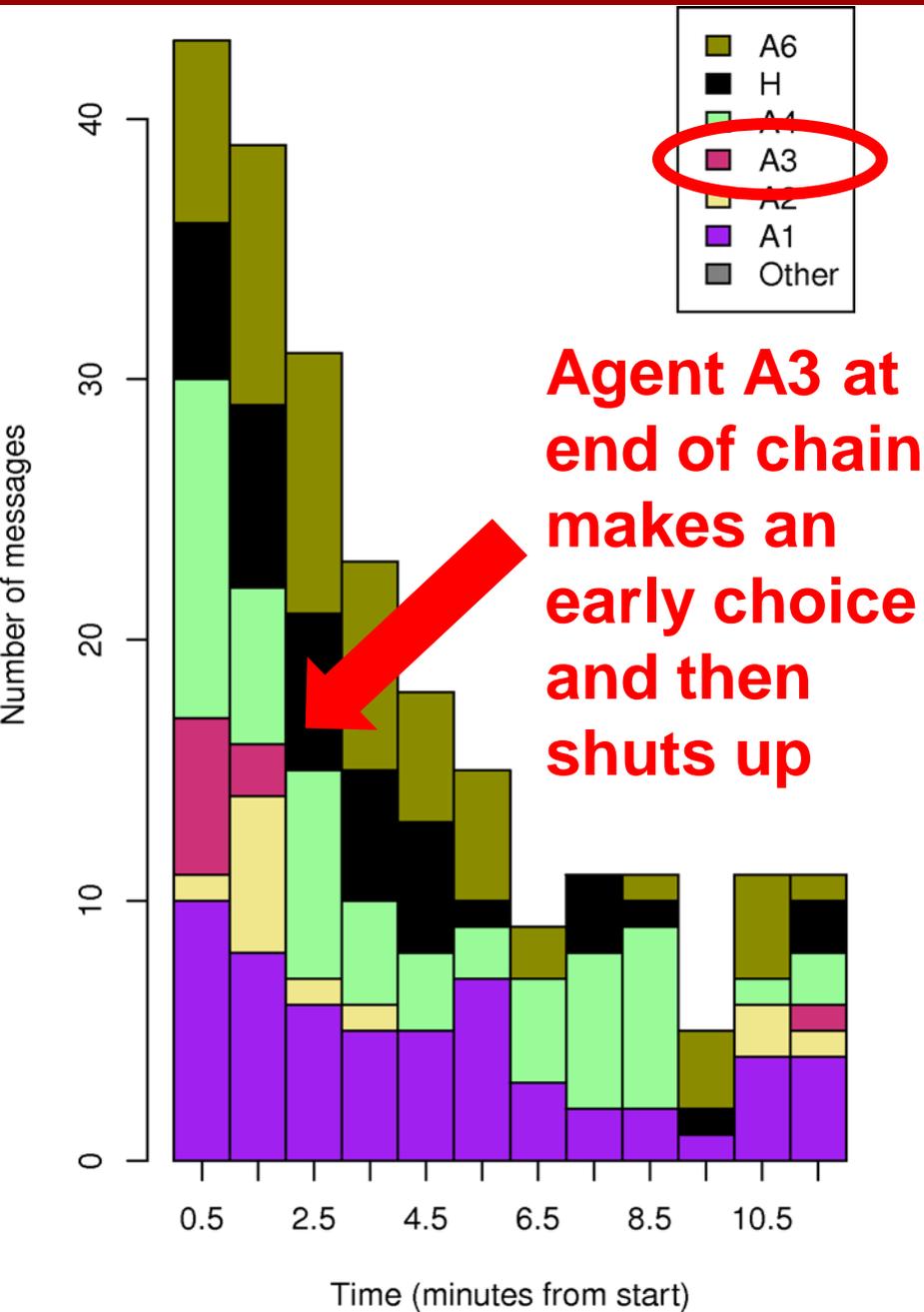


The time to make a decision depends linearly on diameter, and is related to the amount of rebroadcasting going on.

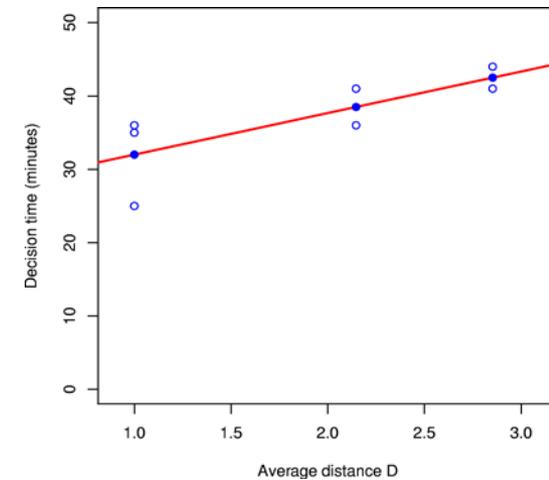
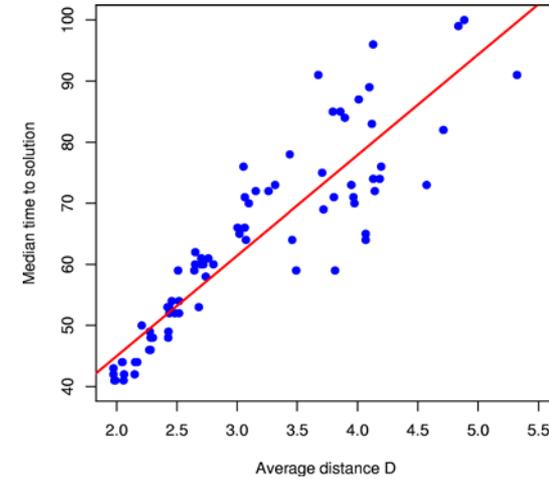
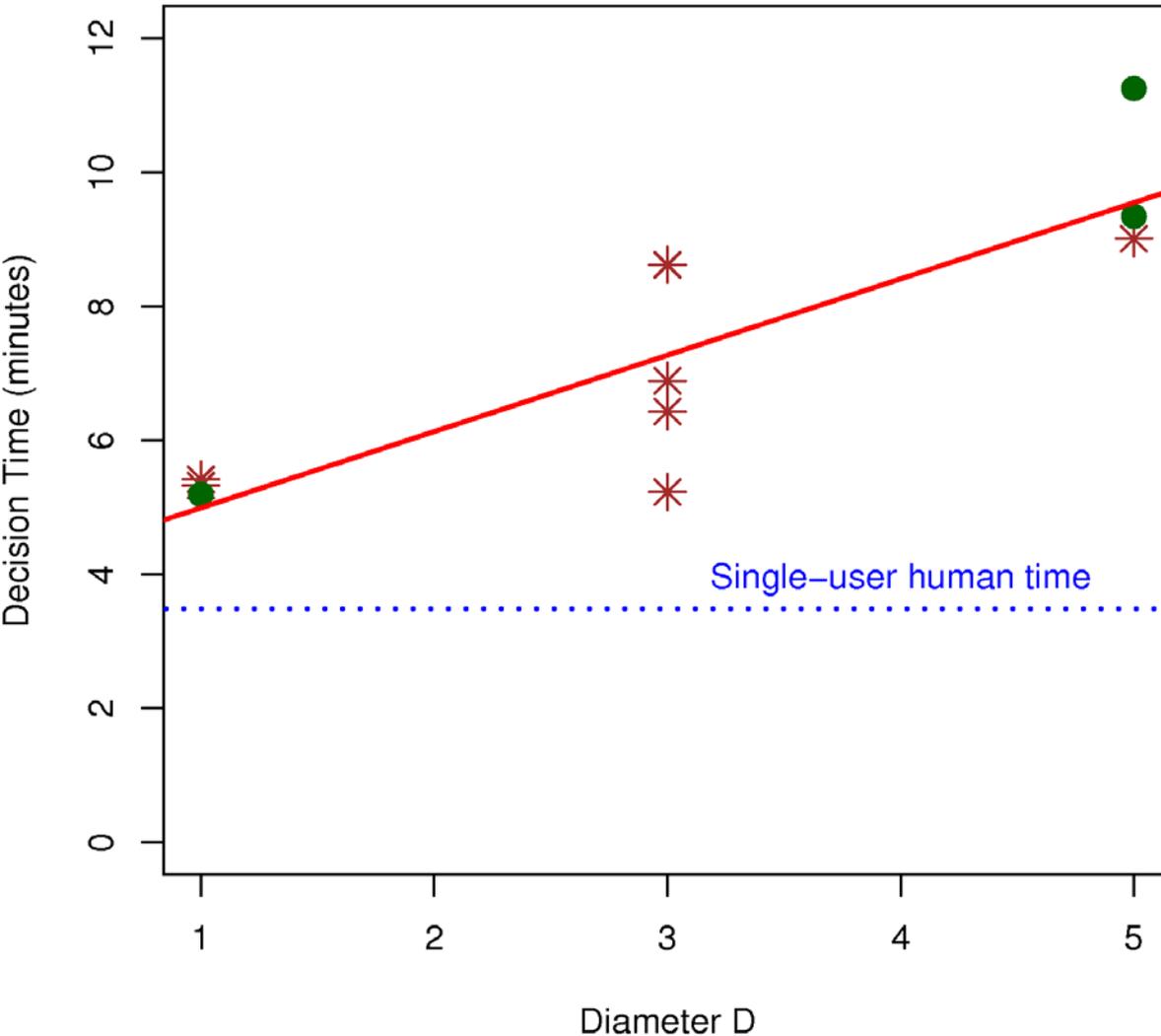
Hybrid human-agent team: Fully Connected



Hybrid human-agent team: Chain

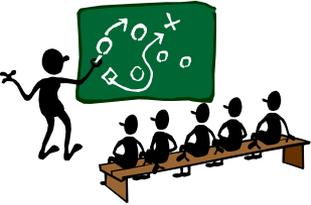


Linear results consistent with past studies

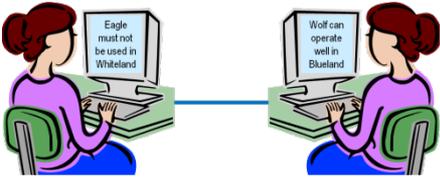


Increasing support for linear relationships between decision time and average distance / diameter.

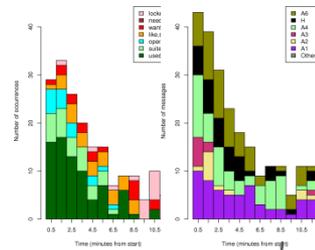
Summary



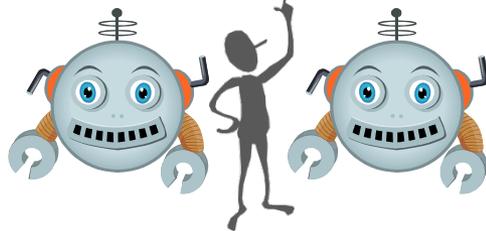
Prompted by past studies on decision time ...



... we built a simple tool for C2 experiments ...



... and analysed the results of some ...



... hybrid human/agent experiments.



As before, the effect is linear.