Accelerating Collaboration in Task Assignment Using a Socially Enhanced Resource Model

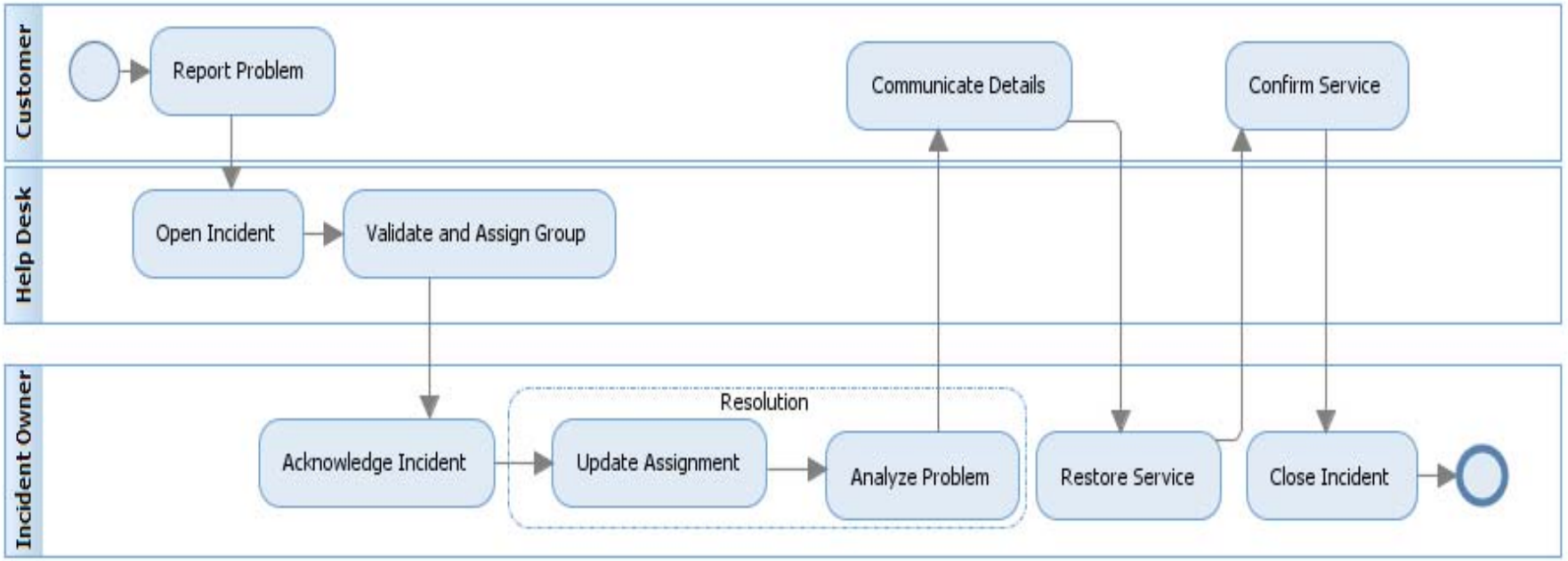
Rong Liu, Shivali Agarwal,
Renuka Sindhgatta, Juhnyoung Lee

IBM Research

Challenges in BPM

- Process models need to be well defined before runtime
- Difficulties in supporting frequent on-demand interactions that usually cannot be prescribed
  - e.g. knowledge-intensive business process, complex decision-making
- Example: IT Incident Management
  - IT Incident: event that causes, or may cause, an interruption to or a reduction in the quality of IT services
  - Resolving IT incidents is often knowledge intensive
  - Application incidents often requires on-demand collaboration among different support teams, e.g. application, middleware, or operation system teams etc.

Incident Management Process



- Iterative resolution: sequential incident transfer between assignees (misrouted or collaboration)
- Incidents with transfers are more likely to miss SLA
- **Challenges: how to engage globally distributed resources to collaborate on-demand and reduce incident transfer?**

Solution

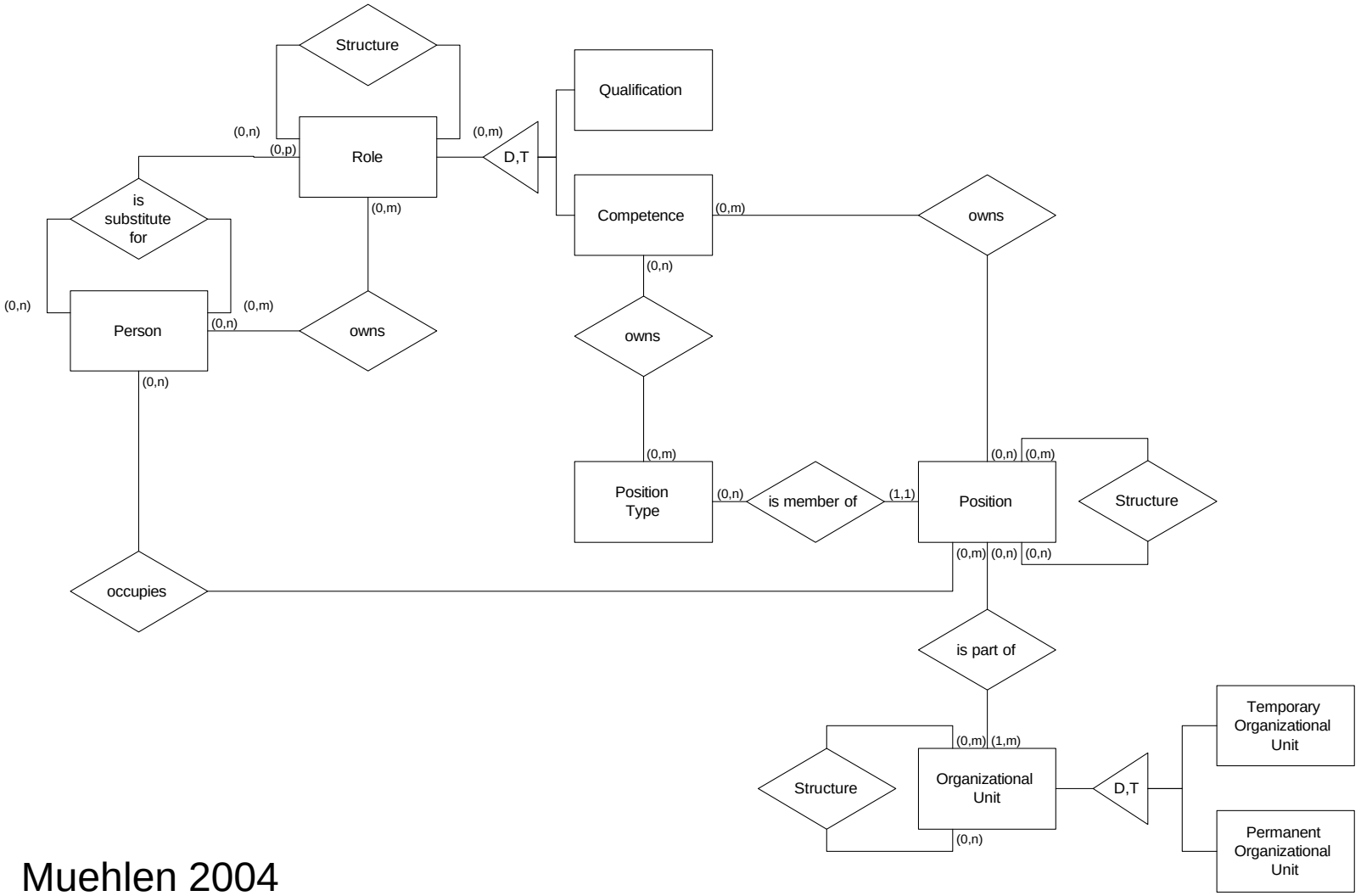
- Solution: Social BPM
  - Social process support, wiki, message, chat
  - **Social Compute Unit**: dynamically configure a resource unit based on task needs (Dustdar and Bhattacharya, 2011)

- **How to recommend appropriate Social Compute Unit (SCU) for a task**?
  - By task complexity and skills required (Sengupta et al 2013)
  - **Based on resources social characteristics**

Basic Idea

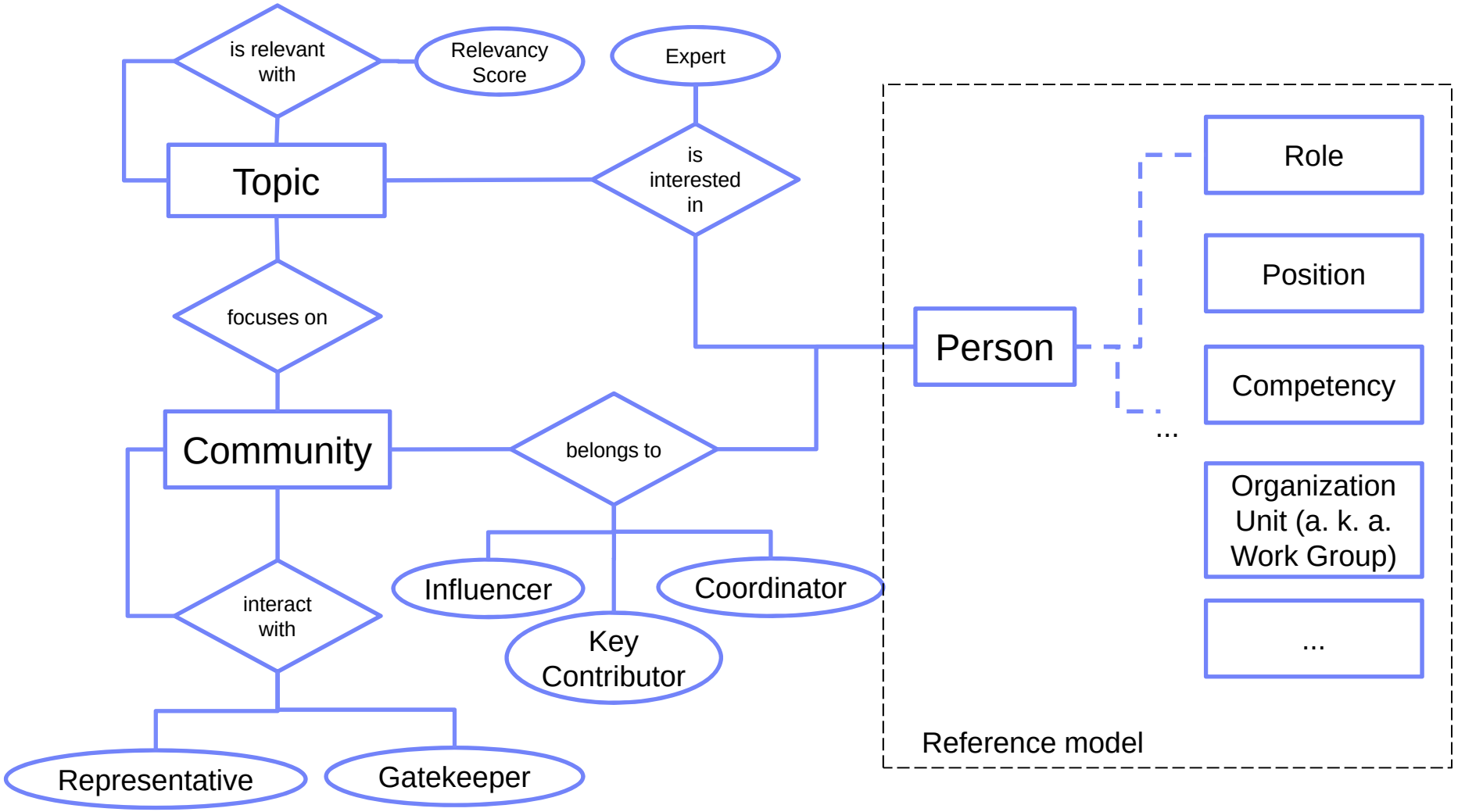
- Extend traditional (human) resource model with **social network features**
- Identify **key social positions** in the social networks of resources
- Develop a new method to **assign resources during business process execution that utilize these key social positions**
- Implement & evaluate the extended resource model and resource assignment method

Traditional Resource Model



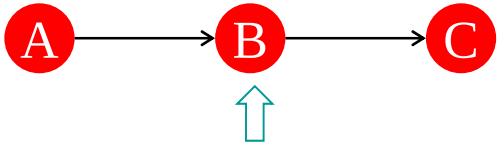
Muehlen 2004

Extended Resource Model

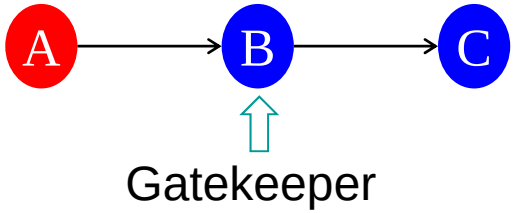


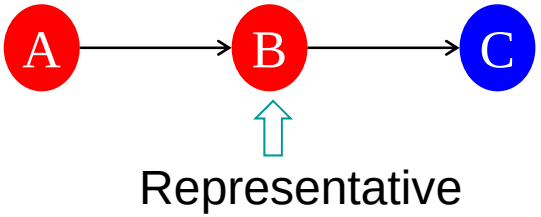
Social Positions

- Influencers: leadership or authority
  - Resources with technical authority: technical leader or proficient subject matter experts (SMEs)
- Coordinators
  - Resources bridge connections between others: IT architects, team leads, mangers etc.



- Key contributors (per work group)
  - Most active resources
- Gatekeeper/Representatives
  - Key role players in communication across communities

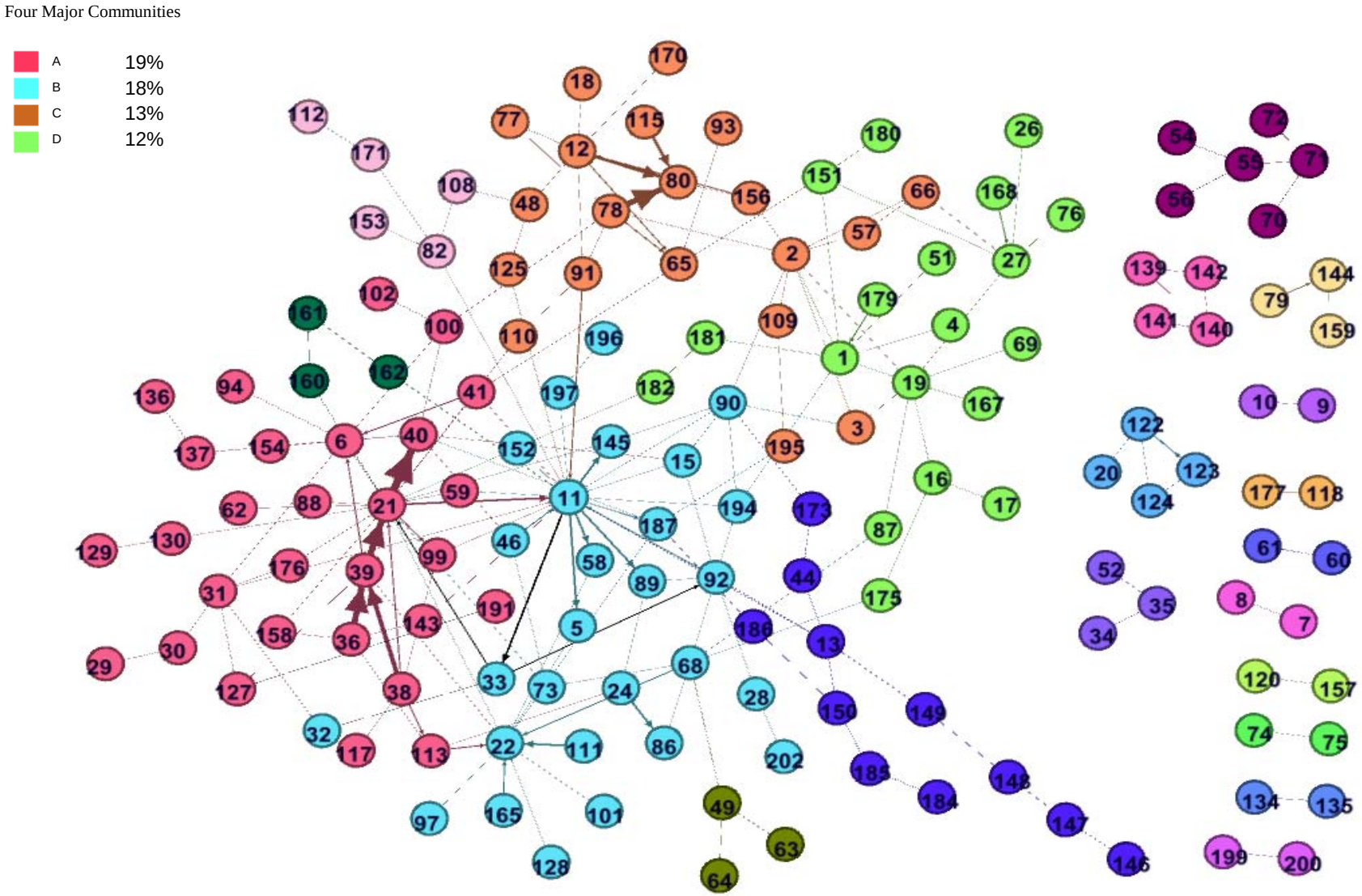




Experiment: IT Incident Management

- Incidents
  - 1,563 incidents with 23,123 task execution logs
  - About 20% tickets with transfer logs
  - Average number of transfers is 3
- Resource Social Network
  - Built based on incident transfer logs
  - Node (154): resources
  - Direct link (220): the number of transferred incidents as the weight

Resource Social Networks



Communities

- Girvan and Newman's algorithm to detect communities
  - Community: subset of nodes with dense connections
  - Modularity: fraction of the edges in a community minus the expected such fraction if edges were distributed at random
  - Algorithm: finds the edges that are most "between" communities and removes them to detect community iteratively

- Results
  - 21 communities with modularity 0.62, indicating significant community structure existing in this network
  - Four major interconnected communities with large populations (60%)
  - Some communities are aligned with resources' work group structures, while others spread across multiple work groups, indicating strong collaboration between these groups

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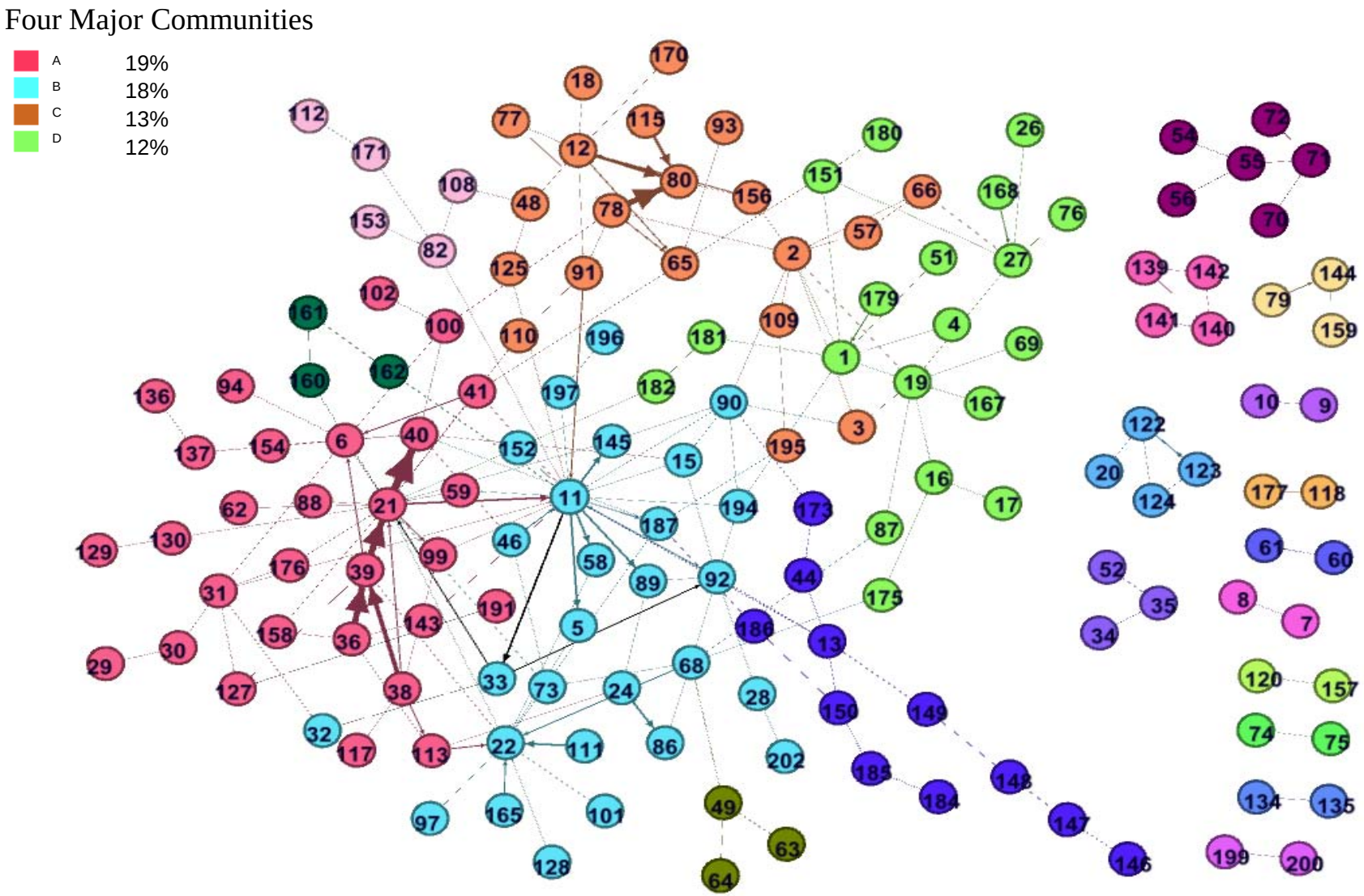
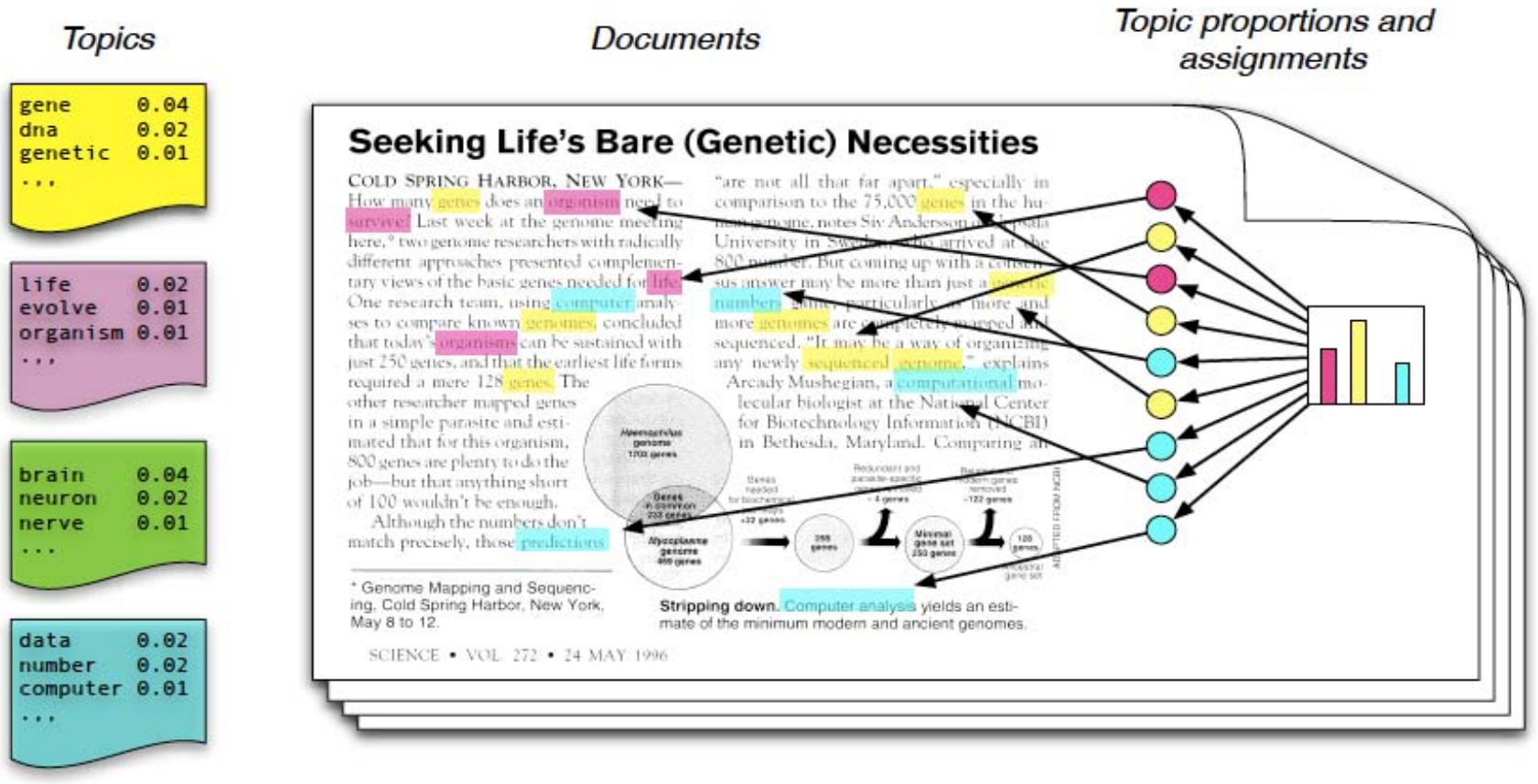
Resource Social Networks

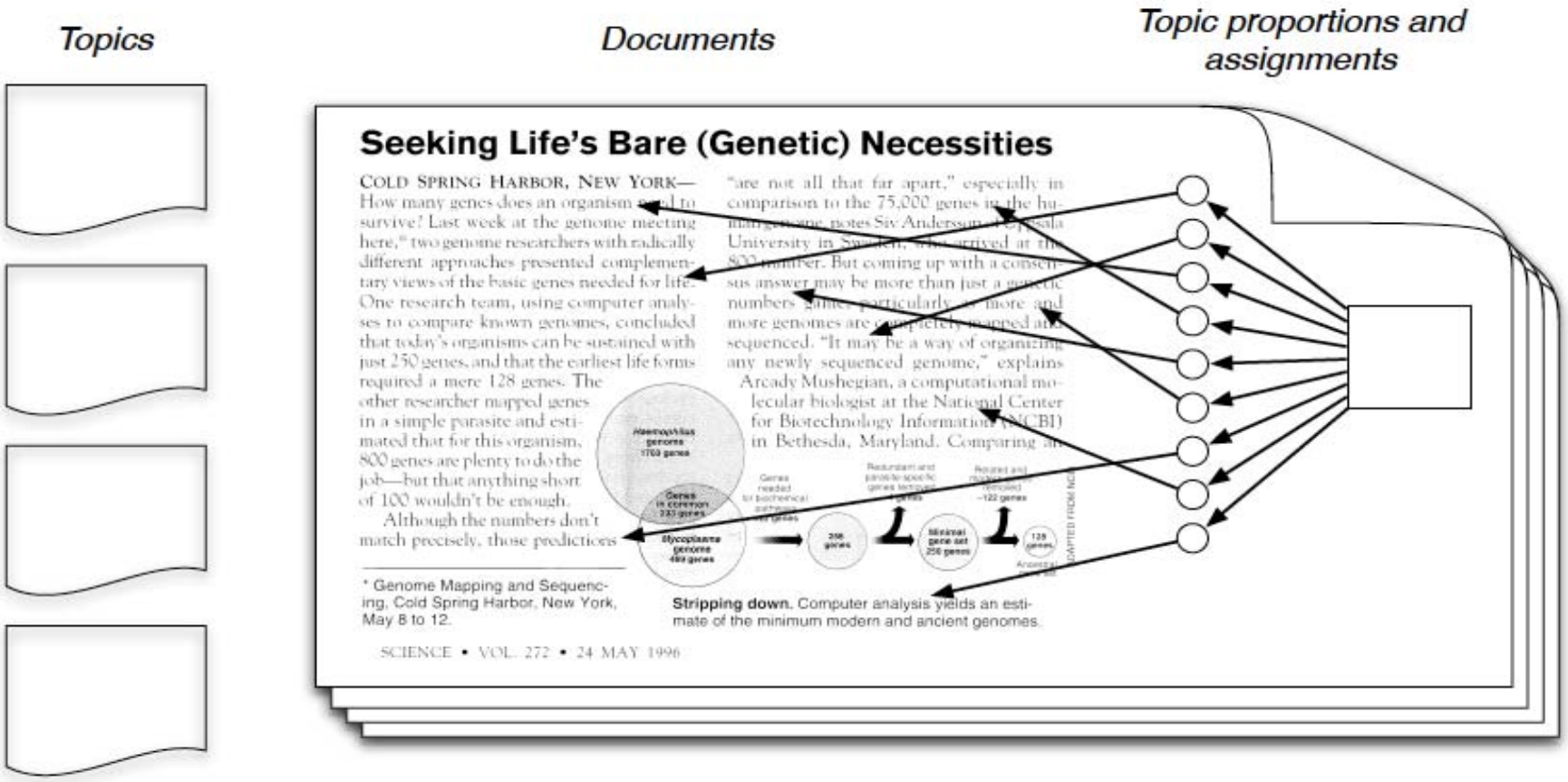


Discover Topics from Incident Text by Latent Dirichlet Allocation (LDA)



- Each **topic** is a distribution over words
- Each **document** is a mixture of corpus-wide topics
- Each **word** is drawn from one of those topics

Latent Dirichlet Allocation



- In reality, we only observe the documents
- The other structure are **hidden** variables, which we **infer**
- Compute the distribution conditioned on the documents
  - P(topics, proportions, assignments| documents)

Topics of Communities

Community	Size	Group Mix	Topics
A	29	Procure to Pay, Web Methods Application, Custom Application	*Purchasing*: purchasing order, shopping cart, goods movement, buyer, process *Payment*: payment, request, approval, transaction, vendor, *Invoice*: invoice, item, line, code *Web Methods Integration*: Hub, Request
B	28	Security, Travel and Expense, HR Payroll	*User Password*: User ID, user locked, password reset *Access*: authentication, connection, access, role, applicable, portal, self service, registration *HR Expense & Payroll*: employee, time, trip, deposit, business
C	20	Planned Transport Charges (PTC), Business Reports	PTC: ledger, session, task abended, printing failure *Reports*: source, error, report, filename
D	19	Business Reports, Security	*Reporting*: report, file, excel, attachment, record, pdf, accessing, absence, transport

Detect Social Positions

- Influencers: leadership or authority
  - Metrics: eigenvector centrality
  - Relative scores to measure the influence of a node in the network
  - Connections to high-scoring nodes weigh more than to low-scoring ones
- Coordinators
  - Metric: betweenness centrality
  - Number of shortest paths from all nodes to all others that pass through a node
- Key contributors (per work group)
  - Metric: degree centrality
- Gatekeeper/Representatives
  - Metrics:
    - Form sub-network by only links cutting across each pair of communities
    - Gatekeeper: indegree centrality
    - Representative: outdegree centrality

Social Positions within Communities

Community	Coordinator		Influencer		Key Contributor		
	Resource	Betweenness	Resource	Eigenvector	Resource	Workgroup	Degree
A	21	87	36	0.46	21	procure to pay	37
	40	24	39	0.39	39	custom application	28
	6	27	38	0.37	40	procure to pay	21
	31	18	21	0.35	36	web methods application	12
B	11	265	90	0.47	11	security	26
	92	206	11	0.39	22	HR travel and expense	15
	22	152	15	0.34	92	HR Payroll	9
	68	151	92	0.30	33	security	7
C	12	90	78	0.39	80	SAP Finance PTC	18
	2	75	57	0.47	12	SAP Finance PTC	15
			2	0.46	78	SAP Finance PTC	13
					2	Business reports	8
D	1	24	4	1.54	1	Business reports	7
	19	23	1	1.35	19	security	6

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Social Positions across Communities

Community Pair	Community	Representative		Gatekeeper	
		Resource	Outdegree	Resource	Indegree
(A, B)	A	21	3	21	5
	A	113	3		
	B	33	2	11	7
	B			22	3
(A,C)	A	21	1	41	1
	A	100	1		
	C	65	1	110	1
	C			78	1
(A,D)	A		1	21	1
	D	182			
(B,C)	B	90	1	11	3
	B	187	1		
	C	91	2	3	1
	C			195	1
(B,D)	B	68	2		
	B	194	1		
	D			1	1
	D			87	1
	D			175	1
(C,D)	C	2	2	2	1
	D	1	1	19	2

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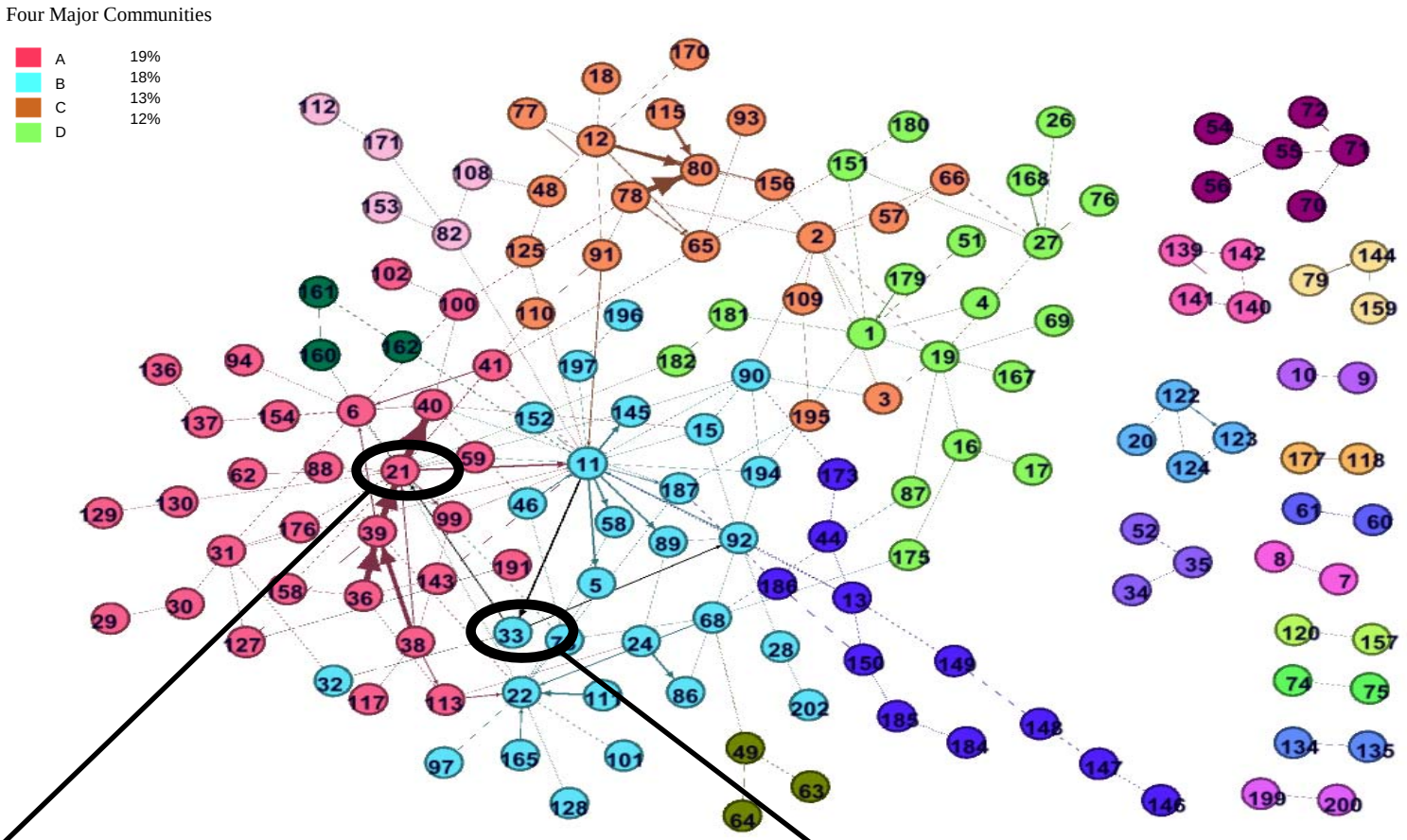
Social Positions

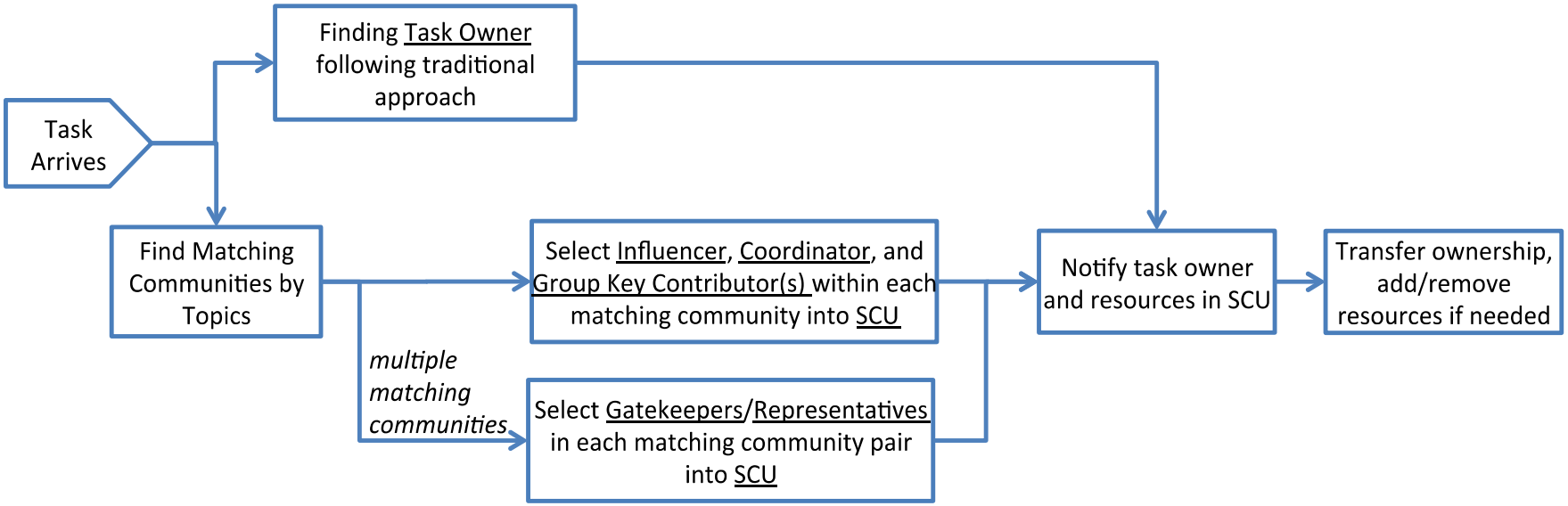


influencer, coordinator, group key contributor, and also gatekeeper/representative

key contributor, representative

Resource Assignment

- Augment traditional resource assignment approach with a Social Compute Unit (SCU)
- SCU is computed based on social positions and resource availability and workload
- Each task has a task owner and SCU
- SCU is informed about the task in anticipation of collaboration



Task Assignment Example – Single Community

Incident ID: INC1
Open Time: 8/3/2010 8:31:47 AM Close Time: 7/16/2010 6:55:20 AM
Description: The USER xxx has a successful *login* into the hub after *registration*, but he is *unable to access* SAP. Every time when he clicks on Sap work place, the screen goes blank!

- Topics related to ***user access***, matching community B
- Possible SCUs
  - Resources 90 (influencer), 92 (coordinator and key contributor of work group "HR Payroll"), 11 (key contributor of work group "Security"), 22 (key contributor of work group "Travel and Expense")
  - Resources 11 (influencer, coordinator and key contributor of "Security" work group), 92 (key contributor of work group "HR Payroll"), 22 (key contributor of work group "Travel and Expense")
- Actual logs:
  - 5 → 33 → 92 → 11
  - key social positions do get involved

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Task Assignment Example – Multiple Communities

Incident ID: INC2
Open time: 8/23/2010 2:02:16 PM Close Time: 7/28/2010 6:34:41 PM
Had system reimaged a few months ago, has not been able to perform *goods movement*, had previous incident opened (INCx) to report *authorization* issue, but is still unable to complete work, referring back to appropriate parties at higher severity. Please help to check.

- Topics related to ***goods moving*** and ***authorization***, matching communities A & B
- A Possible SCU
  - *Community A*: 21 (coordinator, gatekeeper, and representative), 36 (influencer, key contributor), 40 (key contributor), 39 (key contributor)
  - *Community B*: 90 (influencer), 11 (coordinator, key contributor, and gatekeeper), 22 (key contributor), 33 (representative), 92 (key contributor).
- Actual logs: transfer back and forth between A & B
  - 21 (A) → 40 (A) → 46 (B) → 11 (B) → 187 (B) → 40 (A) → 15 (B) →11 (B) → 145 (B) →21 (A).
  - Transfer is caused by necessary collaboration instead of misrouting.
  - The transfers to normal contributors typically have a pattern of coming from these powerful positions.

Future Work

- A pilot to measure the effectiveness of this new socially enhanced method by
  - reduction of incident transfers
  - reduction of incident resolution time
  - improvement in resource utilization
- Extend this approach to Software Development

Summary

- A new approach to executing business processes, including:
  - Social network analysis component which analyzes and creates resource social networks from resource collaboration logs, formulates resource communities and determines topics of communities, detects resource social positions and updates resource social profiles;
  - Socially enhanced resource model which augments the traditional resource model with social properties of resources including topics, social communities, social positions;
  - Socially enhanced task assignment which augments the traditional resource assignment approach with a Social Compute Unit (SCU) which is computed based on social positions and resource availability and workload; each task having a task owner and SCU; SCU being informed about the task in anticipation of collaboration

Thank You!

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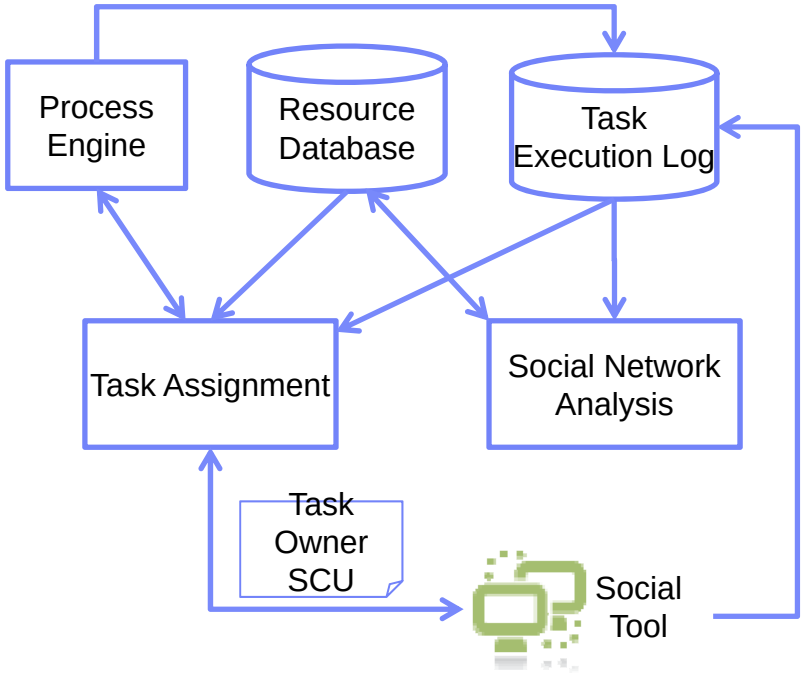
Implementation



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Girvan and Newman's community detection algorithm

Reference: Girvan and Newman's community detection algorithm

- A community (i.e. cluster) consists of a subset of nodes within which the node-node connections are dense, and the edges to nodes in other communities are less dense
- Modularity measures the strength of division of a network into modules
- Modularity is the fraction of the edges that fall within the given groups minus the expected such fraction if edges were distributed at random
- The algorithm finds the edges that are most "between" communities and removes them to detect community iteratively:
  1. The betweenness of all existing edges (the shortest paths between a pair of nodes that run through it) in the network is calculated first.
  2. The edge with the highest betweenness is removed.
  3. The betweenness of all edges affected by the removal is recalculated.
  4. Steps 2 and 3 are repeated until no edges remain.
- For details, see Girvan M. and Newman M. E. J., Community structure in social and biological networks, Proc. Natl. Acad. Sci. USA 99, 7821–7826 (2002)