**Requirements Elicitation:
Towards the Unknown Unknowns**

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Requirements Elicitation

- Mature area, basic techniques understood: interviews, scenarios, workshops, prototypes, protocols, ethnography

- Acknowledged problems:
  - tacit knowledge
  - social and political issues
  - ambiguity in natural language

- New challenges: elicitation via the Internet, trans-national audiences

- But has research pushed the boundaries?

Aims of this Survey

- To propose an Elicitation Review Framework (ERF)

- To review research challenges
  - Techniques
  - Models
  - Tools

- Research road map
  - Green-field domains
  - Brown-field domains

Elicitation Review Framework (ERF)
(Gervasi et al. 2013)

- **Accessible**: knowledge which can be remembered or discovered

- **Expressible**: knowledge which can be communicated by a stakeholder

- **Articulated**: knowledge which has been communicated

- **Relevant**: appropriate requirements or domain knowledge

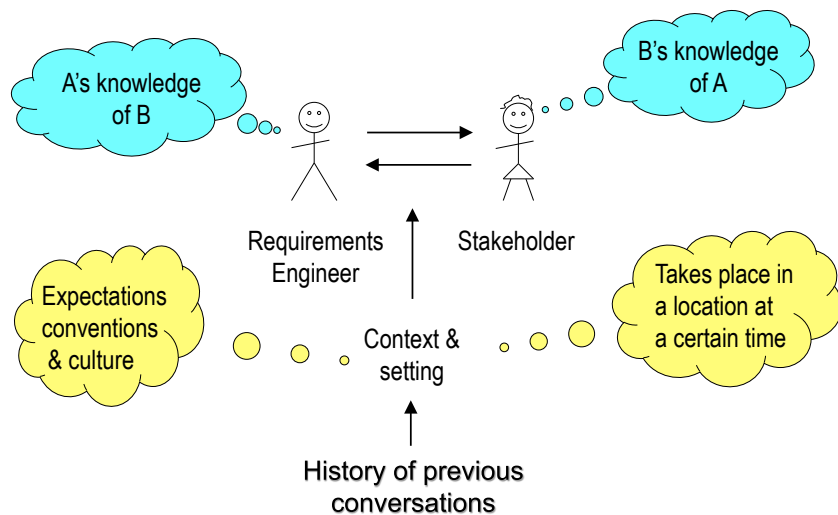NB tacit knowledge only apparent in context

Elicitation Review Framework

	Accessible	Expressible	Articulated	Relevant
Known Knowns	🙂	🙂	🙂	🙂
Known Unknowns	🙂	🙂	?	🙂
Unknown Knowns	🙂	?	🚫	🙂
Unknown Unknowns	🚫	🚫	🚫	?

Requirements Engineer: Known/Unknown / Stakeholder: Known/Unknown

Elicitation Review Framework
Common Ground

A's knowledge of B

B's knowledge of A

Requirements Engineer

Stakeholder

Expectations conventions & culture

Context & setting

Takes place in a location at a certain time

History of previous conversations

Known Unknowns

- **Analyst is aware**, so the challenge is to get the stakeholder to describe/explain it

- **Stakeholder is unaware** of what the analyst needs to know (can also be unknown known, taken-for-granted knowledge)
  - expertise problem: experts know so they assume everyone else does
  - skill problem: skilled behaviour is automatic so it is difficult to describe, e.g. how to ride a bike
  - situated action: you need to be in the real world to understand what is going on

- **Solutions**: ethnographic techniques, demonstrations, prototypes, scenarios

Unknown Knowns

- **Analyst is unaware.** Tacit knowledge held by stakeholder, and/or knowledge withheld for social-political reasons

- Steel mill example: operators see patterns/events in the world that analyst doesn't

- Analyst's problem is to
  (a) be aware that the knowledge exists
  (b) get the stakeholder to describe/explain it

- **Solutions**: elicitation dialogue tactics, expert conversations, demonstrations, observation, ethnographic techniques

Unknown Unknowns

- Neither party is aware of hidden 'over the horizon' knowledge

- Discovery only through shared experience, conversation

- Important because
  - many failures caused by the unanticipated events (safety critical)
  - many new applications go into unknown contexts: globalization, culture
  - many applications have to deal with the (unknown) future

- Solution? a gap in Requirements Elicitation techniques

Requirements Elicitation Techniques

Technique	Known unknowns	Unknown knowns	Unknown unknowns
Interviews	Depends on plan	Open ended questions	Open ended questions, sample size
Observation	Duration and context plan	Serendipitous discovery	Duration and context
Workshops	Plan and composition	limited potential	limited potential
Protocols/ dialogues	Plan and analysis codes	limited potential	limited potential
Scenarios	Plan and sample scope	Serendipitous discovery	Sample size and diversity
Prototypes	Design variations	limited potential	limited potential

Elicitation Techniques

- Interviews: flexible exploration of background domain knowledge (social-political-emotions & values)

- Observation, ethnography: tacit knowledge articulation

- Scenarios, prototypes: grounded conversations reduce ambiguity (articulation)

- Creative & brainstorming approaches, e.g. Creative Problem Solving, KJ, Idea Writing
    - help to discover unknowns by shared conversation
    - good for product/feature-oriented requirements
    - less sure for tacit knowledge

Models-Representations

Model	Goals/Reqs.	Req. Spec.	Domain Knowledge	Articulate./ Accessib.
Use cases [33]	Implicit goals	Action scripts	Limited- ext entities	++
Volere [4]	Goals, req. statement	Rationale, ownership	Org. & env. context	+++
KAOS [7]	Goal hierarchies	Object processes	Obstacles, domain assumptions	-
i* [39]	Goals, soft goals	Agents, tasks, resources, relationships	Roles, agent attributes, org. Setting	+
ISRE [40]	Not explicit	Object processes	Env. setting, spatial location, org. Setting	++

Models-Representations

- Natural Language: good for expressibility but articulation weakness-ambiguity
  - list, formatted templates, semi-formal NL helps

- Diagrams: reasonable expressibility *but*
  - Articulation weakness: formal specification combined with diagrams can help, e.g. KAOS; but comprehensible for stakeholders??
  - Scope/detail weakness: how much context?
  - Complexity: multiple views, goal trees, network diagrams, layers of detail

- Industrial experience suggests KISS (Keep it Simple...)

Tools: Models & Collaboration

- Model checkers established technology, help articulation
  - tend to address known unknowns
  - run-time monitoring can tackle other unknowns
  - depend on scope and formality of the representation

- Simulation tools
  - potential only partially explored (Menzies & Feather RE02, Sutcliffe & Gregoriades RE03,04)

- Social collaboration RE tools extend the common ground arena
  - crowd sourcing, e.g. Amazon Mechanical Turk
  - social network shared knowledge and negotiation: StakeRare
  - social recommender tools
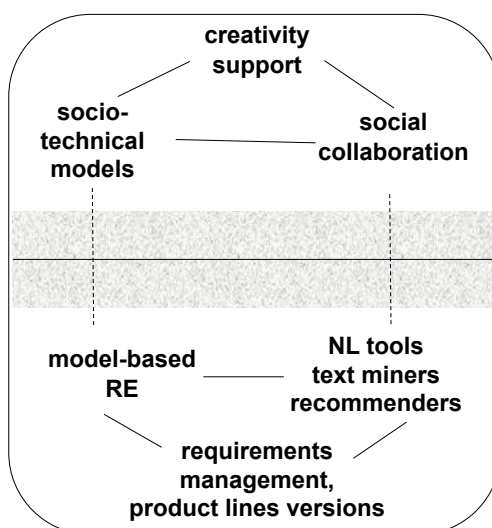
Tools: Natural Language

- Ontologies, ambiguity checkers (nocsious requirements)

- Text mining: semi-automatic extraction of requirements knowledge from documents

- Tools help the articulation for known unknowns

- Assume text exists, so some prior elicitation necessary

- Holy Grail? the Intelligent Requirements Analyser: not for some time-domain knowledge bottleneck
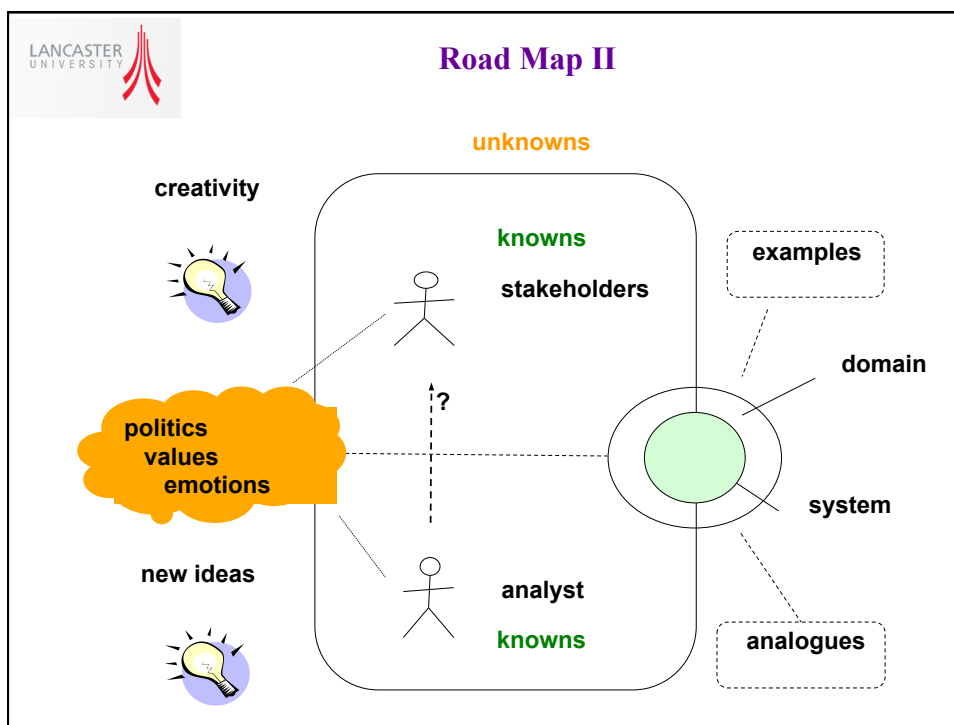
Research Road Map I

green-field RE

creativity support

socio-technical models

social collaboration

unknown unknowns

model-based RE

NL tools text miners recommenders

brown-field RE

requirements management, product lines versions

known unknowns

Road Map II

Conclusions

- No 'silver bullet' for unknown unknowns, but...

- Future potential to expand creative and social RE tools: RE meets social media

- Green-field RE: move towards co-design and participatory discovery for unknown unknowns

- Brown-field RE: NL, text mining and model-based tools to improve known unknowns

- More research on model semantics for system-domain dependencies

Thanks for your attention

and
Any Questions ?

Gervasi, V., Gacitua, R., Rouncefield, M., Sawyer, P., Kof, L., Ma, L., Nuseibeh, B., Piwek, P., de Roeck, A., Willis, A., Yang, H.: "Unpacking Tacit Knowledge for Requirements Engineering", in W. Maalej, A. Kumar Thurimella, H. Becker (Eds), Managing Requirements Knowledge, Springer, 2013.

Sutcliffe, A. G., Fickas, S., & Sohlberg, M. M. (2006). PC-RE: A method for personal and contextual requirements engineering with some experience. Requirements Engineering, 11, 157-163.

Sutcliffe, A. G., Gault, B., & Maiden, N. A. M. (2005). ISRE: Immersive Scenario-based Requirements Engineering with virtual prototypes. Requirements Engineering, 10(2), 95-111.

Requirements Elicitation Techniques

Technique	Known unknowns	Unknown unknowns	Articulation
Interviews	Depends on plan	Follow-up questions, sample size	Natural language ambiguity
Observation	Duration and context plan	Duration and context	Ambiguity in interpretation
Workshops	Plan and composition	Number and composition	NL ambiguity
Protocols/ dialogues	Plan and analysis codes	Limited potential	Narrow, detailed analysis
Scenarios	Plan and sample scope	Sample size and diversity	Sample and bias, NL ambiguity
Prototypes	Design variations	Limited potential	Extent of implementation