Surprise-triggered Reformulation:

Goal reasoning for computational creative design

Image courtesy of Anna Jordanous

Can Computers be Creative?

Development

? ? ?

What is Creativity?

A creative product *“has novelty and value for the thinker or for his* ***culture****.”*

Newell, Shaw and Simon 1958

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Design is not Optimization

Design problems are **not well-specified**.

Design solutions are **not enumerable**.

Design tasks are **not decomposable**.

Design goals are **not initially quantifiable**.

How Do Designers Think?

Internal design representation

‘seeing’

*Designer **reflects** on the effect of the changes that resulted from the action taken*

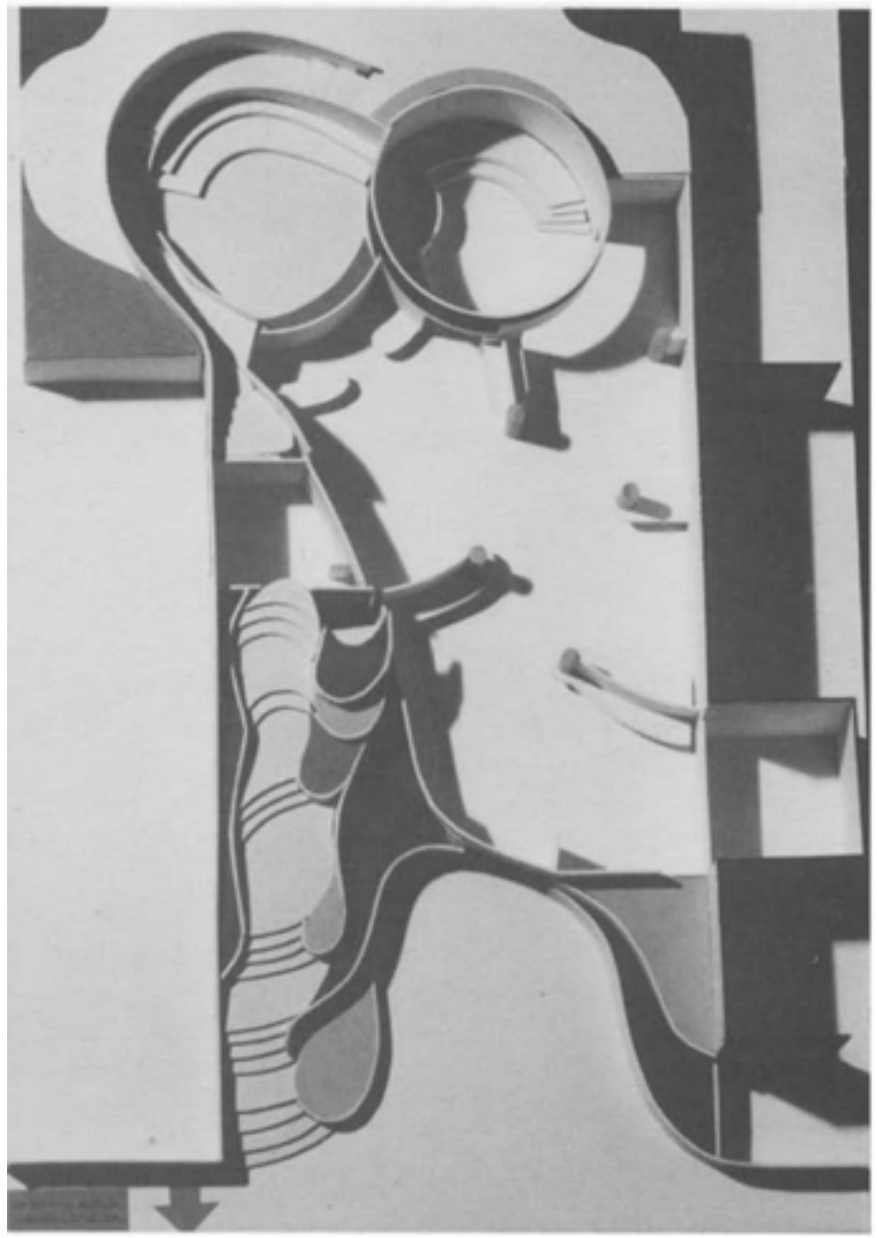
‘moving’

*Designer **takes action** and changes the current design representation*

External design representation

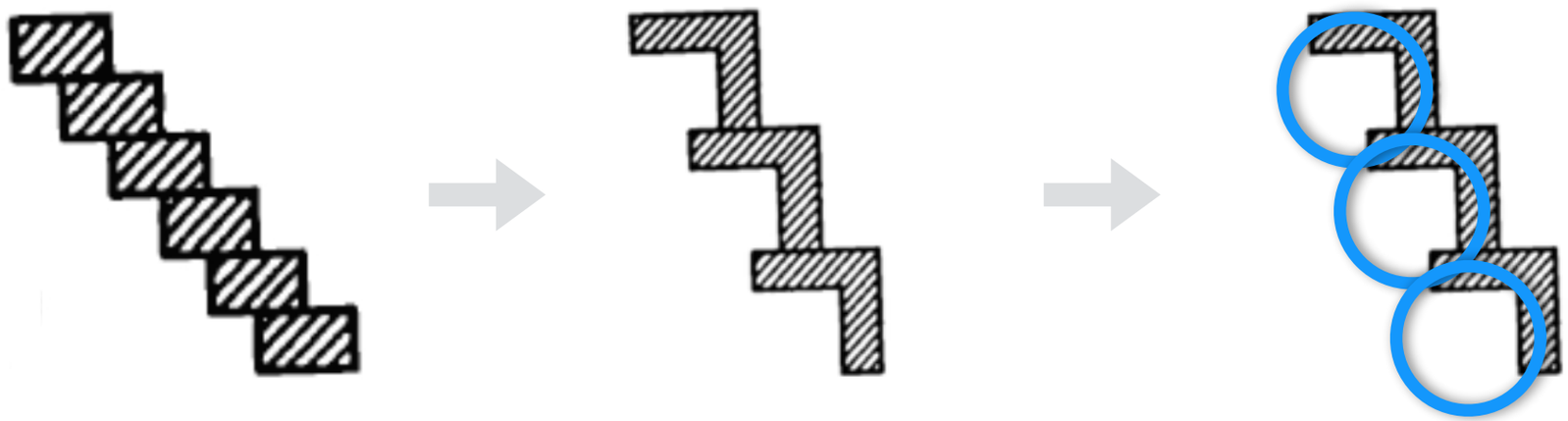
Schön 1983

How Do Designers Think?



Goldschmidt 1994

How Do Designers Think?



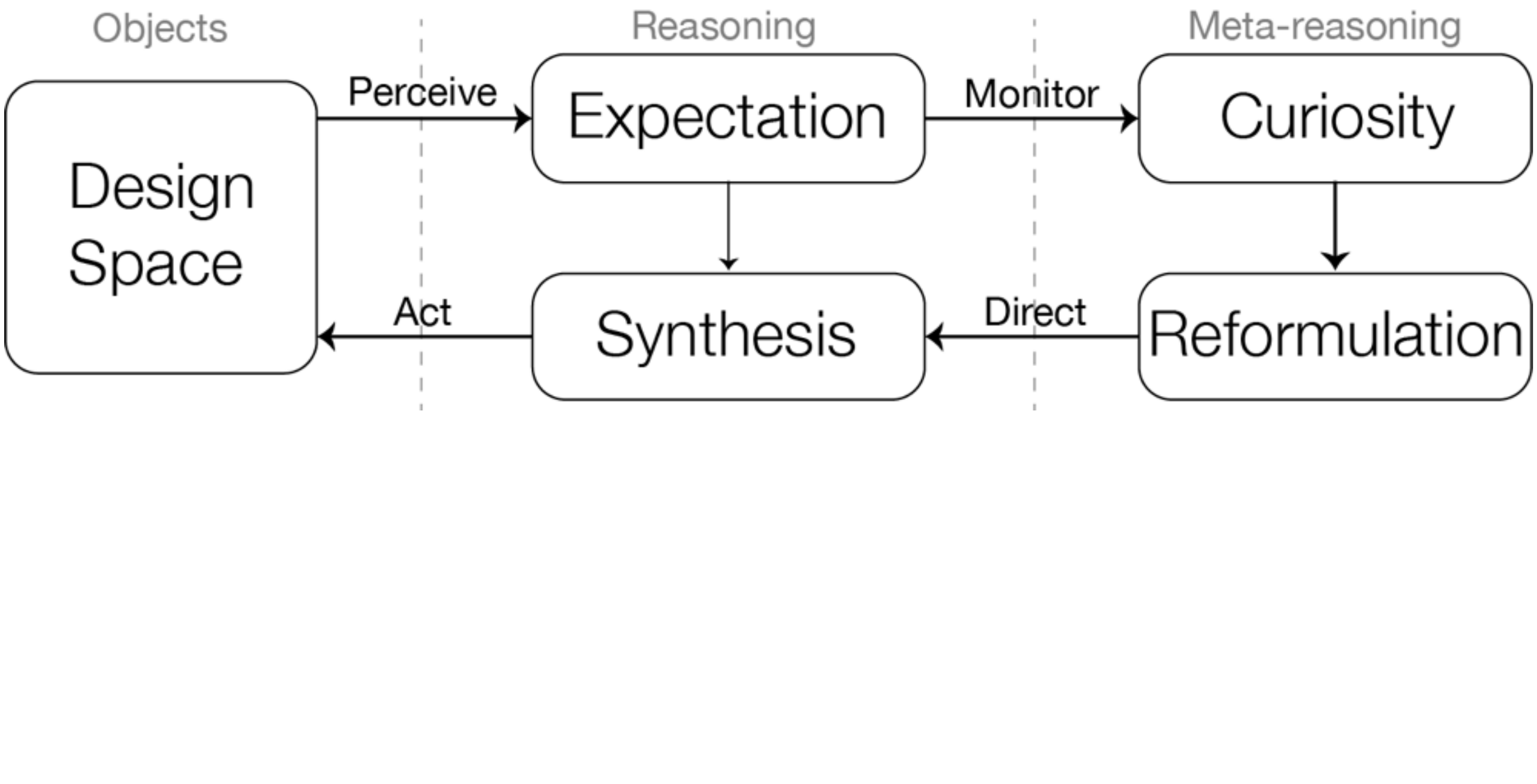
unexpected
discoveries

reformulation

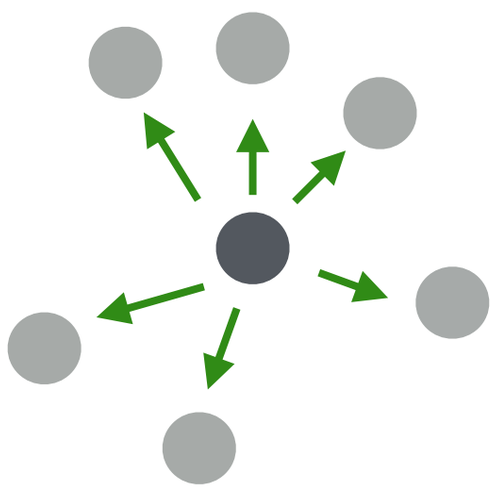
Schön & Wiggins 1992

Q Chef
the Curious Chef

Motivation: Specific and diversive curiosity



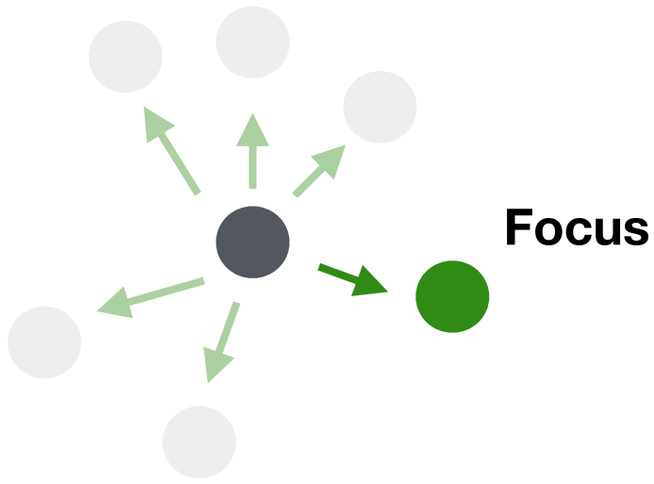
Motivation: **Specific and diversive curiosity**



Diversive curiosity

undirected surprise-seeking

Motivation: **Specific and diversive curiosity**



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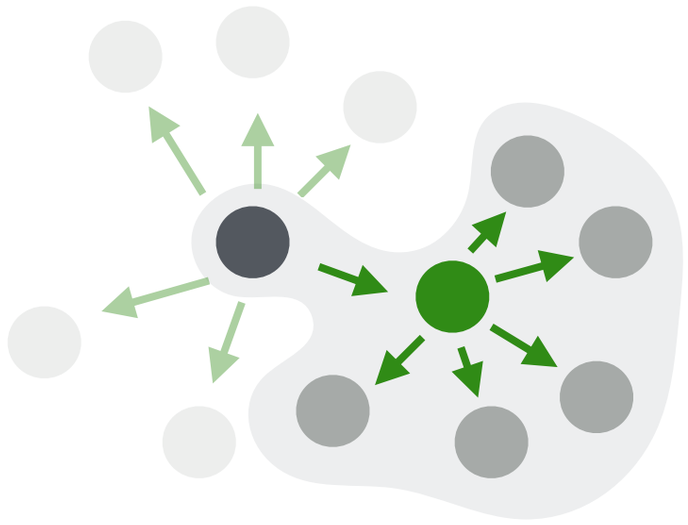
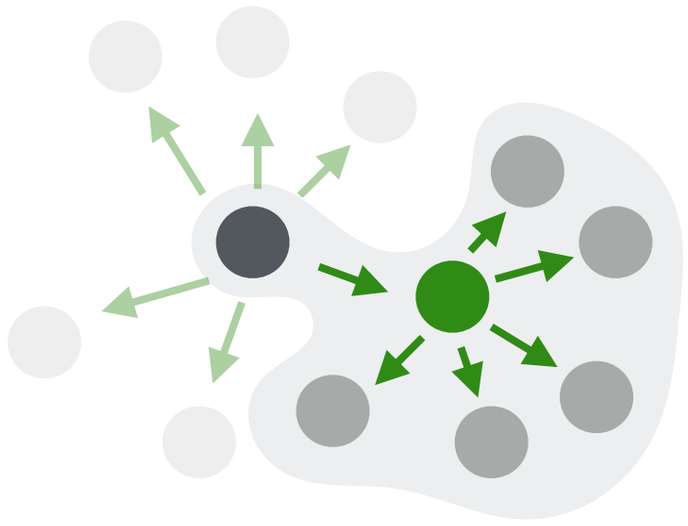


Diversive curiosity
undirected surprise-seeking

Specific curiosity
focussed on a discovery

Motivation: **Specific and diversive curiosity**

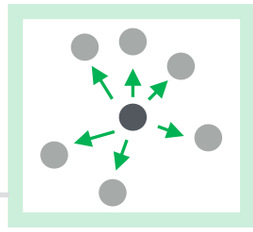


Diversive curiosity
undirected surprise-seeking

Specific curiosity
focussed on a discovery

Specific curiosity **drives goal reformulation**

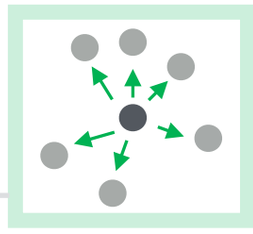
Model: **Diversive curiosity using surprise**



The first step to diversive curiosity is the ability to be surprised.

Something that is both surprising and meets design requirements can trigger specific curiosity.

Model: **Diversive curiosity using surprise**



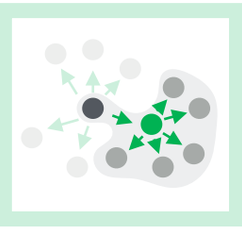
We use machine learning to estimate the likelihood of **feature combinations** occurring together. If you've only ever seen ginger used in sweet dishes, then:

$$P(\text{  } \mid \text{  }) \approx 0$$

$$P(\text{  } \mid \text{  }) \approx 1$$

Surprise: the ratio of a feature's conditional likelihood in context to its marginal likelihood over the whole dataset.

Model: **Specific curiosity using goal formulation**



Specific curiosity requires judging whether a new surprising design is relevant to the stimulus that triggered curiosity.

This requires the ability to **compare surprises**.

Model: **Specific curiosity using goal formulation**

How can we generate designs that are surprising **in a similar way** to the design that triggered specific curiosity?

		Discovery	Context
What makes two surprises similar?			
Different discovery	same context		
Same discovery	different context		
Similar discovery	similar context?		

Experiments: **Experimental design**

Are different recipes generated when specific curiosity is triggered by agents with different experiences?

Simulated Agents	
Sweet	Only recipes containing sweeteners
Non-sweet	Only recipes without sweeteners
Everything	All recipes

Experiments: Specific Curiosity Differences

Kreatopita (Greek meat pie)

lamb, onions, garlic, tomatoes, eggs, mushrooms, phyllo pastry, breadcrumbs, parsley, oregano, cumin, salt, pepper, cinnamon, cloves

Experiments: Specific Curiosity Differences

Kreatopita (Greek meat pie)

lamb, onions, garlic, tomatoes, eggs, mushrooms, phyllo pastry, *breadcrumbs*, parsley, oregano, **cumin**, salt, pepper, cinnamon, cloves

Result: “breadcrumb and butter pudding”

breadcrumbs, eggs, milk, butter, brown sugar, cinnamon, **vanilla**

(*surprise contexts*, **surprising features**)

Demonstration of Reformulation

Kreatopita (Greek meat pie)

lamb, onions, *garlic*, tomatoes, **eggs**, mushrooms, phyllo pastry, breadcrumbs, parsley, oregano, cumin, salt, pepper, *cinnamon*, cloves

Result: “spicy whipped cream dip”

cream, chillies, capsicum, **eggs**, *cinnamon*, *garlic*, coriander, oregano, black pepper, salt

(*surprise contexts*, **surprising features**)

Demonstration of Reformulation

Kreatopita (Greek meat pie)

lamb, onions, garlic, tomatoes, eggs, mushrooms, phyllo pastry, *breadcrumbs*, **parsley**, oregano, cumin, salt, pepper, *cinnamon*, cloves

Result: “deep fried spicy pork chop”

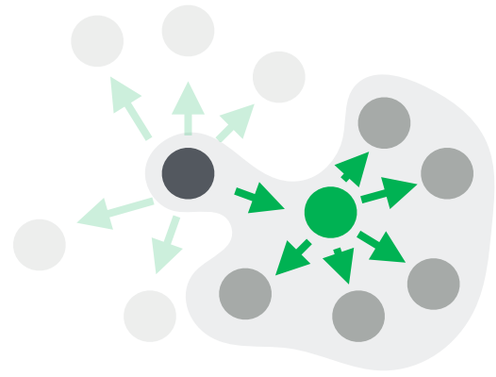
pork, eggs, *breadcrumbs*, chillies, cumin, brown sugar, *cinnamon*, **parsley**, salt.

(*surprise contexts*, **surprising features**)

Key Takeaways

A computational design system that exhibits curiosity.

Explores surprising discoveries by changing its design goals.



We are experimenting with different between-surprise similarity measures to guide reformulation.

Q Chef