How Minds Work
Pandemonium Theory

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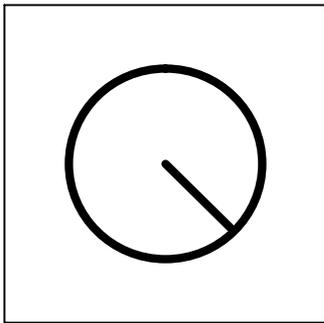Institute for Intelligent Systems
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Selfridge's Pandemonium Theory

- A theory of perception
- Demons—small, specific processes, waiting for a chance to act
- Demons identify objects
- Loudness of demon's shout proportional to match of favored input with the object
- Demon that shouts the loudest wins

Pandemonium Perception in Action

- Stimulates demon for an R

- Stimulates demon for an O

- Stimulates demon for an Q even more

- Recognized as a Q

Pandemonium Theory of Mind

- Demons that act, internally & externally
- Living in a sports arena
- Almost all demons in the stands cheering
- A few performers on the playing field exciting the crowd
- Some, more excited, yell louder
- Loudest demon replaces another on the playing field
- Note similarity to Baars' theater metaphor

Linked Demons

- Initial demons have built-in links

- Time on the field together strengthens old links and builds new (Hebb's law)

- Demons on the field excite others in the stands to whom they are linked

Motivational "Gain"

- Gain is up when things are going well
- Down, even negative, when going poorly
- The higher the gain, the more links are strengthened by time together on the field
- Gain acts as affect to motivate and to facilitate learning

Goals

- High gain when goals are achieved
- Low gain when they are not
- Demons associated with improved conditions tend to reappear on the field
- System thus steers towards it goals

Sequences of Actions

- Improved conditions need coordinated sequences of actions
- Actions in sequence have stronger pulls than pushes
- Uphill links to new arrivals stronger than downhill links
- Sequences keep their order

Demon on the playing field		Newly Arriving Demon
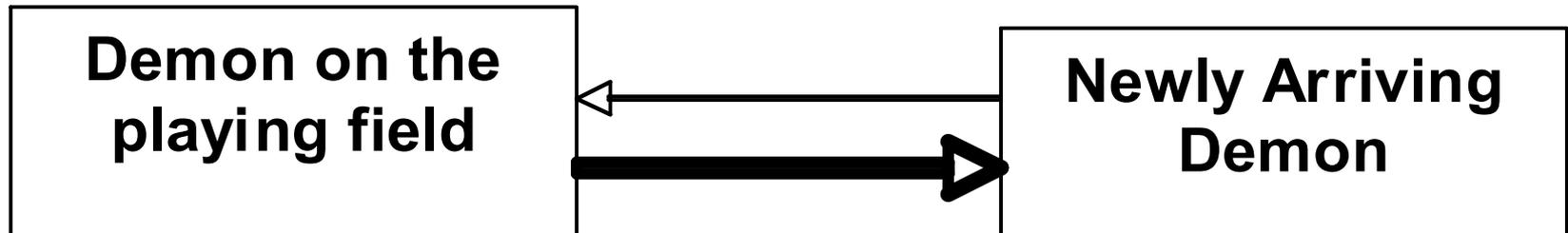
Sequences in Action

- Demons gradually fade from the playing field, activation decaying

- First demon in sequence has a strong link to second, etc.

- Starting an habitual sequence causes it to be repeated

HMW: Pandemonium Theory

Sub-arena

- Measures the system's well-being, adjusting gain

- Primitive sensing and acting capability built in to sub-arena

- Sensory input sends low-level action demons to the playing field

Concept Demons

- Demons with strong links merged into a single concept demon
- Component demons remain
- Relieves bottleneck of the playing field
- Can transfer solution of one problem to another problem

Compound Concept Demons

- Compound concept demons can arise
- Hierarchy of concept demons
- Higher order concept demons decay more slowly
- They linger longer on the playing field, having more affect on future actions

Decay of Links

- Links decay over time
- Negative links at a different rate
- High-level links at a slower rate
- Little used links disappear
- Recent associations count more
- Shows need for tuning such systems

Readings

Pandemonium Theory

- Selfridge, O. G. 1959. *Pandemonium: A Paradigm for Learning. In: Proceedings of the Symposium on Mechanisation of Thought Process* : National Physics Laboratory

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