Causal contexts, Cognitive cartoons and Spatial sound

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Abstract

Based on previous work the proposal here is that spatial perception problems in artificial environments (e.g. spatial music displays) can be cast as a subset of the problems of cognitive mapping of the causal context that surrounds and supports the perceiver. The intuitively available distinctions in these contexts of foreground and background, previously couched in terms of perceptual significance exist as externally valid causal distinctions; the task of perception is to cognitively represent these distinctions sufficiently for appropriate interaction. Effectively, this means that some items will "naturally" occupy attention, whilst others should equally naturally appeal to background, inattentive processes. Hence, aspects of the causal context will be accorded differing cognitive resources according to their significance, and some may be very sparsely represented in cartoon form. That is, perception engages in sophisticated information reduction in cognitive representation in order to capitalise on available resources. This poster outlines how causal contexts (including spatial matters) can be physically cartoonified in reciprocal manner to the dedicated perceptual mechanisms' operations, to economically and intuitively appeal to perception.

Causal contexts

Causal contexts are as *real* as physical objects or energies.

They are *with what* perception must interface

Contexts are *nested,* one inside the other, like 'Russian dolls

Perception must choose the right *scale* by grading according to *perceptual significance*

"*We are always already in a situation*" Dreyfus (1979, p 53).

Perceptual significance:

The non-linearity with which perception treats sense-data

Examples:

- ***Inattentional blindness***: gross items (a person in a gorilla suit moves through a basketball game) fail to enter conscious representation, (Mack and Rock 1998)

- ***Auditory*** and ***visual looming bias:*** *'*items *approaching* the perceiver are judged *more imminent* i.e. time-to-contact is consistently under-estimated (a 'mistake,' consistently better for survival than *over*-estimation) See: Franconeri and Simons (2003); Neuhoff (2001)

- ***Precedence effects*** the first-received example of a sound is perceptually 'preferred' as the direction of *actual* source. (Litovsky et al. 1999)

Foreground-background; attentive-inattentive cognition

Items of greater *causal* significance are promoted in hierarchies of *perceptual* significance. Attention is automatically captured and dominated by potentially hazardous or rewarding items and relationships.

- **Example**: *Near and Far*: Items that are within reach or can reach *me* are intrinsically more important to me than distant items of similar type.

> "But it is clear that between what a man calls me and what he simply calls mine the line is difficult to draw. We feel and act about certain things that are ours very much as we feel and act about ourselves…
> We see then that we are dealing with a fluctuating material. The same object being sometimes treated as a part of me, at other times as simply mine, and then again as if I had nothing to do with it at all. In its widest possible sense, however, a man's Self is the sum total of all that he CAN call his, not only his body and his psychic powers, but his clothes and his house…" (James, 1890)

- **Example**: *Thing: object or organism?* For a given range (distance from *me*), a *predator* is effectively *closer* than a *harmless feature*

Cognitive Cartoons

A perceiver **cannot** be in contact with *all* the information in an environment. ***Perceptual information reduction,*** implemented at *structural* and *semantic* levels, **exaggerates** features of causal significance and de-emphasises those of low significance.

- **Example**: ***Doppler Illusion*** (Neuhoff and McBeath 1996).

Doppler effects:

  - *physical* component (shortening of wavelengths in direction of travel)

  - *Perceptual* component – many (<60%) hear the pitch *continue* to rise on approach and *continue* to fall after passing; this doesn't actually physically occur. This exemplifies perceptual exaggeration of **"coming-ness"** (Lennox Myatt and Vaughan 1999)

Spatial sound: artificial contexts

To manage perception in artificial environments, we must manage *context* –we need perceptually-relevant attributes that must be suitably parameterised

Spatial Sound Cartoons

Entirely accurate sound fields are currently impossible. **Information reduction** is achieved through concentrating on *what* should be accurately rendered, based on *perceptually significant* features

Current empirically derived examples:

- **Foreground/background** differentiation is currently emphasised in the use of 'spot mics' and ambience mics to capture instruments (or vocalists) and 'the sound of the performance space' separately.

- **Artificial reverberation** used for an illusion of distance of some items in relation to others – that is, to correlate ensemble depth with foreground-background perception.

- **Panning controls** are used to simply depict *location*, *separateness* and, possibly, *movement* (**of 'images'**). Basically, a pan control is simply a *direction control* that manipulates interaural differences (for a known listening position).

Context Components

Entities **are** either *corporeal* or *ethereal*

   Ethereal: *idea*, *sound*, *event*, *collection*, *association*

   Corporeal: 'Things' or 'features' **–**

   Things: *organisms* or *objects*

   Organisms: prey, predator, ally, competitor crowd

   Features ('entities of *potential* facility'): **obstacle, trap** (self or other), **shelter** (hide behind/under), '**way**' (gap, doorway, path, escape, gain access), **vantage point** (safe, remote viewing)

Non-entities

   Formless substance *e.g*: *air*

   Background: collection of non-interesting/non-urgent items (e.g. grains of sand, rain)

   Place: container in which events occur

Events

Bounded: *sequence of changes: cause, process and effects*

Ongoing process: *sequence of change without discernible boundary*

Relationships

Near / Far: Within reach / can reach me – or not.

Nearer then / further than: *compared to other salient items*

Behaviour

Moving: *signifies entity, possibly animate*

***Change* of movement** *- acceleration / direction; good signifier of organism-hood.*

Coming/ going: *Threat or reward, imminent or receding*

Passing: *Salient change of significance, from '**coming**' to '**going**'*

Facing-ness: orientation with respect to perceiver and other features. Can be good signifier of **organisms'** intentions.

Component Examples:

Things or ***features*** should have locatable **position** – a control of image focus is required. Non-entities should not be localisable

Organisms should demonstrate <u>intentional</u> <u>behaviour</u> – accelerative behaviour, vocal noises

Background features should not evince foreground perception – the noise-floor should not be too noticeable. Early reflections should not be too discretely focussed

(Component examples 2)

Moving can be detected without knowledge of *position*- It is the sound of an entity moving through the *environment*, not simply in relation to the perceiver

Passing can be signified by exaggerated Doppler effects – but <u>should be accompanied</u> by change of range (near/far)

Coming can be emphasised using exaggerated change-of-amplitude-with-frequency cues. More especially, the change of' blurring of envelop features normally resulting from distance and ground effect can be exaggerated

Facingness can be modelled using filtering, delay (to simulate longer path-travel for high frequencies) and simple early reflections

- ## **<u>References</u>**

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