The Crawler: A Tool For Palimpsest Analysis

This overview describes the concepts and functional features of the Crawler, a computer-based tool whose purpose is to break down archaeological palimpsests formed by artifacts retrieved from several Canadian Barrenland archaeological sites.

Overview of the Problem Domain

The Barrenlands are in what is known today as the Canadian Northwest Territories and Nunavut. The archaeological sites yielded approximately 10,000 artifacts, about which data were painstakingly and carefully collected in field notebooks. The data were later transcribed into a computer-readable database that is now the information source of the current research project.

A key focus of our ongoing Barrenland research is the day-to-day activities of the nomadic bands following the migratory caribou herds. These bands selected specific loci in their camps for their work – manufacturing tools, hunting caribou and butchering and processing them for food, clothing, and shelter. Moreover, the bands apparently reused many of the same locations in subsequent years, as they followed the cyclical migration patterns of the caribou.

The band and herd migrations and the choices of specific locations for their activities occurred repeatedly for several thousand years. Radiocarbon dates of artifacts in the sites indicate an interval from 8,000 years ago to the historic period.

The artifacts that accumulated in the various sites are remnants of human activity and offer a wealth of information: what they were, where and when they occurred and recurred. However, the sheer number of artifacts and their overlapping deposition formed palimpsests that need to be deciphered.

We decipher a palimpsest by breaking it down into artifact clusters from which can be inferred specific types of human activity; e.g. preparing caribou hide for use as clothing would have left debris – artifacts now – as clusters of used knives and chithos.

The following suppositions underlie our approach to palimpsest analysis, of inferring what activities occurred by examining artifact cluster composition and individual artifact positions:

- Each type of human activity was undertaken with a particular tool (artifact), or set of tools. The presence, therefore, of a particular type of artifact, or a

cluster of proximate artifacts, provide an indication of what activity may have taken place in a particular location.

- To verify that an artifact cluster represents a specific activity, one must examine carefully and accurately the geometric pattern that the artifacts form, i.e., the physical location of each artifact relative to every other artifact in the cluster.

- Finding an artifact cluster conforming to precise rules describing a geometric pattern for a particular activity validates the assertion that this activity occurred.

The Crawler addresses the principal problem domain of determining what human activities occurred in specific physical or cultural layers in a site. Its main function is to examine all artifacts in an area, the number of which may exceed a hundred or even a thousand, and to find clusters, artifact combinations, that conform with mathematical precision to clustering rules specified for each activity type.

Activities and Clusters

As of this writing, the Crawler is programmed to search for the following activities: (1) Tool Manufacturing, (2) Point Refurbishing, (3) Roasting or Cooking, (4) Grease Extraction from marrow, (5) Butchering, and (6) Hide Preparation.

For each activity, a set of clustering rules is given to the Crawler. Rule specifications consist of the types of artifacts that make up a cluster and definition of the geometric pattern to which members of a cluster must conform.

Example: One of two types of Tool Manufacturing clusters is defined as consisting of flakes and unused knives. The geometric pattern specification for this simple cluster consists solely of the maximum distance (expressed for Barrenland artifacts in cm) between each cluster member, flake or unused knife, and any other member.

Abstract Cluster Pattern Rules

The above example shows one of two abstract rules the Crawler recognizes, the two abstract rules representing two general cluster types (defined so far):

1. **Simple Cluster** consists of artifacts of specific types, e.g., flakes and unused knives in a simple geometric arrangement wherein a rule defines the maximum distance between the two artifacts that are farthest apart in the cluster.

Clusters formed by activities (1) through (4), Tool Manufacturing to Grease Extraction, belong to this abstract cluster type.

Fig. 1 is a simple cluster, the dots denoting artifacts. The minimum rule governing cluster geometry is that all eligible member artifacts must fit within a circle of given radius, the grey space in the figure.

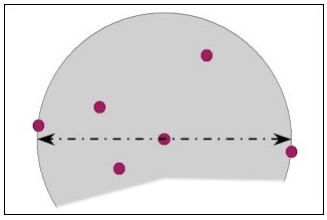

Figure 1. A Simple Cluster

Aside from measuring the distance of each member artifact from the circle's centre, the Crawler implements other metrics, such as the angle formed by the horizontal line that intersects the centre and the ray formed by the line from the centre to the member.

2. **Void-Centred Cluster** is where artifacts are in a band about a circular void, a space that must not contain any member artifact. Activities (5) and (6) {Butchering and Hide Preparation} have cluster pattern definitions of this type.

The band where artifacts are allowed is the grey area in Fig. 2, while the circle at the core of the band is the void. The presence of an eligible member, i.e., any of the artifacts expected to form this type, is not allowed in the void.

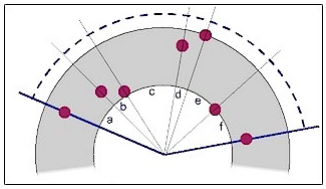

Figure 2. A Void-Centred Cluster

As with the simple cluster, the Crawler measures the displacement of each artifact with respect to the centre of the band (or void). The displacement attribute is a vector quantity with distance and angle components.

Two other metrics are highly meaningful in void-centred clusters: (1) total radial span formed by cluster members or the sum of angles *a*, *b*, *c*, *d*, *e*, and *f* (Fig. 2); and (2) dispersion index how the artifacts distribute in the total radial span.

The basic difference between both cluster types is the area within which artifacts are expected and allowed. In simple clusters, all artifacts must be within a single circle of rule-specified radius. Void-centred clusters involve a void or inner circle without eligible artifacts, and a band, the space between the inner and outer circles, where all cluster members must be located.

Most metrics that the Crawler collects, including some absent in this overview, are available across all cluster types. The various measurements are used in pattern rules to minimum and ideal requirements for clusters or activities. They can also be used to specify ideal artifact formations and to quantify the degree, as between minimum and ideal formations, to which a found cluster conforms to the pattern specifications.

Other Crawler Functions

As indicated earlier, the Crawler's main function is to search a given layer in a site for artifact clusters that conform to geometric formations specified in pattern rules.

The Crawler also features a **visualization function** which creates scatter plots of clusters it finds. The visual rendition of an area showing human activity suggested by the artifact formations greatly facilitates archaeological analysis of Crawler's finds.

Another key function envisioned for the Crawler is an intra-site **activity co-location analyzer**. Having identified human activity locations in various layers of a site, this analyzer will point the researcher to specific site locations in the same vicinity where human activity occurred at different times and according to the various layers.

While the primary Crawler function aims to facilitate the breakdown of palimpsests in a given layer of a site, this functionality traverses all layers of the site to pinpoint places where activities were co-located, thus facilitating the analysis of the palimpsest of the entire site. This analysis is in conjunction with deeper investigation into the reuse, through many generations of Barrenland inhabitants, of specific locations for their various activities.

Further Information

The development of the Crawler is a currently ongoing project undertaken by Ricardo Santiago of PublicMetrics Inc. for the Canadian Museum of Civilization.

He can be contacted for further information by email at: crawler@publicmetrics.ca.