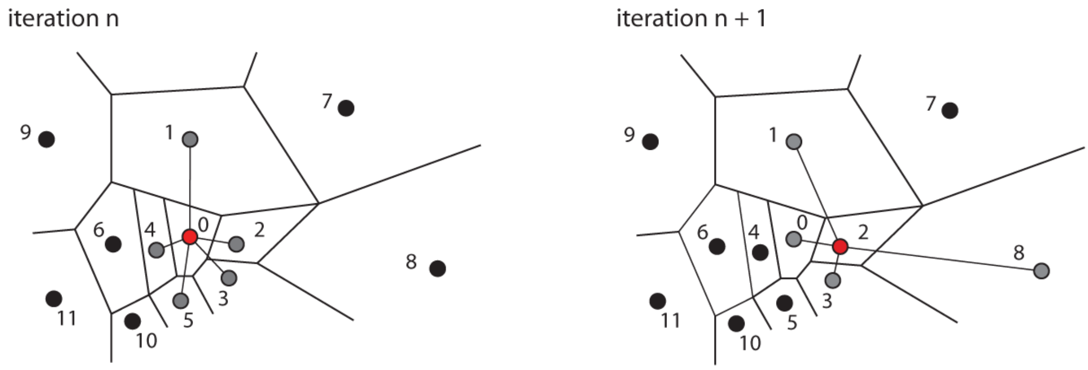
Family Circle Algorithm Notes



Purpose
To determine a set of internally consistent thermal histories for a number of spatially distributed (x,y,z) but related sample locations, i.e. a family of samples. The aim is to use the data from neighbouring samples to "inform" the thermal history search at each location.

The problem to be solved is how best to "weight" the information inherent in the neighbouring data with respect to each location.

The first task is to identify potential family members, making the rash assumption that the samples closest neighbours to the location are the most likely candidates. Use voronoi cell approach to identify natural neighbours (see above).

Algorithm rationale
The algorithm rationale is to start by trying to fit a common thermal history to each family of samples, i.e. sample 0 plus it's family members, which are initially assumed to include all its natural neighbours (i.e. adjacent voronoi cells). This is done by searching for a thermal history common to the selected site AND the other sites simultaneously (misfit is taken as the sum of misfits calculated over all locations). The influence of family members on the thermal history for the location being modelled could be weighted equally (most democratic family), or by inverse weighted distance, i.e. if you are further away from the family centre (home?) you have less influence on the family's thermal history. Could experiment here with how weights are determined, maybe using misfit of individual samples versus common family misfit (the more disruptive you are, larger misfit, the less influence you have?…actually this probably works the other way round in real life, but that's another thing ☺).

The vertical offsets between individual samples are determined relative to a filtered topographic reference surface (long-wave length topography) and the temperatures (but not the times) for the thermal history are adjusted according to this vertical offset and a suitable geothermal gradient (simple version uses fixed value, advanced version estimates gradient as an extra model parameter to be fitted?). Filtered topography reference enables high frequency variations in topography (sample elevation), i.e.

vertical profiles to be identified and separated from long range variations in sample elevation that may not reflect a structural/thermal offset…i.e. isotherms follow long wavelength topography.

Each sample location is visited in turn, and an optimum history fitted to each family of samples. This means of course that each sample will have been involved in several iterations. All thermal histories for determined for each sample need to be stored along with the misfit information. After one complete pass over all sample locations then a sort is made on the misfits of all histories for each sample location and the history assigned to that location is the one with the lowest misfit.

Issues to deal with

1. What happens if no common history can be found for a family group (after a set number of attempts/models have been tested per family group)? One solution would be to run a series of iterations (for each family group) in which we successively drop each of the family members with the worst individual misfit, i.e. the most disruptive family member is expelled first, then the next etc etc. So if after n iterations no solution is found we kick out the most disruptive family member and try and fit a common history to the remaining samples, and repeat until we find a solution. This can be done until a history is found that is acceptable (define what this is by setting some minimum criteria?). Would need to avoid degeneration to fitting histories to single samples…set a minimum family size and/or a lenient/tolerant minimum misfit?

2. What do you do if you find a number of different thermal histories for a sample location that are all acceptable (i.e. tolerable misfit)? Simple solution would be to allocate the spatially weighted average model (i.e. the average thermal history…average temperatures and times for all the acceptable models) to that site. This would have the advantage (?) of smoothing the thermal histories across the model region…both spatially and temporally. This is arguably a sensible and good thing to do, given that temperature would vary smoothly (usually) in space.

What about faults and discontinuities? Not sure…if there is a significant difference in thermal history across a fault for example then the approach if expelling the most disruptive family member from a group might take care of this? So by not expelling the most distant relative from a family first, but the one with worst misfit instead, we could identify sample locations that are close to the family centre but which are not members of the family…i.e. they are simply visiting perhaps ☺?

Roderick Brown
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