
Subject: Re: fast search

Posted by [Paolo Grigis](#) on Tue, 17 Oct 2006 12:53:11 GMT

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This link may be useful to you:

http://www.dfanning.com/code_tips/pts_in_sphere.html

Ciao,
Paolo

m.goullant@gmail.com wrote:

> Hi there,

>

> I have the following problem:

>

> ;data structure of an irregular point cloud

> x = points.x

> y = points.y

> z = points.z

>

> search radio

> radio = 8

>

> FOR i=0L,N_ELEMENTS(z)-1 DO BEGIN

>

> square = WHERE(x LE x[i] + radio AND x GE x[i] - radio AND y LE

> y[i] + radio AND y GE y[i] - radio)

> ;(...)

>

> ENDFOR

>

> I realize that WHERE will do the job, but at very low efficiency.

> WHERE

> makes no assumptions about the list being ordered. It seems to me it

> has

> to check every element of the array, requiring N steps for an N-element

> array

>

> There is a faster way to do this?

>

> thanks,

> Marie

>

Subject: Re: fast search

Posted by [greg michael](#) on Tue, 17 Oct 2006 14:15:12 GMT

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Hi Marie,

Also take a look at this thread...

http://groups.google.de/group/comp.lang.idl-pvwave/browse_thread/thread/1d020842b165598a/8e57c4b2c3841851?#8e57c4b2c3841851

A program to search for pairs closer than a given distance d in a point cloud. It recursively cuts up the volume until there are fewer than a given threshold of points in the subvolume, and then directly compares those few. At each cutting of the space, it's necessary to leave an overlap of d so that points in adjoining subvolumes aren't missed. I don't remember - looks like it might be necessary to check for the uniqueness of the solutions at the end. Anyway, the recursion is the fun part...

By the way, it looks like there are a lot of for-loops there, but they're powerful ones - each run of the loop cuts the space.

regards,
Greg

m.goullant@gmail.com wrote:

```
> Hi there,  
>  
> I have the following problem:  
>  
> ;data structure of an irregular point cloud  
> x = points.x  
> y = points.y  
> z = points.z  
>  
> search radio  
> radio = 8  
>  
> FOR i=0L,N_ELEMENTS(z)-1 DO BEGIN  
>  
>     square = WHERE(x LE x[i] + radio AND x GE x[i] - radio AND y LE  
> y[i] + radio AND y GE y[i] - radio)  
>     ;(...)  
>  
> ENDFOR  
>  
> I realize that WHERE will do the job, but at very low efficiency.  
> WHERE
```

> makes no assumptions about the list being ordered. It seems to me it
> has
> to check every element of the array, requiring N steps for an N-element
> array
>
> There is a faster way to do this?
>
> thanks,
> Marie

Subject: Re: fast search

Posted by [greg michael](#) on Tue, 17 Oct 2006 17:17:57 GMT

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Actually, there's a mistake in that code - it's got mixed
procedure/function syntax. Should be like this:

```
function ss_MakeGalaxies,n
p=replicate({x:0.,y:0.,z:0.},n)
seed=0
p.x=randomu(seed,n)*1000.
p.y=randomu(seed,n)*1000.
p.z=randomu(seed,n)*1000.
return,p
end
```

```
function ss_distance,p1,p2
return,sqrt((p2.x-p1.x)^2+(p2.y-p1.y)^2+(p2.z-p1.z)^2)
end
```

```
pro splitsearch,p,dist
;recursively splits the search volume into n_split^3 subvolumes. When
;there are fewer than 'threshold' points
;in a subvolume, checks for matches the brute force way - every point
;against every other.
```

```
n_split=3
threshold=75
```

```
s=(size(p))[1]
```

```
if s gt threshold then begin
xmn=min(p.x,max=xmx)
ymn=min(p.y,max=ymx)
zmn=min(p.z,max=zmx)
```

```
xg=xmn+findgen(n_split+1)*(xmx-xmn)/n_split ;grid boundaries
```

```

yg=ymn+findgen(n_split+1)*(ymx-ymn)/n_split
zg=zmn+findgen(n_split+1)*(zmx-zmn)/n_split

for j=0,n_split-1 do begin
  for k=0,n_split-1 do begin
    for l=0,n_split-1 do begin
      w= where( (p.x ge xg[j]-dist) and (p.x lt xg[j+1]+dist) and $
                (p.y ge yg[k]-dist) and (p.y lt yg[k+1]+dist) and $
                (p.z ge zg[l]-dist) and (p.z lt zg[l+1]+dist))
      if n_elements(w) ge 2 then begin
        splitsearch,p[w],dist
      endif
    endfor
  endfor
endfor

endif else begin
  for i=0,s-2 do begin
    for j=i+1,s-1 do begin
      if ss_distance(p[i],p[j]) le dist then begin
        print,p[i],p[j]
      endif
    endfor
  endfor
endelse
end

```

Then call it using:

```

IDL> p=ss_MakeGalaxies(1e5)
IDL> splitsearch,p,.5
{ 454.665 175.794 87.0097}{ 454.816 175.504
 87.3471}
{ 556.761 981.076 933.809}{ 556.654 980.922
 934.065}
{ 981.340 196.286 105.551}{ 981.387 196.102
 105.703}

```

The left and right columns are the neighbouring (< .5 units distant) xyz triples.

regards,
Greg

Subject: Re: fast search
Posted by [greg michael](#) on Tue, 17 Oct 2006 18:25:39 GMT

And here's a proper IDL version that uses histograms and the pairwise comparisons that David likes... still got three loops, though - have to think some more to get rid of those.

```
function ss_MakeGalaxies,n
p=replicate({x:0.,y:0.,z:0.},n)
seed=0
p.x=randomu(seed,n)*1000.
p.y=randomu(seed,n)*1000.
p.z=randomu(seed,n)*1000.
return,p
end

pro splitsearch2,p,dist
;recursively splits the search volume into n_split^3 subvolumes. When
;there are fewer than 'threshold' points
;in a subvolume, checks for matches the brute force way - every point
;against every other.

n_split=3 ;1-D cutting factor (for 3, cube is cut into 3x3x3=27
subvolumes)
threshold=75 ;no. of points to start pairwise comparison
n=n_elements(p)

if n gt threshold then begin
  hx=histogram(p.x,nbins=n_split+1,locations=x,reverse_indices =rx) ;1-D
  binning
  hy=histogram(p.y,nbins=n_split+1,locations=y,reverse_indices =ry)
  hz=histogram(p.z,nbins=n_split+1,locations=z,reverse_indices =rz)

  for i=0,n_split-1 do begin
    for j=0,n_split-1 do begin
      for k=0,n_split-1 do begin
        qx=[rx[rx[i]:rx[i+1]-1]] ;indices from 1-D x bins
        qy=[ry[ry[j]:ry[j+1]-1]]
        qz=[rz[rz[k]:rz[k+1]-1]]
        q=where(histogram([qx,qy,qz],min=0) eq 3) ;indices from 3-D bins
        (i.e. where all of x,y,z
                                ;lie inside subvolume

        if n_elements(q) ge 2 then splitsearch2,p[q],dist ;splitsearch
        again, if enough to compare
      endfor
    endfor
  endfor

endif else begin
```

```

q1=rebin(indgen(n),n,n) ;set up indices for pairwise comparison
q2=transpose(q1)
d=sqrt((p[q1].x-p[q2].x)^2+(p[q1].y-p[q2].y)^2+(p[q1].z-p[q2].z)^2)
;calculate pair distances
i=where((d le dist) and (q1 gt q2)) ;select close neighbours (q1>q2)
to avoid reverse pairs and q1=q2
  if i[0] ne -1 then print,p[q1[i]],p[q2[i]] ;print the neighbours, if
found
endelse
end

```

```

IDL> p=ss_MakeGalaxies(1e6)
IDL> splitsearch2,p,.1
{  98.4014   461.355   673.278}{  98.4379   461.400
  673.197}
{  190.002   444.629   924.567}{  189.966   444.613
  924.605}
{  254.499   823.541   494.128}{  254.492   823.492
  494.062}
{  638.107   100.159   240.530}{  638.083   100.108
  240.606}
{  720.787   820.032   405.215}{  720.754   820.070
  405.199}

```

Greg

Subject: Re: fast search

Posted by [greg michael](#) on Wed, 18 Oct 2006 15:25:04 GMT

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All but one indestructible loop removed. Wish I had a use for this program now... hope it's useful to you, Marie!

```

pro splitsearch3,p,dist
;recursively splits the search volume into n_split^3 subvolumes. When
;there are fewer than 'threshold' points
;in a subvolume, checks for matches the brute force way - every point
;against every other.

```

```

n_split=4 ;1-D cutting factor (for 3, cube is cut into 3x3x3=27
subvolumes)
threshold=75 ;no. of points to start pairwise comparison
n=n_elements(p)

```

```

if n gt threshold then begin
  mxx=max(p.x,min=mnx)
  mxy=max(p.y,min=mny)

```

```

mxz=max(p.z,min=mnz)
bx=fix((p.x-mnx)/(mxx-mnx)*n_split)<(n_split-1) ;< to ensure max
element not in new bin
by=fix((p.y-mny)/(mxy-mny)*n_split)<(n_split-1)
bz=fix((p.z-mnz)/(mxz-mnz)*n_split)<(n_split-1)
b=bx+by*n_split+bz*n_split^2
h=histogram(b,min=0,reverse_indices=ri)

for i=0,n_elements(h)-1 do begin
  if ri[i] ne ri[i+1] then begin
    q=[ri[ri[i]:ri[i+1]-1]]
    if n_elements(q) ge 2 then splitsearch3,p[q],dist ;splitsearch
again, if enough to compare
    endif
  endif
endfor

endif else begin
  q1=rebin(indgen(n),n,n) ;set up indices for pairwise matching
  q2=transpose(q1)
  d=sqrt((p[q1].x-p[q2].x)^2+(p[q1].y-p[q2].y)^2+(p[q1].z-p[q2].z)^2)
;calculate pair distances
  i=where((d le dist) and (q1 gt q2)) ;select close neighbours (q1>q2 to
avoid reverse pairs)
  if i[0] ne -1 then print,p[q1[i]],p[q2[i]] ;print the neighbours, if
found
endelse
end

```

```

IDL> p=ss_makegalaxies(5e6)
IDL> splitsearch3,p,.02
{  915.876   843.515   319.991}{  915.861   843.528
  319.994}

```

Subject: Re: fast search

Posted by m.goullant@gmail.com on Thu, 19 Oct 2006 10:46:07 GMT

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Hi Greg,
thank you very much, for your time!

I even dont understood the second algorithm and you already have the 3!! :-(. In this weekend i'll take a better look in your explendid work!

I'm a newbie in IDL, so I have to understand some functions that you use! I

If is not ask to much, can you coment all the lines of your code?

What I want is a point to points search, so I am trying to understand in your "quadtree" technique where I can adapt to my needs. I only need to compare (x,y) - 2D and get the Z values to compare

This is more and less What I want to do:

have this geographic data (could be 100000, 2 million, 4 million depends):

PRO example

```
points = myData()
```

```
;data structure of an irregular point cloud
```

```
x = points.x ;X coord
```

```
y = points.y ;Y coord
```

```
z = points.z ; Elevation
```

```
n = 5 ; number of iterations
```

```
mask = 4.0 ; diameter. in meters. Like your dist
```

```
maskType = 0 ; 0 a circle, 1 square
```

```
FOR i=0L,n-1 DO BEGIN
```

```
    newZ = erosion(x,y,z,dist,MaskType)
```

```
    ;(...)
```

```
    dist = dist + 2
```

```
ENDFOR
```

```
END
```

```
FUNCTION erosion,x,y,z,mask,maskType ; Apply erosion to the data
```

```
    newZ=z
```

```
    radio = mask /2
```

```
    FOR i=0L,N_ELEMENTS(z)-1 DO BEGIN
```

```
        kernel = applyKernel(x,y,z,i,radio,maskType)
```

```
    ;center the kernel in the data(i) and get neighbours there are inside  
    of the mask
```

```
        newZ[i]=MAX(z[kernel])
```

```
    ENDFOR
```

```
    RETURN,newZ
```

```
END
```

FUNCTION applyKernel,x,y,z,i,dist,maskType

```
square = WHERE(x LE x[i] + dist AND x GE x[i] - dist AND y LE y[i]
+ dist AND y GE y[i] - dist)
```

```
IF (maskType EQ 0) THEN BEGIN
    sqDistance = sqrt((x[square] - x[i])^2 + (y[square] -
y[i])^2)
    neighbors = WHERE(sqDistance LE dist)
    circle = square[neighbors]
    RETURN,circle
ENDIF
```

```
RETURN,square
END
```

Because this is an iterative process with a "dist" variable, it's possible to implement your code?

Thank's in advance,
Marie

Subject: Re: fast search
Posted by m.goullant@gmail.com on Thu, 19 Oct 2006 11:01:18 GMT
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Hi Paolo,

thanks for the article, i'll read cautiously!

regards,
Marie

Paolo Grigis wrote:

```
> This link may be useful to you:
>
> http://www.dfanning.com/code_tips/pts_in_sphere.html
>
> Ciao,
> Paolo
>
>
> m.goullant@gmail.com wrote:
>> Hi there,
>>
>> I have the following problem:
```

```
>>
>> ;data structure of an irregular point cloud
>> x = points.x
>> y = points.y
>> z = points.z
>>
>> search radio
>> radio = 8
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>> FOR i=0L,N_ELEMENTS(z)-1 DO BEGIN
>>
>>     square = WHERE(x LE x[i] + radio AND x GE x[i] - radio AND y LE
>> y[i] + radio AND y GE y[i] - radio)
>>     ;(...)
>>
>>     ENDFOR
>>
>> I realize that WHERE will do the job, but at very low efficiency.
>> WHERE
>> makes no assumptions about the list being ordered. It seems to me it
>> has
>> to check every element of the array, requiring N steps for an N-element
>> array
>>
>> There is a faster way to do this?
>>
>> thanks,
>> Marie
>>
```
