EXPLORATORY ANALYSIS OF *bitcoin* MARKET VALUE BY NETWORK GROUP DISCOVERY

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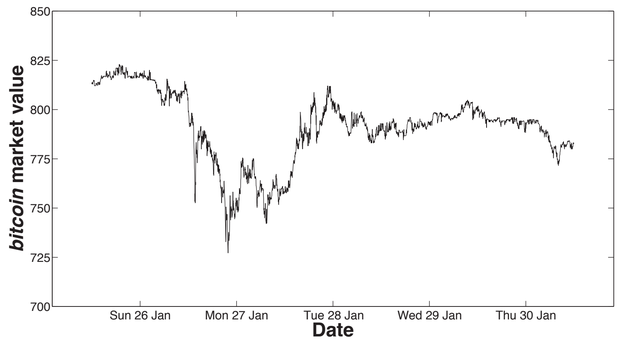
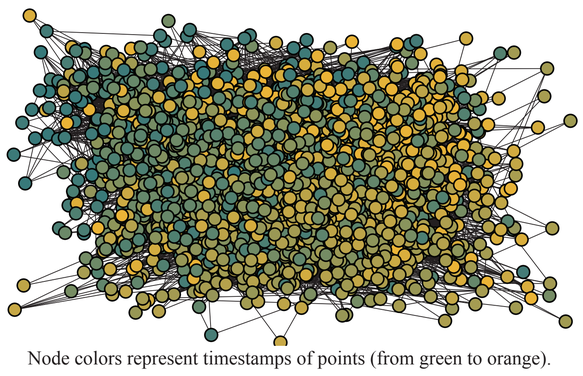


SERIES BitStamp *bitcoin* **market price**
PERIOD *5* days in **January 2014**
FREQUENCY **≈ per minute**
LENGTH ***4339* points**
VALUE **$789.6**

METHODS **network group** discovery [1,2]
APPLICATIONS **stream mining** process [3]

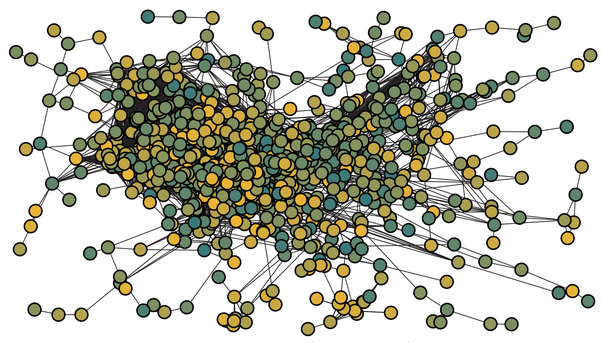
NETWORK REPRESENTATION

NETWORK undirected **visibility** graph [4]
NODES individual **points** of time series
LINKS **non intersecting** lines of points



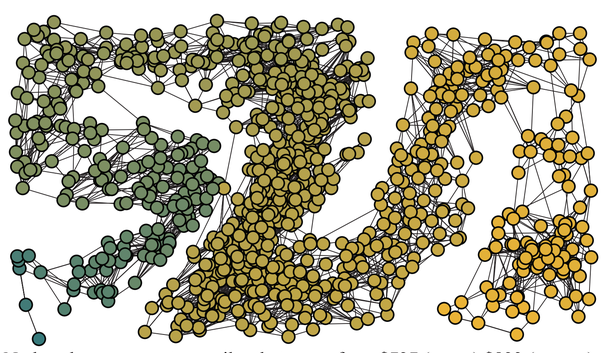
Node colors represent timestamps of points (from green to orange).

NETWORK undirected **correlation** network [5]
NODES overlapping **segments** of *15* points
LINKS Pearson **correlations** above *0.95*



Node colors represent timestamps of segments (from green to orange).

NETWORK directed **transition** network [6]
NODES *1000*-**quantiles** of time series
LINKS **transitions** of consecutive points



Node colors represent quantiles that range from $727 (green) $823 (orange).

NETWORK STRUCTURE

NODES	***4339***	SCALE-FREE	$k^{-2.34}$
LINKS	***30842***	CLUSTERING	***0.72***
DEGREE	***14.22***	DIAMETER	***8.37***
LCC	***100 %***	MIXING	***0.27***

Visibility graphs have similar structure as collaboration networks.

NODES	***1344***	SCALE-FREE	$k^{-1.94}$
LINKS	***10383***	CLUSTERING	***0.34***
DEGREE	***15.45***	DIAMETER	***9.53***
LCC	***87 %***	MIXING	***0.40***

Correlation networks have similar structure as social networks.

NODES	***1000***	SCALE-FREE	/
LINKS	***3822***	CLUSTERING	***0.12***
DEGREE	***7.64***	DIAMETER	***19.78***
LCC	***100 %***	MIXING	***0.05***

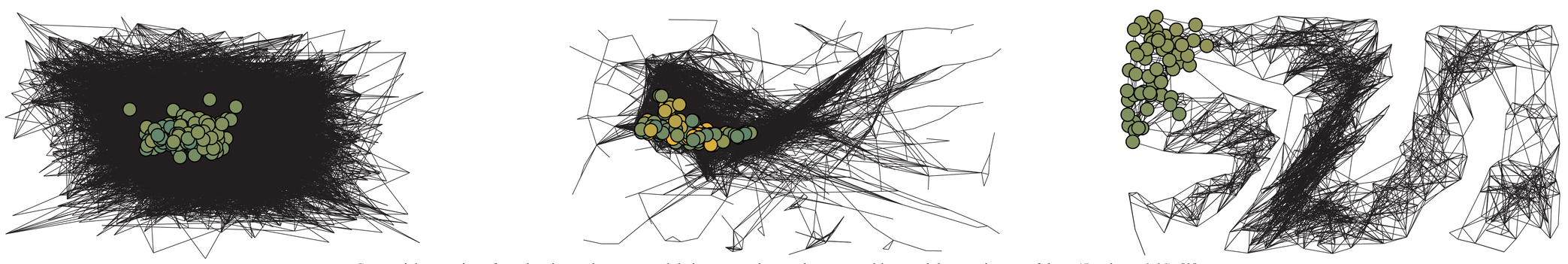
Transition networks have similar structure as technological networks.

GROUP DISCOVERY

NUMBER	***161***	COMMUNITY	***75 %***
GROUP	***38.92***	PATTERN	***39.29***

NUMBER	***71***	COMMUNITY	***77 %***
GROUP	***26.62***	PATTERN	***27.82***

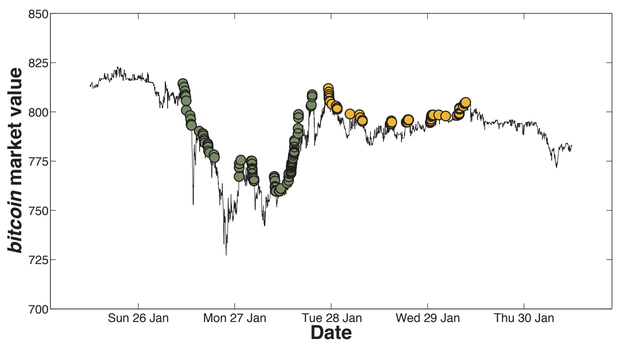
NUMBER	***40***	COMMUNITY	***82 %***
GROUP	***28.85***	PATTERN	***29.78***



Sequential extraction of overlapping node groups and their patterns that can be communities, modules or mixtures of these (*P*-value = *0.01*). [2]

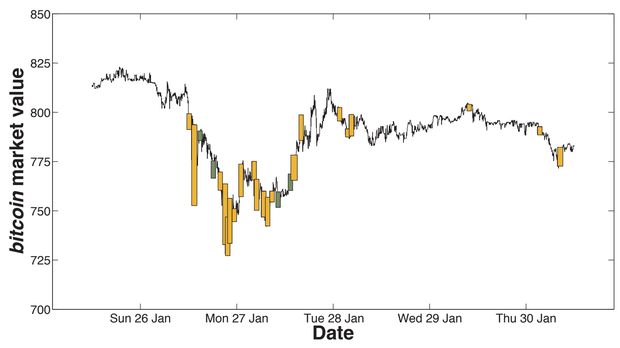
EXPLORATORY ANALYSIS

GROUPS **local maxima** of *bitcoin* value
APPLICATIONS **period & market** prediction



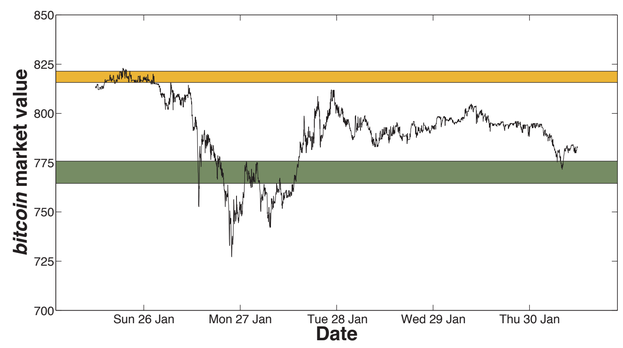
First (green) and second (orange) most significant groups of *133* and *93* points.

GROUPS **sudden shifts** in *bitcoin* value
APPLICATIONS **anomaly & market** prediction



First (green) and second (orange) most significant groups of *117* and *67* segments.

GROUPS **steady periods** of *bitcoin* value
APPLICATIONS market **concept drift** detection



First (green) and second (orange) most significant groups of *60* and *57* quantiles.

[1] Donner, R. V., Small, M., Donges, J. F., Marwan, N., Zou, Y., Xiang, R., & Kurths, J. (2011) *Int. J. Bifurcat. Chaos* **21(4)**.
[2] Šubelj, L., Blagus, N., & Bajec, M. (2013) In *Proc. of NetSci '13*: Copenhagen, Denmark, pp. 152–153.
[3] Šubelj, L., Bosnič, Z., Kukar, M., & Bajec, M. (2014). In *Proc. of CAiSE '14*: Thessaloniki, Greece, pp. 409–423.
[4] Lacasa, L., Luque, B., Ballesteros, F., Luque, J., & Nuno, J. C. (2008) *P. Natl. Acad. Sci. USA* **105(13)**, 4972–4975.
[5] Yang, Y. & Yang, H. (2008) *Physica A* **387(5–6)**, 1381–1386.
[6] Campanharo, A. S. L. O., Sirer, M. I., Malmgren, R. D., Ramos, F. M., & Amaral, L. A. N. (2011) *PLoS ONE* **6(8)**, e23378.