



Visualization of RNA and Protein family models and their comparisons

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Motivation

Why visualize **RNA** and **Protein** family models?

(I) Inspect (newly) constructed models

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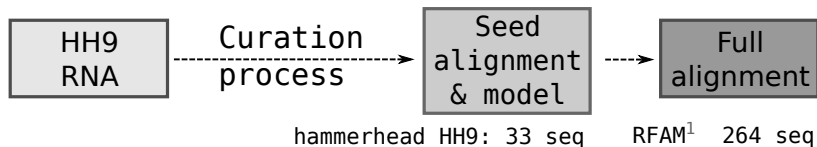
- (I) Inspect (newly) constructed models
- (II) Interpretation of model comparisons

Motivation

Why visualize **RNA** and **Protein** family models?

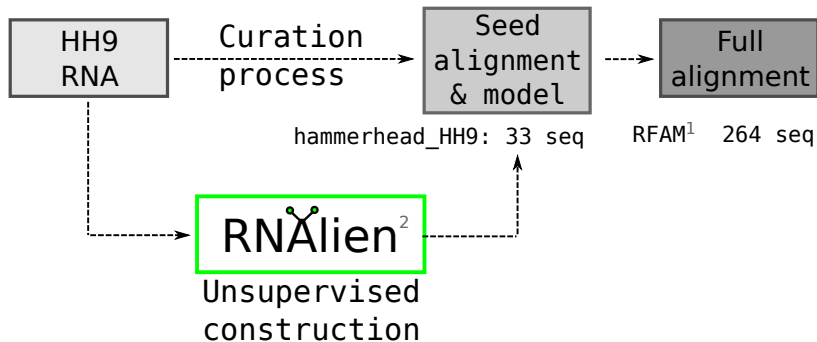
- (I) Inspect (newly) constructed models
- (II) Interpretation of model comparisons
- (III) Teaching

RNA family model construction



¹Kalvari, Argasinska et al., Nucleic Acid Research, 2018

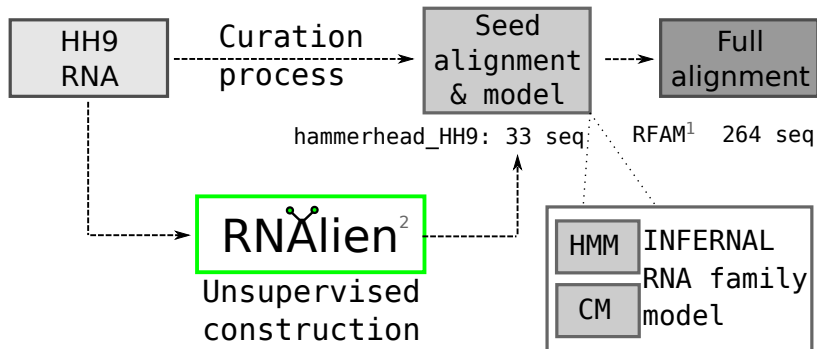
RNA family model construction



¹Kalvari, Argasinska et al., Nucleic Acid Research, 2018

²Eggenhofer, Hofacker et al. , Nucleic Acid Research, 2016

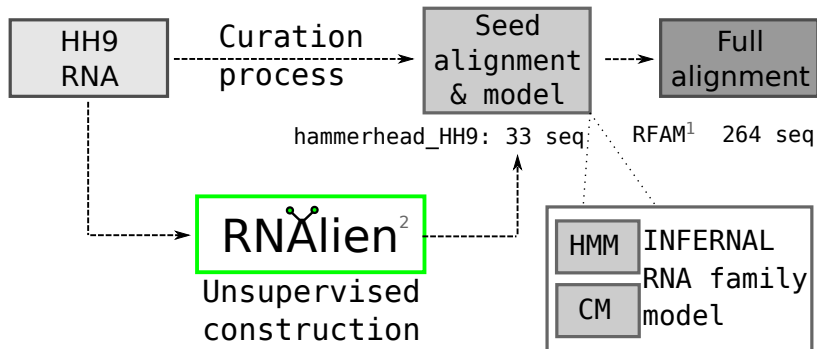
RNA family model construction



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RNA family model construction



Lots of models to inspect, RFAM 13.0 has 2687 models

¹Kalvari, Argasinska et al., Nucleic Acid Research, 2018

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Previous work

- ▶ Sequence Alignment and Model System (SAM) - *drawmodel*¹
Figure shows SAM-HMM visualisation, not included due to copyright

¹Hughey, Krogh, Technical Report UCSC-CRL-95-7, 1995

²Nawrocki, Eddy, Bioinformatics, 2013

Previous work

- ▶ Sequence Alignment and Model System (SAM) - *drawmodel*¹
Figure shows SAM-HMM visualisation, not included due to copyright
- ▶ INFERNAL - User Guide²
Figure shows covariance model visualisation, not included due to copyright

¹Hughey, Krogh, Technical Report UCSC-CRL-95-7, 1995

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HMMV - Hammerhead_1

Minimal

0	1	2	3	4	5	6
---	---	---	---	---	---	---

HMMV - Hammerhead_1

Minimal

0	1	2	3	4	5	6
---	---	---	---	---	---	---

Simple

0	1	2	3	4	5	6
	A C G U	A C G U	A C G U	A C G U	A C G U	A C G U

HMMV - Hammerhead_1

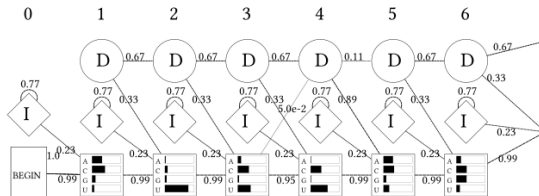
Minimal

0	1	2	3	4	5	6
---	---	---	---	---	---	---

Simple

0	1	2	3	4	5	6
	A C G U	A C C G U	A C C G U	A C C G U	A C C G U	A C C G U

Detailed



HMMV - Hammerhead_1

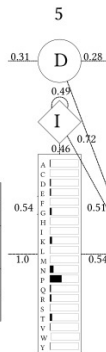
Minimal

0	1	2	3	4	5	6
---	---	---	---	---	---	---

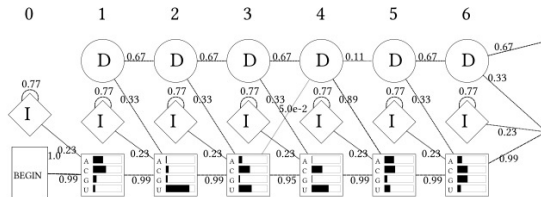
Simple

0	1	2	3	4	5	6
	A C G U	A C G U	A C G U	A C G U	A C G U	A C G U

Protein



Detailed



CMV - Hammerhead_1

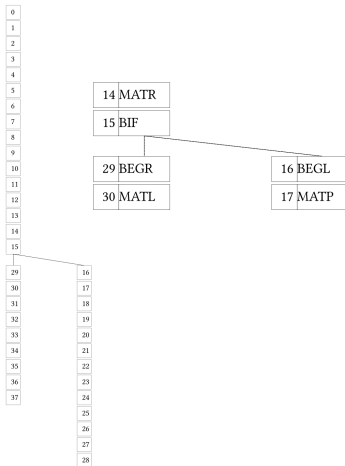
Minimal



CMV - Hammerhead_1

Minimal

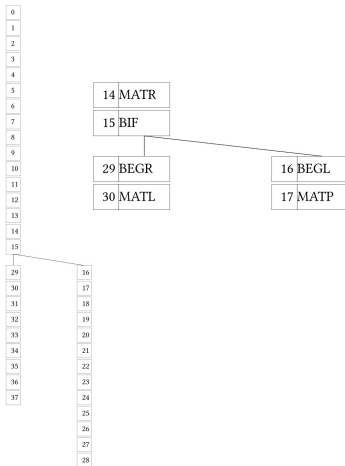
Simple



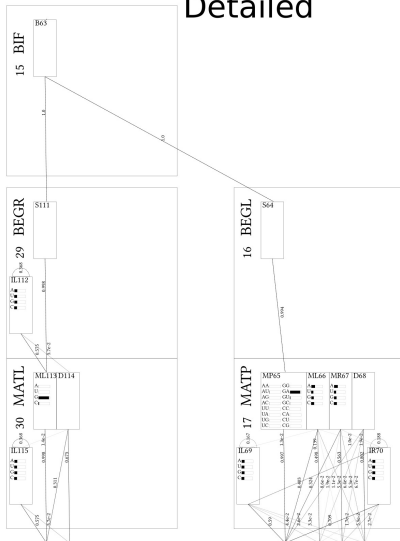
CMV - Hammerhead_1

Minimal

Simple



Detailed



CMcompare⁴ results - Clan

- ▶ Explore RNA family clans³

³Gardner, Jennifer Daub, Nucleic Acids Res., 2011

⁴Eggenhofer, Hofacker et al., Nucleic Acid Res., 2013

CMcompare⁴ results - Clan

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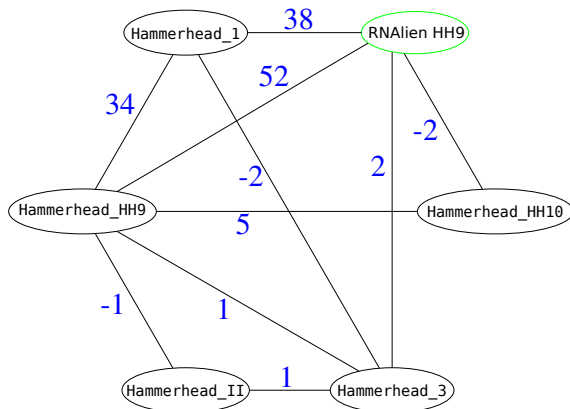
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CMcompare⁴ results - Clan



- Explore RNA family clans³



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CMCV - Overview

Hammerhead_1 



Hammerhead_3 



Hammerhead_HH9 



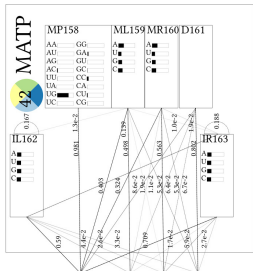
Hammerhead_HH10 



Hammerhead_II 



CMCV - Secondary structure and alignment



MATP
 0.367
 42

MP158
 AA GG
 AU AG
 AG GU
 AC GC
 UA CA
 UG CG
 UC OG

ML159MR160
 A
 U
 G
 C

D161
 A
 U
 G
 C

IL162
 A
 U
 G
 C

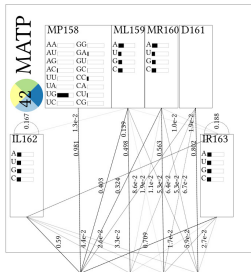
IR163
 A
 U
 G
 C

0.081, 1.3e-2
 0.088, 0.139
 0.39
 1.4e-2
 2.6e-2
 3.5e-2
 0.403
 0.324
 6.6e-2
 1.9e-2
 1.1e-2
 5.1e-2
 0.563
 1.9e-2
 5.3e-2
 6.7e-2
 0.002, 1.6e-2
 0.388
 2.7e-2

AGTP01043633.1/33547-33613
AL773539.18/161561-161627
SS_cons

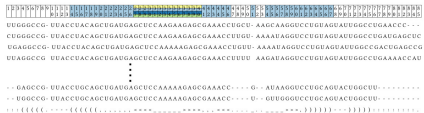
9 / 11

CMCV - Secondary structure and alignment



ABQF01059171.1/305-384
AADN01003451.1/4511-4593
AAWZ02032198.1/15823-15741
AGAI01055016.1/63287-63205

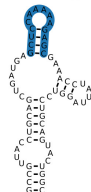
AGTP01043633.1/33547-33613
AL773539.18/161561-161627
SS_cons



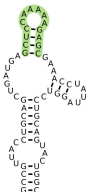
Hammerhead_1



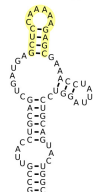
Hammerhead_3



Hammerhead_HH



Hammerhead_II



5'-UUG^{G-C}UAAGAUAAU

5'-UUG^{G=C}UAAGAUAA

5'-UUG^{G=C}UAGUA

5'-UUG^{G=C}UAAGAUAAU

Availability

- ▶ Commandline Tools available via Github:
github.com/eggzilla/cmvm

tag v1.0.6 build passing package v1.0.6 Anaconda Cloud 1.0.6 container ready

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- ▶ Improvements for current visualizations?

Acknowledgements & Thanks

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Rolf Backofen

Ivo L. Hofacker

and Christian Höner zu Siederdissen

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Thanks for your attention!